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Partial Replacement of Mineral Fertilizers and Ameliorative Effects of Organic Fertilizers on Yield and Quality of Sweet Pepper under Green House Conditions

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ABSTRACT

This study pursued to investigate sustainable methods to increase growth and yield of sweet pepper. To realize this purpose, a plastic house experiment was done, and two factors were studied under split-plot design. The main factor was focused on the application of mineral and organic rates (100% NPK,75% NPK+ 25% chicken manure, 50% NPK+ 50% chicken manure). The sub main factor was spraying of the organic liquid tea, specifically compost tea and vermicompost tea, in addition the Control treatment to study its effect on vegetative growth, chemical constituents, photosynthetic pigments, yield and quality. The results cleared that the treatment of 100% NPK of recommended dose enhanced vegetative growth, while 75% NPK of recommended dose + 25% chicken manure enhanced chemical contents in leaves and fruits in addition enhanced yield and quality. Concerning the impact of the organic liquid tea, the maximum values of all studied traits obtained from spraying vermicompost tea compared to other applications. It is evident that the combination of ٧5% NPK of recommended dose + 25% chicken manure and spraying with vermicompost tea showed a bilateral interaction that was noticeably better than other interactions. Growers may improve the productivity and nutritional value of sweet peppers by taking these suggestions into practice, which will ultimately benefit both producers and consumers.

Keywords: Chicken manure, compost tea, vermicompost tea, sweet pepper

INTRODUCTION

Sweet pepper (*Capsicum annuum* L.) is a popular vegetable crop grown for its high nutritional content and commercial value (Fratianni *et al.,* 2020). It is an essential component of many international culinary traditions in addition to being a lucrative commodity in the agricultural sector. Growing sweet peppers, particularly in protected environments, is crucial to guaranteeing a steady supply of this adaptable vegetable all year long (Cisternas-Jamet *et al.,* 2020). It's important to remember that the color and freshness of sweet peppers might have a minor impact on their nutritional makeup. Compared to green peppers, red, yellow, and orange peppers typically have higher concentrations of specific nutrients, such as vitamin C and carotenoids (Salamatullah *et al.,* 2022). Sweet peppers can offer a variety of vital nutrients and support a healthy, balanced diet when added to meals and snacks (Hur *et al.,* 2023). Researchers and growers have been investigating a number of methods to improve growth, yield, and quality in order to maximize sweet pepper production and satisfy the rising demand. One of the main contributing causes to the significant rise in agricultural production to meet the growing human population is the improvement in soil productivity. Soil health is a key component in achieving improved yields and quality. Therefore, in order to attain sustained production with the fewest negative impacts of chemical fertilizers on soil health and the environment, chemical fertilizers must be combined with renewable and environmentally benign organic manures, such as chicken manure, compost, and vermicompost. When organic and inorganic materials are applied in the right proportions, the yield per unit area can be raised while also improving its quality. Although mineral fertilizers are thought to be a significant source of plant nutrition, their overuse results in significant costs for plant production, agro-ecosystem degradation, and a decline in soil fertility (Singh and Ryan, 2015).

It is well recognized that the mineral nutrients N, P, and K have an impact on capsicum development and production. All growth and yield indicators were significantly impacted by the application of N fertilizer amounts. For example, pepper yield rose when nitrogen (N) levels rose, but too much N application might potentially reduce yield (Khan *et al*., 2014).

The osmo-regulation process, the regulation of plant stomata and water use, the translocation of sugars and the formation of carbohydrates, the energy status of the plant, the regulation of enzyme activities, protein synthesis, and numerous other processes required to support plant growth and reproduction are just a few of the numerous significant regulatory functions in which potassium is involved. It has a particular phenomenon known as luxury consumption and is also a highly mobile element in the plant. Due to its significant impact on quality characteristics, potassium is frequently referred to as the quality nutrient (Lester *et al*., 2006).

In plants, phosphate is essential for a number of physiological and biochemical functions, including as photosynthesis, energy conservation, intracellular and intercellular coordination of carbohydrate metabolism, and energy transfers (Abel *et al*., 2002).By improving soil

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aggregation and raising the amount of organic matter in the soil, organic matter improves the chemical and physical properties of the soil, as well as its biological activity and structure. It also stabilizes pH and speeds up the pace at which water infiltrates the soil. Furthermore, by promoting parasitism and antibiosis, organic matter shields crops from diseases and saprophytic (Doklega and Abd El-Hady, 2017).

Nowadays, the most effective integrated fertilization management which incorporates both organic and inorganic fertilizers is essential in this regard.

Thus, the lack of a fertilization program for pepper production in greenhouses continues to be a limiting factor, and further research is necessary to create a suitable fertilization program that meets the needs of pepper plants grown in plastic houses in order to maximize yield and quality. In order to determine the best fertilization schedule for pepper plants, these study aims to investigate the effects of mineral (NPK), organic, and foliar applications with compost tea and vermicompost tea on sweet pepper growth performance and productivity in plastic houses.

