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Response of coriander plant grown on sandy soil and irrigated with saline water to chicken manure, compost and micronutrient in Sirte, Libya

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استجابة نبات الكزبرة النامي في تربة رملية والمروي بمياه مالحة تحت تأثير سماد الدواجن والكمبوست والعناصر الصغرى في مدينة سرت، ليبيا

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Abstract

The use of saline water is an urgent and unavoidable necessity, despite our current knowledge of the harm caused by high salinity in irrigation water and its negative impact on growing plants and the entire agricultural sector. Therefore, overcoming the damage caused by irrigation with degraded, highly saline water is crucial, especially in water-scarce countries like Libya. So, a pot experiment was carried out under sandy soil conditions using completely randomized experiential design aiming to evaluate the effect of four treatments [**T_1:** Without any additions (control), **T_2:** Chicken manure ChM at a rate of 20 ton fed^{-1} (equal 250 g pot^{-1} as soil addition), **T_3:** Compost at a rate of 5.0 ton fed^{-1} (equal 100 g pot^{-1} as soil addition),**T_4:** Micronutrient mixture (iron, zinc, and magnesium at a rate of 500 mg L^{-1} as foliar application] on the soil properties (*i.e.*, pH, EC and bulk density) and growth performance of coriander plants (*i.e.*, fresh and dry weights and plant height). The lowest values of pH were achieved with ChM followed by compost then micronutrient mixture, while the highest pH values were realized with control treatment. The lowest values of EC and bulk density were achieved with compost. Regarding plant performance, the highest values of fresh and dry weights and plant height were achieved with compost followed by ChM then micronutrient mixture, while the lowest values were realized with control treatment. According to these results, it can be concluded that ChM, compost and micronutrient mixture (iron, zinc, and magnesium) have a unique role in enhancing sand soil properties and raising the coriander tolerance to saline water.

Keywords: ChM, compost, micronutrient, coriander, saline water.

الملخص

يُعدّ استخدام المياه المالحة ضرورة ملحة لا مفر منها، على الرغم من معرفتنا الحالية بالأضرار الناجمة عن ارتفاع نسبة الملوحة في مياه الري وتأثيرها السلبي على نمو النباتات والقطاع الزراعي برمته. لذا، يُعدّ التغلب على الأضرار الناجمة عن الري بمياه متدهورة وعالية الملوحة أمرًا بالغ الأهمية، لا سيما في البلدان التي تعاني من ندرة المياه مثل ليبيا. أُجريت تجربة في أصص زراعية على تربة رملية باستخدام تصميم تجريبي تام العشوائية، بهدف تقييم تأثير أربع معاملات [**T_1**: بدون أي إضافات (كنترول)، **T_2**: سماد زرق الدواجن بمعدل 20 طن/فدان (ما يعادل 250 جرام للأصيص كإضافة للتربة)، **T_3**: سماد المكمورة بمعدل 5 طن/فدان (ما يعادل 100 جرام للأصيص كإضافة للتربة)، **T_4**: خليط من العناصر الغذائية الدقيقة (الحديد والزنك والمغنيسيوم بمعدل 500 ملجم/لتر كرش ورقي)] على خصائص التربة (مثل الرقم

الهيدروجيني، والتوصيل الكهربائي، والكثافة الظاهرية) وأداء نمو نباتات الكزبرة (مثل الوزن الطازج والجاف، وطول النبات). سُجلت أدنى قيم للرقم الهيدروجيني مع سماد زرق الدواجن، تليها سماد المكمورة، ثم خليط العناصر الغذائية الدقيقة، بينما سُجلت أعلى قيم للرقم الهيدروجيني مع مجموعة الكنترول. وسُجلت أدنى قيم التوصيل الكهربائي والكثافة الظاهرية مع سماد المكمورة. فيما يتعلق بأداء النبات، سُجّلت أعلى قيم للوزن الطازج والجاف وطول النبات مع سماد المكمورة، تليها سماد زرق الدواجن ثم المعاملة بمزيج المغذيات الدقيقة، بينما سُجّلت أدنى القيم مع المعاملة الكنترول. وبناءً على هذه النتائج، يمكن الاستنتاج أن سماد زرق الدواجن والمكمورة ومزيج المغذيات الدقيقة (الحديد والزنك والمغنيسيوم) لها دورٌ فريد في تحسين خصائص التربة الرملية وزيادة تحمل الكزبرة للمياه المالحة.

