

## Improving Organic Melon Production Through the Application of Compost Tea in Arid Regions.

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### Abstract

This study aims to evaluate some physiological aspects and yield of melon (*Cucumis melo* L.) under organic and conventional fertigation in arid environmental conditions. A greenhouse experiment utilised a randomised complete block design to assess the impacts of compost tea (CT), commercial humic acid (HA), and a non-fertilized control (T0) on growth and yield. The results demonstrated significant disparities among treatments for all characteristics. HA enhanced plant height by 26% and stem diameter by 33% compared to T0, while CT demonstrated increases of 16% and 19%, respectively. Dry biomass increased by 45% under CF and by 24% under CT compared to the control. For yield components, the yield per plant augmented by +131% with HA and +97% with CT. Correspondingly, the average weight of fruit increased by +78% under HA and +67% under CT. Fruit size exhibited significant enhancements: fruit length grew by +46% and +44%, and fruit width by 46% and 44% under HA and CT, respectively, in comparison to T0. Although HA had the highest total yield, CT also achieved notable improvements relative to the control, highlighting its potential as a sustainable and eco-friendly alternative that reduces dependence on conventional fertilisers in melon cultivation systems.

### Introduction

Global food production has experienced steady growth to meet the needs of an expanding population, necessitating intensive farming systems based on the constant use of synthetic chemicals (Pilla et al., 2023). However, the overuse of chemical fertilizers deteriorates soil quality and causes harmful effects in both the short and long term for humans and the environment (Pilla et al., 2023; Su et al., 2022). The use of chemical fertilizers also contributes to soil acidification, compromising their long-term health (Ye et al., 2022).

This environmental and health concern motivates contemporary agriculture to pursue legitimate, sustainable, and eco-friendly options that can enhance and preserve soil quality and fertility throughout time (Pilla et al., 2023). The utilization of compost and other organic fertilizers is increasingly recognized as a viable alternative to chemical fertilizers for the production of healthy food (Jandaghi et al., 2020). The recycling of organic waste into fertilizer

is a crucial strategy for sustainable production, minimizing the reliance on chemical fertilizers by substituting them with organic fertilizers sourced from plant and animal waste (Pilla et al., 2023; Salam & Roshdy, 2022). The utilization of novel compost-derived products, such as compost tea, is on the rise owing to its beneficial impacts on crops (Pilla et al., 2023).

Compost tea is characterized as the application of decomposed organic fertilizer obtained through various extraction techniques, optimizing the retrieval of microbial communities, functional compounds, and nutrients included in the compost (Fu et al., 2024). Compost extract is essentially a liquid fertilizer created by soaking organic compost in water at defined ratios, facilitating nutrient release through an aerobic fermentation process (Metwally & Kishta, 2019). This liquid option provides significant benefits compared to traditional fertilizers. Compost tea serves as the optimal alternative source of liquid organic nutrients for horticultural and agricultural applications, its versatility exceeding that of its parent material (Eudoxie & Martin, 2019). The advantageous microorganisms present can proliferate extensively and effectively execute their biological control function, alongside their nutritional purpose, once introduced to the soil (Fu et al., 2024).

The application of compost tea is characterized by its ease of use and versatility. It can be used as a foliar fertilizer and soil amendment to provide plants with water-soluble nutrients while improving soil structure and its water retention capacity (Metwally & Kishta, 2019). The application techniques include drip irrigation at the root level, foliar spraying thru integrated water and fertilizer technologies, or its use as a nutrient solution for soilless cultivation (Fu et al., 2024; Kiss et al., 2021; Metwally & Kishta, 2019). This adoption of aqueous compost extracts as an ecological alternative to chemical fertilizers is of significant importance for sustainable agriculture (Abubaker et al., 2024).

In addition to agronomic efficiency, compost tea provides supplementary nutritional advantages. It serves as a feasible nutrient source for hydroponic cultivation in greenhouse settings, enhancing nutraceutical quality. The application of compost tea is recommended as a fertilizing alternative to improve the antioxidant capacity of hydroponic (Santiago-Lopez et al., 2016).

