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Response of sweet pepper plants to foliar application of compost tea and dry yeast under soilless conditions

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Abstract

Background: Sweet pepper is considered one of the most important vegetable crops cultivated for local consumption and exportation. Under greenhouse conditions, the effects of different rates of yeast and compost tea on vegetative growth, leaves mineral content, fruit yield and quality were studied for two consecutive years 2018/2019 and 2019/2020 under soilless conditions. Nine treatments of compost tea (CT) and or dry yeast (DY) were applied using control (sprayed with distilled water); CT (10L/fed.); CT (20 L/fed.); DY (3 g/L); DY (6 g/L); CT (10L/fed.) + DY (3 g/L); CT (20L/fed.) + DY (3 g/L); CT (10L/fed.) + DY (6 g/L) and CT (20L/fed.) + DY (6 g/L).

Results: Results showed that the mixture of compost tea and dry yeast at a rate of 20 L./fed. plus 6 g/L, respectively, had significantly increased vegetative growth, fruit physical quality (length, diameter and fresh weight), total yield, leaves mineral content (N, P and K) and fruit nutritional value content (calcium and vitamin C). The maximum return or profit comes from the CT (20 L/fed) + DY (6 g/L) followed by CT (20 L/fed) + DY (3 g/L).

Conclusion: It is clear that all treatments enhanced the yield and the fruit physical parameters of the studied plants as well as all treatments are economically feasible including the control treatment. However, looking at the Revenue/Cost ratio (R/C), one can find that the maximum net revenue comes from the mixture of CT (20 L/fed) plus DY (6 g/L) with a net revenue about 192.72 L.E./m² and R/C ratio of 1.90, followed by CT (20 L/fed) + DY (3 g/L).

Keywords: Sweet pepper, Compost tea, Dry yeast, Growth, Fruit yield, Quality and economic evaluation

Background

Sweet pepper (*Capsicum annuum* L), Solanaceae family, is an important summer vegetable crop due to its high nutritional and medicinal value. It contains various nutrients, rich in thiamine, riboflavin, niacin, antioxidants, flavonoids, vitamin C and vitamin A (Igbokwe et al. 2013). The average cultivated area of pepper in the open field was about 97 thousand feddan in 2015, with a production capacity of about 615 thousand tons. Under protected cultivation, sweet pepper is cultivated in 25 thousand greenhouses with an area estimated at 2320 feddan,

representing about 2.39% of the total cultivated pepper area, but its capacity production amounted to about 95 thousand tons, representing about 15.45% of the total productive capacity of the pepper crop in Egypt according to Ministry of Agriculture Statistics, (2016).

Compost tea became more valuable for applications in organic farming. It is produced by extracting useful microbes from compost and/or vermi-compost, thus obtaining a highly concentrated microbial solution. Compost tea gives positive effects for plants, because it contains chelated micronutrients for easy absorption by plants, bioactive molecules and microorganisms that protect the roots and the plant from pathogens and diseases. Moreover, it provides nutrients to plants, thus improving plant growth and health (Ingram and Millner 2007; Azza and Hendawy 2010). Compost tea produces

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plant hormones, mineralizes nutrients to available form to plants and fixes nitrogen (Abou-El-Hassan et al. 2014; Hatam et al. 2015). The effects of compost tea are short-lived so the applications must be repeated to supply plants and soil surface with nutrients and/or beneficial microbes (Ingham 2005).

Active dry yeast is a natural biofertilizer that improves plant growth and yield. It is rich in protein, vitamin B, thiamin, riboflavin, pyridoxines amino acids and cytokinin (Abdelaal et al. 2017; Nagwa et al. 2020). Also, one of the benefits of yeast is the release of carbon dioxide, which is reflected in improving net photosynthesis (Ahmed et al. 1998) and convert the non-soluble form of phosphorus to soluble one (available form for plant) (Agamy et al. 2013; Kalayu 2019).

