



Article

The Role of Some Organic Compounds in Reducing Salts' Harmful Effects on Growth and Productivity of Olive Trees Picual Cv. in El Moghra Region

Amr S. Mohamed¹, Omran, M. A.¹, Omnia F. Amin² and Wael M. Ibrahim^{3,*}



¹Olive and semi-arid zone fruits research department, Horticulture Research Institute, Agricultural Research Center, Giza, Egypt.

²Soils, Water and Environment Research Institute (SWERI), Agricultural Research Center, Giza, Egypt.

³Central Laboratory of Organic Agriculture (CLOA), Agricultural Research Center, Giza, Egypt.

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*Corresponding author: [Wael Mohamed Ibrahim; dr.waelmohamed@gmail.com](mailto:dr.waelmohamed@gmail.com)

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Abstract: The present study investigated the role of selected organic compounds in mitigating the adverse effects of salinity on growth, physiological performance, and productivity of *Olea europaea* L. cv. Picual in El Moghra region during the 2024 and 2025 growing seasons. Treatments included compost, humic acid, salt-free extract, vermiwash, and their combinations. Results indicated that the compost + salt-free treatment significantly enhanced vegetative growth and achieving the highest shoot length. Humic acid alone produced the greatest leaf surface area, highlighting its stimulatory effect on leaf expansion. Vermiwash favored reproductive development, leading to highest number of inflorescences per shoot and longest inflorescences in addition, Fruit traits were found affected where humic treatments improved fruit weight and salt-free extract increased fruit shape index (L/W) and seed dimensions however, increased fruit moisture content under salt-free and humic treatments was associated with a relative reduction in oil percentage on a dry weight basis. Organic amendments modulated biochemical parameters, as compost and humic treatments enhanced total carbohydrate content and chlorophyll a and b concentrations, while the compost + salt-free combination promoted proline accumulation. Leaf nutrient analysis showed that compost + humic and salt-free treatments improved N, P, K, and Ca contents and optimized K/Na and (K+ Ca)/ Na ratios, reducing osmotic stress under salinity. Finally, the application of organic amendments, individually or in combination, effectively alleviated salt-induced stress, improved vegetative and reproductive performance, leading to enhanced fruit yield and quality in Picual olive trees, demonstrating their potential as sustainable biostimulant strategies in saline environments.

Key words: Olive; organic fertilizers; bio-stimulants; Vegetative growth, Compost, Humic acid, Vermiwash.

1. Introduction

The olive tree (*Olea europaea* L.) is an evergreen species cultivated across 67 countries and accounting for about 19% of the world's woody crop area and its primary production region lies within the Mediterranean basin.

Salinity is one of the major abiotic stresses limiting agricultural productivity in this region and with the progression of climate change, soil salinization is expected to intensify, posing a serious threat to olive cultivation. Salt stress affects olive trees through osmotic and ionic imbalances that hinder growth and disrupt various metabolic processes. Notably, olive cultivars exhibit considerable variation in their tolerance to salinity (El Yamani and Cordovilla, 2024). Dry land agricultural regions face distinct challenges to crop productivity, with soil and irrigation water salinity representing one of the most critical issues (Khondoker *et al.*, 2023). Salinity refers to the accumulation of excessive amounts of water-soluble salts in soil or irrigation water, which can negatively affect seed germination, plant growth, and overall yield. Under conditions of limited water availability and harsh climates, salinity further intensifies the difficulties farmers face in these environments (Zörb *et al.*, 2019).

According to Shahid *et al.*, (2018a), the impacts of soil and water salinity on crop performance are complex. Elevated salinity levels restrict root development, and disrupt nutrient uptake in plants. Moreover, salinity disturbs the osmotic equilibrium within plant cells, leading to physiological stress and reduced growth. Excessive sodicity also deteriorates soil structure, decreasing its water-holding capacity and increasing susceptibility to erosion (Shahid *et al.*, 2018b).

High sodicity deteriorates soil structure by promoting particle dispersion, which restricts water infiltration and reduces hydraulic conductivity. This leads to surface crusting, nutrient imbalances, and soil compaction conditions that significantly hinder plant growth and agricultural productivity (Gangwar *et al.*, 2020).

To alleviate excessive soil and irrigation water salinity, a wide range of physical, chemical, and biological strategies are employed, including subsoiling, sand incorporation, seedbed preparation, salt scraping, improved irrigation systems, and the use of salt-tolerant crops, along with amendments such as gypsum, sulfuric compounds, hydrophilic polymers, humic substances, green manures, and farmyard manures (Shahid *et al.*, 2018; Shilev, 2020; Meena *et al.*, 2020; Bhowmik *et al.*, 2021 and Devkota *et al.*, 2022).

In recent years, increasing attention has been given to organic and biological amendments, including vermicompost, vermiwash, biochar, biofertilizers, and plant growth-promoting rhizobacteria, due to their effectiveness in reducing the negative impacts of salinity on soil and plant performance (Ali *et al.*, 2021; Imran *et al.*, 2022; Hoque *et al.*, 2022). These amendments improve soil organic carbon content; enhance aggregate stability, and increase soil permeability and drainage, facilitating salt leaching from the root zone while limiting surface salt accumulation and evaporation losses (Lakhdar *et al.*, 2008).

Compost is considered one of the most effective organic soil amendments for improving soil fertility and structural quality through the incorporation of stabilized organic matter. Its application enhances soil aeration, water-holding capacity, and cation exchange capacity, creating favorable conditions for root development and microbial activity. The gradual decomposition of compost releases organic carbon and essential nutrients that support nutrient cycling and increase plant productivity, and their application have been shown to improve soil physical properties and nutrient availability in fruit orchards (Bernal *et al.*, 2017 and Awasthi *et al.*, 2020).

In saline environments, compost has also been reported to enhance soil remediation, promote plant growth, and improve physiological processes such as respiration, photosynthesis, and chlorophyll content (Lakhdar *et al.*, 2008; Trivedi *et al.*, 2017 and Mbarki *et al.*, 2020).

Humic acid is a natural organic compound derived from the decomposition of plant and animal residues. It plays an important role in improving soil physicochemical properties, nutrient uptake, and plant growth and its application found to enhance root growth, increases chlorophyll content, and improve plant

resistance to abiotic stresses. Additionally, humic substances act as chelating agents, facilitating the availability of micronutrients and improving soil structure. Finally, several studies have demonstrated that humic acid significantly increases yield and quality parameters in horticultural crops (**Chen *et al.*, 2020 and Canellas & Olivares, 2014**).