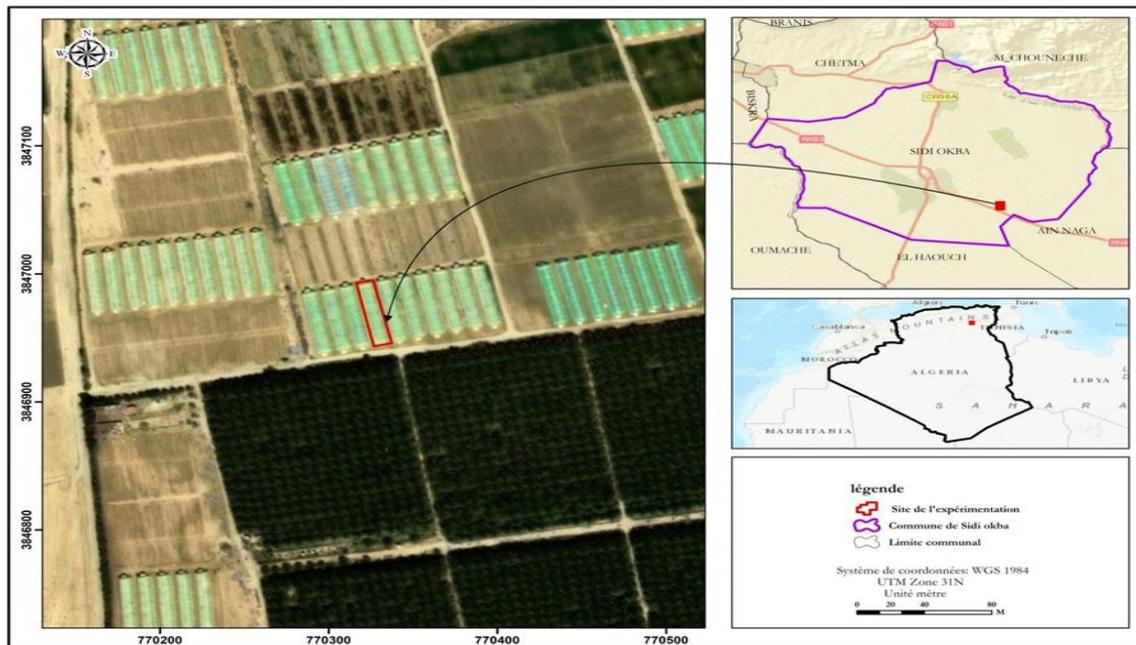
The aim of this study is to quantitatively and qualitatively compare the effects of compost tea and conventional fertilization on the morphological parameters and yield of melon crops. The experiment aims to demonstrate the relative advantages of these fertilization strategies, thereby contributing to informed decisions for farmers and researchers. This work fills the identified knowledge gap by providing a robust and evidence-based assessment that supports the advancement of sustainable melon production systems.

## 1. Materials & Methods

### The experimental site

The study was carried out in a tunnel greenhouse throughout the agricultural seasons of 2023–2024 in Sidi Okba, which occupies a precise geographical position at 34°44'54.44" N latitude and 5°53'59.98" E longitude, is located approximately 10 km southeast of the city of Biskra (Merabti et al., 2019). The climate of the Sidi Okba region is classified as hot desert (BWh

according to the Köppen-Geiger classification)(Besbas et al., 2022). Average temperatures reach 34.8°C in July and 11.5°C in January according to (Selmane & L'Hadji, 2016).



**Figure 1:** Geographical location of the study area

### Plant material and seeding

The melon in issue is an F1 hybrid seed variety, including the DRM 3241, characterized as an orange-fleshed pineapple-type melon. The seeds were initially sown in cell trays containing 12 rows with 6 cells each. The melon plants were relocated on January 22, 2024, with a spacing of 0.8 by 0.9 meters between them.

### Composting and preparation of compost extract

The composting process utilized the pile composting approach, beginning with the preparation of an inoculum consisting of 15 kg of kitchen waste and 5 kg of agricultural soil, which was incubated for 7 days to facilitate the multiplication of degrading microbes. The procedure is layering organic waste and inoculum (5 kg per pile) alternately to create a pile measuring 1.5 meters in diameter and 1 meter in height, with ventilation holes created using a stick, subsequently covered with a white plastic tarp. The heaps are rotated and irrigated biweekly, if needed, throughout a three-month composting duration (Alium et al., 2021).