Soiless culture is a technology for growing plants in nutrient solution with or without the use of growing media, such as sand, peat moss, vermiculite, etc., to supply mechanical support for plants (Pardossi et al. 2011). It has many advantages, such as steady and high-quality production (Veys 1997), earliness, high yield, cleaner production as well as minimum herbicide and pesticide residues in the fruit (Manukyan et al. 2004). Substrate media may significantly affect plant growth (Alsmairat et al. 2018) where media with low bulk density and high-water holding capacity enhances plant aeration and root penetration (Deepagoda et al. 2013). It has been reported that the substrate physical and chemical properties affect the production quality and quantity, such as yield, flower size and number, fruit sugar and phenolic compounds (Al-Ajlouni et al. 2017).

Therefore, this work aimed to study the effect of compost tea and active dry yeast on growth, fruit physical quality, total yield, leaves mineral content and fruit nutritional value (calcium and vitamin C) of sweet pepper under peat moss: perlite media.

Methods

Experimental site and cultivation method

An experiment was conducted in the farm of the Central Laboratory for Agricultural Climate Research Centre (CLAC), Dokki, Giza, Egypt, during the two successive winter seasons of 2018/2019 and 2019/2020 to study the effect of different compost tea and active dry yeast rates on growth, fruit quality and yield of sweet pepper plants.

Sweet pepper cv. Gedeon F1 Hybrid seedlings were obtained from the Central Laboratory of Agriculture Climate (CLAC). Each seedling was transplanted in a five-liter pot (Neveen 2016) filled with a well-mixed media of perlite: peat moss (1:1: v/v). The physical and chemical characteristics of the used media are listed in Table 1.

The experiment contained nine treatments, with three replicates for each treatment. Seedlings were transplanted in pots under greenhouse conditions during the first week of October in both seasons, in plots of 3 m × 1 m arranged in completely randomized design. Each plot contained 48 pots and each pot contained one seedling. The distance between seedlings was 25 cm. This is done through drip irrigation system, which is running through the pots of the sweet pepper rows.

These pots were irrigated by Cooper nutrient solution (Cooper 1979), which adapted according to El-Behairy, (1994). Where desired initial concentration was maintained by dilution of the stock with tap water as illustrated in Table 2. Electrical conductivity (EC) of the nutrient solution was maintained between (2 and 2.2) m. mhos-1 and pH was kept between 6 and 6.5.

Experimental treatments and concentrations

1. Control (sprayed with distilled water).
2. Compost tea 10L./fed.
3. Compost tea 20L./fed.

Table 1 Physical and chemical characteristics of used media substrate

Substrate	Physical				Chemical	
	B.D gL ⁻¹	T.P.S %	W.H.C %	A.P %	E.C mmhos ⁻¹	pH
Peat moss: Perlite	392.6	62.9	47.6	15.3	0.44	7.6

where: B.D is the bulk density, T.P.S is the Total Pore Space, W.H.C is the Water Holding Capacity %, and A.P is the Air Porosity %

Table 2 The chemical composition of the nutrient solution

Macronutrients (ppm)					Micronutrients (ppm)					
N	P	K	Ca	Mg	Fe	Mn	Cu	Zn	B	Mo
Chemical nutrient solution										
200	70	300	190	50	5.0	1.0	0.039	0.044	0.17	0.1

4. Dry yeast 3 g/L.
5. Dry yeast 6 g/L.
6. Compost tea 10 L./fed. + yeast 3 g/L.
7. Compost tea 10 L./fed. + yeast 6 g/L.
8. Compost tea 20 L./fed. + yeast 3 g/L.
9. Compost tea 20 L./fed. + yeast 6 g/L.

Three weeks after transplanting and for three consecutive weeks, the plant leaves were sprayed with aqueous solution of yeast (15L/feddan) and compost tea by one of the above-mentioned concentrations each week, early in the morning, while the control plants sprayed by distilled water (Table 3).

Table 3 Dates of different activities during the two seasons

Stage	First season	Second season
Transplanting	4th October 2018	3rd October 2019
1st spray of fertilizer	1st November 2018	3rd November 2019
2nd spray of fertilizer	8th November 2018	10th November 2019
3rd spray of fertilizer	15th November 2018	17th November 2019
Sampling and measurement	3rd February 2019	2nd February 2020
Season End	8st May 2019	10th May 2020

Compost tea extraction

Compost tea was extracted by adding 10 L of water to a liter of compost. Compost tea was left at room temperature for four days. After that, compost tea was filtered to avoid clogging of the spraying equipment. The chemical composition of the used compost tea is illustrated in Table 4. EC, soluble ions and pH were determined according to Jackson (1973). Available phosphorus and available potassium have been evaluated according to Black 1965 and total nitrogen has been determined according to Jackson (1973).