MATERIALS AND METHODS

The purpose of grow sweet pepper (Capsicum *annuum* L. Cv Lyrica yellow fruit) in the plastic house experiment was to examine the impact of different treatments, such as NPK rates (100- 75- 50% from recommended dose) in addition chicken manure, and spraying with compost tea and vermicompost tea on growth and yield.

This study was conducted on a private farm in Tanta district, El-Gharbia governorate, over the course of two seasons (2023–2024 and 2024–2025).

Soil samples were taken for routine analysis prior to transplantation, using the protocol set by Dewis and Freitas (1970). Before applying any treatments or interventions in the experimental setup, the analysis's goal was to evaluate the soil's baseline properties. Table 1 displays the initial characteristics of the soil.

Table 1. Characteristics of the experimental soil:

Season	Particle size distribution, %				Texture class	Available nutrients, mg kg^{-1}			Organic matter,%	EC, dSm-1 (1: 5 soil extract)	pH (1:2.5 soil suspension)
	C. Sand	F. Sand	Silt	Clay		N	P	K			
1st	6.50	12.7	31.7	49.1	Clay	48.5	7.74	235	1.32	3.12	8.09
2nd	5.70	13.9	32.1	48.3	Clay	47.1	7.66	242	1.29	3.04	8.04

Experimental setup

The plastic house's soil (6 m width and 40 m length) was ploughed and separated into five major plots (1 m width x 40 m length) for main plots. Each ridge was divided into three equal divisions (1 m width x 12 m length) as sub-main plots. Each sub-main plot was divided into three equal divisions (1.0 m width x 4 m length) as replicates. Treatments were done on the three middle ridges, while the two side ridges remained without treatments.

These seeds were utilized to ensure the standardization and reliability of the plant material used in the research. Seedlings were transplanted in plastic house on October 9th and October 7th in first and second seasons, respectively.

Experimental design and treatments

A split-plot design with three replicates was used for the study. There were 9 treatments with two factors to the experimental arrangement. The first primary element concentrated on the utilization of mineral and organic rates (100% NPK,75% NPK+ 25% chicken manure, 50% NPK+ 50% chicken manure). The sub main factor was spraying of the organic liquid tea, specifically compost tea and vermicompost tea, in addition the control (tap water). Chicken manure (Ck) was obtained from local zone at 20 m^3/fed. and added before planting (25% chicken manure was 5 m^3/fed, 50% chicken manure was 10 m^3/fed.). Table 2 clears its specification.

Recommended dose of NPK fertilization 200 kg N, 75 kg P_2O_5 and 150 kg K_2O/feddan were added from Nitric acid (15% N) and ammonium nitrate (33.5 N) as nitrogen sources. Phosphorus was obtained from phosphoric acid (55% P_2O_5). Furthermore, calcium nitrate (15.5%N +19% Ca_2O) was administered as a supply of calcium and nitrogen, and soluble potassium sulphate (50% K_2O) was supplied as a source of potassium.

The recommended dosage quantities (100% NPK) were added at a rate of 415 kg fed^{-1}. 200 kg of ammonium nitrate per fed., 200 kg of calcium nitrate per fed., 200 kg/fed. nitric acid, 100 kg/fed. calcium superphosphate, 82 kg fed^{-1} of phosphoric acid, 312.5 kg fed^{-1} of potassium sulfate. For this investigation, a drip irrigation network was created that included 16 mm diameter laterals (GR) with emitters spaced 0.3 meters apart, one lateral for each row. The discharge rate of the emitters was 4 $l.h^{-1}$.

Table 2. Some characteristic of chicken manure of both:

Properties	EC dS/m	pH	O.M. %	O.C. %	C/N ratio	Available nutrients			Soluble cations	
						N	P	K	Ca^{++}	Mg^{++}
						%			meq/L	
1st	3.88	7.61	59.24	34.63	15.2:1	2.25	1.04	1.56	3.03	2.66
2nd	3.74	7.72	59.41	34.71	15.4:1	2.33	1.06	1.74	3.05	2.78

Compost tea was prepared according to Mostafa *et al.* (2009). Table 3 displays a few of the compost tea's chemical properties.

Vermicompost tea was prepared according to Abdel-Salam and Roshdy (2022). Table 4 displays a few of the Vermicompost tea's chemical properties.

The plants were treated with compost tea and vermicompost tea at 50 ml L^{-1} using a hand sprayer until they reached saturation at five different times during the experiment: 20, 30, 40, 50 and 60 days after transplanting.

Every other agricultural method pertaining to the production of sweet peppers complied with the MASR's recommendations. When the mature pepper fruits reached their full color stage, they were picked. Harvesting in the first season started on 15 January and ended on 15 May. Harvesting in the second season took place from 5th January to 10th May. There were eighteen pickings in each season.