الكلمات المفتاحية: زرق الدواجن، سماد المكمورة، خليط العناصر الصغرى، الكزبرة، المياه المالحة.

INTRODUCTION

The agricultural sector in North African countries faces numerous challenges, requiring those working in the sector to consider practical solutions to overcome them (**Abdelhedi & Zouari, 2020)**. One such challenge is the necessity of using well water with high salinity levels for irrigation purposes under sandy soil conditions (**Choukr-Allah, 2021)**.

Irrigation with saline water increases osmotic pressure within the plant, reducing its ability to absorb water and nutrients (**Abd El Baki *et al.* 2025)**. Furthermore, it causes large amounts of sodium and chlorine to enter plant tissues, negatively impacting all physiological and vital processes. On the other hand, irrigation with saline water leads to soil degradation and a decline in the activity of microorganisms within it **(Lou, *et al.* 2025).**

The use of saline water is an urgent and unavoidable necessity, despite our current understanding of the damage caused by high salinity in irrigation water and its negative impact on plant growth and the agricultural sector as a whole (**Abbas *et al.* 2025)**. Therefore, mitigating the damage caused by irrigation with degraded and highly saline water is crucial, especially in water-scarce countries like Libya (**Brika, 2019)**.

Some soil amendments, as well as some foliar applications, may help reduce the risk of saline irrigation. For example, using chicken manure can improve soil properties, supply the plant with its needs for micro- and macronutrients, and provide certain hormones. All of this increases the plant's ability to withstand the stress caused by saline irrigation (**Ghazi, 2018, Arshad *et al.* 2024)**. Similarly, compost can play the same role as chicken manure. Furthermore, organic fertilizers (chicken manure and compost) in general are very beneficial for poor sandy soils (**Rasool *et al.* 2024)**. They provide a slow supply of nutrients and organic matter, improve the structure of sandy soils, and aggregate soil particles (**Gahory *et al.* 2022)**.

On the other hand, spraying with micronutrients such as iron (Fe), zinc (Zn), and manganese (Mn)…… *etc.*, increases the ability of growing plants to tolerate saline conditions due to the vital nutritional role each element plays. For example, iron is involved in photosynthesis and the formation of chlorophyll molecules. It also plays a role in the oxidation-reduction processes, acting as an electron carrier (**Tavakoli *et al.* 2014;Alhadad2025)**. Manganese is also involved in chlorophyll formation and oxidation-reduction reactions within plants, in addition to its unique role in the synthesis of amino acids and proteins (**Tripathi *et al.* 2015)**. On the other hand, zinc positively affects the activity of plant growth hormones and is necessary for the synthesis of the amino acid tryptophan. It is also involved in chlorophyll formation and contributes to the production of Indole Acetic Acid (IAA) (**Nadeem *et al.* 2018) ;(Lamma,2025)**.

Coriander (*Coriandrum sativum* L.) is one of the most important herbaceous crops, used for many purposes due to its rich content of nutrients, vitamins, and hormones. This plant is known to be sensitive to the salinity of irrigation water (**Yadav, 2024)**. So, the research hypothesis for this work is that the use of organic fertilizers such as chicken manure and compost as well as spraying with micronutrients (a mixture of Fe, Zn, Mn) would improve the performance of coriander grown on sandy soil and irrigated with saline water.

MATERIALS AND METHODS

1. Location site

A pot experiment was carried out under sandy soil conditions at the experimental farm of Agriculture Faculty, Sirte University, Libya during the growing season of 2024/2025.

