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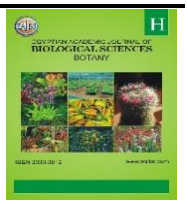

Response of Sunflowers to Compost, Mineral and Bio- Fertilization Under Conditions of Soil Affected by Salinity

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ABSTRACT

To invetigate the effect of compost, mineral and bio- fertilization on yield and quality of sunflower *cv* giza120 under soil as affected by salinity, in this respect the two experiments was carried out at the Experimental Farm, Faculty of Agriculture, Saba Basha, Alexandria University, Alexandria Governorate, Egypt, during the two summer seasons of 2023 and 2024. This experiment was laid out in split plot design with three replications in both seasons. the compost fertilizer treatments are in the main plots, and the bio and mineral fertilization treatments for (nitrogen, phosphorus, and potassium) are distributed randomly in the sub plots. The obtained results showed that significant effects of compost manure, bio-mineral fertilization, and interaction between these two factors on yield characters of sunflowers, where the use of 1.5 tons per fed of compost, when paired with 50% of the recommended dosage of Mineral NPK and the bio-inoculation, resulted in significant improvements in the yield, as well as the various yield components and the seed quality of sunflower under the study conditions.

INTRODUCTION

The sunflower (*Helianthus annuus L.*) is the fifth most significant source of edible oil after peanut, soybean, rapeseed, cotton, and soybean. Its high protein (20–40%) and edible oil (38–53%) content, along with its high unsaturated fatty acid content and low cholesterol, give sunflower oil a desirable quality (Abdel-Motagally and Osman, 2010). In Egypt, where seeds can grow in a variety of environmental circumstances and their roughage may be used to feed animals, they serve a significant role in bridging the gap between the country's need and consumption of edible oil. In Egypt, seeds contain around 40–45% oil. According to Khandekar *et al.* (2018), sunflower came in fourth place, after soybean, peanuts, and rapeseed.

Composting is becoming a more and more crucial component of ecologically responsible, sustainable agriculture. One of the main strategies for potentially lowering massive mounds of organic waste is the bioconversion and recycling of waste organic materials. Furthermore, organic waste that has been recycled can provide vital nutrients for sustainable agriculture. Rather of being disposed of, organic wastes can be applied to improve the soil's fertility and structure. This is because adding organic material to the soil increases its productivity and helps to address micronutrient shortages (Kumar *et al*., 2017).

Through a synergistic interaction between the sources, the combined use of organic fertilizers can result in a reduction in the consumption of chemical fertilizers (Gao et al., 2020). Large amounts of macronutrients, such as N, P, and K, are present in organic manure (Adekiya *et al*., 2020).

Sunflower seed production, biomass, head diameter, 1000 seed weight, seeds/head, leaf area, leaves/plant, plant height, and stem girth were all significantly impacted by the application of organic manure. Since nitrogen (N) is the most widely used mineral nutrient in modern agriculture and is also the most needed, it is the most important nutrient for increasing seed and oil yields (Mulvaney *et al*., 2009). Potassium (K), a necessary nutrient, is important for increasing crop productivity and produce quality (Ahmad *et al*., 2018). Furthermore, it fortifies agricultural plants by granting them resilience against biotic stressors like pests and diseases as well as abiotic stressors like salinity, drought, and higher temperatures (Ramzan *et al*., 2020). Because K contributes to the osmotic pull that draws water into plant roots, plants that are lacking in it are more vulnerable to water scarcity, mostly because they are unable to use the water that is available (Gujar *et al*., 2020). The best combination for 1000-seed weight, biological and achene yields, oil contents, and protein contents was K at a rate of 150 kg/ha. Larger K levels led to larger yields, but early-stage water stress caused yield and yield components to drop. However, as compared to no treatment, K-application reduced the effects of water stress. Considering these findings, it is advised that in dry and semi-arid areas, sunflower should get 150 kg K/ha to increase output and improve seed quality (Dar *et al*., 2021). A necessary component for growing crops is phosphorus (P) (Holford, 1997). It is an essential component of phospho protein, phospholipids, and the nucleic acid of genes and chromosomes. The need for P fertilizer is steadily rising over the world even as global P supplies are decreasing (Cordell *et al*., 2009). Because P depends on soil response and is mostly accessible in the pH range of 6.5–7.5, it is thought to be difficult to get (Aziz *et al*., 2006). P treatment and addition both have a significant impact on crop yields, dry matter production, and sunflower plant properties (Ali, 2013; Muhsin *et al.*, 2021).

