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Improving the Performance of Pea Plant Grown on Salt Affected Soil under Drip Irrigation

Hoda I. Ahmed[1]; M. A. El-Sherpiny[2*] and Asmaa E. El-Bauomy[1]

[1]Horticulture Research Institute, Agriculture Research Center, El-Gama St., Giza, 12619, Egypt
[2]Soil & Water and Environment Research Institute, Agriculture Research Center, El-Gama St., Giza, 12619, Egypt

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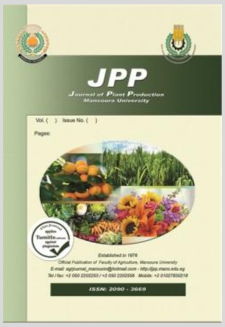

ABSTRACT

The current agricultural strategy of the Egyptian state, focused on reclaiming degraded soils, including salt-affected areas in the Delta region, underscores the need for maximizing productivity, particularly in the case of strategic crops like peas. So, a field experiment was conducted during two consecutive seasons (2023/24 and 2024/25) using a split-plot experimental design aiming to improve pea production under salt-affected soil conditions through organic fertilization [control (without), farmyard manure, poultry manure and vermicompost], which was considered as the main factor. Additionally, cobalt foliar spraying was implemented at different levels (0, 5, 10, 15 mgL^{-1}) as a sub-main factor. Various parameters, such as plant height, fresh and dry weights, chlorophyll (a, b), carotene, chemical constituents (N,P,K), yield metrics and quality (*e.g.,* No. of pods, pod length, weight of pods, early and total green pods yield, protein, total sugars, TDS, and vitamin C), were assessed. The results indicated that poultry manure emerged as the most effective organic treatment, followed by vermicompost, farmyard manure and lastly, the control treatment. Additionally, the values of growth, yield, and quality traits increased with higher cobalt rates. Generally, optimal growth performance, yield, and quality traits were observed in pea plants fertilized with poultry manure, combined with cobalt at a rate of 15 mg L^{-1}.Therefore, this study recommends the adoption of poultry manure and cobalt supplementation as a combined approach to enhance pea production, contributing to the sustainable utilization of salt-affected soils in the Delta region and supporting the broader agricultural goals of the Egyptian state.

***Keywords**:* Degraded soils, farmyard manure, poultry manure and vermicompost.

INTRODUCTION

Nowadays, the agricultural strategy of the Egyptian state, focused on reclaiming degraded soils, including salt-affected areas in the Delta region (Mohamed, 2017), underscores the need for maximizing productivity, particularly in the case of strategic crops like peas. Garden peas (*Pisum sativum* L.) hold significant global importance as a vital vegetable crop renowned for its nutritional richness, containing high levels of protein, total dissolved solids, carbohydrates, vitamins, and essential minerals such as iron, zinc, calcium, and phosphorus (Hacisalihoglu *et al.,* 2021).

The importance of organic fertilizers in reclaiming salt-affected soils lies in their ability to address multiple challenges associated with salinity while promoting sustainable and healthy agricultural practices. Organic fertilizers offer several key advantages in soil reclamation. Organic fertilizers, such as farmyard manure, poultry manure, and vermicompost, are rich sources of essential nutrients (Diacono and Montemurro, 2015). They provide a balanced mix of nitrogen, phosphorus, potassium, and other micronutrients, fostering improved soil fertility. This nutrient enrichment is crucial in replenishing the nutrient levels depleted by salinity. Organic fertilizers support the growth and activity of beneficial soil microbes (Choudhary and Yaduvanshi, 2016). These microorganisms contribute to the breakdown of organic matter, improving soil structure and nutrient availability. Enhanced microbial activity helps in reducing soil salinity by facilitating the decomposition of organic materials and promoting nutrient cycling. Salt-affected soils often suffer from low organic matter content (Leogrande and Vitti, 2019). Organic fertilizers contribute organic substances to the soil, enhancing its water-holding capacity, structure, and overall health. Increased organic matter content aids in mitigating the negative effects of soil salinity by improving water infiltration and reducing soil erosion. Organic fertilizers can help regulate soil pH, which is often disturbed in saline soils. The addition of organic materials buffers the soil pH, creating a more favorable environment for plant growth (Gunarathne *et al.,* 2020 a). Maintaining an optimal pH level is essential for nutrient availability and uptake by plants. Organic matter improves the water-holding capacity of soils. In salt-affected soils, where water availability can be irregular, the ability to retain moisture becomes vital (Gunarathne *et al.,* 2020 b). Organic fertilizers contribute to better water retention, supporting plant growth during periods of water scarcity. Organic fertilizers promote sustainable agricultural practices by reducing dependence on synthetic fertilizers (Shaygan and Baumgartl, 2022). They contribute to long-term soil health and resilience, creating a more sustainable and environmentally friendly approach to soil reclamation (Basak *et al.,* 2023).

Cobalt plays a crucial role in improving the growth and health of plants in salt-affected soils, offering several benefits that contribute to enhanced resilience and productivity (Gad *et al.,* 2020). Salt-affected soils often induce oxidative stress in plants due to the accumulation of reactive oxygen species (ROS) (EL-Bauome *et al*., 2024). Cobalt acts as a cofactor for enzymes involved in antioxidant defense mechanisms, such as

*** Corresponding author.**
E-mail address: M_elsherpiny2010@yahoo.com
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superoxide dismutase (SOD) and peroxidase (POD). These enzymes help scavenge ROS, reducing oxidative stress and preventing damage to plant cells (Alkharpotly *et al.* 2023).

Therefore, the aim of this study is to investigate the efficacy of various organic fertilizer types, in combination with different cobalt levels on the growth, physiological responses, and yield of pea plants cultivated in salt-affected soil. Through a comprehensive analysis, the study aims to provide valuable insights into sustainable agricultural practices for the reclamation and improvement of productivity in salt-affected soils, with a particular focus on optimizing conditions for pea cultivation.

MATERIALS AND METHODS

A field experiment was conducted during two consecutive seasons (2023/24 and 2024/25) in the Experimental Farm of Mansoura University, Egypt using a split-plot experimental design aiming to improve pea production under salt-affected soil conditions through organic fertilization [control (without addition), farmyard manure, poultry manure and vermicompost], which was considered as the main factor. Additionally, cobalt foliar spraying was implemented at different levels (0, 5, 10, 15 mgL^{-1}) as a sub-main factor.

1. Soil sampling and organic fertilizer traits

Sample of soil (0-25 cm depth) was collected before sowing then analyzed according to the standard methods according to Dane and Topp (2020) and Sparks et al. (2020), as outlined in Table 1. Table 2 displays the characteristics of the organic sources.