Active dry yeast (*Saccharomyces cerevisiae*) was dissolved in warm water (38 °C) followed by adding sugar at a ratio of 1:1 to active growth and reproduction of yeast and was left for two hours before spraying according to Morsi et al (2008). The chemical analysis of the used active yeast is shown in Table 5.

Measurements and data collection

Vegetative measurements

The vegetative measurements were determined after 120 days from transplanting in both seasons during the flowering stage. Five plants were randomly chosen from each plot and transferred to laboratory to record the following data:

Table 4 Physical and chemical properties of the compost tea used in this study

Property	Value
pH	6.3
EC (mmhos ⁻¹)	2.4
N (ppm)	165
P (ppm)	20
K (ppm)	150

Plant length (cm); number of leaves/ plants, number of branches/ plants, leaves fresh weight (g/plant) and leaves dry matter (%), plant leaves area (cm²).

Chemical measurements

Determination of mineral content Oven-dried samples from leaves were grinded and used to estimate total nitrogen and phosphorus contents using Kjeldahl and colorimetric methods, according to Cottenie (1980). Potassium content was measured according to Chapman and Pratt (1982) using flame photometer method.

Fruit yield The fruits were harvested when having attained full size for fresh use. Fruit diameter (cm), fruit length (cm), fruit weight (g), total yield kg/pant then total yield kg/m² were estimated.

Fruit chemical content and nutritional value:

- a. Determination of vitamin C (mg/100 g): randomly selected samples from the fresh fruits were analyzed to measure ascorbic acid (vitamin C) content according to AOAC (1990).
- b. Determination of Calcium content:

Oven-dried samples from fruits were grinded and used to estimate Calcium. It was measured with an atomic absorption spectrophotometer (FAO 1980).

Table 5 Chemical analysis of active dry yeast

Minerals (mg/g)		Vitamins (μg/g)	
N	71.8	Thiamin	70
P	13.5	Riboflavin	40
K	19.8	Carbohydrates	31.5%
Ca	0.75		
Mg	1.65	Protein	44.875%
Fe	0.89		
Mn	0.02		
Zn	0.17		

Economic evaluation

The benefit cost ratio was determined according to (Nahed, et al. 2015) by dividing the gross return (LE / m²) on total variable cost (LE /m²).

Total cost was determined by the cost of substrate + plastic pots + seedling + foliar application (compost tea and dry yeast) + nutrient solution + irrigation equipment.

Total yield for the two seasons was summed and multiplied by an average market price to represent the total income (Table 6).

- Net revenue = Revenue—Total cost
- The Revenue to Cost (R/C) ratio was calculated to represent the profit percentage.

Statistical analysis

The experiment data were statistically analyzed using Mstastic (M.S.) software. Mean comparison of the different treatments was tested as illustrated by Snedecor and Cochran (1982), where, means with the same letters are not significantly different at 5% level of significance according to (Duncan 1955).

Table 6 Items and prices of the economic evaluation used in this study

Item	Price (LE)	Item	Price (LE)
Pot	2	Seedling	0.5
Peat moss (L)	1.3	Nutrient Solution (L)	8
Perlite (L)	1.8	Power (m ²)	10
Irrigation system (m ²)	5	Irrigation (m ²)	10
Tank	50	compost tea (L)	10
N. plant/m ²	12	Yeast (1 g)	0.37
Pepper Market prices kg/ FW	8		

Fixed cost = cost of pots + substrate cost + Irrigation system cost

Variable cost = seedlings cost + fertilizer + nutrient solution cost + workers cost

Nutrient solution = one liter of raw nutrient solution is diluted in 100 L of water. Three liters of the prepared solution irrigates 1 m² daily. This means that in a month 90 L of solution is needed, i.e., for a season of 7 months long it needs 6 L of raw nutrient solution

For yeast solution: five liters was used during the whole season per square meter, i.e., the three times of applications consumed five liters of yeast solution regardless with the rate/concentration