Table 3. The chemical properties of compost tea:

Mg L^{-1}						PH	EC
N	P	K	Fe	Mn	Zn		$dS.m^{-1}$
123	15.9	319	16.9	12.2	3.52	6.74	6.24

Table 4. The chemical properties of vermicompost tea:

N%	P%	K%	Mg%	Fe ppm	Zn ppm	Mn ppm	Natural plant extract %
3	1.5	22	0.12	346	323	165	33

Measurement traits.

- Vegetative growth were measured at 100 days after transplanting, plant height (cm) – number of leaves plant^{-1}- fresh weight (g).
- The spectrophotometric measurements of carotene (mg g^{-1} FW) and chlorophyll (a, b, and a+b, mg g^{-1} FW) in the fourth leaves were made in accordance with Picazo *et al.* (2013).
- According to Cottenie *et al.* (1982), the proportion of nitrogen (using the Kjeldahl method), phosphorous (using a spectrophotometer), and potassium (using a flame photometer) in the leaves dry matter were ascertained. According to Peterburgski (1968), the materials were dried at 70°C, crushed, and then wet digested by adding a solution of sulfuric and perchloric acids (1:1).

In order to measure the following criteria, ten fruits were randomly selected from each plot's third picking;

- Fruit weight plant^{-1} as total yield (kg), number of fruits per plant were recorded following each harvesting cumulatively.
- Average of weight (g), length (cm) and diameter (cm) of fruit were measured.
- The N, P, and K (%) in fruits were ascertained using the same techniques as the foliage study previously mentioned.
- The percentage of total sugars and carbohydrates was calculated using the procedures described in the A.O.A.C. (2007).
- Fruit's vitamin C content (mg/100 g) was calculated using FAO (1980) guidelines.
- Caroten pigment (mg g^{-1} FW) was measured as described by Picazo *et al.* (2013).

Statistical analysis.

The analysis of variance (ANOVA) approach was used to examine the experiment's data in accordance with Gomez and Gomez's (1984) recommendations.

RESULTS AND DISCUSSION

Results

1. Vegetative growth:

The results shown in Table 5 illustrate the effects of various treatments, including rates of NPK with chicken manure, and foliar application with compost tea and vermicompost tea, on sweet pepper growth criteria (plant height, No. of leaves plant^{-1} and plant fresh weight). The results show that every treatment under investigation had a major effect on vegetative growth.

Regarding the individual impact of soil fertilization, it was noted that 100% NPK of recommended dose had the most pronounced positive impact on all vegetative growth, followed by 75% NPK + 25% chicken manure, and finally 50% NPK + 50% chicken manure.

About the impact of the foliar applications (compost tea and vermicompost tea), results in the same table reveal that spraying with vermicompost tea gave the highest vegetative growth of sweet pepper, followed by compost tea, then the lowest growth obtained from plants sprayed with tap water (control).

Additionally, the Table 5 also reveals the bilateral interaction between soil fertilization, and foliar applications of organic liquid tea. The interaction between 100% NPK of recommended dose and spraying with vermicompost tea (at rate of 50 ml L^{-1}) produced noticeably better outcomes in terms of vegetative growth compared to other treatments.

Table 5. Vegetative growth characters of sweet pepper as affected by soil fertilization and foliar applications of organic liquid tea during both seasons.

Characters		No. of leaves/plant		Plant height(cm)		Fresh weight(g)	
Treatments		1st season	2nd season	1st season	2nd season	1st season	2nd season
A- Soil fertilization:							
100% NPK		133.0 a	133.44 a	78.67 a	80.56 a	774.78 a	761.44 a
75% NPK + 25% CM		126.6 a	122.00 b	71.56 b	72.11 b	696.56 b	673.78 b
50% NPK + 50% CM		115.7 b	113.25 c	60.78 c	60.50 c	662.67 c	639.63 c
B- Foliar applications:							
Control		120.9 c	117.89 c	65.78 c	67.00 c	691.67 c	674.67 c
Compost tea		125.6 b	123.56 b	71.11 b	72.22 b	712.44 b	693.44 b
Vermicompost tea		128.8 a	129.00 a	74.11 a	75.63 a	729.89 a	715.13 a
A × B – Interaction:							
100% NPK	Control	128.7 c	127.33 c	75.33 c	76.33 b	756.33 c	745.00 c
	Compost tea	133.3 b	134.00 b	79.00 b	81.33 a	774.00 b	761.67 b
	Vermicompost tea	137.0 a	139.00 a	81.67 a	84.00 a	794.00 a	777.67 a
75% NPK + 25% CM	Control	123.3 d	117.33 e	68.00 e	69.00 d	675.33 fg	656.33 f
	Compost tea	127.0 c	122.67 d	72.00 d	72.67 c	697.67 e	676.00 e
	Vermicompost tea	129.3 c	126.00 c	74.67 c	74.67 bc	716.67 d	689.00 d
50% NPK + 50% CM	Control	110.7 f	109.00 g	54.00 g	55.67 f	643.33 h	622.67 h
	Compost tea	116.3 e	114.00 f	62.33 f	62.67 e	665.67 g	642.67 g
	Vermicompost tea	120.0 d	118.50 e	66.00 e	64.50 e	679.00 f	660.50 f

Different letters in the same column which indicate significant differences according to the Duncan Multiple Test ($P < 0.05$)

2. Photosynthetic pigments

Table 6 clears the impact of the soil fertilization, organic liquid tea on the photosynthetic pigments of sweet pepper plant *i.e.,* chlorophyll (a, b and a+b) and carotene contents. The results clarify that the chlorophyll (a, b and a+b) and carotene contents were significantly influenced due to all photosynthetic pigments.