Table 1. Attributes of the initial soil

Particle size distribution (%)				Texture class	Available- N	Available -P	Available -K	EC, dSm^{-1}	pH
C. Sand	F. Sand	Silt	Clay		(mg kg^{-1})				
2.80	22.0	25.6	49.60	Clay	49.05	7.10	210.1	6.25	8.00

Table 2. Characteristics of organic sources

Characteristics	Values		
	Poultry manure	Farmyard manure	Vermicompost
C:N ratio	16.1	16.3	16.2
EC,dSm^{-1}	6.50	6.32	6.15
pH	6.35	6.55	6.44
Organic matter	44.4	35.5	39.6
P , mg kg^{-1}	0.79	0.52	0.72
K, mg kg^{-1}	6.05	4.05	4.99
Zn , mg kg^{-1}	29	26	28
CEC, cmol kg^{-1}	156	150	152

2.Agricultural practices

Seeds of pea variety Master B, sourced from the Agricultural Research Center, were planted at 1st Nov. Of both seasons on both sides of the ridge in hills within moderately moist soil, with an initial sowing rate of 3-4 seeds per hill. Subsequently, thinning was carried out post-germination and before the first irrigation, reducing the plant density to two plants per hill. The soil addition of organic fertilizers followed the prescribed treatments in the study one month before sowing at a rate of 3.0 ton fed^{-1} for each studied organic source. Cobalt treatments, as per the experimental design, were administered three times through foliar application at specific intervals, namely at 20, 30, and 40 days from the initial sowing with a volume of 450 liters per fed^{-1} for each studied cobalt level.

Mineral fertilizers, including phosphoric acid, potassium sulfate, and urea (as a starter dose), along with various agricultural practices essential for commercial pea plant production, were implemented in accordance with the guidelines provided by the Egyptian Ministry of Agriculture. These practices were executed under a drip irrigation system as recommended for optimal cultivation.

3.Harvest

The green pods from each sub-plot were harvested at the appropriate maturing stage, and conducted uniformly across all sub-plots. The harvesting was carried out after 75 days from the initial sowing, maintaining consistency in the timing of this process throughout both investigated seasons.

4.Measurement traits.

At a period of 55 days from sowing pea seeds

- Plant height (cm), leaf area (cm^2 $plant^{-1}$), fresh and dry weights (g $plant^{-1}$) were measured.
- Chlorophyll a and b as well as carotene (mg g^{-1} F.W) were spectrophotometrically determined using 80% acetone as described by Rajput and Patil (2017).
- Nutrients (N, P, K) in leaves were estimated as described by Walinga *et al*. (2013).
- Peroxidase enzyme (POD, unit mg^{-1} $protein^{-1}$) and superoxide dismutase (SOD, unit mg^{-1} $protein^{-1}$) were Spectrophotometrically determined according to Alici and Arabaci (2016).
- Malondialdehyde (MDA, biomarker of lipid peroxidation, µmol.g^{-1}FW) was Spectrophotometrically determined according to Davey *et al*. (2005).

At a period of 75 days from sowing pea seeds (when pea pods reached to the proper maturing stage)

- No. of pods $plant^{-1}$, pod length (cm), weight of pods $plant^{-1}$, weight of 100 fresh seed (g), early and total green pods yield (ton ha^{-1}) were determined.
- Nutrients (N, P, K) in seeds were estimated as described by Walinga *et al*. (2013).
- Protein (%), carbohydrates (%), total sugars(%), total dissolved solids (TDS,%) and vitamin C (VC, mg $100g^{-1}$) were determined according to AOAC (2000).

5.Statistical analysis

The procedure was conducted following Gomez and Gomez, (1984), utilizing CoStat (Version 6.303, CoHort, USA, 1998–2004).

RESULTS AND DISCUSSION

1. Growth performance, photosynthetic pigments and chemical constituents

Data in Tables 3,4 and 5 show the effect of organic fertilizer types [control (without), farmyard manure, poultry manure and vermicompost] and cobalt levels (0, 5, 10, 15 mgL^{-1}) on growth parameters [plant height (cm), leaf area (cm^2 $plant^{-1}$), fresh and dry weights (g $plant^{-1}$),Table 3], photosynthetic pigments[chlorophyll a & b and carotene (mg g^{-1}),Table 4] and chemical constituents [N,P,K (%),Table 5] of pea plants grown on salt affected soil at period of 55 days from sowing during seasons of 2023/24 and 2024/25.

Table 3. Effect of organic fertilizer types and cobalt levels on growth performance of pea plants grown on salt affected soil at period of 55 days from sowing during seasons of 2023/24 and 2024/25

Treatments		Plant height, cm		Leaf area, cm^2 $plant^{-1}$		Fresh weight, g $plant^{-1}$		Dry weight, g $plant^{-1}$	
		1st season	2nd season	1st season	2nd season	1st season	2nd season	1st season	2nd season
Main factor: Organic treatments									
Control		44.96d	47.18d	312.03d	325.04d	49.82d	51.35d	8.92d	9.36d
Farmyard manure		51.63c	54.28c	321.56c	335.03c	57.71c	59.43c	10.61c	11.16c
Vermicompost		56.58b	59.39b	333.93b	346.95b	60.77b	62.67b	12.51b	13.14b
Poultry manure		59.60a	62.48a	340.13a	354.22a	63.26a	65.25a	14.17a	14.86a
Sub main factor: Cobalt levels									
Co ($0.0 mgL^{-1}$)		51.86d	54.53d	323.92c	336.67c	56.75c	58.42c	11.12d	11.70d
Co ($5.0 mgL^{-1}$)		53.24c	55.86c	326.86bc	340.17b	58.21b	60.15b	11.54c	12.13c
Co ($10.0 mgL^{-1}$)		53.66b	56.16b	328.30ab	341.98ab	58.17b	60.01ab	11.69b	12.24b
Co ($15.0 mgL^{-1}$)		54.49a	57.31a	329.53a	342.98a	58.81a	60.62a	12.00a	12.60a
Interaction									
Control	Co ($0.0 mgL^{-1}$)	43.43	45.73	308.97	320.53	47.89	49.44	8.55	9.00
	Co ($5.0 mgL^{-1}$)	44.67	46.87	311.73	325.63	50.04	51.59	8.82	9.26
	Co ($10.0 mgL^{-1}$)	45.83	48.03	313.77	327.17	50.10	51.57	9.03	9.47
	Co ($15.0 mgL^{-1}$)	45.90	48.10	313.63	326.83	51.24	52.79	9.26	9.70
Farmyard manure	Co ($0.0 mgL^{-1}$)	49.97	52.57	318.43	331.13	56.41	58.00	10.11	10.63
	Co ($5.0 mgL^{-1}$)	50.90	53.50	320.50	335.27	57.68	59.48	10.40	10.95
	Co ($10.0 mgL^{-1}$)	51.87	54.27	322.53	336.17	58.13	59.97	10.77	11.28
	Co ($15.0 mgL^{-1}$)	53.77	56.77	324.77	337.53	58.62	60.25	11.16	11.77
Vermicomp-ost	Co ($0.0 mgL^{-1}$)	55.47	58.37	330.90	344.10	60.06	61.76	12.07	12.71
	Co ($5.0 mgL^{-1}$)	56.20	59.00	332.73	345.07	60.52	62.35	12.35	12.96
	Co ($10.0 mgL^{-1}$)	56.97	59.57	335.23	348.30	61.00	62.95	12.66	13.25
	Co ($15.0 mgL^{-1}$)	57.67	60.63	336.83	350.33	61.52	63.63	12.97	13.63
Poultry manure	Co ($0.0 mgL^{-1}$)	58.57	61.47	337.37	350.90	62.65	64.47	13.75	14.44
	Co ($5.0 mgL^{-1}$)	59.23	61.93	338.60	352.43	63.07	65.18	14.04	14.69
	Co ($10.0 mgL^{-1}$)	59.97	62.77	341.67	356.30	63.45	65.54	14.29	14.97
	Co ($15.0 mgL^{-1}$)	60.63	63.73	342.87	357.23	63.86	65.79	14.59	15.32
LSD at 5%		0.75	0.79	6.32	5.52	1.11	1.31	0.24	0.26

