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Response of Sweet Pepper Plants to some Organic and Bio-fertilizers and its Effect on Fruit Yield and Quality

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ABSTRACT

It can by using organic and bio-fertilizer minimize vegetables plants requirements from inorganic synthetic fertilizers which are potentially more detrimental to the environment. The objective of this work was to study the response of sweet pepper plants cv. California Wonder to some micro-organisms and organic fertilizer by soil inoculation with different rats of compost tea (10 or 20 L/fed.) alone or combined with azolla (10 or 20 L/fed.) or yeast *(Saccharomyces cerevisiae*) (10 or 20 L/fed) plus 75% from the recommended mineral fertilization (NPK) of sweet pepper plants for all treatments comparing with full dose of NPK (100%) as control treatment. Field experiment was carried out during two successive summer seasons (2013 and 2014) in the experiment farm of Kaha, Qalubia Governorate, Egypt. The obtained results of this study indicate that, soil inoculation with combination between compost tea, azolla and yeast (*Saccharomyces cerevisiae*) at high rat, i. e. 20 L/fed. plus 75% from the recommended mineral fertilization (NPK) of sweet pepper plants gave the significant highest increase in microbilogical parameters (total count of bacteria and yeast, dehydrogenase and nitrogenase activity), vegetative growth parameters (plant length, number of leaves and branches per plant, leaf area as well as, fresh and dry weight per plant) and chemical composition N, P and K% of sweet pepper plants and leaf chlorophyll content).This treatment led to significant increase in yield and its components (fruit length and diameter, fruit fresh weight and dry matter percent in fruit as well as early and total yield) with highest quality for fruit (N, P, K% and Vitamin C) in both season.

Key words: Sweet Pepper, organic and bio-fertilizer, micro-organisms, Fruit Yield and Quality

Introduction

In Egypt, sweet pepper (*Capsicum annuum* L.) is one of the most popular and favorite vegetable crop cultivated for local market and exportation. High cash crops such as sweet pepper have occupied an important rank in Egyptian and world agriculture due to its high profit and nutritional values for human health (Rajput and Poruleker, 1998).

Nowadays, a great attention has been focused on the possibility of using natural and safe agents for promoting growth and yield of vegetable crops. Applying bio-fertilization to crops during plant growth stages promoting microorganisms and it is currently considered as a healthy alternative to chemical fertilization. Bio-fertilizers are microbial preparations containing living cells of different microorganisms which have the ability to mobilize plant nutrients in the soil from unusable to usable form. It is considered environmentally friendly, play a significant role in the crop production, help to build up the lost micro flora and improve the soil fertility (Zhang *et al.,* 2013). Also, they suppress pathogenic soil organisms, restore natural soil fertility and provide protection against drought and some soil borne diseases. Moreover, they degrade toxic organic chemicals, improve seed germination and aid in balancing soil pH in reducing soil erosion (Walid *et al.,* 2015). Moreover, Mahmoud and Hafez (2010) reported that, its increase crop yield by 20% - 30%, stimulate plant growth, are cost effective and provide optimal conditions for soil biological activity.

Compost tea is a highly concentrated microorganisms solution produced by extracting beneficial microbes from compost .It can use it as foliar or soil inoculation as organic nutrients, contain cheated micronutrients for easy plant absorption and the nutrients is in a biologically available form for both plant uptake. Compost tea is gaining importance as an alternative to chemical fertilizers and pesticides. The microbial population in the compost tea contributes toward its beneficial effectiveness. It has beneficial effects on plant growth and considered as a valuable soil amendment (Gharib *et al.,* 2008). In the last years, the development of new products derived from compost, such as compost tea (CT) are increasing, due to their positive effects on the crops. CT is organic product obtained through a liquid-phase of compost and its extraction period ranging from few hours to two weeks, with or without active aeration with the addition of some active nutrients i. e., molasses, casein, etc.(Zaccardelli *et al.,* 2012). Compost is rich for plant nutrients, it is a readily available fertilizer with beneficial effects on physical, chemical, biochemical and biological properties of the soils Pane *et*

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al., (2013). Moreover, increased seed germination, growth and yield are responses to plant hormones, micro- and macronutrients exist in composts and compost tea (Jamal and Ozra, 2014). Moreover, compost-based treatments can exert protective effects against plant diseases occurrence and/or stimulate an enhanced plant physiological status with improvements in quantity and quality of crop productions (Loredana *et al.,* 2015).