Compost tea was prepared under non-aerated circumstances by immersing compost in a specific volume of water and allowing it to soak for several days, with intermittent agitation (Eudoxie & Martin, 2019). The mixture is sealed and stored in darkness at 18°C for 14 days (Tegegn, 2017). The process is combining 100 g of sieved compost with 2 liters of deionized water, stirring for 24 hours at 1100 rpm, and thereafter allowing it to rest for 24 hours prior to filtration (Vehniwal et al., 2020).

### Study design and treatment applications

The experiment was arranged in a randomized block design with three treatments (compost tea, liquid Liqhumus, and a control) and three replicates per treatment.

Plants were regularly watered manually with one of two treatments (Liqhumus and compost tea). Fertigation application of compost tea, involves applying the liquid fertilizer directly to the soil around plant roots rather than onto plant surfaces (Fouda & Niel, 2021). Application rates at the base of plants to 100 ml of solution applied weekly throughout the growing season starting from the second week after transplanting (Abubaker et al., 2024).

### Agronomic traits related to plant growth and yield

Plant growth and yield parameters Plant vegetative parameters, including plant height, Steam diameter, fresh weight, and dry weight. In addition, yield/plant, weight/fruit, fruits/plant number, fruit diameter, and fruit length were also recorded as indicators for yield potential.

### Data Analysis

The data collected were analysed using the General Linear Model procedure of the R program (version v4.2.2) to assess treatment differences. The Newman & Keul's protected least significant difference (LSD) test, utilizing the Rcmdr software, was applied to identify significant differences at a 5% significance level. The analysis of variable correlation was conducted using the 'corrplot' software.

## RESULTS

**Table 1: The chemical analysis of the experimental soil and compost extracts.**

	CE 1/5	pH	M O	N	P <sub>2</sub> O <sub>5</sub>	K <sub>2</sub> O	Na <sup>+</sup>	Ca <sup>2+</sup>	Mg <sup>2+</sup>	K <sup>+</sup>	HCO <sub>3</sub> <sup>-</sup>	Cl <sup>-</sup>
	(dS/ m)	1/5	(%)	(%)	(ppm)		(méq/L)					
Soil	3.88	7.6 6	2.5 2	0.07 2	756.72	69.77	8.57	7.59	10.8	0.4 5	2.47	2.15
Compos t Tea	4.93	7.7 9	48. 0	1.86	23259.4 1	11679.0 7	13.4 5	85.0 4	131.7 9	90. 9	42.67	24.6 9

**Table 2: Impact of compost tea fertigation treatments on morphologic aspects of melon.**

The values presented ± represent the average value along with the standard deviation, encompassing all data gathered during the entire growing season.

		Plant Height	Steam Diameter	Fresh Weight	Dry Weight
<b>Treatment</b>	T0	1,52 ±0,1 a	1,27 ±0,11 a	1365.66 ±13.20 a	233 ±4.58 a
	CF	1,92 ±0,06 c	1,69 ±0,12 c	1584.33 ±12.5 c	338.33 ±3,51 c
	CT	1,76 ±0,05 b	1,51 ±0,15 b	1455 ±36.01 b	289.66 ±6.66 b
	P- Value	<0,001	<0,001	<0,001	<0,001

A comparison of the growth characteristics of melon plants using distinct nutrient provision strategies, specifically fertigation with compost tea and synthetic humic acids, is shown in (Table 02).

At the conclusion of the cycle, the plants' growth was quantified, revealing the following growth rates: 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 fluctuated depending on the type of fertilisation employed. Statistical analysis revealed that both humic acid and compost extract treatments demonstrated significant growth differences compared to the control group, with humic acid slightly outperforming the compost extract. The mean weight of plants subjected to CT is 1,455.00 grams, situated between the weights of plants treated with HA and those in the control group. Plants subjected to HA treatment exhibited the greatest weight, averaging 1,584.33 grams, whereas the control group displayed the lowest weight, averaging 1,365.66 grams. The average dry weight of plants treated with CT was 289.66 grams, surpassing the control group's average of 233.00 grams; however, it fell short of the average dry weight of plants treated with HA, which was 338.33 grams. The stem diameters of the three treatments exhibit variations, with average values of 1.27, 1.51, and 1.69 for the control, CT, and HA, respectively.