Means within a row followed by a different letter (s) are statistically different at a 0.05 level

Table 4. Effect of organic fertilizer types and cobalt levels on photosynthetic pigments in fresh leaves of pea plants grown on salt affected soil at period of 55 days from sowing during seasons of 2023/24 and 2024/25

Treatments		Chlorophyll a, mg g^{-1}		Chlorophyll b, mg g^{-1}		Carotene, mg g^{-1}	
		1st season	2nd season	1st season	2nd season	1st season	2nd season
Main factor: Organic treatments							
Control		0.745d	0.777d	0.512d	0.532d	0.301d	0.316d
Farmyard manure		0.799c	0.833c	0.552c	0.575c	0.340c	0.358c
Vermicompost		0.847b	0.879b	0.583b	0.607b	0.368b	0.387b
Poultry manure		0.918a	0.956a	0.635a	0.660a	0.406a	0.425a
Sub main factor: Cobalt levels							
Co ($0.0 mgL^{-1}$)		0.810d	0.843d	0.561d	0.584c	0.344d	0.362d
Co ($5.0 mgL^{-1}$)		0.826c	0.862c	0.569c	0.592c	0.352c	0.370c
Co ($10.0 mgL^{-1}$)		0.832b	0.867b	0.574b	0.597b	0.357b	0.374b
Co ($15.0 mgL^{-1}$)		0.844a	0.878a	0.579a	0.603a	0.364a	0.382a
Interaction							
Control	Co ($0.0 mgL^{-1}$)	0.726	0.756	0.503	0.523	0.294	0.310
	Co ($5.0 mgL^{-1}$)	0.742	0.775	0.510	0.529	0.298	0.313
	Co ($10.0 mgL^{-1}$)	0.751	0.782	0.516	0.536	0.304	0.319
	Co ($15.0 mgL^{-1}$)	0.764	0.796	0.519	0.541	0.307	0.322
Farmyard manure	Co ($0.0 mgL^{-1}$)	0.783	0.814	0.543	0.565	0.330	0.347
	Co ($5.0 mgL^{-1}$)	0.794	0.831	0.548	0.570	0.337	0.355
	Co ($10.0 mgL^{-1}$)	0.803	0.837	0.555	0.578	0.344	0.360
	Co ($15.0 mgL^{-1}$)	0.816	0.849	0.562	0.586	0.351	0.370
Vermico-mpost	Co ($0.0 mgL^{-1}$)	0.832	0.863	0.575	0.598	0.360	0.379
	Co ($5.0 mgL^{-1}$)	0.842	0.874	0.579	0.602	0.365	0.383
	Co ($10.0 mgL^{-1}$)	0.852	0.885	0.585	0.613	0.370	0.387
	Co ($15.0 mgL^{-1}$)	0.860	0.895	0.591	0.616	0.378	0.398
Poultry manure	Co ($0.0 mgL^{-1}$)	0.901	0.937	0.625	0.649	0.394	0.414
	Co ($5.0 mgL^{-1}$)	0.913	0.950	0.632	0.657	0.399	0.417
	Co ($10.0 mgL^{-1}$)	0.923	0.964	0.638	0.661	0.411	0.430
	Co ($15.0 mgL^{-1}$)	0.935	0.974	0.646	0.670	0.419	0.439
LSD at 5%		0.017	0.017	0.007	0.012	0.006	0.009

Means within a row followed by a different letter (s) are statistically different at a 0.05 level

Table 5. Effect of organic fertilizer types and cobalt levels on chemical constituents in dry leaves of pea plants grown on salt affected soil at period of 55 days from sowing during seasons of 2023/24 and 2024/25

Treatments		N,%		P,%		K,%	
		1st season	2nd season	1st season	2nd season	1st season	2nd season
Main factor: Organic treatments							
Control		2.80d	2.94d	0.333d	0.339d	2.42d	2.47d
Farmyard manure		3.06c	3.21c	0.366c	0.371c	2.67c	2.70c
Vermicompost		3.39b	3.56b	0.396b	0.402b	2.88b	2.93b
Poultry manure		3.64a	3.82a	0.423a	0.430a	3.11a	3.16a
Sub main factor: Cobalt levels							
Co (0.0mgL^{-1})		3.15d	3.31d	0.371c	0.377c	2.70d	2.74d
Co (5.0mgL^{-1})		3.22c	3.39c	0.380b	0.387b	2.77c	2.82c
Co (10.0mgL^{-1})		3.23b	3.38b	0.383a	0.389a	2.80b	2.84b
Co (15.0mgL^{-1})		3.31a	3.49a	0.386a	0.392a	2.83a	2.87a
Interaction							
Control	Co (0.0mgL^{-1})	2.73	2.89	0.324	0.331	2.34	2.38
	Co (5.0mgL^{-1})	2.76	2.90	0.330	0.336	2.40	2.45
	Co (10.0mgL^{-1})	2.83	2.97	0.337	0.344	2.46	2.51
	Co (15.0mgL^{-1})	2.87	3.01	0.342	0.345	2.50	2.53
Farmyard manure	Co (0.0mgL^{-1})	2.96	3.11	0.358	0.363	2.60	2.63
	Co (5.0mgL^{-1})	3.01	3.17	0.366	0.371	2.65	2.70
	Co (10.0mgL^{-1})	3.04	3.18	0.369	0.375	2.68	2.71
	Co (15.0mgL^{-1})	3.21	3.39	0.372	0.377	2.73	2.77
Vermicomp-ost	Co (0.0mgL^{-1})	3.34	3.51	0.388	0.395	2.85	2.90
	Co (5.0mgL^{-1})	3.38	3.55	0.394	0.400	2.86	2.90
	Co (10.0mgL^{-1})	3.41	3.56	0.399	0.405	2.90	2.94
	Co (15.0mgL^{-1})	3.42	3.60	0.402	0.408	2.93	2.97
Poultry manure	Co (0.0mgL^{-1})	3.56	3.74	0.412	0.420	3.02	3.07
	Co (5.0mgL^{-1})	3.61	3.78	0.422	0.429	3.10	3.14
	Co (10.0mgL^{-1})	3.64	3.81	0.427	0.433	3.15	3.19
	Co (15.0mgL^{-1})	3.76	3.95	0.430	0.436	3.17	3.23
LSD at 5%		0.05	0.06	0.008	0.009	0.07	0.06