Calcium carboxylic acids are novel formulations designed to provide readily available calcium to plants without the negative effects of salts commonly found in traditional calcium fertilizers. Calcium is essential for cell wall integrity, membrane stability, and fruit firmness. The carboxylic component forms stable complexes with calcium ions, improving their mobility within plant tissues. Its application enhances calcium uptake efficiency and reduces physiological disorders such as blossom end rot and fruit cracking furthermore, studies have shown that organic calcium complexes improve fruit quality and reduce salinity stress compared to conventional sources (**Wójcik, 2019 and Singh *et al.*, 2021**).

During the last decades, the Organic amendments such as vermicompost (VC), vermiwash (VW), biochar (BC), biofertilizers (BF), and plant growth promoting rhizobacteria (PGPR) have gained increasing attention for their effectiveness in reducing salt stress and improving crop growth, development, and yield (**Md. Najmol *et al.*, 2022; Hoque *et al.*, 2022 and Imran *et al.*, 2022**). Among these amendments, VC and VW are found particularly valuable due to their rich composition of macro- and micronutrients, enzymes, vitamins, phytohormones, and beneficial microorganisms, which enhance nutrient uptake and regulate plant growth processes (**Hannan *et al.*, 2020**), in addition, they have been shown to mitigate the adverse effects of salinity by strengthening antioxidant enzyme activities, reducing electrolyte leakage, and alleviating oxidative stress, thereby contributing to improved soil conditions and plant performance (**Ruiz-Lau *et al.*, 2020**), add to that the VW which is , aliquid extract derived from vermicompost systems, can be applied as a foliar spray or soil drench to stimulate microbial activity, enhance soil fertility, and improve plant resistance to stress and diseases, making it an eco-friendly option for sustainable agriculture (**Ismail, 2018; Pathma & Sakthivel, 2019**), finally, it worth to mention that the application of VC has been reported to improve morphological traits, chlorophyll content, and overall salinity tolerance in crops such as maize (**Alamer *et al.*, 2022**).

In spite of all above, the interactive effects of saline irrigation water and different organic soil amendments practices on soil salinity and olive tree productivity under field conditions remain insufficiently investigated. Therefore, the objective of the current presented work is to shed light on the effect of certain organic compounds in mitigating the adverse effects of salinity on growth and productivities of the olive tree.

2. Materials and Methods

This study was conducted over two successive growing seasons (2024 and 2025) on the olive cultivar, "Picual" to evaluate the effect of different organic and bio-stimulant treatments on plant growth and productivity. Treatments included compost, humic acid, carboxylic acids for calcium salts (Salt-free), vermiwash and combination between them.

The experimental trees were vegetatively propagated via cuttings and established in sandy soil within a private orchard located in the El Moghra region, Matrouh Governorate. The cultivation was conducted at a 3 × 6 m spacing under a saline drip irrigation system, utilizing water with a total dissolved solids (TDS) concentration of 5096 ppm. To ensure experimental precision, all trees were maintained under uniform agro-climatic conditions and subjected to standardized agricultural practices. This setup aimed to characterize the qualitative and quantitative traits of the specimens and to identify the most salt-tolerant treatments suitable for cultivation in newly reclaimed lands.

Physical and chemical analyses of the soil and irrigation water were conducted at the laboratories of the Soil, Water, and Environment Research Institute (SWERI), following the methodologies described by **Jackson (1973)**. The analytical data are summarized in Tables 1 and 2.

Table (1). Physical and chemical properties of the experimental soil

Texture	EC	pH	Available macronutrients (mg kg ⁻¹)						Cations (meq/L)			
	(dS m ⁻¹)	(1:2.5) susp.	N	P	K	Ca	Mg	Na	Ca ⁺⁺	Mg ⁺⁺	Na ⁺	K ⁺
7	(1:5)		155	9.81	0.16	7.53	0.97	0.81	7.89	2.97	12.9	0.26
Sandy	1.07	7.79	Available micronutrients (mg kg ⁻¹)				Anions (meq/L)					
			Cu	Fe	Mn	Zn	CO ₃ ⁻	HCO ₃ ⁻	Cl ⁻	SO ₄ ⁻		
			0.21	4.01	1.02	0.21	-	2.83	14.41	6.78		

Table (2). The chemical analyses of the experimental ground water

pH	6.15	Cations (meq/L)				Anions (meq/L)			SAR
		Ca ⁺⁺	Mg ⁺⁺	Na ⁺	K ⁺	HCO ₃ ⁻	Cl ⁻	SO ₄ ⁻	
E.C	6.37 dSm ⁻¹	11.66	10.37	53.83	0.57	4.00	69.72	2.71	16.22
		Macro and micro nutrients (mg/L)							
	5096.0 ppm	N(NH ₄ ⁺)	N(NO ₃ ⁻)	P	Fe	Mn	Zn	Cu	B
	0.70	1.4	0.01	0.17	0.39	0.01	0.06	0.55	

Tested organic compounds and bio-stimulants

All treatments described below were applied during the vegetative and early fruiting stages under field conditions. Standard agronomic practices were followed for irrigation, weed control, and pest management throughout the experimental period and the functions and applied doses of the tested organic compounds and bio-stimulants are described as follows:

- Compost

To enhance soil physical properties, water-holding capacity, and nutrient availability, a well-decomposed organic amendment (a mixture of plant residues and farmyard manure) was applied. At the onset of the growing season, the organic matter was incorporated into the soil within the basin of each tree at a rate of 30 kg.

- Humic acid

To enhance root development, nutrient uptake, and overall plant vigor, humic acid was applied twice during the growth season at a final concentration of 2% (2 L/100 L of water), with a rate of 10 L per tree.

- Carboxylic acids for calcium salts (salt-free)

This treatment aimed to improve calcium absorption and strengthen cell wall formation, thereby enhancing fruit firmness and reducing physiological disorders.

Carboxylic acids formulated for calcium salts (Salt-free) were applied at a concentration of 2% (2 L/100 L of water), with an application rate of 10 L per tree.

- Vermiwash

Vermiwash serves as a bio-liquid fertilizer containing plant growth-promoting substances, beneficial microbes, and essential nutrients, contributing to improved plant health and productivity.

The Vermiwash was prepared from the leachate of vermicompost and applied at a concentration of 2% (2 L/100 L of water), with a total rate of 10 L per tree.

All treatments were applied during the vegetative and early fruiting stages under field conditions. Standard agronomic practices were followed for irrigation, weed control, and pest management throughout the experimental period.