Concerning the impact of soil fertilization, 75% NPK of recommended dose + 25% chicken manure was the best treatment for getting the maximum levels of the photosynthetic pigments under study, followed by 100% NPK of recommended dose then 75% NPK + 50% chicken manure.

Regarding foliar application organic liquid tea, the superior treatment for achieving the maximum values of photosynthetic pigments was vermicompost tea followed by compost tea, while the corresponding plants sprayed with tap water possessed the lowest values of photosynthetic pigments.

The same table also indicates the interaction between soil fertilization and organic liquid tea and shows that 75% NPK of recommended dose + 25% chicken manure and sprayed with vermicompost tea was significantly superior in achieving the maximum values of photosynthetic pigments compared to other interventions.

Table 6. Photosynthetic pigments of sweet pepper leaves as affected by soil fertilization and foliar applications of organic liquid tea during both seasons.

Characters		Chlorophyll a(mg g^{-1} FW)		Chlorophyll b(mg g^{-1} FW)		Chlorophyll a+b(mg g^{-1} FW)		Carotene(mg g^{-1} FW)	
Treatments		**1st season**	**2ndseason**	**1st season**	**2ndseason**	**1st season**	**2ndseason**	**1st season**	**2ndseason**
A- Soil fertilization:									
100% NPK		0.677 b	0.658 b	0.483 b	0.483 b	1.212 b	1.142 b	0.443 b	0.444 b
75% NPK + 25% CM		0.855 a	0.843 a	0.614 a	0.618 a	1.291 a	1.460 a	0.603 a	0.604 a
50% NPK + 50% CM		0.457 c	0.443 c	0.356 c	0.352 c	0.940 c	0.795 c	0.324 c	0.324 c
B- Foliar applications:									
Control		0.639 c	0.636 c	0.458 c	0.458 c	1.097 c	1.095 c	0.435 c	0.438 c
Compost tea		0.670 b	0.653 b	0.490 b	0.490 b	1.160 b	1.143 b	0.458 b	0.461 b
Vermicompost tea		0.681 a	0.681 a	0.505 a	0.524 a	1.187 a	1.204 a	0.477 a	0.491 a
A × B – Interaction:									
100% NPK	Control	0.663 e	0.651 c	0.467 f	0.470 f	1.136 e	1.121 f	0.415 f	0.421 f
	Compost tea	0.678 d	0.658 c	0.486 e	0.484 e	1.238 d	1.142 e	0.442 e	0.446 e
	Vermicompost tea	0.691 c	0.666 c	0.496 d	0.496 d	1.262 c	1.162 d	0.471 d	0.464 d
75% NPK + 25% CM	Control	0.821b	0.829 b	0.593 c	0.599 c	1.256 c	1.428 c	0.578 c	0.580 c
	Compost tea	0.868 a	0.845 ab	0.614 b	0.618 b	1.292 b	1.462 b	0.606 b	0.611 b
	Vermicompost tea	0.877 a	0.855 a	0.635 a	0.636 a	1.326 a	1.491 a	0.625 a	0.621 a
50% NPK + 50% CM	Control	0.431 h	0.428 e	0.315 i	0.306 i	0.898 h	0.735 h	0.311 i	0.314 h
	Compost tea	0.464 g	0.457 d	0.369 h	0.368 h	0.950 g	0.825 g	0.326 h	0.325 g
	Vermicompost tea	0.476 f	0.443 d	0.385 g	0.396 g	0.972 f	0.839 g	0.335 g	0.337 g

Different letters in the same column which indicate significant differences according to the Duncan Multiple Test (P < 0.05)

3. leaves chemical constituents

Sweet pepper's performance in terms of its chemical contents (N, P, and K%) was greatly impacted by the use of soil fertilization, organic liquid tea as shown in Table 7.

As for impact of soil fertilization, the maximum percentage of N, P, K on sweet pepper leaves were obtained from plant treated with 75% NPK of recommended dose + 25% chicken manure.

Concerning spraying of compost tea and vermicompost tea, the vermicompost tea came in the first order for the maximum percentage of leaves chemical constituents, while compost tea came in the second order, while, the control treatment came in the third order.

Regarding the interaction impact, the combined treatment that fertilized with 75% NPK of recommended dose + 25% chicken manure and sprayed with vermicompost tea outperformed other treatments in leaves' chemical constituents, followed by 75% NPK of recommended dose + 25% chicken manure and sprayed with compost tea.