Means within a row followed by a different letter (s) are statistically different at a 0.05 level

The results demonstrate that the organic fertilizer types can be arranged in order of effectiveness, with poultry manure being the most effective, followed by vermicompost, farmyard manure, and finally, the control treatment. This suggests that the application of poultry manure significantly enhances the growth, photosynthetic pigments and chemical constituents of pea plants compared to other organic fertilizers and the absence of organic fertilization.

Additionally, all aforementioned growth parameters, photosynthetic pigments, and chemical constituents of pea plants exhibited an upward trend with increased cobalt rates. Specifically, the highest values were observed with plants sprayed with 15 mg Co L^{-1}, followed by those sprayed with 10, 5, and 0 mg Co L^{-1}, respectively. This suggests that cobalt plays a crucial role in promoting pea plant development and enhancing their physiological processes, particularly under salt stress conditions.

Generally, optimal growth parameters, photosynthetic pigments, and chemical constituents were observed in pea plants fertilized with poultry manure, combined with cobalt at a rate of 15 mg L^{-1}. This combined approach demonstrated the highest values across all evaluated parameters, indicating a synergistic effect between poultry manure and cobalt in enhancing the overall performance and stress resistance of pea plants.

The superior effectiveness of poultry manure compared to other organic fertilizers and the positive impact of cobalt supplementation on pea plants' growth and stress resistance can be explained through several scientific reasons:

Poultry manure is rich in essential nutrients such as nitrogen, phosphorus, and potassium (NPK), as well as other micronutrients. These nutrients play vital roles in plant growth, development, and overall health (Diacono and Montemurro, 2015). The unique composition of poultry manure provides a more balanced and nutrient-rich environment for plants compared to other organic fertilizers (Choudhary and Yaduvanshi, 2016).

Cobalt is known to have a positive impact on various physiological processes in plants. It is a component of vitamin B_{12}, which plays a crucial role in plant metabolism (Gad *et al.*, 2020). Cobalt is also involved in nitrogen fixation and helps improve plant resilience to environmental stresses, including soil salinity. The application of cobalt, especially at higher concentrations, stimulates these processes, leading to improved growth parameters and enhanced stress tolerance in pea plants (Alkharpotly *et al.*, 2023).

Cobalt's influence on photosynthetic pigments, such as chlorophyll a and b, can be attributed to its role in chlorophyll synthesis. Higher cobalt levels promote chlorophyll production, enhancing the plant's ability to capture light energy for photosynthesis. This, in turn, contributes to increased biomass and improved overall plant health (Akeel and Jahan, 2020).

Poultry manure, with its nutrient-rich content, complements the positive effects of cobalt by providing a favorable environment for nutrient uptake and utilization by the plants. The combination of poultry manure and cobalt ensures that the essential nutrients are efficiently absorbed and utilized, leading to optimal growth and development. Generally, the combination of poultry manure and cobalt at specific concentrations creates a synergistic effect, addressing the nutrient needs of pea plants and enhancing their physiological processes. This holistic approach results in improved resistance to soil salinity stress and overall better performance of pea plants in challenging environmental conditions. The obtained results are in harmony with those of Alkharpotly *et al.* (2023); Amer *et al.* (2023).

2.Enzymatic antioxidants (POD, SOD) and indicators of oxidative stress (MDA)

Data presented in Table 6 illustrate the impact of various organic fertilizer types (control, farmyard manure, poultry manure, and vermicompost) and cobalt levels (0, 5, 10, 15 mg L^{-1}) on enzymatic antioxidants, specifically peroxidase enzyme (POD) and superoxide dismutase (SOD) expressed in units mg^{-1} $protein^{-1}$, and indicators of oxidative stress, including malondialdehyde (MDA, µmol g^{-1} F.W). The assessment was conducted on fresh leaves of pea plants cultivated in salt-affected soil after 55 days from sowing, spanning the seasons of 2023/24 and 2024/25.

In terms of enzymatic antioxidants, poultry manure emerged as the most effective organic fertilizer, with vermicompost ranking second, followed by farmyard manure, and finally, the control treatment.

Table 6. Effect of organic fertilizer types and cobalt levels on enzymatic antioxidants and indicators of oxidative stress in fresh leaves of pea plants grown on salt affected soil at period of 55 days from sowing during seasons of 2023/24 and 2024/25