Most of the research has focused on the use of particular bacterial species, commonly referred to as plant-growth promoting rhizobacteria (PGPR) (Vessey, 2003). The role of other microbial species, including yeasts, has received less attention (Nassar *et al*., 2005). Yeasts are unicellular fungi that proliferate primarily through asexual means and grow rapidly on simple carbohydrates. Because of their nutritional preference, yeast populations are generally an order of magnitude higher in the rhizosphere as opposed to the bulk soil (Botha, 2011). A diverse range of yeasts exhibit plant growth promoting characteristics, including pathogen inhibition (El-Tarabily and Sivasithamparam, 2006); phytohormone production and phosphate solubilization (Amprayn *et al*., 2012); stimulation of mycorrhizal- root colonization (Alonso *et al*., 2008) and production of vitamin B12 (Medina *et al*., 2004). Yeasts in the root zone may influence plant growth indirectly by encouraging the growth of other plant growth promoting rhizo-microorganisms, through vitamin B12 production (Medina *et al*., 2004). In this respect, Fawzy *et al.* (2012) found that, using bio fertilizer increase Ascorbic acid on sweet pepper fruits. Also, Gaafar (2014) mentioned that, used yeast as soil application showed significant response, on growth, yield and good quality on snap bean pods.

Regarding to azolla, azolla is an excellent bio-fertilizer and green manure having global distribution because of its quick multiplication rate and rapid decomposing capacity (Yadavi *et al.,* 2014). This free-floating freshwater fern, fixes atmospheric nitrogen through the symbiotic association with *Anabaena azollae* that lives inside the dorsal lobes of *Azolla* leaves, potentially supplying a substantial amount of N2 to the crop (Kannaiyan , 1992). Azolla is rich source of protein, essential amino acids, vitamins (C, A, B12 and Betacaroten), growth promoting substances ,i .e, gibberellins, cytokinins, auxins and minerals like calcium, phosphorus, potassium, ferrous, copper, magnesium etc. It contains 25-30% protein, 10-15 %mineral content and 7-10 % a combination of amino acids, bio-active substances and biopolymers. Azolla also build important nitrogen balancing biological source of many crops. According to Azolla can serve as good nitrogen supplement to plants. Azolla can release nutrient into soil in an easily available from plants. After death and decay Azolla releases nutrients as fresh matter in water (Marwaha *et al*.,1992). Application of *Azolla* not only increases the growth and yield of crops but also improves the soil fertility (Awodum, 2008). This aquatic fern can be exploited as a potential source of bioferitilizer to increase the production of plants (Saurabh *et al.,* 2014). Moreover, Azolla extracts contains cytocinins, gibberellins and auxins content to promote the plant growth and yield quality (Bindhu, 2013). The use of azolla as organic fertilizer will increase soil organic matter and total-N content (Sudadi and Sumarno, 2014 and Azin 2014).

Since, most of the research has focused on the use of plant-growth promoting rhizobacteria (PGPR) and the role of other microbial species such as yeasts has received less attention. It is supposed that a good understanding of the role of soil yeasts in the rhizosphere hold a key to future sustainable agricultural practices.

Therefore, the objective of this work was to study the impact of soil inoculation with different concentration of compost tea (alone or combined with azolla or yeast or mix of all) plus75% from the recommended mineral fertilization (NPK) of sweet pepper plants on the growth parameters and productivity of sweet pepper plants in addition minimizing about 25% from mineral fertilizer with increasing fruit yield and its quality.