For the compost tea: the rate was calculated as 2.5 cm³ per square meter for one time application so the for the season where spray took place 3 times 7.5 cm³ were used per meter square

Results

Effect of compost tea, dry yeast and their mixtures on vegetative growth

Table 7a, b illustrate the response of vegetative parameters to the different rates of compost tea and or dry yeast and their mixtures applications. Plant length, number of leaves/plants, and number of branches/plants of sweet pepper plants positively responded to all foliar spray treatments with compost tea and or dry yeast as clear from Table 7a. The highest significant increases of all vegetative parameters were obtained by the mixture of CT (20L/fed.) + DY (6 g/L) followed by CT (20L/fed.) + DY (3 g/L) in both seasons. The plant length of CT (20L/fed.) + DY (6 g/L)-treated plants increased compared to the control in the first and second seasons, respectively. Similarly, number of branches and number of leaves per plant also increased with the application of CT (20L/fed.) + DY (6 g/L) treatment.

Plant leaf area significantly increased from (129.73, 131.87 cm²) in case of the control treatment to (172.47, 184.07 cm²) due to the application of CT (20L/fed.) + DY (6 g/L) mixture in the two successive seasons. Also, plant fresh weight (g/plant) of the same treatment plants increased (998.90 and 1004.67) as compared with control (351.10 and 371.00). Dry matter percentage of CT (20L/fed.) + DY (6 g/L)-treated plants increased by (24.67 and 26.17) as compared with control (13.83 and 15.33) in the first and second seasons, respectively.

Effect of compost tea, dry yeast and their mixtures on physical quality and total yield

Results showed that mixture of compost tea and active dry yeast treatments enhanced fruit physical quality and total yield compared with the control treatment as shown in (Table 8). The highest values of all physical quality and total yield were obtained by the mixture of CT (20L/fed.) + DY (6 g/L). The fruit diameter of CT (20L/fed.) + DY (6 g/L)-treated plants increased (6.17, 5.90 cm) as compared with control (3.27, 3.13 cm) in the first and second seasons, respectively. Moreover, the fruit length of CT (20L/fed.) + DY (6 g/L)-treated plants increased by (8.77 and 10.02). The fruit weight (g) also increased by (117.62 and 122.68) in the first and second seasons, respectively. Similarly, total yield (kg/plant) of 20L/fed. (CT) + 6 g/L (DY)-treated plants increased by (2.06 and 2.18) as compared with control (1.09 and 1.21) in the first and second seasons, respectively.

Effect of compost tea, dry yeast and their mixture on leaf mineral content

There were significant increases due to compost tea and or dry yeast applications in terms of leaf mineral

Table 7 Effect of compost tea, dry yeast and their mixture (a) on vegetative characteristics of sweet pepper during 2018/2019 and 2019/2020. (b) On sweet pepper vegetative characteristics during 2018/2019 and 2019/2020

Treatments	Plant length (cm)		Number of branches/plants		Number of leaves/plants	
	1st Season	2nd Season	1st Season	2nd Season	1st Season	2nd Season
Control	54.67 ^f	58.33 ^g	4.33 ^g	5.00 ^f	151.67 ^f	150.67 ^f
CT 10 L./fed	60.00 ^e	61.33 ^{fg}	5.67 ^f	6.67 ^e	156.67 ^e	156.00 ^e
CT 20L./fed	64.00 ^{cd}	67.00 ^e	7.00 ^{de}	7.67 ^d	160.33 ^d	159.33 ^{de}
DY 3 g/L	62.33 ^{de}	64.67 ^{ef}	6.33 ^{ef}	6.37 ^e	157.00 ^e	157.33 ^e
DY 6 g/L	65.00 ^{cd}	68.33 ^{de}	7.33 ^d	8.72 ^c	162.33 ^{cd}	163.00 ^{cd}
CT 10L./fed. + DY 3 g/L	67.33 ^{bc}	71.00 ^{cd}	8.67 ^c	8.83 ^c	162.67 ^{cd}	165.67 ^{bc}
CT 10L./fed. + DY 6 g/L	70.00 ^{ab}	73.33 ^{bc}	9.00 ^{bc}	9.02 ^c	165.00 ^{bc}	169.00 ^b
CT 20L./fed. + DY 3 g/L	69.67 ^{ab}	75.00 ^b	9.67 ^b	10.00 ^b	166.67 ^b	170.33 ^b
CT 20 L./fed. + DY 6 g/L	72.33 ^a	80.67 ^a	11.67 ^a	11.33 ^a	182.00 ^a	183.67 ^a