**Table 3: Impact of compost tea watering treatments on melon yield measurements.**

		Yield/Plant	Weight/Fruit	Fruits N° /Plant	Fruit diameter	Fruit length
Treatment	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
	CF	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
Values represent the average value plus or minus the standard deviation of all data gathered during the entire growing season.						

According to Table 03, the findings indicate that both treatments yielded greater outcomes than the control group, averaging 2.02 kg per plant. The yield fluctuated based on the fertiliser type employed. The plants subjected to CT exhibited a modest output, averaging 3.99 kg per plant, but those treated with HA demonstrated the highest yield, averaging 4.68 kg per plant. The additional characteristics we analysed, including the quantity of fruits per plant as well as the weight, length, and diameter of the fruits, exhibited substantial disparities relative to the control group. Nevertheless, no substantial variations were observed among these parameters. The control plants had the lowest average values for all these traits in comparison to the plants treated with CT and HA. The results reveal that the HA treatment yielded the highest average fruit weight per plant (1.98 kg), followed by the CT treatment (1.85 kg). The HA and CT treatments yielded the maximum amount of fruits per plant, at 2.4 and 2.2, respectively. The control group exhibited the lowest yields, with an average of 1.87 fruits per plant. Additionally,

it was noted that plants subjected to CT exhibited an average length of 28.65 cm and a diameter of 20.38 cm. In contrast, plants subjected to HA exhibited the greatest dimensions, averaging 29.08 cm in length and 20.65 cm in diameter. The control group displayed the smallest dimensions, with an average length of 19.87 cm and a diameter of 14.14 cm.



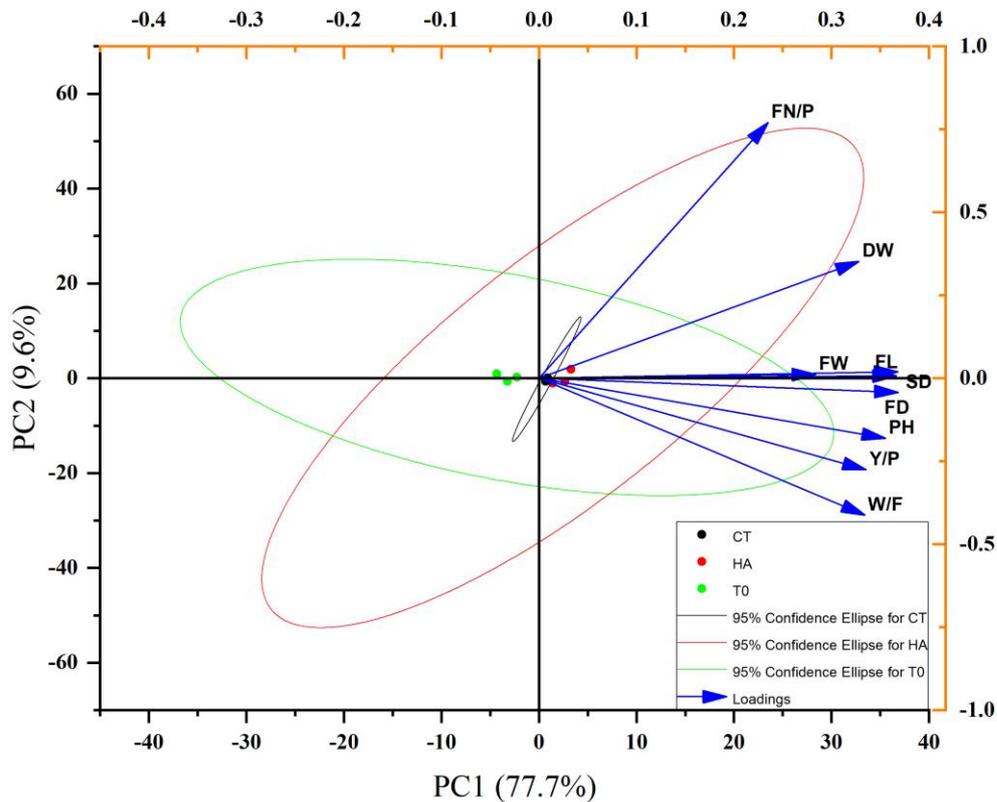
**Figure 2.** Correlation matrix between the studied parameters