2. Soil and irrigation water analysis

Soil and irrigation water samples were brought then analyzed according to the standard methods reported by **Tandon, (2005)** and their characteristics are presented in Table 1.

Table 1. The initial sandy soil and irrigation water analysis.

Initial sandy soil		
Characteristics and unit		**Values**
pH		8.80
EC, mscm^{-1}		62.9
Bulk density, Kg cm^{-1}		1.31
Sand,%		89.5
Clay,%		5.50
Silt,%		5.00
Textural class		Sandy
Irrigation water		
Characteristics and unit		**Values**
Well water	**pH**	8.10
	EC, mscm^{-1}	41.5
River water	**pH**	9.20
	EC, mscm^{-1}	4.07

3. Pots preparation

Plastic pots (50 cm diameter and 40 cm depth) were filled by 20 kg oven dry sand soil.

4. Studied substances

Chicken manure and compost were brought and added to the studied soil at three weeks before the sowing. The characteristics of chicken manure and compost are shown in Table 2. All studied microelements (Fe, Zn, Mn) were purchased from Libyan commercial market as chelated fertilizers (Fe-EDTA, Zn-EDTA and Mn-EDTA), then the used standard solution was prepared *via* dissolving a known mass of the compounds in the solvent.

Table 2. Chicken manure and compost properties**.**

Characteristics and unit	Chicken Manure	Compost
pH	7.37	6.5
EC, dScm^{-1}	14.50	3.40
Av-N, mg.kg^{-1}	2595.43	4950
Av-P, mg.kg^{-1}	427.06	33.900
Av-K, mg.kg^{-1}	455.60	35.000
C:N ratio	9:1	15:1
Fe, ppm	1060	3.11

5. Experimental design and treatments

This research work was done using completely randomized experiential design with three replicates (**Photo1)**. Four treatments [**T_1:** Without any additions (control), **T_2:** Chicken manure ChM at a rate of 20 ton fed^{-1} (equal 250 g pot^{-1} as soil addition), **T_3:** Compost at a rate of 5.0 ton fed^{-1} (equal 100 g pot^{-1} as soil addition), **T_4:** Micronutrient mixture (iron, zinc, and magnesium at a rate of 500 mg L^{-1} as foliar application] were evaluated.

6. Experimental setup and measurements

Twenty coriander seeds were sown on October 1, 2024 in each pot. Three weeks before coriander seeds sowing, both chicken manure and compost were added in a single application according to the studied treatments as well as all Plastic pots received the mineral P-fertilization (calcium superphosphate, 6.6% P), while the mineral N and K-fertilizers (ammonium nitrate, 33.5 %N and potassium sulphate, 39% K) were applied in one dose after 15 days from sowing at the recommended doses as reported by Ministry of Agriculture and Livestock, Libya. Foliar application of micronutrient mixture was done four times at periods of 15, 25, 30 and 35 days from sowing. At the harvest stage, some soil properties such as pH, EC, and bulk density were determined as described by **Tandon (2005),** as well as five plants were chosen to measure the coriander growth performance in terms of fresh and dry weights and plant height. The statistical analysis was executed *via* CoStat software, Version 6.303, CoHort, USA, 1998-2004 **(Gomez and Gomez,1984)**.

Photo1. A photo showing the implementation of the experiment**.**

Photo2. A photo showing the steps of soil analysis in the laboratories of the Soil and Water Department.

RESULTS AND DISCUSSIONS

1. Soil properties (*i.e.*, pH, EC and bulk density)

As shown in **Figs 1, 2 & 3**, the effect of the studied treatments on soil properties (*i.e.,* pH, EC and bulk density) at harvest of coriander plants was significant and clear. Regarding the soil pH, the lowest values were achieved with ChM followed by compost then micronutrient mixture, while the highest pH values were realized with control treatment **(Fig 1).** The lowest values of EC were achieved with compost followed by ChM then micronutrient mixture, while the highest EC values were recorded with control treatment **(Fig 2).** On the other hand, the highest values of bulk density were recorded with ChM followed by mixture of micronutrient, while the lowest bulk density values were recorded with compost treatment **(Fig 3).**

2. Performance of coriander plants (*i.e.*, fresh and dry weights and plant height)

The effect of the chicken manure, compost and micronutrient mixture treatments on the performance of coriander plants (*i.e.*, fresh and dry weights and plant height) are shown in **Figs (4, 5 & 6).** These figs show that the highest values of fresh and dry weights and plant height were achieved with compost followed by ChM then micronutrient mixture, while the lowest values were realized with control treatment.