- Vegetative, floral and yield characteristics

The following morphological traits were recorded

- Vegetative characteristics (leaf and shoot characteristics).
- Shoot length (cm) and number of leaves per meter.
- Leaf Surface Area (cm²): To determine the average leaf surface area, representative samples of approximately 40 mature leaves were randomly collected from the middle portion of one-year-old shoots. The leaf area was then calculated according to the following equation:

$$\text{Leaf area} = 0.53 (\text{length} \times \text{width}) + 1.66 \text{ (Ahmed and Morsy, 1999).}$$

Floral characteristics the following data were recorded:

- Number of inflorescences per shoot (IOC, 2015).
- Flowering Density: It was tabulated according to the following equation Flowering density = No. of inflorescence x 100/ shoot length.
- Inflorescence length (cm): It was classified into Short (> 2.5), medium (2.5-3.5) and long (< 3.5) according to the (IOC, 2015).
- Number of total flowers per inflorescence: it was counted and characterization according the (IOC, 2015) into Low (>18), Medium (18-25) and High (< 25).
- Percentage of perfect flowers: It was calculated according to (Hegazi and Stino, 1982) and (Hegazi, 2001) and as the following equation:

$$\text{Percentage of perfect flower} = \text{No. of perfect flowers} / \text{Total No. of flowers} \times 100.$$

Fruit and seed characteristics and yield/tree

- **Fruit Characteristics:** Thirty of Fresh olive fruits were randomly hand-picked from the evaluated genotypes to determine fruit and seed according to the International Olive Council standard method (IOC, 2015) as following categories:
- Fruit, seed and flesh weight (g).
- Fruit polar length (mm); Fruit cross-sectional width (mm); and fruit shape index Fruit shape: determined according the ratio between the length and the width (L/W) as follow: Spherical (< 1.25), ovoid (1.25-1.45), elongated: (> 1.45) (Barranco *et al.*, 2000).
- Seed polar length (mm); seed cross-sectional; seed shape index (L/W), and
- Flesh/seed ratio, flesh/fruit (%) and seed/fruit (%).

Yield (Kg/tree): Fruits were harvested during ripe stage (olive with superficial pigmentation on more than 50% of the skin) and the average tree yield of each genotype was calculated. **Dag *et al.*, (2011).**

- **Fruit Moisture Content:** Representative samples of 100 g of whole olive fruits were desiccated in a drying oven at 105°C for 24 hours until a constant weight was achieved to determine the moisture percentage, according to **IOC (1997)** methodology.
- **Fruit Oil Content:** The oil percentage was determined on both fresh and dry weight bases following the standard methods of **A.O.A.C. (2000)**.
- **Oil Content Classification:** According to **Barranco *et al.* (2000)**, the oil percentage (on a dry weight basis) was categorized as follows: very low (< 30%), low (30–40%), medium (40–50%), high (50–60%), and very high (> 60%).

Leaf Nutrient Analysis

During July of each season, samples of fully expanded mature leaves were randomly collected from the middle portion of non-bearing shoots for each treatment. The collected leaves were rinsed

with tap water, followed by distilled water to remove any surface contaminants. Subsequently, the samples were oven-dried at 70°C until a constant dry weight was reached.

A half gram of plant tissues was wet digested using a sulphuric - perchloric acids mixture ($\text{HClO}_4 + \text{H}_2\text{SO}_4$) acids according to the procedure of Benton and Jones (2001). Total Nitrogen was determined according to **A.O.A.C. (2000)** by using kjeldahl and (potassium-sodium) was measured by using flame photometer instrument. Total content of (P, Ca, B) in digestion extract of plant samples at Olive leaf Plant were determined by Inductively Coupled Plasma Spectrometry (ICP) (Ultima 2 JY Plasma) according to **EPA (1991)**. Chloride to prepare soln, 928.04A, add known volume of standard AgNO_3 , soln in excess. Stir well, filter, and wash AgCl thoroughly. For combined filtration and washing, add 5 mL of ferric indicator and a few mL of HNO_3 , and change excess Ag with thiocyanate standard soln to a permanent light brown. From mL of AgNO_3 used, calculate % Cl. **A.O.A.C. (1995)**.

Proline was determined by using the method described by **Bates *et al.* (1973)** where, 0.2 g sample was homogenized with 3% sulfosalicylic acid. The homogenate was centrifuged at 3000 RPM for 20 min. The supernatant was treated with 200 μL acetic acid and 200 μL ninhydrin, and then boiled for 1 h in a hot water boiling bath. After boiling for 1 h, the solution was kept in ice water. Then, absorbance at 520 nm was determined by UV-Visible using a spectrophotometer.

Total carbohydrate was extracted according to (**Smith, *et al.* 1964**) and determined using spectrophotometer according to (**Murphy, 1958**).

Chlorophyll extraction and measurement: chlorophyll concentration was determined from fully expanded leaves. A leaf sample of 0.1 g was ground and extracted with 5 mL of 80% (v/v) acetone in the dark (**Arnon, 1949**). The mixture was filtered and absorbencies (Jenway 6105 UV/VIS, Spectrophotometer) were determined at 645, 663 and 450 nm. Concentration of chlorophyll a (Chlorophyll a) and chlorophyll b (Chlorophyll b) were estimated by the equations of **Witham *et al.* (1971)**.

Statistical analysis

The experiment was arranged in a randomized complete blocks design and the obtained data were subjected to analysis of variance and significant differences among means were determine according to **Snedecor and Cochran (1980)**. In addition, significant differences among means were distinguished according to the Duncan multiple tests range **Duncan (1995)**.

3. Results and Discussion

Shoot length (cm)

The obtained results in Table 3 clearly indicate that the combinations, particularly compost + salt-free treatment, recorded the highest shoot length in both seasons (21.00 and 21.12 cm), exceeding all other treatments. This remarkable increase may be attributed to the synergistic effect of compost in improving soil physical structure, moisture retention, and nutrient availability, combined with the salinity-free extract that reduces osmotic stress and enhances nutrient uptake. Similar findings were reported by **El-Hady *et al.* (2021)** and **Mohamed & El-Sayed (2022)** who confirmed that organic amendments combined with anti-salinity bio-stimulants significantly promoted shoot elongation and vegetative growth in olive and grapevines.

Number of leaves per meter

The obtained results in Table 3 illustrate that the compost + salt-free combination again recorded the highest number of leaves per meter (142.77 and 142.53), followed by the control and compost alone. The substantial increase in leaf number per unit shoot length reflects dense foliage development and strong vegetative vigor. Salt-free extract plays a key role in maintaining osmotic balance and reducing salinity stress, resulting in greater shoot elongation and higher leaf initiation rates. These results agree with **Osman *et al.* (2020)** and **Gamal *et al.* (2023)**, who reported that compost improves nutrient availability especially nitrogen thereby enhancing leaf formation and overall canopy density in olives.