Materials and Methods

The experiment was conducted at the Experimental Farm of Kaha, Qalubia Governorate, Egypt.The present investigation was conducted during two successive summer seasons of 2013 and 2014. Seeds of sweet pepper (*Capsicum annum* L. cv. California Wonder.) were sown under plastic house in nursery at first week of February during both 2013 and 2014 seasons and received recommended agricultural practices. After 50 day from sowing healthy seedlings were selected and transplanted in the open field at 35cm apart in one side of ridge (4.0m length and0.7 m width). The plot area was (8.4 m²) and includes 3 ridges. The soil texture was clay having the following characteristics : Coarse sand 13.9%, Fine sand 9.1% Silt 26 %, Clay 51% Organic matter 1.66%, pH 7.8, EC dS/m 2.2 , available macronutrients (ppm): N 53.3, K 60.35, P 4.1, anions, HCO_3^- 3.5, CL^- 11.0, $SO4^{-2}$ 6.45 and cations Na^+ 8.8, Ca^{+2} 3.9, Mg^{+2} 8.1, K^+ 0.15. Physical and chemical properties were analyzed as described by Piper (1950). The experiment was carried out in complete randomized block design with three replicates.

The experiment was contained nine treatments as the following:

T1: control, full NPK %.(recommended mineral fertilization 140 kg N+60 kg P_2O_5+72 kg K_2O / fed.

T2: compost tea 10 L/fed. + 75% (recommended NPK).

T3: compost tea 20 L/fed. + 75% (recommended NPK).
T4: compost tea10 L/fed. + Azolla extract 10 L/fed. + 75% (recommended NPK).
T5: compost tea 20 L/fed. + Azolla extract 20 L/fed. + 75% (recommended NPK).
T6: compost tea10 L/fed. + yeast 10 L/fed. + 75% (recommended NPK).
T7: compost tea 20 L/fed. + yeast 20 L/fed. + 75% (recommended NPK).
T8: compost tea 10 L/fed. + Azolla extract 10 L/fed. + yeast 10 L/fed. + 75% (recommended NPK) .
T9: compost tea 20 L/fed. + Azolla extract 20 L/fed. + yeast 20 L/fed. + 75% (recommended NPK).

Micorbial strain and culture condition:

Compost water extract preparation (CWE):

Compost water extract was prepared from shredded rice. The compost was soaked in previously stored tap water (2:10 w/v) to avoid the chlorine harmful effect on the compost microbial load. The compost extract was kept in shaded place for seven day and stirred from time to time (Ben Jenana *et al.*, 2009). Then the extract was filtered and kept at room until used. The chemical and microbiological characteristics of the CWE are found in Table (1). Compost water extract (20% concentration) was applied with two rates of 10 and 20 L/fed at 30, 60 and 80 days, respectively gradually with plant age.

Saccharomyces cerevisiae (66) was kindly provided by Microbiology Department, Soils, Water and Environment Research Institute (ARC), Giza, Egypt. The strain was grown on glucose peptone and yeast extract (GPY) medium (Difico, 1985). *S. cerevisiae* inoculated in 250 ml Erlenmeyer flasks containing 50 ml of liquid glucose peptone and yeast extract (GPY) medium. Then, flasks incubated at 30°C for 48h on a rotary shaker at 150 rpm. *Saccharomyces cerevisiae* 66(10^9 CFU/ ml) was added with water irrigation at two rates of 10 and 20 L/fed. after 30, 60 and 80 days of transplanting.

Preparation of azolla extract: Azolla was grown in the greenhouse up to log phase on Yoshida medium (Yoshida *et al.,* 1976) wet Azolla was hardly crushed and blended till obtaining a suspension. It was added with soil irrigation at two levels 10 and 20 L/ fed for three times 30, 60 and 80 days respectively gradually with plant age.

The other agricultural practices were followed according to the recommendation for sweet pepper plantation.

