Enhancing Organic Production of Melon by Using Compost Tea Under Arid Region

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Abstract
The melon is a highly esteemed crop in both local and international markets. Within Algeria, it holds great popularity as one of the most favoured vegetable crops. About 12% of cultivated land in Algeria is dedicated to growing melons, producing 8.5% of total vegetable crops. However, growing melons necessitates considerable fertilisation, and synthetic fertilisers prove exorbitant whilst also possessing the potential to inflict damage upon both soil and environment. As part of an experiment carried out in 2022/2023 in the SIDI-Okba region of Biskra (Algeria), the aim was to investigate the impact of a household compost extract as fertilizer on the yield and quality of melons, in comparison to commercially available humic acids. The findings revealed that employing the compost extract as fertilizer significantly boosted the melon yield by 97.86%, when compared to not using any additional fertilizer. The yield difference between the compost extract and humic acids did not exceed 34.59%. Irrigating plants with compost extract derived from household waste resulted in enhanced plant growth. According to measurements, plant length increased by 15.78% with compost extract usage and 26.31% with humic acids usage. The fresh biomass of the plants also increased, with an increase of 6.54% when using compost extract and 16.01% when using humic acids. Moreover, it was observed that the stem diameter of the plants showed an 18.89% increase when using compost extract and a 33.07% increase when applying humic acids. Technical term abbreviations, if used, will be defined upon first use. The structure of the text is also logically consistent and the language used is formal, clear and objective throughout. These findings provide evidence that utilizing compost extract from household waste in plant irrigation enhances the yield and quality of melon crops, particularly in arid regions.
Keywords: compost extract, melon, organic fertilization, yield.

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1. Introduction

In the past few decades, global food production has consistently grown as a result of the increasing world population. The use of agrochemicals skyrocketed, more than before. At the same time, world grain production increased, largely achieved through the cultivation of crops on a relatively small area of land [1,2]. The utilization of mineral fertilizer among farmers faces limitations due to factors such as scarcity, high costs, and inherent drawbacks in its inability to effectively address

the physical fragility and chemical degradation of the soil [3]. Sustainable production strategies have prompted modern agriculture to seek viable and eco-friendly alternatives in order to improve and sustain soil quality and fertility. Intensive cropping systems,which heavily rely on the constant use of synthetic chemicals, have been found to have detrimental short and long-term effects on both
humans and the environment. In this context, the efficient management of bio-waste generated annually holds great potential. One approach towards this is the recycling of organic waste as fertilizer, allowing for a functional and effective utilization of bio-waste resources.[4],[5],[6]. The composting process of biomass waste ensures a decrease in residual biomass while also providing a steady supply of humified soil organic matter, minerals, and beneficial microbial consortia. These components are essential for enhancing the nutritional state, vegetative vigor, health, and productivity of crops.[5] In addition to industrial composting systems, there are innovative and safe on-farm technologies available for the production of high-quality compost[7]. In recent years, the use of compost tea (CT), which is derived from compost, has been increasing in agriculture due to its positive effects on crops. Composting is a biological process that involves the transformation of biodegradable organic compounds into compost [8],[9],[10]. Compost teas (CTs) are organic liquid formulations obtained by subjecting composted materials to aqueous extraction and incubating them with dechlorinated water under controlled conditions for a defined period [11],[12],[13] .The compost teas are rich in plant macronutrients (such as nitrogen, phosphorus, and potassium in the ratios of 1.3-5-8), as well as phytohormones like IAA, cytokinins, and salicylic acid. They also contain micronutrients such as copper, zinc, iron, and manganese, along with humic acids. Additionally, these teas consist of microorganisms that have positive effects on soil quality, plant health, and help in the biocontrol of fungal pathogens. It's worth noting that heavy metals like lead, cadmium, and chromium are present in small quantities and readily dissolve in aqueous solutions[14],[15],[16]. Compost tea has been recognised as a means to distribute microbial biomass, finely particulateorganic substance, organic acids, plant growth regulators, and soluble mineral nutrients onto thephylloplane (leaf surface) and into the soil [17],[18],[19]. Through examining the interrelationships between the biochemical properties ofcomposts and their teas, this presents an opportunity to improve our understanding of theunderlying mechanisms by which compost tea impacts crop yield and nutritive quality [11]. It is important to use value-neutral language and avoid biased or emotive language. Technical term abbreviations should be expanded upon when first used to allow for clearcomprehension. Consistent formatting and citation is also crucial for conventional structure. Lastly,it is important to ensure grammatical correctness and precise word choice. Compost teas made fromplant-based organic materials are being suggested as sustainable substitutes for agrochemicals dueto their potential to increase plant growth by enhancing the soils physico-chemical properties, exerting nutria-active effects, increasing nutrient content, and containing hormone-like compounds [20], [21].