Generally, it can be said that ChM, compost and micronutrient mixture (iron, zinc, and magnesium) had a unique role in enhancing sand soil properties and raising the coriander tolerance to saline water. This can be explained by the vital role played by each treatment, whether in improving soil properties or increasing the coriander's tolerance to irrigation water salinity.

Chicken manure and compost may have increased soil structure, resulting in a decrease in soil density. They may also have increased the soil's ability to retain irrigation water while holding salinity and stabilizing sodium and chloride, which explains the reduced salinity observed when coriander is harvested with both Chicken manure and compost compared to the control treatment. Furthermore, they may have aggregated the soil particles, improving porosity and potentially aiding in salt leaching. These organic fertilizers may also have increased cation exchange capacity and microbial activity, significantly reducing soil pH. Additionally, they may have provided a slower supply of nutrients, enabling coriander to withstand the effects of saline irrigation. This explains their role in improving coriander plant performance. The results are in harmony with those of **Ghazi, (2018), Gahory *et al.* (2022); Arshad *et al.* (2024)**; **Rasool *et al.* (2024)**.

On the other hand, spraying with micronutrients mixture may have increased the ability of coriander plants to tolerate saline irrigation water due to the vital nutritional role each element plays. Iron is involved in photosynthesis and the formation of chlorophyll molecules. It also plays a role in the oxidation-reduction processes, acting as an electron carrier (**Tavakoli *et al.* 2014& Lamma,2016)**. Manganese is also involved in chlorophyll formation and oxidation-reduction reactions within plants, in addition to its unique role in the synthesis of amino acids and proteins (**Tripathi *et al.* 2015)**. Zinc positively affects the activity of plant growth hormones and is necessary for the synthesis of the amino acid tryptophan. It is also involved in chlorophyll formation and contributes to the production of Indole Acetic Acid (IAA) (**Nadeem *et al.* 2018)**.

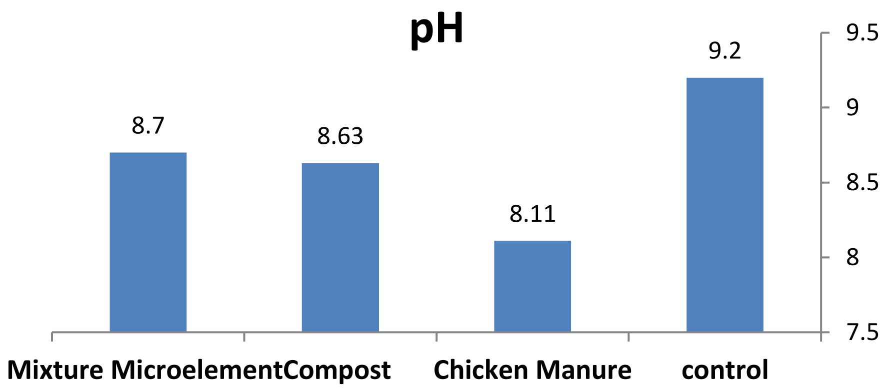

Fig 1. Effect of the studied treatments on soil pH.