Table 1: Analysis of compost tea and azolla extract was as follows:

Properties	Compost tea	Azolla
pH	6.5	6.35
EC	2.5	1.01
Total nitrogen ppm	160	150
Total Phosphorus (P_2O_5) ppm	20	34
Total potassium (K_2O) ppm	34	152
Chemical oxygen demand (COD). mg/L	17.5	12
Biological oxygen demand (BOD). mg/L	5	3.1

Data Recorded:

Microbiological parameter:

Samples of soil were taken from the rhizospheric zone of sweet pepper plants roots after 40 and 70 days from transplanting to recorded population dynamics of total bacterial, yeast count, total nitrogen fixer bacteria count, Nitrogenase activity and dehydrogenase activity.

The total bacterial and yeast count was determined by the plate count method according to Reinhold *et al.* (1985) using nutrient ager medium for total bacterial count and Glucose Peptone Yeast extract agar (GPY) medium for yeast count (Difico, 1985). But the total nitrogen fixer bacteria count was determined by the most probable number (CFU/g soil) method described by Cochran (1950) using Ashby medium (Difico, 1985). Nitrogenase activity (N_2-ase) in rhizosphere (roots) was measured as described by Hardy *et al.,* (1973). The dehydrogenase activity was also estimated according to Skujins (1976).

Vegetative growth parameters:

Three plants were chosen randomly from each treatment in the three replicates at the beginning of flowering stage (after 75 days from transplanting) in order to determine the following:

plant length (the length of main stem cm), number of leaves and branches per plant as well as fresh and dry weight (g/plant). A random sample of other three plants from each plot was taken and dried at 70 Cº till constant weight and the dry weight of whole plant was determined using the standard methods as illustrated by AOAC (1990).

The leaf area was calculated according to the following formula of Wallace and Munger (1965).

Leaf area (cm^2)= Leaves dry weight (gm) x disk area / Disk dry weight (gm).

Fruit yield and its characteristics:

Five sweet pepper fruits were randomly selected from each plot at the second picking to determine the following data:

Fruit length (cm) - Fruit diameter (cm) - Average fruit weight (g) – Dry matter percent in fruit 100g from fruits was taken and dried at 70 Cº till constant weight and the dry weight was determined - Early fruit yield(ton/fed) as the first and second pickings and total fruit yield (ton/fed) were estimated.

Chemical properties:

Total leaf chlorophyll was measured using Minolta chlorophyll meter SPAD- 501 as SPAD units.

Total nitrogen, phosphorus and potassium were determined in dry plant and fruits on the basis of dry weight according to the methods described by Bremner and Mulvaney (1982), Olsen and Sommers(1982) and Chapman and Pratt (1961) respectively .

Total ascorbic acid: (Vitamin C mg/100g fresh weight) content was determined using 2, 6 di-chlorophenol indophenols, method as described by Ranganna(1979).

Economic study:

Economic performance of sweet pepper plants, i.e., gross return, treatment cost, total variable cost, net return and benefit-cost ratio were calculated based on market prices as average of the two seasons. The benefit-cost ratio was determined according to Boardman *et al.* (2001) by dividing the gross return (£E /fed)) on total variable cost (£E /fed).

Statistical Analysis:

All data were subjected to statistical analysis according to the procedures reported by Snedecor and Cochran (1982) using M. stat program and means were compared by L.S.D multiple range tests at the 5 % level of probability in the two seasons of experimentation.

Results

Microbiological parameter:

The soil microbiology activity was enhanced by bio and organic fertilizers in the combined mixture compost tea + Azolla extract + yeast (T9) as shown in (Table 2). It was cleared that, total bacterial counts were increased in all treatments, the highest counts were recorded with (T9) which recorded 95 and 102 X10^6 CFU/g dry soil at 2013 and 2014 seasons, respectively), after 40 days of planting. More counts were recorded after 70 days from planting, being 98 and 112 X10^6 CFU/g dry soil respectively at two seasons). Moreover, yeast counts were increased in all treatments special with (T9) which it was recorded the highest counts (91 and 94 X10^4 CFU/g dry soil at two seasons ,respectively), after 40 days of planting. More increased was recorded after 70 days of planting, it (97 and 104 X10^4 CFU/g dry soil at two seasons, respectively).