Table 7. Minerals composition contents of sweet pepper leaves as affected by soil fertilization and foliar applications of organic liquid tea during both seasons.

Characters		N (%)		P (%)		K (%)	
Treatments		**1st season**	**2ndseason**	**1st season**	**2ndseason**	**1st season**	**2ndseason**
A- Soil fertilization:							
100% NPK		4.33 b	4.47 a	0.439 b	0.429 b	2.51 b	2.39 b
75% NPK + 25% CM		4.75 a	4.65 a	0.485 a	0.473 a	2.67 a	2.55 a
50% NPK + 50% CM		3.58 c	3.57 b	0.345 c	0.370 c	2.22 c	2.15 c
B- Foliar applications:							
Control		4.03 b	3.99 c	0.398 c	0.409 c	2.32 c	2.24 c
Compost tea		4.27 a	4.25 b	0.423 b	0.426 b	2.46 b	2.40 b
Vermicompost tea		4.36 a	4.56 a	0.448 a	0.445 a	2.61 a	2.50 a
A × B – Interaction:							
100% NPK	Control	4.18 c	4.14 d	0.415 d	0.412 e	2.36 d	2.24 d
	Compost tea	4.31 bc	4.56 bc	0.432 c	0.432 d	2.46 c	2.46 bc
	Vermicompost tea	4.50 b	4.72 ab	0.472 b	0.443 c	2.70 b	2.46 bc
75% NPK + 25% CM	Control	4.51 b	4.42 c	0.472 b	0.459 b	2.50 c	2.39 c
	Compost tea	4.84 a	4.70 ab	0.489 a	0.475 a	2.68 b	2.57 b
	Vermicompost tea	4.90 a	4.84 a	0.495 a	0.484 a	2.82 a	2.70 a
50% NPK + 50% CM	Control	3.42 e	3.41 f	0.309 g	0.356 g	2.11 f	2.08 e
	Compost tea	3.65 d	3.50 f	0.349 f	0.372 f	2.24e	2.16 de
	Vermicompost tea	3.68 d	3.92 e	0.376 e	0.388 f	2.30 de	2.24 d

Different letters in the same column which indicate significant differences according to the Duncan Multiple Test (P < 0.05)

4.Total yield and its components

It can be observed that all treatments soil fertilization and organic liquid tea significantly impacted yield and its components of sweet pepper plant *i.e.,* total yield per plant, No. of fruits per plant average fruit weight, length and diameter.

Concerning the impact of soil fertilization, Table 8 clears that the superior treatment with 75% NPK of recommended dose + 25% chicken manure gave the maximum plant yield, No. of fruits, average of fruit weight, length and diameter compared to other treatments. The highest plant yield was 2.58 and 2.56 kg plant^{-1} in the first and second season, respectively.

Regarding the impact of organic liquid tea, Table 8 shows that foliar application of vermicompost tea gave the maximum yield and its components compared to other treatments. It increases plant yield 36.24% and 28.67% over control in the first and second season, respectively.

Based on the results displayed in Table 8, It is clear that the combination of 75% NPK of recommended dose + 25% chicken manure with vermicompost tea shown a noticeably better bilateral relationship. This interaction produced the maximum yield and its components, followed by 75% NPK of recommended dose + 25% chicken manure with compost tea

Table 8. Yield of sweet pepper and its components as affected by soil fertilization and foliar applications of organic liquid tea during both seasons.

Characters Treatments		Average Fruit weight (g)		No. of fruit/plant		Fruit length (cm)		Fruit diameter(cm)		Fruit weight/plant(kg)	
		1st season	2nd season	1st season	2nd season	1st season	2nd season	1st season	2nd season	1st season	2nd season
A- Soil fertilization:											
100% NPK		142.67 b	141.22 b	10.22 b	10.56 b	7.89 b	7.67 b	7.33 b	7.22 b	1.50 b	1.46 b
75% NPK + 25% CM		156.22 a	154.11 a	16.33 a	16.67 a	10.11 a	10.56 a	7.78 a	8.11 a	2.58 a	2.56 a
50% NPK + 50% CM		122.33 c	120.13 c	9.22 c	8.88 c	7.22 c	6.63 c	6.56 c	6.38 c	1.07 c	1.13 c
B- Foliar applications:											
Control		130.22 c	129.00 c	11.22 c	11.22 c	7.89b	7.89 b	6.89 b	6.67 c	1.49 c	1.50 c
Compost tea		141.00 b	139.67 b	12.00 b	12.11 b	8.44 a	8.33 a	7.22 ab	7.22 b	1.73 b	1.73 b
Vermicompost tea		150.00 a	150.13 a	12.56 a	13.25 a	8.89 a	8.88 a	7.56 a	8.00 a	2.03 a	1.93 a
A × B – Interaction:											
100% NPK	Control	131.67 d	129.00 f	9.67 ef	9.67 e	7.33 bc	7.33 cde	7.00 ab	6.33 cd	1.25 f	1.27 f
	Compost tea	143.00c	141.67 e	10.33 de	10.67 d	8.00 b	7.67 cd	7.33 ab	7.33 bc	1.51 e	1.48 e
	Vermicompost tea	153.33 b	153.00 c	10.67 d	11.33 d	8.33 b	8.00 c	7.67 ab	8.00 ab	1.73 d	1.64 d
75% NPK + 25% CM	Control	146.33 c	144.67 d	15.33 c	15.67 c	9.67 a	10.00 b	7.33 ab	7.67 ab	2.27 c	2.25 c
	Compost tea	157.00 b	155.67 b	16.33 b	16.67 b	10.00 a	10.67 ab	7.67 ab	8.00 ab	2.60 b	2.57 b
	Vermicompost tea	165.33 a	162.00 a	17.33 a	17.67 a	10.67 a	11.00 a	8.33 a	8.67 a	2.86 a	2.87 a
50% NPK + 50% CM	Control	112.67 f	113.33 h	8.67 g	8.33 f	6.67 c	6.33 f	6.33 b	6.00 d	0.95 g	0.98 h
	Compost tea	123.00 e	121.67 g	9.33 ef	9.00 ef	7.33 bc	6.67 ef	6.67 ab	6.33 cd	1.10 f	1.15 g
	Vermicompost tea	131.33 d	128.00 f	9.67 f	9.50 e	7.67 bc	7.00 def	6.67 ab	7.00 cd	1.21 f	1.27 f