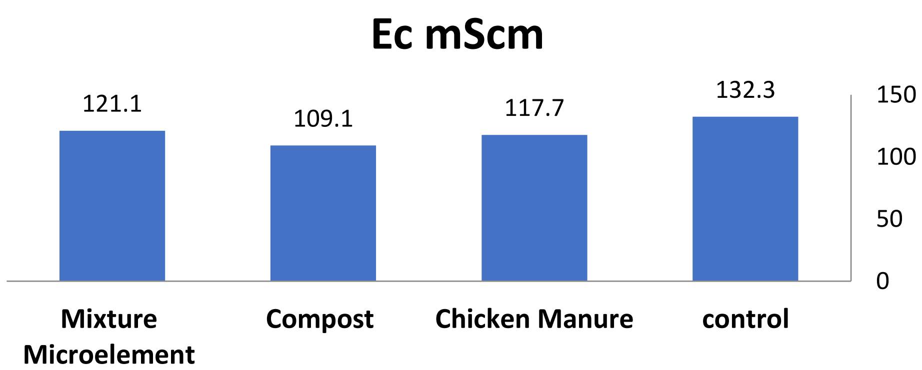

Fig 2. Effect of the studied treatments on soil EC.

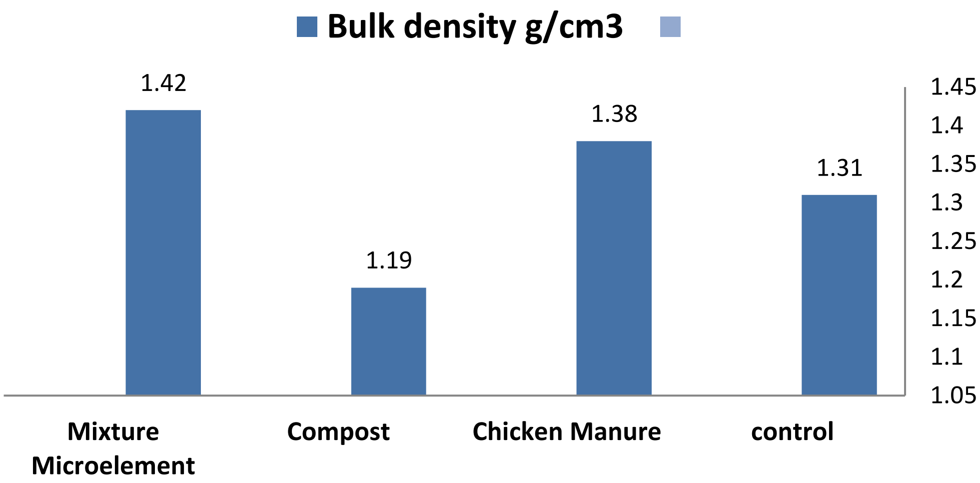

Fig 3. Effect of the studied treatments on soil bulk density.

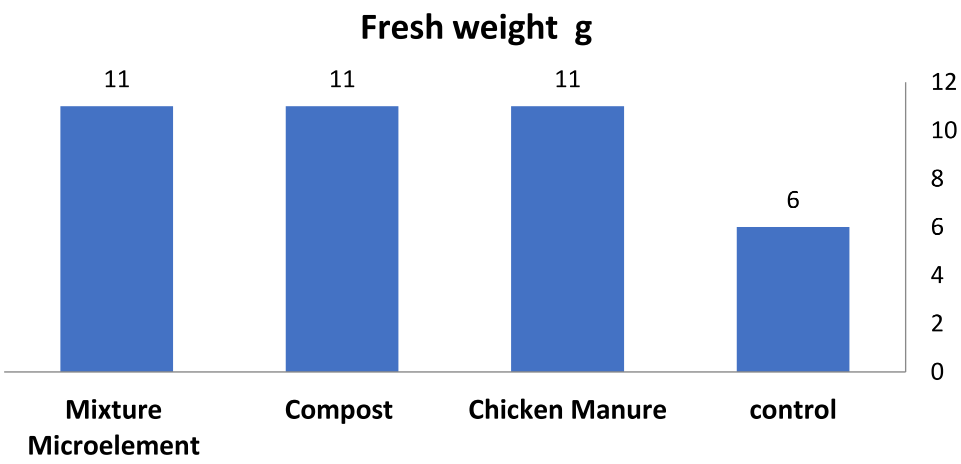

Fig 4. Effect of the studied treatments on fresh weight of coriander plant.