Leaf surface area

The results presented in Table 3 show that all treatments significantly affected leaf surface area during both growing seasons (2024 and 2025). In general, leaf surface area values in 2025 were slightly higher than those recorded in 2024 across all treatments. The humic treatment recorded the highest leaf surface area in both seasons (5.94 and 6.23 cm², respectively), followed by the salt-free and compost + humic treatments, which showed statistically similar and comparatively high values. In contrast, the control treatment exhibited the lowest leaf surface area in both seasons (4.22 and 4.47 cm²). The application of vermiwash and compost + vermiwash resulted in moderate increases compared with the control.

In fact, among all treatments, the humic acid application consistently produced the highest leaf surface area in both seasons, highlighting its strong stimulatory role in vegetative development. Humic substances are widely recognized as effective plant biostimulants that enhance nutrient uptake, stimulate root growth, and improve photosynthetic performance. Several reviews have demonstrated that humic acids act through hormone-like mechanisms, particularly auxin-like activity, promoting cell division and expansion in leaf tissues, which directly contributes to increased leaf surface area (Canellas & Olivares, 2002; Canellas *et al.*, 2015).

Table (3). Effect of compost, humic, salt free and vermiwash only or combination between them on shoot length (cm), number of leaves/m and leaf surface area (cm²) of Picual cv. during 2024 and 2025 seasons

Treatments	Shoot length (cm)		No. of leaves/m		Leaf surface area (cm ²)	
	2024	2025	2024	2025	2024	2025
1- Control	11.00F	11.27F	134.04B	126.16B	4.22F	4.47D
2- Compost	15.00E	15.10E	120.00C	120.00C	5.25CD	5.41C
3- Humic	16.00D	16.10D	100.26D	100.65D	5.94A	6.23A
4- Salt free	17.33C	17.43C	100.00D	100.27D	5.68AB	5.83B
5- Vermiwash	18.00C	18.15C	92.59E	90.64E	5.09D	5.32C
6- Compost + humic	19.00B	19.13B	115.63C	115.45C	5.48BC	5.69B
7- Compost + salt free	21.00A	21.12A	142.77A	142.53A	4.55E	4.63D
8- Compost + vermiwash	19.33B	19.48B	103.33D	103.04D	5.02D	5.26C

Values in the same column followed by the same letter(s) do not significantly differ from each other according to Duncan's multiple range test at 5% level.

Number of inflorescences per shoot

Data in Table 4 indicate that interestingly, vermiwash alone produced the highest number of inflorescences per shoot (12.20 and 12.42), indicating its strong positive influence on flowering potential. Vermiwash contains plant hormones such as cytokinin's, auxins, and gibberellins, as well as beneficial microorganisms, which collectively stimulate reproductive bud differentiation. This treatment outperformed all combinations, suggesting that vermiwash may directly favor floral induction more than vegetative growth.

These findings are in agreement with **Rady et al. (2020)** and **Khalil et al. (2022)**, who confirmed that vermiwash enhances flowering intensity and improves reproductive performance in fruit trees.

On the other hand, the compost + humic treatment recorded lower flowering values despite having high vegetative vigor, which may indicate a shift in resource allocation toward vegetative rather than reproductive growth. Similar trends were reported by **Erel et al. (2013)**, emphasizing that strong vegetative growth may sometimes reduce floral differentiation if not balanced.

Flowering density %

The data presented in Table 4 clearly show interestingly that the highest number of inflorescences per meter was recorded by the control treatment in both seasons (75.25 and 76.00 %). High numbers of inflorescences under control conditions may indicate a compensatory mechanism due to weak vegetative vigor and reduced carbohydrate accumulation, leading the plant to produce more inflorescences but with poor fruit retention. Similar findings were reported by (Erel *et al.*, 2016), who noted that stressed olive trees tend to produce numerous inflorescences with reduced reproductive success. The lowest numbers were observed in compost + humic and compost + salt-free treatments (47-50 inflorescences/m), likely due to increased fruit-setting efficiency that reduces the need for excessive inflorescence formation. This aligns with Dag *et al.* (2022) who explained that improved nutrient supply reduces the production of “excess inflorescences” because more flowers successfully set fruits.

Inflorescence length

Data in Table 4 cleared that; vermiwash alone produced the longest inflorescences in both seasons (2.397 and 2.523 cm), reflecting favorable hormonal stimulation promoting floral elongation. Longer inflorescences enhance the spatial distribution of flowers, improving pollination and potential fruit set. On the contrary, humic acid and compost + humic treatments recorded shorter inflorescence lengths, suggesting that these treatments favor compact floral structures or allocate more energy towards vegetative organs, consistent with Zhang *et al.* (2021) who reported that humic materials often enhance leaf expansion but may reduce flower elongation.

Total flowers per inflorescence

The obtained results in Table 4 demonstrate clear that the salt-free extract and vermiwash treatments produced the highest number of total flowers per inflorescence (13.17-13.37 flowers), significantly surpassing compost, humic, and combination treatments. The increase in flower numbers under these treatments may be attributed to improved nutrient uptake, enhanced osmotic regulation, and the hormonal content present in vermiwash (chiefly cytokinins and auxins), which promotes floral meristem differentiation.

These findings align with Khalil *et al.* (2022) and Rady *et al.* (2020) who indicated that vermiwash enhances flower primordia formation due to its stimulatory biochemical composition. Similarly, Methenni *et al.* (2018) reported that salt-free bio-stimulants improve floral abundance under stress conditions by enhancing physiological stability and nutrient balance. On the other hand, compost + humic, compost + salt-free, and compost + vermiwash combinations recorded the lowest flower counts. These results suggest a shift toward vegetative vigor rather than excessive flowering, consistent with Dag *et al.*, (2022) who found that nutrient-rich conditions may reduce flower overproduction due to improved resource allocation efficiency.

Percentage of perfect flowers

The data in Table 5 showed that, humic acid recorded the highest percentage of perfect flowers (68.90-69.91%), followed closely by compost (67.39-68.04%). These high percentages reflect improved hormonal balance, enhanced nutrient uptake particularly N, P, and micronutrients and better internal flower development. Humic acid is known to enhance pollen viability and ovule functionality, which may explain its superior performance. These findings are supported by Gamal *et al.*, (2023) and Osman *et al.*, (2020), who reported improved floral fertility in olives treated with organic amendments and humic substances. On the other side, Salt-free extract and vermiwash, despite producing the highest total flowers, showed moderate perfect flower percentages (62-65%). This pattern suggests that although these treatments stimulate flower abundance, a smaller proportion develops into fully fertile flowers. This is consistent with the findings of Erel *et al.*, (2016), who explained that increased flowering does not always translate into enhanced fertility, especially under conditions of physiological stress or rapid flower differentiation. Conversely, the lowest percentages were recorded by compost combinations (40.91-43.12%), likely due to imbalanced vegetative reproductive growth and reduced allocation of carbohydrates toward floral development.