**PH:** Plant Height; **SD:** Stem Diameter; **FW:** Fresh Weight; **DW:** Dry Weight; **Y/P:** Yield/Plant; **W/F:** Weight/Fruit; **FN/P:** Fruits Number /Plant; **FD:** Fruit diameter; **FL:** Fruit length.

The results of the correlation analysis showed strong positive relationships between most of the studied indicators (Figure 2). It was found that plant height (PH) is strongly correlated with stem diameter (SD) ( $r = 0.94$ ), reflecting the relationship between the longitudinal and radial growth of the plant. High correlations were also observed between vegetative growth and fruit traits, as plant height and stem diameter were correlated with both fruit diameter and length ( $r > 0.89$ ), indicating that plant vigour plays a key role in determining fruit size.

On the other hand, fresh weight (FW) was moderately correlated with dry weight (DW) ( $r = 0.71$ ), while stem diameter showed a strong correlation with dry weight ( $r = 0.85$ ). These results confirm the importance of balance in vegetative growth and dry matter accumulation in supporting the formation of fruits with good characteristics. The yield per plant (Y/P) had a substantial correlation with the weight of fruit (W/F) ( $r = 0.89$ ) and its dimensions (fruit diameter and length,  $r > 0.85$ ), although its association with dry weight was moderate ( $r = 0.59$ ). Conversely, the fruits number per plant (FN/P) had modest connection coefficients with most

characteristics, including total yield, underscoring that productivity is predominantly influenced by the size and weight of the fruits rather than their quantity.



**Figure 3.** The PCA biplot of the three unique groupings

**PH:** Plant Height; **SD:** Steam Diameter; **FW:** Fresh Weight; **DW:** Dry Weight; **Y/P:** Yield/Plant; **W/F:** Weight/Fruit; **FN/P:** Fruits Number /Plant; **FD:** Fruit diameter; **FL:** Fruit length.

Principal Component Analysis (PCA) shows that the first two dimensions (PC1 and PC2) explained a large percentage of the total variance among the treatments, amounting to 77.7% and 9.6%, respectively, which exceeds 87% of the total variation. The first dimension (PC1) shows a close correlation with most of the productive and morphological variables, particularly the number of fruits per plant (FN/P), dry weight (DW), fresh weight (FW), fruit length (FL), yield per plant (Y/P), and fruit weight (W/F), indicating that this axis primarily represents the productivity factor. The second dimension (PC2) contributed minimally to differentiating the treatments, as it was predominantly linked to the variable's the number of fruits per plant (FN/P) and dry weight (DW).

The chart indicates that the HA treatment is situated on the favorable side of PC1, demonstrating a notable enhancement in growth and production characteristics relative to the other treatments. The T0 was situated on the negative side of PC1, signifying its subpar results for growth and productivity. The CT treatment was positioned in the middle and close to the origin center, indicating a lower yield less related to productive traits compared to the HA treatment.

## Discussion

The use of compost tea significantly enhances plant vertical growth. (Natsheh & Abu-Khalaf, 2020) reported that plants subjected to compost tea attained a maximum length of 42.3 cm after 60 days, representing a 77% increase compared to the control plants, which measured only 23.8 cm. The enhancement in longitudinal growth is corroborated by further morphological characteristics, particularly plant height, which markedly rises with the use of compost tea (Abubaker et al., 2024). Research on marjoram confirms this general trend, showing that the application of compost tea significantly increases plant height (Sayara et al., 2020). These morphological enhancements result in improved plant nutrition and indicate more robust vegetative growth under the effect of compost tea.