Different letters in the same column which indicate significant differences according to the Duncan Multiple Test (P < 0.05)

5. Fruits chemical contents

The impact of soil fertilization and organic liquid tea on the fruit chemical constituents (N, P, K %) is displayed in Table 9. The results show that all treatments had a significant impact on these fruits chemical percentage.

Results in Table 9 observe that 75% NPK of recommended dose + 25% chicken manure exhibited superior in terms of achieving the maximum percentage of fruits chemical contents. Application 100% NPK of recommended dose came in the second order, followed by application with 50% NPK of recommended dose + 50% chicken manure.

Concerning foliar application of organic liquid tea, results demonstrate that spraying with vermicompost tea gave the highest values of fruits chemical percentage, following with compost tea.

Regarding the interaction between 75% NPK of recommended dose + 25% chicken manure and spraying with vermicompost tea was noticeably better at reaching the highest levels of the fruit's chemical components. (N, P and K %).

Table 9. Minerals composition contents of sweet pepper fruits as affected by soil fertilization and foliar applications of organic liquid tea during both seasons.

Characters Treatments		N (%)		P (%)		K (%)	
		1st season	2nd season	1st season	2nd season	1st season	2nd season
A- Soil fertilization:							
100% NPK		7.93 b	7.83 b	0.260 b	0.257 b	4.57 b	4.57 b
75% NPK + 25% CM		8.75 a	8.66 a	0.284 a	0.279 a	5.26 a	5.23 a
50% NPK + 50% CM		6.56 c	6.51 c	0.218 c	0.218 c	4.11 c	4.14 c
B- Foliar applications:							
Control		7.45 c	7.46 c	0.241 c	0.239 c	4.46 c	4.50 cs
Compost tea		7.79 b	7.74 b	0.255 b	0.252 b	4.66 b	4.65 b
Vermicompost tea		8.00 a	7.97 a	0.267 a	0.268 a	4.81 a	4.87 a
A × B – Interaction:							
100% NPK	Control	7.76 e	7.72 f	0.244 e	0.237 d	4.40 f	4.42 f
	Compost tea	7.90 d	7.82 e	0.259 d	0.259 c	4.54 e	4.57 e
	Vermicompost tea	8.13 c	7.96 d	0.278 bc	0.274 b	4.77 d	4.70 d
75% NPK + 25% CM	Control	8.53 b	8.54 c	0.275 c	0.270 b	5.07 c	5.07 c
	Compost tea	8.82 a	8.67 b	0.284 b	0.277 b	5.30 b	5.21 b
	Vermicompost tea	8.90 a	8.77 a	0.293 a	0.289 a	5.40 a	5.41 a
50% NPK + 50% CM	Control	6.07 h	6.11 h	0.204 h	0.210 g	3.91 i	4.00 i
	Compost tea	6.65 g	6.72 g	0.221 g	0.220 f	4.14 h	4.18 h
	Vermicompost tea	6.96 f	6.78 g	0.230 f	0.229 e	4.27 g	4.30 g

Different letters in the same column which indicate significant differences according to the Duncan Multiple Test (P < 0.05)

6.Fruits quality parameters

Table 10 clears the impact of soil fertilization and organic liquid tea on the sweet pepper fruits quality *i.e.,* total sugars and carbohydrates, vitamin C, and carotene pigment. The results demonstrate that all aforementioned contents were significantly influenced due to all studied treatments.