Table (4). Effect of compost, humic, salt free and vermiwash only or combination between them on number of Inflorescence/shoot, flowering Density %, inflorescence length and total flowers /infl. of Picual cv. during 2024 and 2025 seasons

Treatments	No. of Infl./shoot		Flowering Density %		Infloresc. Length		Total flowers /infl.	
	2024	2025	2024	2025	2024	2025	2024	2025
1- Control	8.23E	8.52E	75.25A	76.00A	2.377B-D	2.433E	10.24C	10.31C
2- Compost	9.90C	10.12C	66.00B	66.99B	2.390AB	2.477D	11.08B	11.16B
3- Humic	10.87B	11.17B	67.83B	69.29B	2.367D	2.473D	11.07B	11.15B
4- Salt free	9.80C	9.93C	56.59C	57.02C	2.387A-C	2.447E	13.30A	13.37A
5- Vermiwash	12.20A	12.42A	67.78B	68.42B	2.397A	2.523A	13.17A	13.26A
6- Compost + humic	8.87D	9.07D	46.75E	47.46E	2.363D	2.490CD	9.55D	9.62D
7- Compost + salt free	9.90C	10.17C	47.06E	48.08E	2.373B-D	2.497BC	9.90CD	9.98CD
8- Compost + vermiwash	9.53C	9.88C	49.50D	50.87D	2.370CD	2.513AB	9.55D	9.67D

Values in the same column followed by the same letter(s) do not significantly differ from each other according to Duncan's multiple range test at 5% level.

Number of fruits per meter

Data results in Table 5 showed that, similar to fruit numbers per shoot, salt-free extract produced the highest fruit density per meter (65.59-66.74 fruits/m), followed by vermiwash (59.44-62.07 fruits/m). These treatments enhanced both floral viability and initial fruit development, contributing to higher fruit density. This improvement can be attributed to enhanced water balance, reduced salinity stress, and improved carbohydrate allocation under these bio-stimulant treatments. The results are in line with **Alowaiesh *et al.*, (2023)**, who confirmed that salt-free bio-stimulants support olive reproductive development under stress conditions. An opposite the lowest values were found in the control and compost + vermiwash treatments, indicating poor fruit set efficiency and low reproductive performance when no bio-stimulants are applied.

Table (5). Effect of compost, humic, salt free and vermiwash only or combination between them on Perfect flowers % and No. of fruits/m of Picual cv. during 2024 and 2025 seasons

Treatments	Percentage of perfect flowers		No. of fruits/m	
	2024	2025	2024	2025
1- Control	46.26E	47.28E	26.50G	27.38G
2- Compost	67.39B	68.04B	44.67E	49.22D
3- Humic	68.90A	69.91A	47.99D	49.35D
4- Salt free	62.46D	63.19D	65.59A	66.74A
5- Vermiwash	64.12C	65.20C	59.44B	62.07B
6- Compost + humic	42.10F	43.12F	50.69C	51.74C
7- Compost + salt free	40.91F	41.89F	44.59E	45.27E
8- Compost + vermiwash	42.10F	42.92F	30.93F	31.88F

Values in the same column followed by the same letter(s) do not significantly differ from each other according to Duncan's multiple range test at 5% level.

Fruit length, width and weight (g)

Fruit weight and flesh weight are considered the most important parameters that used as descriptive fruit characters' measurements of the olive cultivar "Picual" and their treatments are given in Table 6. Significant differences were observed according to fruit weight, fruit length and Fruit width. The highest fruit weight, fruit length and fruit width values was obtained from Humic treatments, while the control treatments acquired the lowest fruit weight, fruit length and fruit width during two studied seasons.

Such morphological traits are closely linked with plant nutritional status; enhanced nutrient availability improves sink strength of developing fruits through increased carbohydrate partitioning and enhanced cell expansion. The positive response of fruit weight and dimensions to humic acid is consistent with the well-documented role of humic substances in improving nutrient uptake, root morphology, and hormonal regulation key factors that influence fruit development (Canellas *et al.*, 2015 and Calvo *et al.*, 2014).

Fruit shape index (L/W)

As regard to the presented data in Table 7, it could be noticed that, salt free treatment significantly appeared the greatest shape index (L/W) of fruit in the two season respectively, Meantime, the ratio between the length and the width was calculated to determine the differences among the tested treatments in shape, According the description of (IOC, 2015). This result was the parallel with those found by Khadivi *et al.* (2022) who reported that Length, diameter and length/diameter ratio influence the olive shape which is important in characterization during breeding programs.

Flesh weight (g)

As regard to the presented data in Table 7, the highest value of flesh weight was obtained in Humic, while (compost + salt free) achieved the least on during two studied seasons. In general, many studies on olive cultivars, revealed that, a high percentage of pulps means a better commercial value for both table and oil production (Medina *et al.*, 2012, Laaribi *et al.*, 2014 and Khadivi *et al.* (2022).

Seed weight (g)

On during two studied seasons. In general, many studies on olive cultivars, revealed that, a high percentage of pulps means a better commercial value for both table and oil production (Medina *et al.*, 2012, Laaribi *et al.*, 2014 and Khadivi *et al.* (2022).

Seed shape index (L/W)

Data in Table 7 displays obviously that, the (Compost + salt free) treatment was the superior in seed length and seed width of the two studied seasons, compared to the control and other treatments. Whereas, the Compost and Humic treatments in in addition, it showed the same effect during 2024, 2025 seasons in seed width., Salt free treatment cleared that in the 1st and 2nd seasons in seed shape index (L/W), whereas, the least Seed width (cm) and Seed length was concomitant to control. Whereas, referring to length/width ratio for seeds conformed to the seed shape index.

Table (6). Effect of compost, humic, salt free and vermiwash only or combination between them on fruit length (cm), fruit width (cm) and fruit weight (g) of Picual cv. during 2024 and 2025 seasons

Treatments	Fruit length (cm)		Fruit width (cm)		Fruit weight (g)	
	2024	2025	2024	2025	2024	2025
1- Control	2.55F	2.60D	2.05DE	2.09DE	6.74F	6.82E
2- Compost	2.75BC	2.79B	2.15BC	2.18BC	7.61BC	7.71BC
3- Humic	2.87A	2.89A	2.35A	2.38A	8.11A	8.16A
4- Salt free	2.70CD	2.69C	2.15BC	1.85F	6.99D	7.07D
5- Vermiwash	2.60EF	2.63D	2.00E	2.04E	6.98D	7.03D
6- Compost + humic	2.80B	2.82B	2.20B	2.23B	7.53C	7.61C
7- Compost + salt free	2.65DE	2.64CD	2.10CD	2.12CD	6.85E	6.91E
8- Compost + vermiwash	2.80B	2.83B	2.15BC	2.18BC	7.66B	7.73B

Values in the same column followed by the same letter(s) do not significantly differ from each other according to Duncan's multiple range test at 5% level.