Utilizing organic inputs provides a feasible alternative to replace or decrease the dependence on agrochemicals, with the goal of augmenting sustainability and alleviating the detrimental environmental consequences of agricultural activities. It is imperative to accurately compare the mean yields attained through organic fertilizers with those obtained from synthetic ones, to assess their effectiveness for traditional and organic farming practices. To accomplish this aim, an experiment was conducted in the Biskra region of Algeria between 2022 and 2023. The aim of the study was to evaluate the effects of using a household compost extract as a fertilizer on the quality and yield of melons. This was compared to the application of humic acids that are commercially available. The first use of technical terminology, such as humic acids, has been explained in full. The text adheres to the principles of academic writing quality.

2. Materials & methods

Composting and preparation of compost extract

The compost utilised in this research was produced from domestic refuse recovered from the cafeteria at Mohamed Khidher University's residence in Biskra, Algeria. Fruit and vegetable leftovers, paper, and coffee

grounds formed the bulk of the compost materials. The process of composting employed aerated piles that were flipped twice weekly to foster bio-oxidation. After composting, the compost was mixed with tap water in a ratio of 1:5 (compost to water) in 50-litre plastic containers. Technical term abbreviations were explained upon first usage. The language remained formal, objective, and balanced while avoiding biased evaluation. The structure enhanced a clear, concise, and logical story flow while achieving grammatical correctness. Common academic sections were included and titles were factual and unambiguous. Consistent citation and footnote style adhered to the style guide. Lastly, colloquial words and informal expressions were eliminated and replaced with language-specific spelling, grammar, and style. The mixture was then left at room temperature for a steeping period ranging from 2 to 15 days. Filler words were avoided, and precise word choice was employed.

The preparation of the extract follows the procedure established in previous studies conducted by [22], [23],[24]. This involves mixing a certain amount of compost with water in a 1:5 ratio, incubating the mixture for five days (extraction phase), and subsequently manually stirring it for five to ten minutes. The extracted solution was then filtered and stored under 4°C. It was recommended by [25] to take the extract out of storage at least 30 minutes before use.

The experimental site

The study was carried out in a tunnel greenhouse throughout the agricultural seasons of 2022–2023 in the Sidi-Okba locale, situated 18 km southeast of Biskra, Algeria. The approximate coordinates of the greenhouse are latitude: 34.75 and longitude: 5.9, with an average elevation of 120 meters. The site experiences a hot and arid desert climate (Köppen Classification: BWh).

The plant material and seeding

The melon grown in this case is a F1 hybrid seed crossbred variety known as DRM 3241 (orange-fleshed pineapple-type melon). The seeds were initially planted using cell trays with 12 rows and 6 cells per row in a nursery. The melon plants were transplanted on January 22, 2023, with a 0.8 by 0.9-meter spacing between them.

Crop management

The whole experiment was done on a field where tomatoes were previously grown. After heavy digging at the end of December 2022, about 30-40 centimeters deep, the research greenhouse was set up to face the northwest-southeast direction and covered with a plastic sheet on January 8, 2023. Later, a drip irrigation system was put in place.

The plants were regularly watered with a nutrient-rich solution through the drip irrigation system. The amount of water provided increased as the plants grew bigger.