Biofertilizers, also known as biological fertilizers, are beneficial microorganisms that can colonies the rhizosphere and increase the availability or supply of vital nutrients to plants, thereby promoting plant growth (Patra *et al*., 2013). Plant height and total chlorophyll content were highly impacted by biofertilizer inoculation. According to Khandekar *et al.* (2018) and Vessey (2003), biofertilizers also considerably improved yield attributes. Compared to utilizing either technique alone, the combination of nitrogen fertilizer and organic manure improved both grain and biological yield. They discovered that the quality and production of sunflower seed plants were enhanced by biofertilizer (Akbari *et al*., 2011).

The objectives of this study were to: 1- examine the effects of organic manure, bio- and mineral fertilizers on sunflower yield and yield components; and 2- examine the interactions between organic manure and bio-mineral fertilizers on sunflower yield and its component characteristics to identify the most effective combination that will maximize sunflower production while protecting the crop from salt stress.

MATERIALS AND METHODS

Two field experiments were carried out at the experimental farm, Faculty of Agriculture, Saba Basha, Alexandria University, Alexandria Governorate, Egypt, in the two summer seasons of 2023 and 2024 to study the impact of compost, bio- and mineral fertilizers on productivity and quality of sunflower under soil as affected by salts.

Table 1 shows the physical and chemical parameters of the experimental soil using the approach given by Page *et al*. (1982).

Table 1: Soil physical and chemical properties of experimental sites in both seasons.

Soil properties	Seasons	
	2023	2024
A- Mechanical analysis		
Sand %	14.50	14.70
Silt %	42.10	42.10
Clay %	43.40	43.20
Soil texture	Clay loam	Clay loam
B- Chemical properties		
pH (1:1)	8.05	8.10
EC (1:1) dS/m	4.70	4.75
1- Soluble cations (1:2)		
K^+	1.40	1.45
Ca^{++}	14.20	15.40
Mg^{++}	11.30	11.50
Na^+	13.60	13.80
2- Soluble anions (1:2)		
CO^-_3+ HCO^-_3	2.80	2.90
CL^-	19.70	19.80
SO^-_4	12.40	12.50
Calcium carbonate (%)	6.70	6.90
Total nitrogen (%)	1.10	1.20
Available P (mg/kg)	3.70	3.60
Organic matter (%)	1.50	1.60

Experiments were conducted using a split-plot design in three replicates, with compost treatments in the main plots and bio- and mineral fertilization treatments (nitrogen, phosphorus, and potassium) in the subplots, and all treatments were distributed randomly.

A- Main plot: Compost treatments:

1- Control (no addition).
2- Compost 1t/fed.
3- Compost 1.5 t/fed.

B- Sub plot: Bio and mineral fertilization treatments:

1- Recommended dose of (N, P, K) (40, 24, 24 kg/fed) as control
2- 75% mineral (NPK) (30, 18, 18 kg/fed) + seeds treatment pre-sowing by bio-fertilization (Nitrobin, Phosphorin, Potasiumag)
3- 50% mineral (NPK), without bio-fertilization
4- 0 NPK + bio-fertilization

Sunflower seeds were sowed on April 22nd and 20th in both the 2023 and 2024 growing seasons, respectively.

The area of each experimental plot was 10.5 m² with 5 ridges, each one 0.60 m wide and 3.5 meters long. The sowing was conducted according to the Afair method, and all the other cultural practices were followed according to the recommendation of the Ministry of Agriculture and Land Reclamation.

After harvesting following yield components including 100-Seed weight (g). Seed yield was determined by collecting seeds and stalk yield from an area of middle ridges form each experimental unit (plot) were recorded in both seasons, then converted to kg/ fed.

The percentage oil content in seed was determined by Soxhlet extraction method using the following equation;

Oil percentage (%) = weight of extracted oil (g)/weight of sample (g)*100 Oil yield kg/ fed.

To determine protein content, 10 grams of seeds were randomly collected from the yield of each sub plot and used for the determination by the microKjeldahl method (Alimohammadi and Azizov, 2011).

The acquired data was subjected to the suitable statistical analysis of variance procedure given by Gomez and Gomez (1984). The means of the treatments were compared using the least significant differences test (LSD) at a 5% level of probability. All statistical analyses were performed using the computer software CoStat 6.311 (2005).

RESULTS AND DISCUSSION

The results in Tables 2, and 3, illustrated the significant effects of compost, bio- and mineral fertilization, and its interaction on sunflower yield, and its characteristics. Additionally, these results encompassed the various components of sunflower production as well as the quality of the seeds produced, all of which were observed during the growing seasons of 2023 and 2024. The data provided a comprehensive understanding of how these agricultural practices influenced not only the overall yield but also the finer aspects related to seed development and quality assessment.