Results also revealed that, total nitrogen fixers count increased with all treatments special T8 and T9. T9 recorded 11 and 14 X10^3 CFU/g dry soil at two seasons, respectively, after 40 days of planting and nitrogen fixer reached 13 and 17 X10^3 CFU/g dry soil at two seasons, respectively after 70 days of planting.

Concerning dehydrogenase activity, the data showed a close correlation between dehydrogenase activity and microbial populations. Significant markedly increases of dehydrogenase activity was recorded in all treatments especial with (T9), which reached 24.2 and 27.8 µg TPF/g dry soil /day at two seasons, respectively after 40 day of planting. The same trend was observed after 70 day from planting, where it recorded 26.3 and 29.5 µg TPF/g dry soil /day at two seasons, respectively. Moreover, Nitrogenase activity was increased significantly with organic and biological treatments, high increaces was observed with T9 which recorded (9.6 and 10.2 µmol C_2H_4 / g dry soil/ h at the two seasons, respectively after 40 day of planting, and (29.6 and 32.7 µmol C_2H_4 / g dry soil/ h at two the seasons, respectively) after 70 day from planting.

Vegetative growth parameters:

Data in Table (3) showed that, vegetative growth parameters of sweet pepper plants were affected by adding microbial and organic fertilizers (compost tea, Azolla extract and yeast) combined with 75% from the recommended mineral fertilization (NPK) of sweet pepper plants. It was obvious that vegetative growth parameters i.e. plant length, number of leaves per plant, number of branches per plant, leaf area as well as fresh and dry weight of plant showed significant effects especially with the high level of mixture between (compost tea + azolla extract + yeast) T9 in both growing seasons.

Table 2: The effect of organic and bio-fertilizer on total bacteria, yeast count, nitrogen fixer count, dehydrogenase and Nitrogenase activities during the two seasons of 2013 and 2014..

Treatments	Total bacterial count (CFU X10^6/ g dry soil)				Total yeast count (CFU X10^4/ g dry soil)				Total nitrogen fixer count (CFU X10^3/ g dry soil)				Dehydrogenase activity (µg TPF/g dry soil /day)				Nitrogenase activity (µmol C_2H_4 /g dry soil/h)			
	40 days		70 days		40 days		70 days		40 days		70 days		40 days		70 days		40 days		70 days	
	2013	2014	2013	2014	2013	2014	2013	2014	2013	2014	2013	2014	2013	2014	2013	2014	2013	2014	2013	2014
T1	20.	23	21	26	2	6	3	7	0.41	0.6	0.54	0.64	10.47	12.3	11.36	13.19	1.35	1.49	2.86	2.73
T2	27	31	29	35	5	7	10	13	1.2	1.3	1.3	1.7	11.2	13.92	12.03	14.08	2.45	2.51	6.4	6.03
T3	31	36	35	42	7	11	12	17	1.4	1.7	1.9	2.2	12.84	14.58	13.75	16.38	3.72	3.65	7.34	7.67
T4	39	43	41	48	10	12	15	21	4	4.5	4.2	5.4	15.12	18.12	16.87	19.76	4.12	4.38	9.38	9.72
T5	42	47	46	51	13	14	21	26	4.8	5.3	5.6	6.4	18.37	19.97	20.85	22.05	4.94	5.32	12.36	12.73
T6	67	72	71	76	60	67	72	71	2	2.2	2.4	2.9	19.68	21.32	21.89	23.54	2.62	3.4	8.63	9.01
T7	76	81	79	86	72	75	78	83	3.2	3.9	3.4	4	20.74	22.76	23.07	25.45	5.31	5.92	15.3	14.8
T8	83	87	85	91	68	73	71	76	8.1	9.2	7.9	9.5	21.79	24.38	23.27	26.37	7.1	7.62	20.8	21.39
T9	95	102	98	112	91	94	97	104	11	14	13	17	24.18	27.82	26.34	29.49	9.58	10.2	29.6	32.7