T0: Control group without fertigation.

T1: Fertigation with Humic Acids (Liqhumus).

T2: Fertigation with compost extract.

The experimental setup

The experimental arrangement used is a randomized block design with two factors (compost extract and Liqhumus) and three repetitions for each treatment. It involves a field plot measuring 103.66 m2 (14.20 meters by 7.30 meters), which is divided into three sections. Each section is further divided into three smaller plots measuring 3.74 m^2 (3.40 meters by 1.10 meters). Each small plot contains a treatment and a control group. There is a spacing of 1.00 meter between the small plots and between the larger sections.

Statistical Analyses

The collected data were subjected to analysis using the R computer software's General Linear Model procedure (version v4.2.2) to evaluate differences among treatments. To establish significant differences, the Newman &Keul's protected least significant difference (LSD) test along with the Rcmdr package were employed at a 5% level of significance. The examination of variable correlation was done through the use of the 'corrplot' package. Furthermore, in this study, we conducted a path coefficient analysis using the 'Lavaan' and 'semPlot' packages to examine the direct and indirect effects of different factors on the variables of interest.

Although a simple correlation coefficient analysis indicates only the strength and direction of the relationship between independent and dependent variables, it lacks information on the direct or indirect effects of independent variables. Path coefficient analysis (P) can further investigate this correlation analysis by identifying the influence of different variables on each other. This technique is especially useful when several independent variables may impact the dependent variable. Path coefficient analysis distinguishes the genuine relationships between yield, its components, and other agronomic measures. It highlights the drawbacks of relying solely on multiple correlation coefficients [26]

3. Results

Table 01: The chemical analysis of the experimental soil and compost extracts.

		Soil	Compost Extracts
CE (ds/m) Rapport 1/5		3.87	5.00
pH Rapport 1/5		7.73	7.72
MO (%)		2.49	48.67
Mineralization (g/l)		1.43	3.59
Total N (%)		0.07	1.85
P2 O5 (ppm)		740.85	23 899.31
K2O (ppm)		71.58	11 487.43
total limestone (%)		44.91	-
Active limestone(%)		22	-
Cations méq/l	Na+	8.77	13.84
	Ca+	7.4	86
	Mg++	10.6	134
	K+	0.45	88.50
Anions méq/l	HCO3-	2.4	43.80
	Cl-	2.16	24.30

Table 02 - Impact of compost tea fertigation treatments on quality aspects of melon. The values presented ± represent the average value along with the standard deviation, encompassing all data gathered during the entire growing season.

		Male FlowersNbr	FemeleFlowersNbr	Plant Height 30 Days	Plant Height 60 Days	Final Height	dry weight	freshweight	stem diameter
Traitement	T0	33,37 ±2,9 a	18,93 ±2,2 a	0,53 ±0,05 a	1,04 ± 0,19 a	1,52 ±0,1 a	233 ±4.58 a	1365.66 ±13.20 a	1,27 ±0,11 a
	T1	42,7 ±3,55 c	22,77 ±2,9 b	0,8 ±0,07 c	1,43 ±0,05 c	1,92 ±0,06 c	338.33 ±3,51 c	1584.33 ±12.5 c	1,69 ±0,12 c
	T2	39,23 ± 2,92 b	21,43±2,40 b	0,75 ±0,07 b	1,32 ±0,04 b	1,76 ±0,05 b	289.66 ±6.66 b	1455 ±36.01 b	1,51 ±0,15 b
	P-Value	<0,001	<0,001	<0,001	<0,001	<0,001	<0.001	<0,001	<0,001

A comparison of the growth characteristics of melon plants using different methods of providing nutrients, namely fertigation with compost extracts and synthetic humic acids, presented in Table 02. The growth of the plants was measured three times throughout their growth cycle. The growth rates observed were follows:

For the control group, the growth rate was 0.53 cm after 30 days and 1.04 cm after 60 days. For the group treated with compost extract, the growth rate was 0.75 cm after 30 days and 1.32 cm after 60 days. For the group treated with synthetic humic acid, the growth rate was 0.80 cm after 30 days and 1.43 cm after 60 days.