The findings that are illustrated in Tables 2 and 3, clearly demonstrate that there is a significant increase in various agricultural metrics when the application of compost manure is elevated from an initial amount of 0 to a total of 1.50 tons per fed. This enhancement in compost manure application corresponds to improved measurements for essential factors such as the weight of 100 seeds (measured in grams), seed yield expressed in kilograms per fed, stalk yield also quantified in kilograms per fed, along with notable increases in the percentage of seed protein and seed oil. Furthermore, this rise in compost application leads to greater overall oil yield, again recorded in kilograms per fed, in both growing seasons. These results underscore the positive impact of compost manure on crop performance across various parameters. Organic manure can improve soil fertility, increase water-holding capacity, decrease soil erosion, improves amount of oxygen, and promotes beneficial organisms and productivity (Hamza and Abd-Elhady, 2010).

The influence of the bio-mineral fertilization mixture on various outcomes, such as yield, component characteristics, and seed quality, is clearly illustrated in Tables 2 and 3. The data presented in these tables show that the application of Mineral NPK at a 50% rate of recommended dosage (RD), when combined with bio-inoculation techniques, significantly improved all the measured attributes of sunflower plants. These attributes include the weight of 100 seeds in grams, the overall seed yield per fed in kilograms, the stalk yield produced per fed in kilograms, as well as the protein percentage found in the seeds, the oil percentage present in the seeds, and the total oil yield per fed measured in kilograms across both growing seasons analyzed. The results obtained through this study are consistent with those from previous research highlighted by [reference], further reinforcing the benefits of using this particular fertilization approach for enhancing the performance of sunflower crops. These results are confirmed by Abd El-Lattief, (2011); Dhanasekar *et al.* (2012), Farnia *et al*. (2015), Khan *et al*. (2016) ; Mirparsa *et al.* (2016).

The interaction between compost, bio- and mineral fertilizer, as presented in Tables 2 and 3, shows that the best results for various parameters, including the weight of 100 seeds (g), seed yield (kg/fed), stalk yield (kg/fed), the percentage of protein and oil in seed, and oil yield (kg/fed), were achieved when compost was added at a rate of 1.5 t/fed, with 50% of mineral NPK and bio-fertilization during both growing seasons.

In the same trend of this study, the integrated combined use of bio-fertilizers and/or organic + N-mineral, increase the seed yield and decrease the use of chemical fertilizers to reduce the environmental pollution caused by their use. It seems that the integrated nutrition system of bio-fertilizers and manures is justifiable for both economically and

environmentally and compatible with the environment in permanent farming (Abd El-Rahman *et a*l., 2016). The presence of bio and organic manure can have positive effects on plant growth, which increase unsaturated fatty acids, with corresponding decrease in saturated fatty acids (Shehata and ELKhawas, 2003). Also, Munir *et al.* (2007) investigated the effects of organic and inorganic fertilization on seed and oil yield of sunflower and found that the highest values of seed oil content and oil yield were produced from sunflower plants received the nitrogen fertilizer at the recommended rate (30 kg N/fed) alone or in combination with 20 or 30 m^3 farmyard manure. Biological fertilizers or bio fertilizers contain useful microorganisms, which could colonize in the rhizosphere and promote plant growth through increasing the supply or availability of essential nutrients to the plants (Vessey, 2003).

Table 2: The effect of compost (t/fed) Bio- and mineral fertilizer and their interaction on some Characteristics of sunflower in both growing seasons.