T1: control, full NPK %.(recommended mineral fertilization 140 kg N+60 kg P2O5+72 kg K2O / fed, T2: compost tea 10 L/fed. + 75% (recommended NPK), T3: compost tea 20 L/fed. + 75% (recommended NPK), T4: compost tea10 L/fed. + Azolla extract 10 L/fed. + 75% (recommended NPK) , T5: compost tea 20 L/fed. + Azolla extract 20 L/fed. + 75% (recommended NPK), T6: compost tea10 L/fed. + yeast 10 L/fed. + 75% (recommended NPK), T7: compost tea 20 L/fed. + yeast 20 L/fed. + 75% (recommended NPK), T8: compost tea 10 L/fed. + Azolla extract 10 L/fed. + yeast 10 L/fed. + 75% (recommended NPK) and T9: compost tea 20 L/fed. + Azolla extract 20 L/fed. + yeast 20 L/fed. + 75% (recommended NPK).

Table 3: The effect of organic and bio-fertilizer on plant growth parameters of sweet pepper plants during the two seasons of 2013 and 2014.

Treatments	Plant length (cm)		No. of. leaves / plant		No. of branches/plant		Leaf area (cm)^2		Fresh weight (g)/ plant		Dry weight (g)/ plant	
	2013	2014	2013	2014	2013	2014	2013	2014	2013	2014	2013	2014
T1	33.66	32.00	135.50	132.00	4.50	5.00	187.14	198.20	195.00	203.33	24.15	27.25
T2	35.16	36.33	136.50	141.33	5.33	5.33	244.88	261.39	215.62	210.00	37.38	34.85
T3	39.50	38.50	149.33	145.66	5.66	6.00	248.54	266.95	221.61	225.30	38.40	36.80
T4	35.63	37.25	140.50	142.88	5.83	5.66	247.57	250.35	233.75	227.22	35.33	36.50
T5	36.50	38.00	166.50	170.13	7.33	7.66	261.08	274.81	245.00	238.75	35.88	37.20
T6	34.92	35.33	141.50	143.25	6.00	6.00	259.78	251.37	227.50	230.83	38.00	33.90
T7	35.00	36.00	163.83	168.22	7.00	6.66	327.76	308.99	250.00	236.66	44.16	40.00
T8	40.33	40.66	169.00	172.50	6.66	7.00	282.51	305.13	261.66	256.66	42.00	38.76
T9	43.50	44.12	176.66	178.73	7.50	8.00	332.56	342.57	285.53	291.66	45.16	42.86
L.S.D at 5%	1.43	1.58	1.46	1.81	1.53	1.69	27.20	1654	1.49	1.67	3.76	3.28

T1: control, full NPK %.(recommended mineral fertilization 140 kg N+60 kg P2O5+72 kg K2O / fed, T2: compost tea 10 L/fed. + 75% (recommended NPK) ,T3: compost tea 20 L/fed. + 75% (recommended NPK), T4: compost tea10 L/fed. + Azolla extract 10 L/fed. + 75% (recommended NPK) , T5: compost tea 20 L/fed. + Azolla extract 20 L/fed. + 75% (recommended NPK), T6: compost tea10 L/fed. + yeast 10 L/fed. + 75% (recommended NPK), T7: compost tea 20 L/fed. + yeast 20 L/fed. + 75% (recommended NPK), T8: compost tea 10 L/fed. + Azolla extract 10 L/fed. + yeast 10 L/fed. + 75% (recommended NPK) and T9: compost tea 20 L/fed. + Azolla extract 20 L/fed. + yeast 20 L/fed. + 75% (recommended NPK).

Fruit yield and its characteristics.

The data in Table (4) showed that the fruit length, fruit diameter, fresh fruit weight ,dry matter in fruit as well as early and total yield were significantly higher in almost all treatments comprise compost tea in combined mixture with Azolla extract and yeast. Moreover, it was cleared that, (T9) treatment recorded the highest significant values in all studied yield parameters and its characteristics in the both seasons.