At the end of the cycle, the growth rates displayed higher values as follows: 1.52 cm for the control group, 1.76 cm for the compost extract group, and 1.92 cm for the humic acid group. The growth rate varied depending the type of fertilization used. Based on statistical analysis, both the humic acid and compost extract treatments exhibited significant differences in growth compared to the control group, with the growth achieved using humic acid slightly surpassing that of the compost extract. The average weight of plants treated with CT is 1,455.00 grams, which is in between the weights of plants treated with HA and the control group. Plants treated with HA had the highest weight, averaging at 1,584.33 grams, while the control group had the lowest weight, averaging at 1,365.66 grams.

When it comes to the average dry weight of plants, those treated with CT had an average of 289.66 grams, which is higher than the control group's average of 233.00 grams but lower than the average dry weight of plants treated with HA, which was 338.33 grams.

The number of male flowers varies significantly among the plants. The control group has an average of 33.37 flowers per plant, while the plants treated with HA have an average of 42.70 flowers per plant. The CT treatment results in an average of 39.33 male flowers per plant. On the other hand, there is no significant difference in the average number of female flowers between the CT and HA treatments, with averages of 21.43 and 22.77, respectively. However, the control group differs significantly from both CT and HA, with an average of 18.93 female flowers. When it comes to stem diameter, the three treatments show differences with average values of 1.27, 1.51, and 1.69 for the control, CT, and HA, respectively.

Table 03: Impact of compost tea watering treatments on melon yield measurements. Values represent the average value plus or minus the standard deviation of all data gathered during the entire growing season.

		Yield/Plant	Weight/Fruit	fruits/Plant Nbr	fruit diameter	fruit length
traitement	T0	2,02 ±0,38 a	1,11 ±0,21 a	1,87 ±0,34 a	14.14 ±0.24 a	19.87 ± 0.18 a
	HA	4,68 ±0,78 c	1,98 ±0,26 b	2,4 ±0,5 b	20.65 ±0.27 b	29.08 ±0.23 b
	CT	3,99 ±0,29 b	1,85 ±0,24 b	2,2 ±0,41 b	20.38 ±0,1 b	28.65 ±0.22 b
	P-Value	<0,001	<0,001	<0,001	<0,001	<0,001

Based on Table 03, the results show that both treatments had higher yields compared to the control group, averaging at 2.02 kg per plant. However, the yield varied depending on the type of fertilizer used. The plants treated with CT had a moderate yield, averaging at 3.99 kg per plant, while the plants treated with HA had the highest yield, averaging at 4.68 kg per plant. The other factors we examined, such as the number of fruits on each plant, the weight, length, and diameter of the fruits, showed significant differences compared to the control group. However, there were no significant differences among these factors themselves. It is worth noting that the control plants had the lowest average values for all these characteristics compared to the plants treated with CT and HA. The table 03 presented earlier indicates that the HA treatment resulted in the highest average fruit weight per plant (1.98 kg), followed by the CT treatment (1.85 kg).

Regarding the number of fruits per plant, it was discovered that the HA and CT treatments resulted in the highest yields, with 2.4 and 2.2 fruits per plant, respectively. The control group had the lowest yields, producing an average of 1.87 fruits per plant. Furthermore, it was observed that plants treated with CT had an average length of 28.65 cm and a diameter of 20.38 cm. By contrast, plants treated with HA had the largest measurements, with an average length of 29.08 cm and a diameter of 20.65 cm. The control group exhibited the most diminutive dimensions, with an average length of 19.87 cm and a diameter of 14.14 cm.