Treatments	Leaf area (cm ²)		Leaves fresh weight (g/plant)		Leaves dry matter (%)	
	1st Season	2nd Season	1st Season	2nd Season	1st Season	2nd Season
Control	129.73 ^g	131.87 ^e	351.10 ^f	371.00 ^g	13.83 ^f	15.33 ^f
CT 10 L./fed	132.98 ^{fg}	133.95 ^{de}	487.40 ^e	543.00 ^f	16.33 ^e	17.83 ^e
CT 20L./fed	138.25 ^{de}	135.84 ^{de}	700.80 ^c	648.00 ^e	18.17 ^d	19.67 ^{de}
DY 3 g/L	135.39 ^{ef}	134.19 ^{de}	539.25 ^d	569.83 ^f	17.17 ^{de}	18.67 ^c
DY 6 g/L	139.59 ^d	137.60 ^d	717.19 ^c	666.50 ^{de}	19.33 ^c	20.83 ^c
CT 10L./fed. + DY 3 g/L	144.83 ^c	142.84 ^c	882.68 ^b	714.50 ^d	20.17 ^c	21.67 ^c
CT 10L./fed. + DY 6 g/L	147.33 ^c	147.24 ^c	965.27 ^a	848.00 ^c	20.33 ^c	21.83 ^c
CT 20L./fed. + DY 3 g/L	155.44 ^b	158.09 ^b	980.27 ^a	920.17 ^b	23.00 ^b	24.50 ^b
CT 20 L./fed. + DY 6 g/L	172.47 ^a	184.07 ^a	998.90 ^a	1004.67 ^a	24.67 ^a	26.17 ^a

* Values followed by the same letter (s) are not significantly different at 5%

Table 8 Effect of compost tea, dry yeast and their mixture on fruit physical quality and total yield of sweet pepper during 2018/2019 and 2019/2020

Treatment	Fruit diameter (cm)		Fruit length (cm)		Fruit weight (g)		Total yield (kg /plant)	
	1st Season	2nd Season	1st Season	2nd Season	1st Season	2nd Season	1st Season	2nd Season
Control	3.27 ⁱ	3.13 ⁱ	6.37 ^g	7.62 ^f	70.85 ^g	62.50 ^e	1.09 ^h	1.21 ^f
CT 10 L./fed	3.56 ^h	3.47 ^h	6.73 ^f	7.98 ^{ef}	75.85 ^{fg}	70.50 ^{de}	1.21 ^g	1.33 ^f
CT 20L./fed	4.19 ^e	4.10 ^f	7.00 ^e	8.25 ^{de}	84.49 ^e	77.00 ^d	1.50 ^e	1.62 ^d
DY 3 g/L	3.76 ^g	3.67 ^g	6.87 ^{ef}	8.12 ^{ef}	77.00 ^f	73.50 ^d	1.36 ^f	1.49 ^e
DY 6 g/L	4.06 ^f	4.47 ^e	7.47 ^d	8.72 ^{cd}	94.03 ^d	90.88 ^c	1.61 ^d	1.73 ^{cd}
CT 10L./fed. + DY 3 g/L	4.93 ^d	4.67 ^d	7.80 ^c	9.05 ^c	98.17 ^{cd}	96.09 ^{bc}	1.67 ^c	1.80 ^c
CT 10L./fed. + DY 6 g/L	5.09 ^c	5.10 ^c	8.00 ^c	9.25 ^{bc}	101.17 ^{bc}	99.34 ^{bc}	1.70 ^c	1.82 ^c
CT 20L./fed. + DY 3 g/L	5.53 ^b	5.37 ^b	8.40 ^b	9.65 ^{ab}	106.22 ^b	103.48 ^b	1.89 ^b	2.01 ^b
CT 20 L./fed. + DY 6 g/L	6.17 ^a	5.90 ^a	8.77 ^a	10.02 ^a	117.62 ^a	122.68 ^a	2.06 ^a	2.18 ^a

* Values followed by the same letter (s) are not significantly different at 5%

contents, i.e., N, P and K compared with the control treatment (Table 9). Nitrogen, phosphorus and potassium concentrations in the treated plants by mixture of CT (20L./fed.) + DY (6 g/L) increased in the first and

second season, respectively, as compared to control. The lowest values of the mentioned parameters were recorded by control in both seasons.