Treatments		POD, unit mg^{-1} $protein^{-1}$		SOD, unit mg^{-1} $protein^{-1}$		MDA, µmol g^{-1} F.W	
		1st season	2nd season	1st season	2nd season	1st season	2nd season
Main factor: Organic treatments							
Control		0.253d	0.258d	11.37d	9.57d	13.55a	11.32a
Farmyard manure		0.350c	0.357c	12.76c	10.92c	12.30b	10.36b
Vermicompost		0.448b	0.457b	14.57b	12.60b	11.08c	9.51c
Poultry manure		0.597a	0.610a	16.55a	14.34a	9.53d	8.16d
Sub main factor: Cobalt levels							
Co (0.0mgL^{-1})		0.378d	0.386d	13.33d	11.45c	12.14a	10.31a
Co (5.0mgL^{-1})		0.403c	0.412c	13.72c	11.42d	11.67b	10.00b
Co (10.0mgL^{-1})		0.422b	0.431b	14.01b	12.26b	11.45c	9.59c
Co (15.0mgL^{-1})		0.449a	0.459a	14.31a	12.40a	11.12d	9.38d
Interaction							
Control	Co (0.0mgL^{-1})	0.221	0.226	11.01	9.57	14.00	12.19
	Co (5.0mgL^{-1})	0.248	0.252	11.29	9.82	13.75	11.55
	Co (10.0mgL^{-1})	0.255	0.260	11.48	9.43	13.44	10.99
	Co (15.0mgL^{-1})	0.288	0.294	11.71	9.47	13.02	10.54
Farmyard manure	Co (0.0mgL^{-1})	0.309	0.315	12.14	10.45	12.76	10.97
	Co (5.0mgL^{-1})	0.329	0.336	12.38	10.42	12.44	10.43
	Co (10.0mgL^{-1})	0.367	0.376	13.09	11.13	12.14	9.83
	Co (15.0mgL^{-1})	0.394	0.402	13.44	11.68	11.88	10.22
Vermicomp-ost	Co (0.0mgL^{-1})	0.413	0.420	14.09	12.27	11.53	9.68
	Co (5.0mgL^{-1})	0.432	0.439	14.39	11.80	11.21	9.55
	Co (10.0mgL^{-1})	0.460	0.470	14.75	13.42	10.94	9.52
	Co (15.0mgL^{-1})	0.486	0.497	15.04	12.91	10.64	9.27
Poultry manure	Co (0.0mgL^{-1})	0.568	0.581	16.07	13.50	10.27	8.41
	Co (5.0mgL^{-1})	0.585	0.598	16.35	13.24	9.58	8.71
	Co (10.0mgL^{-1})	0.606	0.619	16.72	15.07	9.30	8.00
	Co (15.0mgL^{-1})	0.630	0.641	17.05	15.53	8.95	7.51
LSD at 5%		0.009	0.008	0.31	0.19	0.24	0.22

Means within a row followed by a different letter (s) are statistically different at a 0.05 level

Conversely, the highest levels of Malondialdehyde (MDA), an indicator of oxidative stress, were observed in the control treatment, followed by farmyard manure and vermicompost. In contrast, plants fertilized with poultry manure exhibited the lowest MDA values. Poultry manure is known for its rich content of organic compounds and nutrients, including antioxidants. The application of poultry manure enhances the activity of enzymatic antioxidants like peroxidase (POD) and superoxide dismutase (SOD) in plants (Leogrande and Vitti, 2019). These enzymes play a crucial role in scavenging reactive oxygen species, mitigating oxidative stress, and promoting overall plant health. Vermicompost, being a product of decomposition by earthworms, fosters a microbial-rich environment. The microbial activity in vermicompost contributes to the release of bioactive compounds and enhances the plant's ability to combat oxidative stress. While not as potent as poultry manure, vermicompost still provides valuable support for enzymatic antioxidant activities (Gunarathne *et al.,* 2020 b). The variation in Malondialdehyde (MDA) levels among treatments can be linked to the nutrient composition of the fertilizers. Poultry manure, being nutrient-dense, aids in the prevention of lipid peroxidation and the accumulation of MDA. In contrast, the control treatment, lacking these beneficial nutrients, experiences higher oxidative stress, leading to elevated MDA levels. The differences observed in antioxidant levels may be a result of variations in nutrient uptake and utilization by plants. Poultry manure not only provides essential nutrients but also supports the plant's ability to efficiently utilize these nutrients, leading to superior antioxidant defense mechanisms (Shaygan and Baumgartl, 2022). Generally, the superior performance of poultry manure in enhancing enzymatic antioxidants and reducing oxidative stress can be attributed to its rich nutrient content, antioxidant properties, and the overall favorable microbial environment it promotes (Basak *et al.,* 2023).

On the other hand, the application of cobalt at a concentration of 15 mg L^{-1} proved to be the most efficacious in terms of enhancing enzymatic antioxidants, with the 10 mg L^{-1} concentration ranking second, followed by 5.0 and 0.0 mg L^{-1}, respectively. In contrast, the control treatment (0.0 mg L^{-1}) exhibited the highest levels of Malondialdehyde (MDA), a key indicator of oxidative stress, and these MDA values exhibited a decreasing trend as the cobalt concentration increased.

Cobalt is recognized for its role as a cofactor in various enzymatic reactions, including those involving antioxidants. The higher concentrations of cobalt, particularly at 15 mg L^{-1}, contribute to the activation of enzymatic antioxidants such as peroxidase (POD) and superoxide dismutase (SOD), enhancing the plant's defense mechanisms against oxidative stress (Akeel and Jahan, 2020).The observed decrease in Malondialdehyde (MDA) levels with increasing cobalt concentrations aligns with the antioxidant properties of cobalt. As cobalt enhances enzymatic antioxidant activities, it concurrently reduces lipid peroxidation and the formation of MDA, indicative of a diminishing oxidative stress level within plant tissues (Alkharpotly *et al.,* 2023).The hierarchy in enzymatic antioxidant effectiveness and the reduction in MDA levels suggest that there is an optimal concentration of cobalt that positively influences the physiological processes in pea plants. The concentrations of 15 mg L^{-1} and 10 mg L^{-1} emerge as the most favorable for promoting antioxidant defense mechanisms and mitigating oxidative stress.

Concerning the interaction effect, the best performance, in terms of enzymatic antioxidants and indicators of oxidative stress, were observed in pea plants fertilized with poultry manure, combined with cobalt at a rate of 15 mg L^{-1}.

3.Yield and pods physical and quality characteristics

Tables 7, 8, and 9 elucidate the impact of various organic fertilizer types (control, farmyard manure, poultry manure, and vermicompost) and cobalt levels (0, 5, 10, 15 mg L^{-1}) on the yield and its components, chemical constituents of pea seeds, and quality traits of pea seeds. The assessment includes parameters such as the No. of pods plant^{-1}, pod length (cm), weight of pods plant^{-1}, weight of 100 fresh seed (g), early and total green pods yield (ton ha^{-1}) presented in Table 7. Additionally, Table 8 provides information on the chemical constituents of pea seeds, including nitrogen (N, %), phosphorus (P, %), and potassium (K, %). Furthermore, Table 9 details the quality traits of pea seeds, encompassing protein content (%), carbohydrates (%), total sugars (%), total dissolved solids (TDS %), and vitamin C (VC) content (mg 100g^{-1}). This comprehensive analysis was conducted on pea plants cultivated in salt-affected soil at the harvest stage during the seasons of 2023/24 and 2024/25.