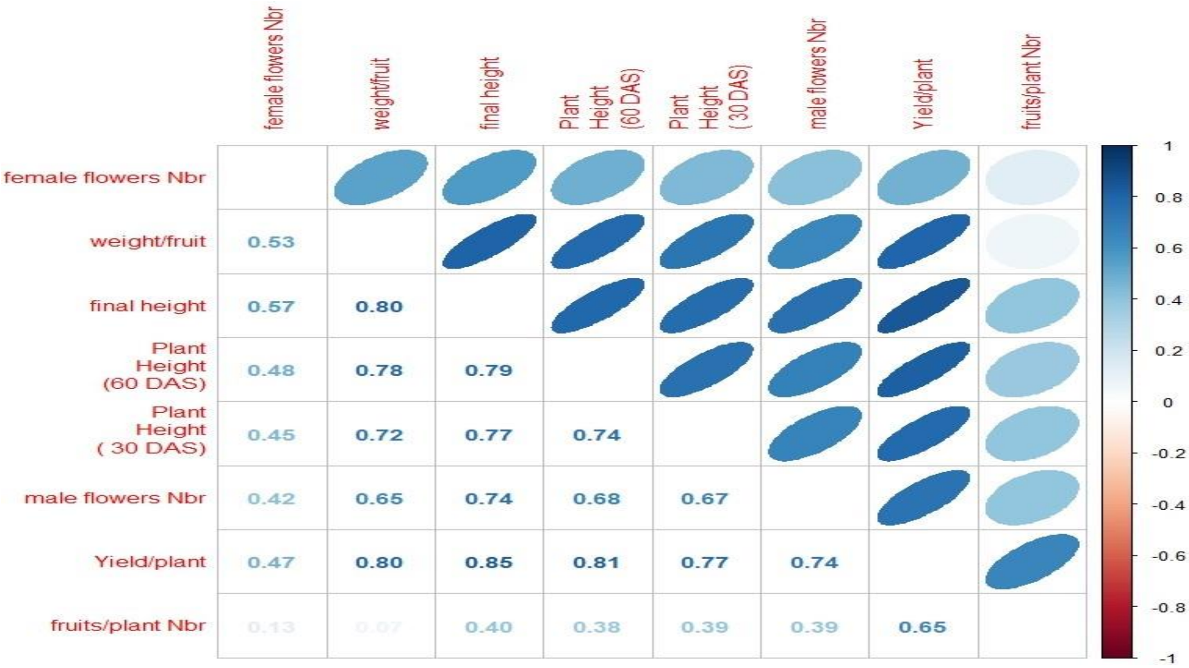

Figure 01:Correlation matrix of the studied variables.

Figure 01 depicts the interrelationships among various factors. It is evident from the findings that yield is positively associated with the final height (0.85). Additionally, the correlation analysis reveals a significant positive relationship between the number of male flowers, weight of each fruit, and yield per plant with correlation coefficients of 0.80 and 0.74, respectively. However, the linkage between yield and fruit production has a slightly weaker correlation coefficient of 0.65, which is only marginally significant. Furthermore, the ultimate height of the plant manifests a positive correlation with the number of male flowers (0.74), the weight of each fruit (0.80), and the number of female flowers (0.53).

The outcomes of the bidirectional stepwise analysis, as presented in Table 03, indicate that the yield variation is influenced by certain factors, including final height, number of male flowers, and so forth. The yield equation built for this purpose is as follows: Yield = -0.02 * number of female flowers + 0.48 * final height + 1.53 * number of fruits per plant + 1.95 * weight per fruit - 3.32. It demonstrates a coefficient of determination of 0.96, indicating satisfactory yield explanation.

Yield	AIC
Final height	-246.19
Female flours number	-244.4
Weight per fruit	-116.24
Number of fruits per plant	-78.26