According to the impact of soil fertilization, Application with 75% NPK of recommended dose + 25% chicken manure was the best treatment for giving the maximum fruit quality except carotene content in the first season.The results presented in Table 10 clears that foliar application with vermicompost tea gave the highest values of fruits quality, followed by spraying with compost tea, then control treatment.

It's clear that the interaction between 75% NPK of recommended dose + 25% chicken manure and spraying with vermicompost tea exhibited a significantly superior bilateral combination of fruit quality except carotene in the first season, while the highest content of carotene in the first season obtained from fertilization with 100% NPK of recommended dose and spraying with vermicompost tea.

Table 10. Fruits quality of sweet pepper fruits as affected by soil fertilization and foliar applications of organic liquid tea during both seasons.

Characters		**Total sugars(%)**		**Carbohydrates(%)**		**Vitamin C(mg 100g^{-1})**		**Carotene(mg g^{-1} FW)**	
Treatments		**1st season**	**2ndseason**	**1st season**	**2ndseason**	**1st season**	**2ndseason**	**1st season**	**2ndseason**
A- Soil fertilization:									
100% NPK		48.76 b	48.89 b	25.56 b	25.61 b	39.45 b	39.70 b	0.513 a	0.385 b
75% NPK + 25% CM		49.94 a	50.29 a	26.22 a	26.26 a	42.40 a	42.57 a	0.369 b	0.515 a
50% NPK + 50% CM		48.41 c	48.54 c	25.28 c	25.20 c	37.65 c	37.69 c	0.319 c	0.324 c
B- Foliar applications:									
Control		48.89 c	48.79 c	25.49 c	25.51 c	39.47 c	39.62 c	0.383 c	0.389 c
Compost tea		49.03 b	49.18 b	25.70 b	25.70 b	39.82 b	40.00 b	0.402 b	0.406 b
Vermicompost tea		49.18 a	49.76 a	25.86 a	25.93 a	40.20 a	40.68 a	0.416 a	0.443 a
A × B – Interaction:									
100% NPK	Control	48.60 f	48.49 de	25.35 f	25.39 f	39.25 f	39.55 f	0.490 c	0.367 f
	Compost tea	48.78 e	48.84 d	25.58 e	25.65 e	39.47 e	39.70 e	0.520 b	0.382 e
	Vermicompost tea	48.89 d	49.35c	25.74 d	25.78 d	39.64 d	39.85 d	0.531 a	0.406 d
75% NPK + 25% CM	Control	49.76 c	49.65 c	25.96 c	26.03 c	41.76 c	41.82 c	0.353 f	0.486 c
	Compost tea	49.89 b	50.12 b	26.24 b	26.28 b	42.36 b	42.55 b	0.369 e	0.516 b
	Vermicompost tea	50.16 a	51.11 a	26.46 a	26.47 a	43.07 a	43.35 a	0.388 d	0.544 a
50% NPK + 50% CM	Control	48.32 h	48.17 e	25.16 g	25.11 i	37.40 i	37.50 h	0.307 i	0.313 i
	Compost tea	48.43 g	48.61 d	25.28 fg	25.19 h	37.64 h	37.74 g	0.316 h	0.321 h
	Vermicompost tea	48.49 g	48.82 d	25.39 f	25.35 g	37.90 g	37.91 g	0.332 g	0.345 g

Different letters in the same column which indicate significant differences according to the Duncan Multiple Test ($P < 0.05$)

Discussion

There is an increasing need to investigate sustainable approaches to increase sweet pepper productivity in order to improve its quality and decrease production cost by using synergetic organic fertilization and mineral fertilization and spraying with organic liquid tea that are useful for fruit quality and human health, thus this study focused the effect of organic fertilization and mineral fertilization rates in addition compost tea and vermicompost tea of sweet pepper growth, yield and quality.

The noticed significant impacts on growth, yield, quality, and quality traits of sweet pepper can be attributed to decrease NPK rates and increase chicken manure rates and foliar application with compost tea and vermicompost tea. The following scientific explanations for these consequences are provided:

The results demonstrate the combined effect of the tested combinations on the specified traits, i.e., the balanced and improved nutrition that plants absorb and metabolize more carbohydrates as a result of receiving the optimal combination of nutrients that may provide the rapid release of mineral NPK elements as well as those released gradually through organic fertilization, which may improve vegetative growth (Adhikari *et al.*, 2016). Applying chicken manure to pepper plants may therefore increase their vegetative growth because it improves the physical characteristics of the soil, such as its texture and water-holding capacity, improves soil aeration, lowers pH levels, and makes nutrients in the soil more accessible for promoting plant growth. Additionally, it contains gibberellic acid and auxins that encourage plant growth (Alkharpotly, 2018). This results are consistent with Baiyeri *et al.* (2016); Khandaker *et al.* (2017). This result may also be explained by the crucial role that nitrogen plays in plants, which is present in nucleic acids, co-enzymes, and also contributes to N_2 fixation and increases plant photosynthesis. Even though phosphorus plays a crucial role in energy metabolism, chemical reactions are induced by the high energy of phosphate hydrolysis and various organic phosphate bonds. While K^+ ions are essential for controlling leaves, stomatal guard cells, and increasing photosynthesis, potassium also activates certain enzymes. Vegetative development that was first brought about by the plants' enhanced nutritional status, which was evident in the production of more fruits per plant and the highest average fruit weight, both of which increased fruit output. Balanced nutrition and improved nutrient uptake by plants that produced such high yields were linked to increased yield. Both macro and micronutrients can be found in chicken manure. It is a good source of organic matter that stores all plant nutrients, including trace elements, which may have been released gradually and consistently. This helped ensure that the crop was well nourished, which led to the highest possible fruit yield. This results are agree with those obtained by EL-Shimi *et al.* (2015); Alhrout (2017).