Table (7). Effect of compost, humic, salt free and vermiwash only or combination between them on fruit shape index, flesh weight (g), seed weight (g), seed length (cm), seed width (cm) and seed shape index of Picual cv. during 2024 and 2025 seasons

Treatments	Fruit shape index		Flesh weight (g)		Seed weight (g)		Seed length (cm)		Seed width (cm)		Seed shape index	
	2024	2025	2024	2025	2024	2025	2024	2025	2024	2025	2024	2025
1- Control	1.263 AB	1.250 BC	6.12 C	6.14 D	0.86 DE	0.89 E	1.63 F	1.66 F	0.85 C	0.88 E	1.92 C	1.89 D
2- Compost	1.280 A	1.283 B	6.76 B	6.82 B	0.85 E	0.89 E	1.67 E	1.72 E	0.90 A	0.92 A	1.87 E	1.87 E
3- Humic	1.220 B	1.217 C	7.17 A	7.20 A	0.94 B	0.96 C	1.72 C	1.76 C	0.90 A	0.93 A	1.93 C	1.93 C
4- Salt free	1.257 AB	1.587 A	6.12 C	6.13 D	0.87 D	0.93 D	1.75 B	1.79 B	0.85 C	0.88 D	2.06 A	2.03 A
5- Vermiwash	1.303 A	1.287 B	5.88 D	5.89 E	0.86 DE	0.93 D	1.70 D	1.74 CD	0.87 BC	0.89 CD	1.95 B	1.97 B
6- Compost + humic	1.273 AB	1.267 BC	6.61 B	6.63 C	0.92 C	0.98 B	1.67 E	1.72 E	0.88 AB	0.90 C	1.90 D	1.91 CD
7- Compost + salt free	1.243 AB	1.247 BC	5.86 D	5.89 E	0.99 A	1.02 A	1.77 A	1.82 A	0.90 A	0.92 A	1.97 B	1.99 B
8- Compost + vermiwash	1.300 A	1.300 B	6.74 B	6.77 B	0.92 C	0.96 C	1.68 E	1.73 DE	0.89 AB	0.91 AB	1.89 DE	1.90 D

Values in the same column followed by the same letter(s) do not significantly differ from each other according to Duncan's multiple range test at 5% level.

Fruit seed weight (%)

As regard to the presented data in Table 8, the highest value of fruit seed weight (%) was obtained in (Compost + salt free), while humic achieved the least on during two studied seasons. In general, many studies on olive cultivars, revealed that, a high percentage of pulps means a better commercial value for both table and oil production (Medina *et al.*, 2012, Laaribi *et al.*, 2014 and Khadivi *et al.* (2022).

Fruit flesh weight (%) and fruit/seed ratio

As regard to the presented data in Table 8, the highest value of Fruit flesh weight (%) and Fruit/seed ratio was obtained in Compost treatment, Vermiwash treatment achieved the least on during two studied seasons. In general, many studies on olive cultivars, revealed that, a high percentage of pulps means a better commercial value for both table and oil production (Medina *et al.*, 2012, Laaribi *et al.*, 2014 and Khadivi *et al.* (2022).

Yield (Kg/tree)

Yield per tree differed significantly among treatments in both seasons Table 8. In 2024, yields ranged from 6.33 to 14.33 kg tree⁻¹, while in 2025 they increased markedly, ranging from 12.67 to 22.33 kg tree⁻¹. The highest yield was consistently recorded in treatment compost + vermiwash, which was statistically superior to all other treatments in both seasons (14.33 and 22.33 kg), respectively. However, the lowest ones were control (6.33 and 12.67kg/tree), in the 2024 and 2025 seasons, respectively. Similarly, the present result is partially consistent with that reported by Mikhail (2015), and Dridi *et al.* (2019), who found that the yield of olive crops is largely independent of flower number and influenced by several variables, including biennial fruiting at varying levels based on the variety's genotype and environmental conditions.

Table (8). Effect of Compost, Humic, Salt free and Vermi wash only or combination between them on fruit seed weight (%), fruit flesh weight (%), fruit/seed ratio and yield (kg) of Picual cv. during 2024 and 2025 seasons

Treatments	Fruit seed weight (%)		Fruit flesh weight (%)		Fruit/seed ratio		Yield (Kg/tree)	
	2024	2025	2024	2025	2024	2025	2024	2025
1- Control	12.32CD	12.65E	87.68DE	87.35C	8.12D	7.90C	6.33E	12.67F
2- Compost	11.17G	11.59H	88.83A	88.41A	8.95A	8.63A	9.00C	14.67E
3- Humic	11.59F	11.76G	88.41B	88.24A	8.63B	8.50A	8.33D	15.53D
4- Salt free	12.45C	13.21C	87.55E	86.79E	8.04D	7.57E	9.00C	15.33D
5- Vermiwash	12.76B	13.64B	87.24F	86.36F	7.84E	7.53F	9.33C	18.00C
6- Compost + humic	12.22D	12.88D	87.78D	87.12D	8.19CD	7.76D	12.33B	17.67C
7- Compost + salt free	14.45A	14.77A	85.55G	85.23G	6.92F	6.77G	12.33B	19.00B
8- Compost + vermiwash	12.01E	12.41F	87.99C	87.59B	8.33C	8.06B	14.33A	22.33A

Values in the same column followed by the same letter(s) do not significantly differ from each other according to Duncan's multiple range test at 5% level.

Moisture percentage

The results revealed significant differences among treatments in fruit moisture content during both seasons Table 9. The salt-free treatment consistently recorded the highest moisture percentage (60.74&61.13) in both seasons, respectively, followed by humic and compost + humic applications. This indicates that reducing salinity stress and improving soil conditions enhanced water uptake and retention in olive fruits. In contrast, lower moisture percentages were observed in the compost and compost + salt-free treatments, which may reflect improved water use efficiency and a more balanced water status within the fruits. The general trend was consistent across both seasons, confirming the stability of treatment effects.

Oil Percentage on Dry Weight Basis

Oil content differed significantly among treatments in both seasons as shown in Table 9. The control treatment showed the highest oil percentage (37.10 and 37.90A) in both seasons, respectively. Whereas a noticeable reduction in oil accumulation was observed under salt-free and compost + humic treatments. Meanwhile, treatments such as vermiwash and compost + salt-free maintained relatively high oil percentages compared with other organic treatments. These findings suggest that enhanced water availability and reduced stress conditions may shift metabolic activity toward fruit growth and moisture accumulation rather than oil biosynthesis. This may indicate a balanced nutritional effect without excessive vegetative stimulation. Vermiwash has been reported to improve nutrient availability and microbial activity while avoiding excessive water retention, thus maintaining favorable physiological stress levels for oil synthesis. Review studies suggest that organic amendments can positively influence olive oil content when they improve nutrient efficiency without inducing excessive vigor or water surplus (Talhoui *et al.*, 2016).