The utilisation of compost tea results in significant enhancements in stem diameter. The stem diameter markedly rises with the application of compost tea in comparison to control treatments (Moursy et al., 2021; Zenna & Mahmoud, 2020). The advantageous impact of compost tea on stem width has been recorded in several species, including peppers, tomatoes, melons, and potatoes, illustrating the adaptability of this organic remedy (Khairani et al., 2023). These morphological enhancements are concomitant with improved biomass allocation, prioritising root development over aerial structures in comparison to inorganic fertilisers (Eudoxie & Martin, 2019). The utilisation of compost tea yields significant increases in fresh biomass in melon, averaging 8.2% more than the chemically fertilised control (Moursy et al., 2021; Natsheh & Abu-Khalaf, 2020; Vilecco et al., 2020). The enhancement in biomass production is attributed to an augmented absorption of mineral nutrients, which favourably affects the leaf area and improves light interception, photosynthesis, and the utilisation of water and nutrients (Eudoxie & Martin, 2019). Research on several crops corroborates these advantages, especially in peppers, where compost tea yields the greatest fresh and dry fruit weight (Mohamed et al., 2021). Inorganic fertilisers can surpass compost tea, yielding much more fresh and dry biomass compared to organic treatments (Carrascosa et al., 2023).

Compost tea exhibits advantageous effects on dry matter in several cultivated species, such as tomatoes, melons, and potatoes (Khairani et al., 2023). Tomato plants subjected to weekly compost tea treatment exhibit a threefold increase in dry weight relative to the control group (Khairani et al., 2023). It is crucial to acknowledge that, under specific circumstances, inorganic fertilisers can yield considerably greater dry biomass than compost tea (Carrascosa et al., 2023). Compost tea can yield growth attributes akin to inorganic fertilisers while necessitating reduced nutritional input (Eudoxie & Martin, 2019). A significant distinction exists in biomass allocation: compost tea enhances root growth at the expense of aerial parts, but inorganic fertilisers yield the contrary effect (Eudoxie & Martin, 2019; Russo & Fish, 2012). The integrated nutrient management technique enhances the biophysical characteristics of the soil while sustaining plant growth and yield (El-Gizawy & Gerjes, 2013).

Relative performance fluctuates based on experimental settings. Inorganic fertilisers yield markedly greater fresh and dry biomass of aerial components than compost tea alone (Carrascosa et al., 2023). Likewise, mineral fertiliser applications can achieve the highest

metrics for all growth parameters, although compost tea alone occasionally results in the lowest metrics (Abou-El-Hassan & El-Batran, 2020).

Our study comparing compost tea to chemical fertilisers shows variable results in terms of total yield per plant. Several researchers have found that compost tea can produce yields equivalent to those of synthetic fertilisers (González et al., 2020). In greenhouse tomato production, the application of compost tea to the soil resulted in significant yield increases compared to control treatments (Abubaker et al., 2024). For sweet pepper cultivation, compost tea treatments resulted in substantial yield increases of 52.9% and 38.5% compared to the control treatments watered only during consecutive seasons (Hassanin et al., 2021). Similarly, the application of compost tea at optimal rates resulted in higher fruit yields in eggplant production, with the best results obtained at 100 litres per hectare (Rufa'i et al., 2024).

However, chemical fertilisers are often more effective than compost tea alone. Research on date palms has shown that, while compost tea combined with other organic amendments improved yield compared to basic organic treatments, chemical fertilisers retained the highest yield characteristics (Mohammed et al., 2010). For cucumber production, the highest total yield was observed with inorganic nutrient solutions, followed by chicken compost tea, and then other compost tea formulations (Diab et al., 2012). Studies on hydroponic systems have shown that the Steiner solution achieved higher yields (41.8-44.4%) than organic nutrient solutions (Santiago-Lopez et al., 2016).

The application of compost tea can match, or even exceed, the performance of chemical fertilisers in terms of yield per melon plant. Studies show that compost tea improves fruit yield, equivalent to that of inorganic nutrient solutions (González et al., 2020). In cantaloupe production, biological treatments, including compost tea, have resulted in higher total yields than recommended doses of chemical fertilisers, with the highest yields observed in specific compost tea formulations (Mohamed & Ali, 2016). The extent of yield improvements varies depending on the application method and concentration. The incorporation of compost into the soil has shown more moderate but consistent improvements, with average yield increases of 11% according to different application rates (Villena et al., 2018).