The results indicated that poultry manure emerged as the most effective organic treatment, followed by vermicompost, farmyard manure and lastly, the control treatment. Additionally, the values of all aforementioned traits increased with higher cobalt rates. Generally, the highest values were realized with the combined treatment of poultry manure and spraying cobalt at a rate of 15 mg L^{-1}. The observed superiority of poultry manure over other organic treatments, such as vermicompost and farmyard manure, and its outperformance compared to the control treatment can be attributed to its rich nutrient composition and beneficial microbial content. Poultry manure provides essential nutrients and fosters a favorable microbial environment, enhancing soil health and nutrient availability for pea plants. The positive impact of cobalt on all assessed traits suggests its role in promoting plant growth and stress tolerance. The synergistic effect observed with the combined treatment of poultry manure and cobalt at 15 mg L^{-1} underscores the complementary nature of these factors, where poultry manure serves as a nutrient source, and cobalt further enhances physiological processes, resulting in optimal yield, seed chemical constituents, and seed quality traits. Overall, the combined treatment demonstrates a holistic approach that addresses both nutrient requirements and stress resilience in pea plants. The findings are in agreement with those of Alkharpotly *et al.* (2023); Amer *et al.* (2023).

Table 7. Effect of organic fertilizer types and cobalt levels on yield and its components of pea plants grown on salt affected soil at harvest stage during seasons of 2023/24 and 2024/25

Treatments		No. of pods plant^{-1}		Pod length, cm		Weight of pods plant^{-1}		Weight of 100 fresh seed, g		Early yield, ton ha^{-1}		Total yield, ton ha^{-1}	
		1st season	2nd season	1st season	2nd season	1st season	2nd season	1st season	2nd season	1st season	2nd season	1st season	2nd season
Main factor: Organic treatments													
Control		8.08d	9.25d	6.60d	6.91d	39.15d	39.86d	37.77d	38.54d	1.79d	1.84d	5.97d	6.22d
Farmyard manure		9.75c	10.50c	7.85c	8.28c	43.25c	43.85c	39.87c	40.69c	2.13c	2.19c	7.31c	7.61c
Vermicompost		11.42b	11.50b	8.92b	9.34b	46.82b	47.50b	41.67b	42.56b	2.48b	2.56b	8.42b	8.76b
Poultry manure		12.67a	12.92a	10.02a	10.52a	49.84a	50.62a	42.60a	43.50a	2.82a	2.91a	9.31a	9.70a
Sub main factor: Cobalt levels													
Co (0.0mgL^{-1})		9.83b	10.50c	7.95c	8.35c	43.87d	44.58c	39.99b	40.93c	2.22d	2.29c	7.45d	7.75d
Co (5.0mgL^{-1})		10.29b	10.93bc	8.33bc	8.66bc	44.81c	45.58b	40.45b	41.21bc	2.31c	2.39b	7.75c	8.09c
Co (10.0mgL^{-1})		10.83a	11.17ab	8.53ab	8.93ab	45.13b	45.84a	40.70a	41.49ab	2.33b	2.41ab	7.86b	8.18b
Co (15.0mgL^{-1})		11.08a	11.58a	8.68a	9.13a	45.56a	46.22a	40.96a	41.81a	2.39a	2.46a	8.04a	8.37a
Interaction													
Control	Co (0.0mgL^{-1})	7.67	8.67	6.27	6.57	38.02	38.77	37.14	38.05	1.72	1.78	5.54	5.77
	Co (5.0mgL^{-1})	7.67	9.33	6.43	6.77	38.86	39.61	37.55	38.28	1.77	1.82	5.86	6.12
	Co (10.0mgL^{-1})	8.33	9.33	6.80	7.10	39.59	40.39	37.99	38.63	1.80	1.85	6.14	6.40
	Co (15.0mgL^{-1})	8.67	9.67	6.90	7.20	40.14	40.68	38.42	39.20	1.87	1.93	6.33	6.60
Farmyard manure	Co (0.0mgL^{-1})	9.00	10.00	7.30	7.70	42.12	42.69	39.05	39.78	2.02	2.08	6.95	7.23
	Co (5.0mgL^{-1})	9.33	10.33	7.70	8.10	42.82	43.42	39.40	40.24	2.10	2.17	7.20	7.54
	Co (10.0mgL^{-1})	10.33	10.67	8.17	8.57	43.84	44.47	40.39	41.24	2.17	2.24	7.44	7.74
	Co (15.0mgL^{-1})	10.33	11.00	8.23	8.73	44.23	44.82	40.63	41.48	2.23	2.29	7.64	7.94
Vermicomp-ost	Co (0.0mgL^{-1})	10.67	11.00	8.57	8.97	46.18	46.90	41.42	42.49	2.40	2.47	8.20	8.52
	Co (5.0mgL^{-1})	11.33	11.33	8.90	9.30	46.67	47.33	41.54	42.33	2.46	2.53	8.32	8.65
	Co (10.0mgL^{-1})	11.67	11.67	9.00	9.40	47.05	47.65	41.77	42.60	2.50	2.59	8.48	8.81
	Co (15.0mgL^{-1})	12.00	12.00	9.20	9.70	47.40	48.11	41.94	42.84	2.55	2.64	8.69	9.05
Poultry manure	Co (0.0mgL^{-1})	12.00	12.33	9.67	10.17	49.17	49.95	42.37	43.39	2.74	2.82	9.12	9.48
	Co (5.0mgL^{-1})	12.33	12.67	9.90	10.40	49.63	50.38	42.55	43.40	2.81	2.90	9.25	9.62
	Co (10.0mgL^{-1})	13.00	13.00	10.13	10.63	50.06	50.85	42.64	43.50	2.85	2.95	9.37	9.78
	Co (15.0mgL^{-1})	13.33	13.67	10.37	10.87	50.48	51.29	42.84	43.73	2.90	2.99	9.51	9.91
LSD at 5%		1.00	1.15	0.75	0.75	0.67	0.93	0.69	0.89	0.05	0.12	0.17	0.16

Means within a row followed by a different letter (s) are statistically different at a 0.05 level

Table 8. Effect of organic fertilizer types and cobalt levels on pea seeds chemical constituents at harvest under salt affected soil conditions during seasons of 2023/24 and 2024/25