Table 4: The effect of organic and bio-fertilizer on fruit yield and its component of sweet pepper plants during the two seasons of 2013 and 2014.

Treatments	Fruit length (cm)		Fruit diameter(cm)		Fresh fruit weight (g)		Dry matter in fruit %		Early fruit yield (ton/fed)		Total fruit yield (ton/fed)	
	2013	2014	2013	2014	2013	2014	2013	2014	2013	2014	2013	2014
T1	6.01	6.33	6.01	5.98	72.78	73.88	4.55	4.70	3.19	3.34	8.68	8.29
T2	6.77	6.45	6.13	6.08	78.97	76.52	4.65	4.80	2.31	2.11	5.42	5.62
T3	6.84	7.08	6.46	6.33	78.74	78.33	5.80	5.10	2.40	2.28	5.77	5.77
T4	7.29	7.37	6.64	6.51	89.99	88.33	5.45	5.95	2.52	2.40	6.92	6.72
T5	7.35	7.46	6.63	6.60	84.79	90.00	5.95	6.00	2.68	2.88	7.06	6.94
T6	7.51	7.42	6.50	6.45	84.44	85.55	5.70	5.60	2.39	2.52	6.88	6.79
T7	7.81	7.80	6.70	6.86	90.83	90.14	6.10	6.20	2.85	2.96	7.56	8.03
T8	7.86	7.50	6.60	6.53	88.32	89.58	6.10	6.23	3.68	3.78	8.05	8.52
T9	8.00	8.04	7.00	6.95	102.40	100.55	6.35	6.30	4.10	4.30	11.13	10.28
L.S.D at 5%	0.72	0.50	0.66	0.60	2.97	1.59	0.27	0.24	0.16	0.15	0.49	0.35

T1: control, full NPK %.(recommended mineral fertilization 140 kg N + 60 kg P2O 5+ 72 kg K2O / fed, T2: compost tea 10 L/fed. + 75% (recommended NPK), T3: compost tea 20 L/fed. + 75% (recommended NPK), T4: compost tea10 L/fed. + Azolla extract 10 L/fed. + 75% (recommended NPK) , T5: compost tea 20 L/fed. + Azolla extract 20 L/fed. + 75% (recommended NPK), T6: compost tea10 L/fed. + yeast 10 L/fed. + 75% (recommended NPK), T7: compost tea 20 L/fed. + yeast 20 L/fed. + 75% (recommended NPK), T8: compost tea 10 L/fed. + Azolla extract 10 L/fed. + yeast 10 L/fed. + 75% (recommended NPK) and T9: compost tea 20 L/fed. +Azolla extract 20 L/fed. + yeast 20 L/fed. + 75% (recommended NPK).

Chemical properties:

Data in Table (5) revealed that N, P and K% in sweet pepper plants were significant increased in the most treatments. N% was significantly increased from 2.75 % and 2.73 % in control to 3.07 and 3.31% in T9 in the two seasons, respectively. Moreover, P % was significantly increased from 0.30 % and 0.31 % in control to 0.36 % and 0.37 % in T9 in the two seasons, respectively.

The same trend was observed with K content which was significantly increased from 3.03 % and 3.01 % in T1 to 3.95 % and 4.09 % in T9 respectively at season 2013 and 2014. Furthermore, the leaf chlorophyll content was recorded high significant concentration in all treatment, the most increases was observed in T9 which recorded 74.3 and 76.86 SPAD units respectively at seasons 2013 and 2014, while the control (T1) recorded 59.93 and 60.35 respectively at the two seasons.

Table 5: The effect of organic and bio-fertilizer on N, P and K% in plants and leaf chlorophyll content of sweet pepper plants during the two seasons of 2013 and 2014.