The effect of compost tea on fruit weight varies depending on growing conditions and application methods. In melon production, compost amendments increased the average fruit weight by 0.2 kg compared to control treatments, although this effect was more pronounced during certain growing seasons than others (Villena et al., 2018).

Research on related crops corroborates these results, showing that compost tea consistently improves fruit weight parameters. In cantaloupe production, the fresh weight of the fruits significantly increased with compost tea applications, compared to the recommended doses of chemical fertilisers (Mohamed & Ali, 2016). Similarly, studies on sweet peppers demonstrate that plants fertilised with compost tea produced the highest values of fresh and dry fruit weight compared to other treatments (Mohamed et al., 2021).

However, the relationship between compost tea and fruit weight may vary depending on the application method (Hassanin et al., 2021). This suggests that different formulations of organic tea can influence fruit development through distinct mechanisms.

Research shows that the application of compost tea significantly increases fruit production per plant for many crops. In pepper cultivation, compost tea treatments increased the number of fruits per plant, rising from 15.82 to 19.77 fruits in control treatments to 23.42 to 24.33 fruits per plant in consecutive seasons (Hassanin et al., 2021). The yield increases in these pepper studies were specifically related to a higher number of fruits rather than changes in the weight of individual fruits (Zaccardelli et al., 2018).

Spraying compost tea on greenhouse tomatoes significantly increased the number of fruits per cluster from 5.5 to about 7 compared to control treatments (Abubaker et al., 2024). In other crops like green beans, the optimal application of compost tea at a rate of 100 litres per hectare significantly increased the number of pods per plant compared to lower rates and control treatments (Ibrahim et al., 2021). However, the relationship between the number and size of the fruits can vary, with some treatments producing more small fruits while others favour fewer but larger fruits (Lasum & Chan, 2024).

The constant improvement in diameter and length parameters indicates that organic fertilisation promotes balanced fruit growth rather than a simple increase in mass due to water content. The application of compost tea improves the dimensional parameters of melon fruits. In cantaloupe production, the diameter and circumference of the fruits significantly increased when the plants received organic fertilisers, compared to the control treatment with the recommended doses of chemical fertilisers (Mohamed & Ali, 2016). For melon in particular, the combination of compost fertiliser with 50% NPK gave the highest yield in fruit circumference, although the results were not significantly different from other treatments (Junaidi & Wulandari, 2018).

Plants fertilised with compost tea produced the highest values for fruit length and diameter, followed by those treated with fulvic acid during both growing seasons (Mohamed et al., 2021). The effects vary depending on the crop and the method of application. In chilli cultivation, the application of organic compost increased fruit length by 8.9% and 7.1% compared to urea-based fertiliser, while also improving their diameter (Setyowati et al., 2014). For eggplant production, compost tea at a rate of 100 litres per hectare significantly affected fruit diameter and overall yield (Rufa'i et al., 2024).

## Conclusion

The experimental groups exhibited an increase in both the quantity and mass of fruits in relation to the control group, substantiating the hypothesis. This investigation sought to examine the effects of different treatments on the yield and quality of melons. The results indicated a marked enhancement in yield per plant associated with both compost extract and synthetic humic acid treatments, with the latter yielding the most substantial results. These outcomes imply that the application of such treatments favourably influences nutrient availability and growth-promoting attributes, thereby contributing to an increase in melon production. The treated cohorts demonstrated an increase in both the quantity and mass of fruits when contrasted with the control, reinforcing the beneficial impacts of these treatments on fruiting. Our results elucidate that this methodology facilitates the growth and yield of melon plants, thereby improving the physical, chemical, and biological properties of the soil, which is advantageous. Additionally,

the integration of compost extracts in fertigation presents a commendable alternative to synthetic fertilisers, thereby protecting the environment. The findings show that compost tea and synthetic humic acid can greatly improve melon plant development and output. These findings could pave the way for the development of effective nutrient management systems that are consistent with environmentally sustainable farming practices, thereby benefiting both agricultural communities and consumers.

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