Table 9 Effect of compost tea, dry yeast and their mixture on leaf mineral contents (N, P, and K %) of sweet pepper during 2018/2019 and 2019/2020

Treatments	N (%)		P (%)		K (%)	
	1st Season	2nd Season	1st Season	2nd Season	1st Season	2nd Season
Control	2.30 ^g	2.57	0.53 ^g	0.59 ^g	1.93 ^h	1.95 ⁱ
CT 10 L./fed	2.36 ^g	2.69	0.54 ^{fg}	0.62 ^f	2.04 ^g	2.07 ^h
CT 20L./fed	2.75 ^e	2.86 ^f	0.61 ^{de}	0.65 ^e	2.13 ^e	2.18 ^f
DY 3 g/L	2.55 ^f	2.80 ^{fg}	0.57 ^{ef}	0.64 ^e	2.09 ^f	2.12 ^g
DY 6 g/L	3.17 ^d	3.30 ^e	0.64 ^{cd}	0.68 ^d	2.18 ^d	2.22 ^e
CT 10L./fed. + DY 3 g/L	3.44 ^c	3.63 ^d	0.65 ^c	0.70 ^c	2.21 ^c	2.25 ^d
CT 10L./fed. + DY 6 g/L	3.53 ^{bc}	4.13 ^c	0.72 ^b	0.71 ^{bc}	2.23 ^c	2.29 ^c
CT 20L./fed. + DY 3 g/L	3.65 ^b	4.48 ^b	0.75 ^{ab}	0.73 ^b	2.26 ^b	2.33 ^b
CT 20 L./fed. + DY 6 g/L	4.23 ^a	4.79 ^a	0.78 ^a	0.76 ^a	2.33 ^a	2.45 ^a

* Values followed by the same letter (s) are not significantly different at 5%

Table 10 Effect of compost tea, dry yeast and their mixture on fruit nutritional values of sweet pepper during 2018/2019 and 2019/2020

Treatments	Calcium (%)		Vit. C (mg/100gm)	
	1st Season	2nd Season	1st Season	2nd Season
Control	1.48 ^d	1.59 ^d	72.49 ^g	75.23 ^g
CT 10 L./fed	1.61 ^c	1.67 ^{cd}	81.05 ^f	84.93 ^f
CT 20L./fed	1.67 ^c	1.63 ^d	81.97 ^f	86.68 ^e
DY 3 g/L	1.64 ^c	1.66 ^{cd}	81.68 ^f	86.38 ^e
DY 6 g/L	1.70 ^{bc}	1.78 ^{bcd}	83.23 ^e	87.73 ^d
CT 10L./fed. + DY 3 g/L	1.72 ^{bc}	1.85 ^{bc}	84.60 ^d	88.17 ^{cd}
CT 10L./fed. + DY 6 g/L	1.79 ^b	1.88 ^b	85.97 ^c	88.87 ^c
CT 20L./fed. + DY 3 g/L	1.80 ^b	1.91 ^b	87.13 ^b	92.60 ^b
CT 20 L./fed. + DY 6 g/L	2.01 ^a	2.14 ^a	89.33 ^a	94.52 ^a

* Values followed by the same letter (s) are not significantly different at 5%

Effect of compost tea, dry yeast and their mixture on fruit nutritional values

Nutritional values (calcium and vitamin C) of sweet pepper fruits were significantly increased due to all applications of compost tea and/or dry yeast treatments compared with the control in both seasons as shown in Table 10. Calcium percentage and vitamin C (mg/100 g) content in the treated plants by mixture of CT (20L./fed.) + DY (6 g/L) significantly increased (2.01 and 2.14) and (89.33 and 94.52) as compared to control (1.48 and 1.59) and vit. C (72.49 and 75.23) in the first and second seasons, respectively.