Table (9). Effect of Compost, Humic, Salt free and Vermiwash only or combination between them on Moisture percentage and Oil percentage in dry weight of Picual cv. during 2024 and 2025 seasons

Treatments		Moisture percentage		Oil percentage in dry weight	
		2024	2025	2024	2025
1	Control	59.06C	59.68B	37.10A	37.90A
2	Compost	56.77E	57.14D	33.70D	34.00D
3	Humic	59.10C	60.71A	34.15C	34.00D
4	Salt free	60.74A	61.13A	26.20G	36.50G
5	Vermiwash	58.18D	58.61C	34.40BC	34.60C
6	Compost + humic	60.01B	60.86A	29.30F	29.80F
7	Compost + salt free	56.68E	57.60D	34.65B	35.10B
8	Compost + vermiwash	58.02D	58.95C	33.25E	33.60E

Values in the same column followed by the same letter(s) do not significantly differ from each other according to Duncan's multiple range test at 5% level.

Effect of irrigation water salinity and organic amendments on N, P, K, Ca, B, Na, Cl percentages (%) in olive leaf

The results presented in Tables 10 and 11 show that different treatments significantly affected Nitrogen, Phosphorus, Potassium, Calcium, Boron, Sodium and Chloride during both the 2024 and 2025 growing seasons, with consistent trends across years.

Nitrogen content was markedly influenced by organic content and varied significantly among treatments in both seasons. The highest levels of nitrogen were recorded (0.920 and 0.925% in 2024 and 2025, respectively) and phosphorus the highest levels were recorded (0.251 and 0.255 % in 2024 and 2025, respectively), the highest Nitrogen and Phosphorus values were recorded under the (compost + humic) treatment compared to other treatment. The control plants comparatively lower nitrogen and phosphorus values. The consistency of nitrogen and phosphorus patterns between seasons suggests stable. For potassium content in olive leaf was by organic content varied significantly among treatments in both seasons. The highest value was recorded (1.140 and 1.145% in 2024 and 2025, respectively) under (Salt free) treatment. While the highest value of calcium content was (3.375 -3.378) under humic treatment compared to other treatment and control. difference between Born and Sodium concentration (%) in olive leaves as a result of different treatments was not significant. Chloride a concentration differed significantly among treatments. The control plants resulted in the highest Chloride values during both seasons (0.177 and 0.182 %) while compost treatment showed the lowest value.

Data in Table 12 showed that the use of compost the highest ration of K/Na and K + Ca /Na ratio and may be compost in a leaves assisting in the reduction of the negative effects of salt on plants. Moreover, under salinity stress. compost treatment improves osmotic balance by compost + salt free treatment assimilation, which ultimately results in a better photosynthetic rate. stomatal conductance.

These results are in accordance with **Magdich and Ammar (2022)** who reported that the organic fertilizers led to an increase in the levels of soil organic matter and total nitrogen, and the presence of phosphorus and potassium, also led to increased soil mineralization and the Organic matter with releases significant amounts of essential macro and micronutrients which are necessary for plant growth. **Hegazi *et al.* (2007)** reported that organic fertilization helps maintain leaf mineral levels in olive trees, enhancing yield. **Tenshia and Singaram (2005)** concluded that, soil application of humic 20 kg/ha improved uptake of N, P, K, Fe and Zn than control. Humic is an organic fertilizer that can positively impact plant growth and enhance the uptake of nutrients such as calcium, magnesium, phosphorous, potassium, nitrogen, and potassium (**Elmongy *et al.*, 2018**).

Table (10). Effect of compost, humic, salt free and vermiwash only or combination between them on N (%), P (%), K (%) and Ca (%) of Picual cv. during 2024 and 2025 seasons

Treatments	N (%)		P (%)		K (%)		Ca (%)	
	2024	2025	2024	2025	2024	2025	2024	2025
1- Control	0.173E	0.187E	0.177C	0.181C	0.570G	0.575G	0.740F	0.744F
2- Compost	0.457D	0.463D	0.061D	0.065D	0.973BC	0.977BC	1.869D	1.873D
3- Humic	0.450D	0.458D	0.178C	0.181C	0.677F	0.681F	3.375A	3.378A
4- Salt free	0.787B	0.791B	0.190C	0.194C	1.140A	1.145A	2.138C	2.141C
5- Vermiwash	0.457D	0.457D	0.220B	0.233B	1.037B	1.042B	1.855D	1.858D
6- Compost + humic	0.920A	0.925A	0.251A	0.255A	0.937CD	0.941CD	2.294B	2.295B
7- Compost + salt free	0.463D	0.468D	0.175C	0.180C	0.773E	0.778E	1.886D	1.892D
8- Compost + vermiwash	0.687C	0.690C	0.168C	0.172C	0.883D	0.886D	0.923E	0.928E

Values in the same column followed by the same letter(s) do not significantly differ from each other according to Duncan's multiple range test at 5% level.

Table (11). Effect of compost, humic, salt free and vermiwash only or combination between them on B (%), Na (%) and Cl (%) of Picual cv. during 2024 and 2025 seasons

Treatments	B (%)		Na (%)		Cl (%)	
	2024	2025	2024	2025	2024	2025
1- Control	0.002A	0.004A	0.013A	0.016A	0.177A	0.182A
2- Compost	0.004A	0.007A	0.006A	0.008A	0.072D	0.075D
3- Humic	0.005A	0.008A	0.011A	0.009A	0.107C	0.109C
4- Salt free	0.003A	0.006A	0.014A	0.016A	0.143B	0.147B
5- Vermiwash	0.005A	0.007A	0.014A	0.016A	0.178A	0.182A
6- Compost + humic	0.004A	0.007A	0.017A	0.018A	0.107C	0.111C
7- Compost + salt free	0.006A	0.008A	0.009A	0.010A	0.105C	0.107C
8- Compost + vermiwash	0.004A	0.005A	0.012A	0.015A	0.142B	0.147B

Values in the same column followed by the same letter(s) do not significantly differ from each other according to Duncan's multiple range test at 5% level.

Table (12). Effect of compost, humic, salt free and vermiwash only or combination between them on K/Na, and K+Ca/Na of Picual cv. during 2024 and 2025 seasons

Treatments		K/Na		K + Ca /Na	
		2024	2025	2024	2025
1	Control	44.61G	34.44G	102.56H	81.20G
2	Compost	162.22A	123.26A	473.67A	359.77A
3	Humic	59.80E	52.55F	358.03B	313.41B
4	Salt free	80.00C	71.77C	230.01D	205.95D
5	Vermiwash	71.89C	65.28D	200.49E	181.71E
6	Compost + humic	56.65F	52.43F	195.40F	180.15E
7	Compost + salt free	85.93B	75.48B	295.48C	258.92C
8	Compost + vermiwash	71.73D	60.68E	146.70G	124.16F

Values in the same column followed by the same letter(s) do not significantly differ from each other according to Duncan's multiple range test at 5% level.