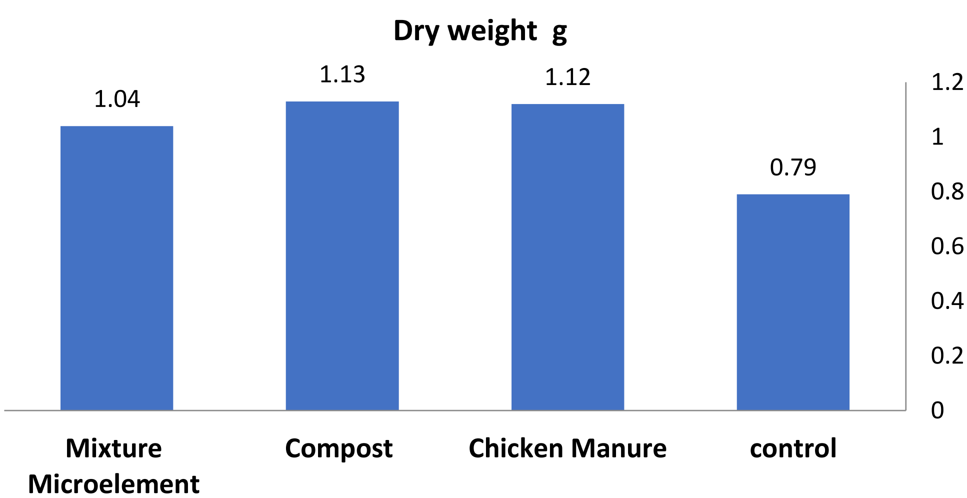

Fig 5. Effect of the studied treatments on dry weight of coriander plant.

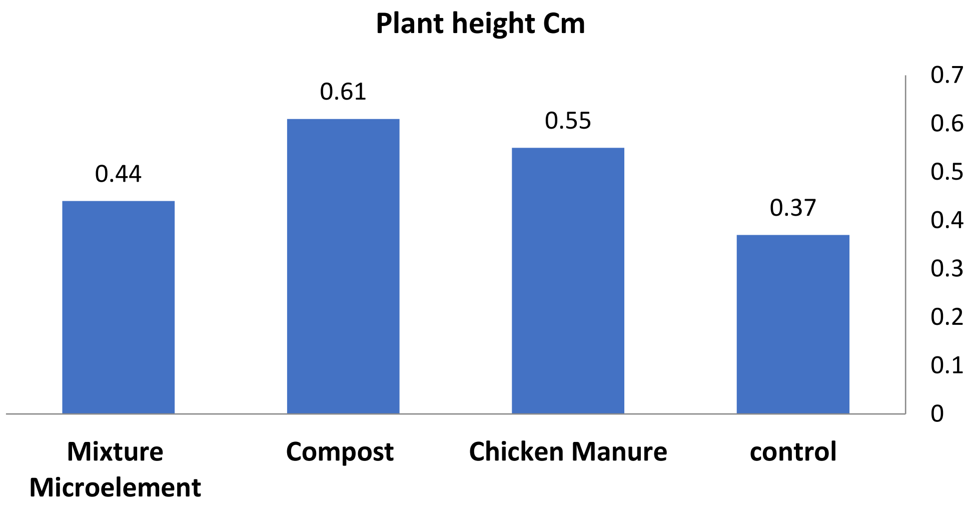

Fig 6. Effect of the studied treatments on plant height of coriander plant.

CONCLUSION

Depending on the obtained findings, it can be concluded that chicken manure, compost and micronutrient mixture (iron, zinc, and magnesium) have a unique role in enhancing sandy soil properties and raising the coriander tolerance to saline water, thus this approach is considered an innovative solution for achieving sustainability in the Libyan agricultural sector.

Compliance with ethical standards

Disclosure of conflict of interest

The author(s) declare that they have no conflict of interest.

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