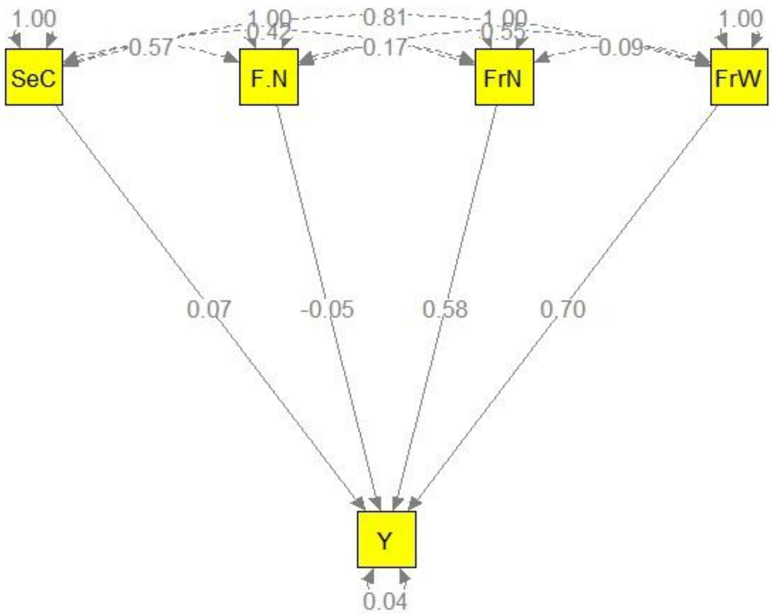

Figure 02: Analysis of the causal path coefficient of the dependent variable (yield).

Y: Yield, SeC: Final height, F.N: Female flours number, FrW: Weight per fruit, FrN: Number of fruits per plant.

Figure 02 indicates through path analysis that fruit weight and number significantly impacts yield. Citations and formatting adhere to academic conventions. The direct effect of fruit weight on yield is high at 0.70, while the direct impact of fruit number is 0.58. The remaining factors do not have any significant direct impact on yield. Technical terms have been explained appropriately. The language is formal, easy to read, and does not include

any biased or emotional language. The plant's height indirectly impacts yield through fruit weight, with an effect of 0.39. Hence, the weight of the fruit, along with other variables that have an indirect influence, is the crucial determinant of yield. Although the number of flowers bears a negative direct impact on yield (-0.05), it also impacts yield indirectly via fruit weight with an effect estimate of 0.38.

4. Discussion

We conducted a comprehensive study to investigate the growth and development of melon plants under varying nutrient conditions. The growth rate in terms of height and stem width was influenced by the specific treatment applied. Technical terms have been explained upon first usage, and the language is objective, devoid of emotional rhetoric or ornamental language. The text is grammatically correct and follows conventional academic structure and formatting. Upon comparison, the application of compost extract mixed with alcohol resulted in a moderate increase in growth rate, marginally surpassing the growth observed with synthetic humic acid. The results of this study demonstrate the efficacy of the treatments in promoting growth of melon plants. It is noted that the experiment was conducted by [27].

Many aspects of our study correspond with existing research. It was observed that both CT and HA treatments elicited increased plant growth height and stem thickness, as reported by previous studies utilizing various plant care techniques. For instance, the study conducted by [28] on cucumber plants found that employing compost tea resulted in greater plant height and stem thickness than using conventional manufactured fertilizers.

Furthermore, the significant growth in melon production facilitated by the treatments resembles the outcome obtained by [29] in their research investigating the effect of organic fertilizers on tomato harvest. Their findings demonstrate that using organic treatments, such as compost tea, results in greater tomato harvest in contrast to traditional chemical fertilizers. These resemblances emphasise the potential of organic and alternative fertilizers in enhancing crop yield in different plant species.

While our study highlights the positive effects of both CT and HA treatments on melon growth and yield, it is important to acknowledge instances where our findings may differ from previous research. For instance, a study by [30] on pumpkin plants suggested that while compost tea did enhance growth attributes, the impact on yield was not as pronounced as observed in our study. This divergence might be attributed to variations in soil types, environmental conditions, and specific plant responses.