Economic feasibility

Economic feasibility is a criterion that can be used to evaluate the benefit in terms of economic value or cash return investment. In this study the sum of the total fixed cost is calculated once for the two seasons and the variable costs were estimated for one season and multiplied by two representing the total cost, while the total yield for the two seasons were summed and multiplied by an average market price to represent the total revenue. The difference between the total cost and the total revenue is the profit. The Revenue to Cost (R/C) ratio was calculated to represent the profit percentage, where its value reflects the economic feasibility of the proposed treatments. When the R/C ratio is less than one the proposed treatment is not feasible in terms of cost to revenue aspects. In contrast if the R/C ratio is greater than one the project is profitable.

Table 11 represents the results of the conducted economic feasibility study for these proposed treatments. It is clear that all treatments are economically feasible including the control treatment; however, looking at the R/C ratio, one can find that the maximum return or profit comes from the compost tea (20 L./fed) and yeast (6 g/L) mixture, followed by compost tea (20 L./fed) and yeast (3 g/L) mixture as indicated by the treatment order column in Fig. 1.

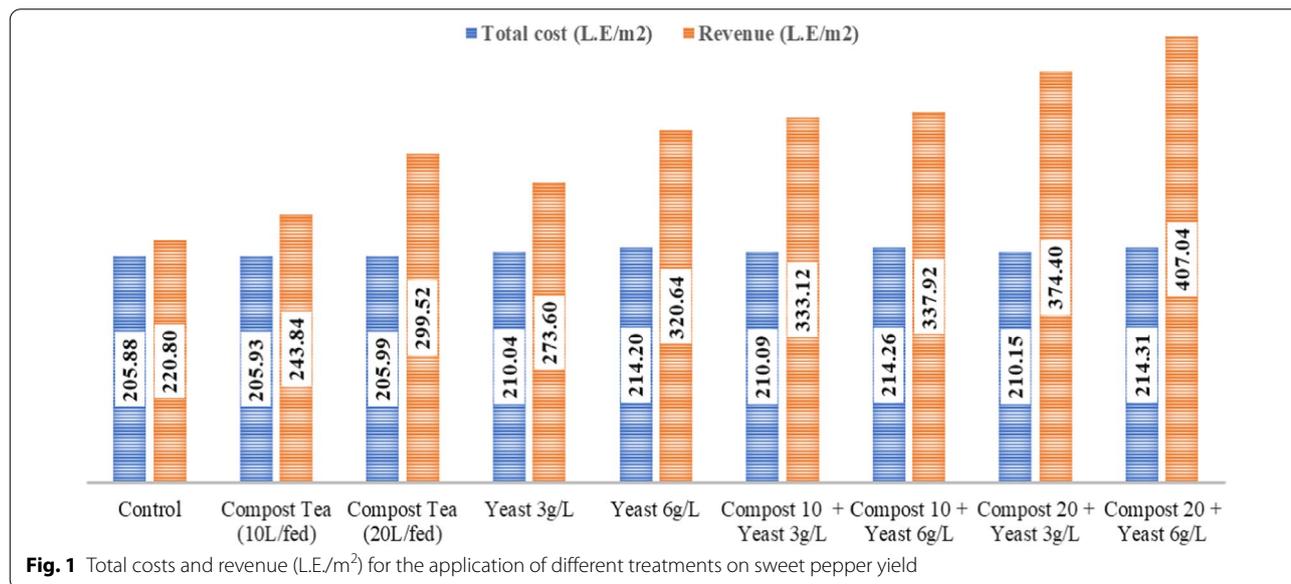
Discussion

Results reported that foliar spray of sweet pepper with the mixture of CT (20L./fed.) + DY (6 g/L) is the most suitable under soilless culture, which ranked the first in all vegetative growth characters, total yield, fruit quality, and chemical composition. It could be attributed to the dual effect of compost tea and dry yeast on plant metabolism, which promotes cell division, amino acids

Table 11 Economic feasibility study for the application of different treatments on pepper yield (L.E./ m²)