Character	A) Compost (t/fed)	Season 2023					Season 2024				
		B) Bio- and mineral fertilizer					B) Bio- and mineral fertilizer				
		Mineral NPK (100 % RD)	Mineral NPK (75 % RD) + Bio-inoculation	Mineral NPK (50 % RD) + Bio-inoculation	Bio-inoculation (NPK)	Average	Mineral NPK (100 % RD)	Mineral NPK (75 % RD) + Bio-inoculation	Mineral NPK (50 % RD) + Bio-inoculation	Bio-inoculation (NPK)	Average
100-seed weight (g)	Control (no addition)	4.00	4.02	4.21	4.22	4.11	4.07	4.08	4.24	4.28	4.17
	1	3.99	4.24	4.29	4.21	4.18	4.09	4.31	4.39	4.31	4.27
	1.5	4.27	4.38	4.47	4.21	4.33	4.37	4.48	4.51	4.24	4.40
	Average	4.09	4.21	4.32	4.21		4.18	4.29	4.38	4.28	
LSD at 0.05		A= 0.05	B= 0.09	AB= 0.15			A= 0.03	B= 0.07	AB= 0.12		
Seed yield kg/fed	Control	1077.28	1198.53	1187.86	1271.61	1183.82	1132.83	1254.08	1243.41	1327.16	1239.37
	1	1190.94	1290.75	1309.89	1265.46	1264.26	1232.03	1332.12	1365.44	1321.01	1312.65
	1.5	1289.07	1364.54	1405.08	1334.06	1348.19	1344.62	1397.91	1445.78	1372.09	1390.10
	Average	1185.76	1284.61	1300.94	1290.38		1236.49	1328.04	1351.54	1340.09	
LSD at 0.05		A= 51.75	B= 39.68	AB= 68.73			A= 63.74	B= 40.25	AB= 69.71		
Stalk yield kg/fed	Control	3447.30	3835.30	3801.16	4069.14	3788.23	3546.30	3934.30	3900.16	4168.14	3887.23
	1	3811.00	4130.41	4191.64	4049.48	4045.63	3910.00	4229.41	4290.64	4148.48	4144.63
	1.5	4125.01	4379.81	4501.91	4268.99	4318.93	4224.01	4479.14	4601.24	4367.99	4418.10
	Average	3794.44	4115.17	4164.90	4129.20		3893.44	4214.29	4264.01	4228.20	
	LSD at 0.05	A=163.99	B=128.08	AB=221.85			A=163.96	B=128.11	AB=221.89		

Table 3: The effect of compost (t/fed) Bio- and mineral fertilizer and their interaction on some Characteristics of sunflower in both growing seasons.

Character	A) Compost (t/fed)	Season 2023					Season 2024				
		B) Bio- mineral fertilizer									
		Mineral NPK (100 % RD)	Mineral NPK (75 % RD) + Bio-inoculation	Mineral NPK (50 % RD) + Bio-inoculation	Bio-inoculation (NPK)	Average	Mineral NPK (100 % RD)	Mineral NPK (75 % RD) + Bio-inoculation	Mineral NPK (50 % RD) + Bio-inoculation	Bio-inoculation (NPK)	Average
Seed protein %	Control (no addition)	19.38	19.87	20.99	21.03	20.32	18.79	19.49	20.67	20.16	19.78
	1	19.62	21.18	21.85	20.98	20.91	19.40	20.69	21.87	20.10	20.51
	1.5	21.37	22.01	22.62	20.98	21.75	20.50	21.35	21.79	20.29	20.98
	Average	20.13	21.02	21.82	21.00		19.56	20.51	21.44	20.19	
LSD at 0.05		A=0.28	B= 0.56	AB= 0.97			A= 0.57	B= 0.61	AB= 1.05		
Seed oil %	Control	38.78	39.58	40.34	41.21	39.98	40.28	41.08	41.84	42.71	41.48
	1	39.10	41.09	41.77	41.07	40.76	40.60	42.59	43.27	42.57	42.26
	1.5	41.62	42.45	43.35	42.83	42.56	43.12	43.95	44.85	44.33	44.06
	Average	39.84	41.04	41.82	41.70		41.34	42.54	43.32	43.20	
LSD at 0.05		A=0.38	B=0.63	AB= 1.09			A=0.35	B= 0.60	AB= 1.05		
Oil yield kg/fed	Control	417.70	474.51	479.07	524.18	473.87	456.24	515.31	520.13	566.98	514.67
	1	465.68	530.37	547.29	519.89	515.81	500.20	567.42	590.98	562.52	555.28
	1.5	536.62	579.29	609.14	571.22	574.07	579.91	614.42	648.48	608.12	612.73
	Average	473.33	528.06	545.17	538.43		512.12	565.72	586.53	579.21	
LSD at 0.05		A=22.77	B=17.03	AB=29.50			A=28.63	B= 18.54	AB= 32.11		

CONCLUSION:

The study reached the conclusion that the use of 1.5 tons per fed of compost, when paired with 50% of the recommended dosage of Mineral NPK and the bio-inoculation, resulted in significant improvements in the yield, as well as the various yield components and the seed quality of sunflowers. This improvement was observed consistently over two separate growing seasons within the specific agricultural context of Alexandria Governorate, Egypt under salinity-impacted soil conditions. The findings indicate that the combination of these practices can effectively enhance sunflower production in that region, suggesting a potential benefit for farmers aiming to optimize their crop outcomes

Declarations:

Ethical Approval: No plant, animal model(s) or human subjects were recruited directly for the current study. Consequently, no ethical considerations are necessary.

Conflict of interest: The authors declare no conflict of interest.

Authors Contributions: I hereby verify that all authors mentioned on the title page have made substantial contributions to the conception and design of the study, have thoroughly reviewed the manuscript, confirm the accuracy and authenticity of the data and its interpretation, and consent to its submission.

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