The results presented in Table 13 show that the different treatments significantly affected proline accumulation, total carbohydrate content, and chlorophyll pigments (a and b) during both the 2024 and 2025 growing seasons, with consistent trends across years.

Proline content varied significantly among treatments in both seasons. The control treatment exhibited relatively high proline values (1.93 and 1.97% in 2024 and 2025, respectively), indicating an inherent physiological response. While among treatments, the highest proline levels were recorded under the compost + salt-free treatment (1.80 and 1.82%), followed by compost + vermiwash and compost + humic however, treatments such as compost alone, humic, vermiwash, and salt-free showed comparatively lower proline values. The consistency of proline patterns between seasons suggests stable treatment-induced responses.

Proline is a well-known osmoprotectant that accumulates in plants in response to various stresses, including water deficit and salt stress, and can also reflect metabolic adjustments triggered by organic amendments (Ashraf & Foolad, 2007 and Szabados & Saviouré, 2010). In the present study, proline content varied significantly among treatments across seasons. The relatively high proline levels observed in the control treatment suggest an inherent physiological response to baseline stress or suboptimal growth conditions. This aligns with numerous reports indicating that under stress or nutrient limitation, plants accumulate proline as a protective osmolyte to stabilize proteins, membranes, and redox balance (Verbruggen & Hermans, 2008).

Total carbohydrate content was markedly influenced by organic amendments Table 13. The highest carbohydrate percentages were observed under humic and compost treatments in both seasons ($\approx 27.7\%$), with no significant difference between them. Moderate carbohydrate levels were recorded under compost + salt-free, whereas the control, vermiwash, salt-free, and compost + humic treatments showed significantly lower carbohydrate contents. Seasonal differences were minimal, indicating that treatment effects predominated. Carbohydrates are central to plant metabolism, serving as energy sources and structural components, and their synthesis is closely linked to photosynthesis and nutrient status (Amthor, 2010). The elevated carbohydrate percentages under humic and compost treatments suggest enhanced photosynthetic efficiency and carbon assimilation, likely due to improved nutrient uptake and better overall plant vigor (Canellas *et al.*, 2015).

Chlorophyll a concentration differed significantly among treatments Table 13. Compost application resulted in the highest chlorophyll a value in both seasons (20.48 and 20.52 mg kg⁻¹) respectively, followed by compost + humic and humic treatments. The control plants exhibited the lowest chlorophyll a concentration, while vermiwash and combined treatments showed intermediate values. Similar response patterns were observed in both years. Chlorophyll a concentration was highest under compost treatment, followed by compost + humic and humic treatments, while control plants showed the lowest values. This pattern suggests that organic amendments enhanced photosynthetic pigment synthesis, likely due to improved nutrient status, especially nitrogen and magnesium, which are essential for chlorophyll biosynthesis (Taiz & Zeiger, 2010).

Chlorophyll b content responded distinctly to the applied treatments Table 13. The highest chlorophyll b values were consistently obtained under the humic treatment (34.23 and 34.26 mg kg⁻¹), followed by compost application. In contrast, the control treatment recorded the lowest chlorophyll b concentrations in both seasons. Other treatments showed intermediate pigment levels with minor variation between years. Chlorophyll b responses also varied, with the humic treatment recording the highest values, followed by compost, and the control exhibiting the lowest pigment levels. Higher chlorophyll b under humic treatment may indicate enhanced light-harvesting capacity, potentially leading to improved photosynthetic performance under a wider range of light conditions (Porra, 2002).

Overall, the results indicate that organic amendments and their combinations significantly modified osmolyte accumulation, carbohydrate synthesis, and photosynthetic pigment content, with highly consistent responses across the two growing seasons.

Table (13). Effect of compost, humic, salt free and vermiwash individually or in combination on proline (%), total carbohydrate (%), chlorophyll a (mg/kg) and chlorophyll b (mg/kg) of Picual cv. during 2024 and 2025 seasons

Treatments	Proline (%)		Total carbohydrate (%)		Chlorophyll A (mg/kg)		Chlorophyll B (mg/kg)	
	2024	2025	2024	2025	2024	2025	2024	2025
1- Control	1.933A	1.973A	10.13F	10.15F	9.44G	9.50G	16.13H	16.20H
2- Compost	1.333E	1.390EF	27.64A	27.67A	20.48A	20.52A	33.76B	33.81B
3- Humic	1.600D	1.643D	27.74A	27.78A	16.19C	16.24C	34.23A	34.26A
4- Salt free	1.367E	1.413E	15.01C	15.03C	13.52E	13.57E	19.10E	19.14E
5- Vermiwash	1.300E	1.337F	12.63D	12.66D	13.84D	13.89D	16.68G	16.72G
6- Compost + humic	1.633CD	1.663D	10.19F	10.24F	16.83B	16.88B	22.40C	22.45C
7- Compost + salt free	1.800B	1.820B	24.32B	24.37B	13.39E	13.46E	19.78D	19.85D
8- Compost + vermiwash	1.700C	1.727C	12.16E	12.21E	10.88F	10.93F	17.37F	17.42F

Values in the same column followed by the same letter(s) do not significantly differ from each other according to Duncan's multiple range test at 5% level.

4. Conclusion

Application of organic amendments, particularly the combination of compost and salt-free extract, significantly improved the vegetative growth, leaf development, and reproductive performance of *Olea europaea* L. cv. Picual under saline conditions in El-Moghra region. Humic acid enhanced leaf expansion and photosynthetic efficiency, while vermiwash stimulated flowering and inflorescence quality. Biochemical analyses revealed that organic amendments promoted carbohydrate accumulation, chlorophyll content, and osmolyte regulation, contributing to improved stress tolerance. Nutrient uptake and ion balance were positively affected, mitigating the harmful effects of salinity. Overall, these treatments enhanced both growth and fruit yield, demonstrating their potential as effective biostimulants for olive cultivation in stress-prone environments.

Recommendations

- The use of compost combined with salt-free extracts is recommended for saline soils to maximize olive growth and productivity.
- Humic acid applications can be prioritized when the objective is to enhance vegetative development and leaf expansion.
- Vermiwash is recommended to improve flowering, fruit set, and reproductive efficiency.

Further long-term studies under different environmental conditions are advised to optimize application rates and combinations of organic amendments for sustainable olive production.

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