Treatment	Input			Output			
	Fixed cost (L.E./m ²)	Variable cost (L.E./ m ²)	Total cost (L.E/ m ²)	Economic criterion			
				Revenue (L.E/ m ²)	Net revenue (L.E/ m ²)	R/C ratio*	Treatment order
Control	120.75	85.13	205.88	220.8	14.93	1.07	9
CT 10 L./fed	120.75	85.18	205.93	243.84	37.91	1.18	8
CT 20L./fed	120.75	85.24	205.99	299.52	93.53	1.45	5
DY 3 g/L	120.75	89.29	210.04	273.6	63.56	1.30	7
DY 6 g/L	120.75	93.45	214.20	320.64	106.44	1.50	6
CT 10L./fed. + DY 3 g/L	120.75	89.34	210.10	333.12	123.03	1.59	3
CT 10L./fed. + DY 6 g/L	120.75	93.51	214.26	337.92	123.67	1.58	4
CT 20L./fed. + DY 3 g/L	120.75	89.40	210.15	374.4	164.25	1.78	2
CT 20 L./fed. + DY 6 g/L	120.75	93.56	214.31	407.04	192.73	1.90	1

* R/C: Total Revenue /Total Cost



and vitamin synthesis which improves plant growth (Matter and El Sayed 2015). Consequently, the plants received the benefit of both factors at the same time. The positive impact of compost tea on plants may return to supply them with chelated microelements and increase elements availability which make them easier for plants absorption. Also, these fertilizers supply plants with nutrients and useful microorganisms that increased the time for the stomata to remain opened. Our results agree to a great extent with those obtained by (Gharib et al. 2008 and Azza & Hendawy 2010). They showed that vegetative growth and oil yield and quality of sweet marjoram (*Majorana hortensis*) and *Borago*

officinalis plants, respectively, were increased by foliar application of compost tea. In addition, dry yeast plays an important role in secretion of some growth promoters, such as cytokines that induces cell reproduction and differentiation, controlling shoot and root development and chloroplast maturation (Abdelaal et al. 2017 and Nagwa et al. 2020). Also, the effect of adding dry yeast on improving vegetative growth may be due to the fact that many physiological and biological processes take place in the leaves, in addition to the leaves being an effective method for better absorption and transport of nutrients inside the plant (AL-Karawi et al. 2018). Moreover, the importance of dry yeast for improving

the vegetative growth characters, yield and quality of sweet pepper may be due to its content of nutrients like nitrogen as shown in Table 5. Several authors have been attributed this bio-stimulatory effect to its influence on the nutritional signal transduction producing growth regulators and crushing harmful microorganisms (El-Ghadban et al. 2003). Also, El-Tohamy and El-Greadly (2007) studied the promoting effect of foliar application of dry yeast on snap beans plants, and it increased growth, yield and quality. Our findings are similar with the findings of Azza and Hendawy (2010) on borage plants. Also, Gomaa and Mohamed (2007) studied the combined effect of organic and bio-fertilizers on guar plants, and found that the highest yield was obtained from the mixture application of 20-ton manure and rhizobium + yeast (40 L/feddan).

Conclusion

The application of compost tea and dry yeast significantly enhanced the fruit chemical and physical characteristics of sweet pepper plants for the two studied seasons. The combination of the two fertilizers was superior compared to each one alone. Using 20 L./fed. of compost tea + 6 g/L. of dry yeast resulted in the highest vegetative growth, yield, physical and chemical qualities of sweet pepper plants. Moreover, economically speaking this treatment also was the highest in terms of benefit to cost ratio compared to all other treatments.

As a general recommendation from this study, the foliar spraying mixtures of organic and bio-fertilizer (compost tea and active dry yeast) to sweet pepper plants produced the highest yield and better fruit quality. Also, this means that decreasing the quantity of mineral fertilization which increases the net income to the growers and reduces the environment pollution caused by extensive application of mineral fertilizers.

Abbreviations

CT: Compost tea; DY: Dry yeast; R/C: Revenue to cost ratio.

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Authors' contributions

HA have contributed in conceptualization of the study, literature review search, experimental design and data interpretation and statistical data analysis, manuscript writing and reviewing. FS have contributed in running and following up the experiment throughout the two seasons, taking and recording the measurements, manuscript writing, reviewing and publishing. All authors have read and approved the manuscript.

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Availability of data and materials

Authors declare that all data generated or analyzed during this study are included in this published article.

Declarations

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Competing interests

The authors declare that they have no competing interests.

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