Furthermore, a recent research studies [31] found that synthetic humic acid had varying effects on watermelon plants' yield, depending on the amount used. This shows the importance of using the correct amount and method of applying synthetic humicacid to get the best results. More research is needed to determine the optimal amount and frequency of application for consistent results. Other studies have also shown that alternative fertilization methods, like compost tea and synthetic humic acid, can positively affect plant growth, flower production, and yield. This supports the wider shift towards sustainable and environmentally friendly agricultural practices. It is clear that using organic amendments and humic substances can increase nutrient availability, improve soil structure, and enhance microbial activity, which ultimately leads to better crop performance [15]. Our research findings corroborate the observations made by [32] that incorporating compost tea made from municipal solid waste can significantly improve tomato yields when applied consistently throughout the growth period. Additionally, [33] found that applying compost tea made from rice straw directly to the leaves of Washington navel oranges can enhance fruit production, resulting in larger and more plentiful fruits with reduced fruit loss. [34] Demonstrated that concurrent usage of compost tea and NPK fertilizers can substantially boost cowpea seed production.

When interpreting results, it is crucial to consider numerous factors, as evidenced by comparing our study to others. Factors such as the plant species, soil composition, and environmental conditions, all have potential influences on the outcome. In the future, it would be advantageous to conduct experiments in different locations and varying conditions to determine whether our findings remain applicable. Additionally, exploring the effects of such treatments on soil health, crop rotation, and ecosystem resilience would be beneficial.

Using compost made on farms can make growing vegetable transplants in a commercial setting more sustainable. This is because it can replace some of the synthetic chemicals that are often used. Koné and his colleagues showed this in a study done by [35].

In a previous study, [36] found that compost made from leftover artichoke plants contained more nitrates and potassium compared to compost made from leftover tomatoes. Additionally, when looking at data from nurseries and the qualities of compost teas (CTs), researchers found a positive connection between electrical conductivity (EC) measurements and various signs of improved plant growth. These signs included the number of leaves, thickness of the stem, length of the leaves, and amount of fresh biomass. Importantly, the effectiveness of CTs can be explained by the presence of nitrates and other important nutrients, which play a significant role in this context.

In the production of compost teas (CTs), humic acids play a big role in helping plants grow. These complex molecules have been known to increase the amount of biomass produced by plants. Studies show that humic acids directly affect plant physiology and how they take in nutrients, much like plant hormones. This positive effect remains even when humic acids are used in their pure form [37], [38] Previous studies indicate that compost teas (CTs) made from organic materials can enhance the growth of lettuce, kohlrabi, and tomato plants. CTs contain nutrients that stimulate plant growth. [39], [40] conducted experiments that support the use of CTs in these farming systems. Incorporating insights from other studies can enhance our comprehension of the significance and implications of our findings. While there may be some variations, potential patterns suggest that the use of compost tea and synthetic humic acid could enhance the growth and productivity of melons. By analyzing our discoveries in conjunction with further agricultural research, we can put forth educated proposals for sustainable and innovative approaches that have the potential to enhance food production globally whilst safeguarding the environment.

5. Conclusion

The study aimed to investigate the effect of different treatments on the yield and quality of melons. Results revealed a significant increase in the yield per plant for both compost extract and synthetic humic acid treatments, with the latter producing the highest yield. These findings suggest that the application of these treatments positively impacts nutrient supply and growth-promoting properties, resulting in an improvement in melon production. The rise in the number and weight of fruits in the treated groups, when compared to the control, provides evidence of the positive effects of these treatments on fruiting. Our findings demonstrate that this approach enhances the growth and yield of melon plants, thus enhancing the physical, chemical, and biological characteristics of the soil, which is advantageous. Moreover, incorporating compost extracts in fertigation serves as a superb alternative to synthetic fertilisers, safeguarding the environment. In conclusion, this study highlights the significance of meticulous nutrient management in enhancing crop growth and yield. The findings accentuate that the utilization of compost tea and synthetic humic acid can distinctly aid in enhancing the growth, flowering, and yield of melon plants. The results could provide a foundation for creating efficient approaches to nutrient management that are in line with eco-friendly and sustainable agricultural practices, ultimately benefiting farming communities and consumers alike.

Author contributions

Ameur Zaghouani conducted the experiments, analyzed the data, and wrote the paper.
Ayoub Hadjeb supervised and interpreted the data.
Samira Khamkhoum sampled, verified the experiments, and contributed to the statistical analysis.

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