Treatments		N,%		P,%		K,%	
		1st season	2nd season	1st season	2nd season	1st season	2nd season
Main factor: Organic treatments							
Control		2.54d	2.59d	0.233d	0.239d	2.15d	2.24d
Farmyard manure		2.83c	2.89c	0.260c	0.265c	2.44c	2.54c
Vermicompost		3.19b	3.26b	0.334b	0.340b	2.80b	2.91b
Poultry manure		3.49a	3.56a	0.374a	0.383a	3.09a	3.22a
Sub main factor: Cobalt levels							
Co (0.0mgL^{-1})		2.92d	2.98b	0.291c	0.297c	2.52c	2.61d
Co (5.0mgL^{-1})		3.01c	3.05b	0.303bc	0.311b	2.62b	2.72c
Co (10.0mgL^{-1})		3.05b	3.11a	0.305ab	0.312a	2.66ab	2.77b
Co (15.0mgL^{-1})		3.10a	3.16a	0.307a	0.314a	2.72a	2.83a
Interaction							
Control	Co (0.0mgL^{-1})	2.47	2.52	0.226	0.231	2.06	2.14
	Co (5.0mgL^{-1})	2.51	2.55	0.236	0.243	2.13	2.22
	Co (10.0mgL^{-1})	2.57	2.62	0.242	0.247	2.19	2.28
	Co (15.0mgL^{-1})	2.60	2.66	0.230	0.234	2.23	2.32
Farmyard manure	Co (0.0mgL^{-1})	2.74	2.79	0.251	0.255	2.33	2.42
	Co (5.0mgL^{-1})	2.79	2.84	0.258	0.265	2.40	2.51
	Co (10.0mgL^{-1})	2.88	2.94	0.262	0.268	2.49	2.59
	Co (15.0mgL^{-1})	2.93	2.99	0.268	0.274	2.55	2.65
Vermicomp-ost	Co (0.0mgL^{-1})	3.07	3.13	0.324	0.330	2.67	2.77
	Co (5.0mgL^{-1})	3.16	3.22	0.329	0.335	2.78	2.89
	Co (10.0mgL^{-1})	3.24	3.30	0.336	0.343	2.84	2.95
	Co (15.0mgL^{-1})	3.29	3.37	0.348	0.353	2.92	3.04
Poultry manure	Co (0.0mgL^{-1})	3.42	3.50	0.364	0.372	3.02	3.14
	Co (5.0mgL^{-1})	3.47	3.54	0.372	0.379	3.06	3.19
	Co (10.0mgL^{-1})	3.51	3.57	0.379	0.389	3.11	3.26
	Co (15.0mgL^{-1})	3.57	3.63	0.381	0.394	3.17	3.31
LSD at 5%		0.05	0.13	0.016	0.005	0.13	0.11

Means within a row followed by a different letter (s) are statistically different at a 0.05 level

Table 9. Effect of organic fertilizer types and cobalt levels on pea seeds quality traits at harvest under salt affected soil conditions during seasons of 2023/24 and 2024/25

Treatments		Protein, %		Carbohydrates, %		Total sugars, %		TDS, %		V.C, mg 100g^{-1}	
		1st season	2nd season	1st season	2nd season	1st season	2nd season	1st season	2nd season	1st season	2nd season
Main factor: Organic treatments											
Control		15.86d	16.16d	42.11d	42.94d	10.45d	10.63d	12.90d	13.44d	25.49d	26.48d
Farmyard manure		17.72c	18.06c	44.78c	45.72c	12.41c	12.58c	14.78c	15.41c	28.31c	29.49c
Vermicompost		19.93b	20.35b	46.57b	47.59b	13.90b	14.10b	15.93b	16.56b	29.90b	31.16b
Poultry manure		21.83a	22.25a	48.31a	49.37a	15.42a	15.65a	17.18a	17.93a	31.56a	32.76a
Sub main factor: Cobalt levels											
Co (0.0mgL^{-1})		18.27d	18.64b	44.84a	45.86c	12.58d	12.78d	14.77d	15.39d	28.32d	29.44b
Co (5.0mgL^{-1})		18.81c	19.08b	45.49a	46.36bc	13.03c	13.25c	15.17c	15.82c	28.84c	30.07ab
Co (10.0mgL^{-1})		19.05b	19.43a	45.62a	46.55ab	13.20b	13.40b	15.34b	15.99b	28.99b	30.17ab
Co (15.0mgL^{-1})		19.36a	19.75a	45.99a	46.98a	13.48a	13.67a	15.61a	16.27a	29.28a	30.47a
Interaction											
Control	Co (0.0mgL^{-1})	15.42	15.73	41.40	42.28	9.79	9.96	12.34	12.85	24.97	25.93
	Co (5.0mgL^{-1})	15.67	15.92	42.05	42.89	10.33	10.52	12.69	13.23	25.27	26.21
	Co (10.0mgL^{-1})	16.06	16.38	42.32	43.07	10.60	10.82	13.07	13.62	25.63	26.60
	Co (15.0mgL^{-1})	16.27	16.61	42.66	43.53	11.08	11.23	13.49	14.08	26.09	27.17
Farmyard manure	Co (0.0mgL^{-1})	17.13	17.42	44.06	44.88	11.86	12.02	14.29	14.88	27.64	28.76
	Co (5.0mgL^{-1})	17.46	17.77	44.44	45.41	12.23	12.42	14.67	15.35	28.11	29.20
	Co (10.0mgL^{-1})	17.98	18.38	45.00	45.96	12.61	12.76	14.92	15.56	28.59	29.84
	Co (15.0mgL^{-1})	18.29	18.67	45.63	46.63	12.94	13.13	15.21	15.83	28.91	30.15
Vermicomp-ost	Co (0.0mgL^{-1})	19.19	19.54	45.97	47.16	13.45	13.67	15.58	16.23	29.39	30.62
	Co (5.0mgL^{-1})	19.77	20.15	46.54	47.38	13.74	13.93	15.80	16.38	29.86	31.05
	Co (10.0mgL^{-1})	20.23	20.63	46.74	47.76	14.12	14.31	16.08	16.73	30.08	31.42
	Co (15.0mgL^{-1})	20.54	21.06	47.02	48.07	14.28	14.48	16.25	16.91	30.29	31.53
Poultry manure	Co (0.0mgL^{-1})	21.36	21.86	47.94	49.12	15.23	15.48	16.88	17.60	31.28	32.45
	Co (5.0mgL^{-1})	21.69	22.13	48.25	49.22	15.35	15.56	17.08	17.78	31.46	32.71
	Co (10.0mgL^{-1})	21.92	22.34	48.41	49.43	15.46	15.71	17.27	18.05	31.68	32.83
	Co (15.0mgL^{-1})	22.33	22.67	48.65	49.70	15.62	15.85	17.50	18.28	31.82	33.04
LSD at 5%		0.31	0.84	2.37	1.00	0.10	0.30	0.35	0.38	0.21	1.56

Means within a row followed by a different letter (s) are statistically different at a 0.05 level

Economic feasibility of the applied treatments

The cost of pea cultivation was determined based on the prevailing market rates of agricultural inputs, including fertilizers, irrigation, labor, and other associated expenses. The gross income was calculated based on the market price of peas in Egypt, reflecting the revenue generated from the harvested yield. The net income was derived by subtracting the total cost of cultivation from the gross income, following the formula:

Net income = gross income – cost of cultivation

Table 10. Economic analysis

Treatments		Total yield (ton/fed)	Total cost(L.E/fed)	Gross return (L.E/fed)	Net return (L.E/fed)
Control	Co (0.0mgL^{-1})	2.30 - 2.40	10,500	46,000 - 48,000	35,500 - 37,500
	Co (5.0mgL^{-1})	2.44 - 2.55	10,500	48,800 - 51,000	38,300 - 40,500
	Co (10.0mgL^{-1})	2.55 - 2.66	10,500	51,000 - 53,200	40,500 - 42,700
	Co (15.0mgL^{-1})	2.63 - 2.75	10,500	52,600 - 55,000	42,100 - 44,500
Farmyard manure	Co (0.0mgL^{-1})	2.89 - 3.01	12,500	57,800 - 60,200	45,300 - 47,700
	Co (5.0mgL^{-1})	3.00 - 3.14	12,500	60,000 - 62,800	47,500 - 50,300
	Co (10.0mgL^{-1})	3.10 - 3.22	12,500	62,000 - 64,400	49,500 - 51,900
	Co (15.0mgL^{-1})	3.18 - 3.30	12,500	63,600 - 66,000	51,100 - 53,500
Vermicomp-ost	Co (0.0mgL^{-1})	3.41 - 3.55	12,500	68,200 - 71,000	55,700 - 58,500
	Co (5.0mgL^{-1})	3.46 - 3.60	12,500	69,200 - 72,000	56,700 - 59,500
	Co (10.0mgL^{-1})	3.53 - 3.67	12,500	70,600 - 73,400	58,100 - 60,900
	Co (15.0mgL^{-1})	3.62 - 3.77	12,500	72,400 - 75,400	59,900 - 62,900
Poultry manure	Co (0.0mgL^{-1})	3.80 - 3.95	12,500	76,000 - 79,000	63,500 - 66,500
	Co (5.0mgL^{-1})	3.85 - 4.00	12,500	77,000 - 80,000	64,500 - 67,500
	Co (10.0mgL^{-1})	3.90 - 4.07	12,500	78,000 - 81,400	65,500 - 68,900
	Co (15.0mgL^{-1})	3.96 - 4.12	12,500	79,200 - 82,400	66,700 - 69,900

This calculation provides a clear assessment of the economic viability of the applied treatments compared to conventional practices, highlighting their potential to enhance profitability and sustainability in pea production.

According to the Table 10, the economic feasibility analysis of the applied treatments was assessed by comparing their total production costs, yield performance, and revenue with the control treatment. The total costs per feddan included fixed expenses for land preparation and infrastructure, as well as variable costs such as organic fertilizers, labor, irrigation, and harvesting. The treated plots exhibited a significant increase in yield compared to the control, leading to higher revenue. The net profit per feddan was calculated by subtracting total costs from the gross income, which was determined based on the market price of the harvested crop (20,000 EGP per ton). The economic return was notably higher in the treated plots, demonstrating the cost-effectiveness of organic amendments and cobalt foliar application. The return on investment (ROI) indicated a substantial profitability margin, suggesting that the implemented treatments not only enhanced crop productivity but also improved economic sustainability compared to conventional practices.

CONCLUSION

Optimal outcomes under salt-affected soil conditions, in terms of growth performance, yield, and quality traits, were notably observed in pea plants fertilized with poultry manure and supplemented with cobalt at a rate of 15 mg L^{-1} . As a result, this study recommends the adoption of a combined approach involving poultry manure and cobalt supplementation to improve pea production, thereby contributing to the sustainable utilization of salt-affected soils in the Delta region and aligning with the broader agricultural objectives of the Egyptian state.

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تحسين اداء البسلة النامية بالأراضي الملحية تحت نظام الري بالتنقيط

هدي ابراهيم احمد ابراهيم[١] ، محمد عاطف الشربيني [٢]و أسماء السعيد السعيد البيومي[١]

[١]معهد بحوث البساتين، مركز البحوث الزراعية، شارع الجامعة، الجيزة، ١٢٦١٩، مصر
[٢]معهد بحوث الاراضي والمياه والبيئة، مركز البحوث الزراعية، شارع الجامعة، الجيزة، ١٢٦١٩، مصر

الملخص

تؤكد الاستراتيجية الزراعية الحالية للدولة المصرية، والتي تركز على استصلاح الأراضي المتدهورة، بما في ذلك المناطق المتضررة من الملوحة في الدلتا، على الحاجة إلى تعظيم الإنتاجية، لا سيما في حالة المحاصيل الاستراتيجية مثل البسلة. لذلك أجريت تجربة حقلية خلال موسمين متتاليين (٢٤/٢٠٢٣ و٢٥/٢٠٢٤) باستخدام تصميم تجريبي القطع المنشقة يهدف إلى تحسين إنتاج البسلة تحت ظروف الأراضي المتأثرة بالأملاح من خلال التسميد العضوي [الكنترول (بدون)، السماد البلدي، زرق الدواجن والسماد الدودي]، كعامل رئيسي للدراسة. بالإضافة إلى ذلك، تم تطبيق الرش الورقي بالكوبالت بمستويات مختلفة (٠، ٥، ١٠، ١٥ ملجم لتر-١) كعامل منشق. تم اخذ بعض القياسات، مثل ارتفاع النبات، والوزن الطازج والجاف، والكلوروفيل (أ، ب)، والكاروتين، والمكونات الكيميائية (النيتروجين والفسفور والبوتاسيوم)، ومدلولات الإنتاجية والجودة (على سبيل المثال، عدد القرون، طول القرون، وزن القرون، المحصول المبكر والكلي، البروتين، السكريات الكلية، المواد الصلبة الذائبة، فيتامين سي) . أشارت النتائج إلى أن سماد زرق الدواجن برز كأكثر المعاملات العضوية فعالية، يليه السماد الدودي، ثم السماد البلدي وأخيراً معاملة الكنترول. بالإضافة إلى ذلك، زادت قيم صفات النمو والمحصول وصفات الجودة مع ارتفاع معدلات الكوبالت. بشكل عام، لوحظ أداء النمو الأمثل، وكذلك أفضل محصول وصفات الجودة مع نباتات البسلة التي تم تسميدها بسماد زرق الدواجن وفي نفس الوقت تم رشها بالكوبالت بمعدل ١٥ ملجم لتر-١ . لذلك توصي هذه الدراسة باستخدام سماد زرق الدواجن ومكملات الكوبالت كنهج لتعزيز إنتاجية البسلة، والمساهمة في الاستخدام المستدام للتربة المتأثرة بالأملاح في منطقة الدلتا ودعم الأهداف الزراعية الأوسع للدولة المصرية.