The superiority of compost tea and vermicompost tea compared to the control can be referred to vermicompost include plant nutrients N, P, K, Fe, Ca, Mg, S, B, Cu, Zn, and Mn and help to make different plant parts like roots, shoots, and fruits more nutritious (Theunissen *et al.*, 2010). Vermicompost tea's living microorganisms promote plant growth, disease resistance, and nutrient uptake (Hargreaves *et al.*, 2009). Therefore, it has been demonstrated that applying a watery extract of vermicompost tea enhances crop productivity, plant health, and plant nutrients (Pant *et al.*, 2009). Abdel-Salam and Roshdy (2022) showed that spraying vermicompost tea on pomegranate fruits improved leaves chemical and chlorophyll contents as well as physical properties of fruit in addition yield and quality.

Additionally, because of certain characteristics, compost tea may be used a foliar application as an organic biofertilizer to support plant nutrition during all crucial stages of the cycle, such as growing, flowering, and fruiting (Omar *et al.*, 2012). However, the existence of hormone-like molecules found in highly bioactive compost teas, such as gibberellins, indoleacetic acid, and cytokinins, has been significantly connected to the positive effects of these organic treatments on the growth, development, and physiology of the plants (Zhang *et al.*, 2014). Zaccardelli *et al.* (2018) showed that foliar application with compost tea enhanced sweet pepper growth and productivity under green house.

CONCLUSION

Under the same investigational conditions, it could be suggested that the best way to achieve the highest safe and economical yield and high quality in a greenhouse is to apply 75% NPK of the recommended dose to sweet pepper plants with 25% chicken manure and foliar application of vermocompost tea. Therefore, this combined treatment may lower the danger of environmental damage and save part of the high costs associated with chemical fertilizers.

When it comes to the creation of sustainable farming systems that emphasize fertilizer reduction, decreasing mineral fertilization and replace it with organic fertilization organic liquid tea can be quite important. Therefore, with efforts to further study the fine individuation of the mechanisms of action, standardization, and practical implementation works, it is desirable to have a wider distribution of these applications in agricultural management.

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الاستبدال الجزئى للأسمدة المعدنية و التأثيرات المحسنة للسماد العضوى على محصول وجودة الفلفل الحلو تحت الظروف المحمية

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الملخص

تهدف هذه الدراسة الى إسستكشاف طرق مستدامة لتعزيز نمو وإنتاجية الفلفل الحلو. ولتحقيق هذا الهدف تم إجراء تجربة تحت الصوب الزراعية لدراسة عاملين رئيسيين تحت تصميم القطع المنشقة مرة واحدة، حيث كان العامل الأول هو معدلات من التسميد المعدنى و العضوى (١٠٠٪ NPK من الكمية الموصى بها - ٧٥٪ NPK+ ٢٥٪ سماد الدواجن - ٥٠٪ NPK+ ٥٠٪ سماد الدواجن)، بينما كان العامل الثانى الشقى هو الرش بالسائل العضوى مثل شاى الكمبوست وشاى الفيرمى كمبوست بالاضافة الى الكنترول على نمو الفلفل الحلو والمحتوى الكيماوى وصبغات البناء الضوئى والمحصول وجودته. أوضحت النتائج تفوق ١٠٠٪ NPK من الكمية الموصى بها فى صفات النمو الخضرى بينما تفوقت المعاملة ٧٥٪ NPK+ ٢٥٪ سماد الدواجن فى المحتوى الكيماوى والمحصول وجودته. أما بالنسبة لتأثير الرش بالسائل العضوى فأوضحت النتائج أن الرش بشاى الفيرمى كمبوست أعطى أعلى القيم بالنسبة للصفات السابقة. بينما أدى التفاعل بين ٧٥٪ NPK+ ٢٥٪ سماد الدواجن والرش بشاى الفيرمى كمبوست الى افضل النتائج مقارنة بباقى الفاعلات الاخرى. يمكن للمزارعين تحسين إنتاجية الفلفل الحلو وقيمته الغذائية من خلال تطبيق هذه الاقتراحات، مما يعود بالنفع في نهاية المطاف على كل من المنتجين والمستهلكين

الكلمات الدالة: سماد الدواجن – شاى الكمبوست – شاى الفيرمى كمبوست – الفلفل الحلو