Treatments	N %		P %		K %		Total chlorophyll (SPAD units)	
	2013	2014	2013	2014	2013	2014	2013	2014
T1	2.75	2.73	0.30	0.31	3.03	3.01	59.93	60.35
T2	2.83	2.94	0.38	0.36	3.65	3.45	67.36	68.44
T3	2.93	3.09	0.33	0.35	3.79	3.56	68.81	68.55
T4	2.87	2.98	0.33	0.35	3.52	3.64	67.50	68.53
T5	3.02	3.16	0.34	0.35	3.80	3.91	69.80	68.90
T6	2.89	3.11	0.33	0.36	3.97	3.78	71.33	70.46
T7	2.93	3.21	0.35	0.34	3.91	3.91	72.45	71.80
T8	2.95	3.25	0.35	0.37	3.87	3.84	68.06	69.48
T9	3.07	3.31	0.3 6	0.37	3.95	4.09	74.30	76.86
L.S.D at 5%	0.12	0.23	0.02	0.02	0.31	0.18	2.90	2.03

T1: control, full NPK %.(recommended mineral fertilization 140 kg N+60 kg P2O5+72 kg K2O / fed, T2: compost tea 10 L/fed. + 75% (recommended NPK), T3: compost tea 20 L/fed. + 75% (recommended NPK), T4: compost tea10 L/fed. + Azolla extract 10 L/fed. + 75% (recommended NPK) , T5: compost tea 20 L/fed. + Azolla extract 20 L/fed. + 75% (recommended NPK), T6: compost tea10 L/fed. + yeast 10 L/fed. + 75% (recommended NPK), T7: compost tea 20 L/fed. + yeast 20 L/fed. + 75% (recommended NPK), T8: compost tea 10 L/fed. + Azolla extract 10 L/fed. + yeast 10 L/fed. + 75% (recommended NPK) and T9: compost tea 20 L/fed. + Azolla extract 20 L/fed. + yeast 20 L/fed. + 75% (recommended NPK).

According to the data in Table (6) the obtained results revealed that the quality of fruits was increased after adding organic and microbial special the mixture of all. It was cleared that N, P and K% in the fruits were significantly increased. It is noticed that, the mixture of compost tea, azolla and yeast gave the highest significant value of in N % in fruits. T8 recorded 2.11and 1.90 % respectively at two seasons. Moreover, T9 recorded 2.15 and 2.06 %respectively at two seasons. While, the control recorded 1.45 and 1.15 % respectively at two seasons). The same trend was observed in fruits P %, T8 recorded 0.51 and 0.53% respectively at two seasons. Furthermore, T9 recorded 0.53 and 0.53% respectively at two seasons.

Table 6: The effect of organic and bio-fertilizer on N, P and K% and Vitamin C in fruits of sweet pepper plants during the two seasons of 2013 and 2014.

Treatments	N %		P %		K %		Vitamin C mg/100g fresh weight	
	2013	2014	2013	2014	2013	2014	2013	2014
T1	1.45	1.15	0.35	0.38	4.16	4.41	96.03	100.98
T2	1.51	1.20	0.38	0.39	4.21	4.47	116.57	115.08
T3	1.41	1.15	0.48	0.49	4.15	4.37	130.68	132.16
T4	1.46	1.21	0.38	0.40	4.12	4.37	126.22	123.25
T5	1.86	1.60	0.47	0.51	4.31	4.56	137.36	131.05
T6	1.61	1.42	0.37	0.39	4.09	4.39	124.74	125.48
T7	2.01	1.71	0.49	0.51	4.22	4.51	135.87	138.84
T8	2.11	1.90	0.51	0.53	5.05	5.25	139.58	143.30
T9	2.15	2.06	0.53	0.53	5.11	5.30	144.79	148.50
L.S.D at 5%	0.13	0.17	0.01	0.02	0.31	0.21	5.25	3.59

T1: control, full NPK %.(recommended mineral fertilization 140 kg N+60 kg P2O5+72 kg K2O / fed, T2: compost tea 10 L/fed. + 75% (recommended NPK), T3: compost tea 20 L/fed. + 75% (recommended NPK), T4: compost tea10 L/fed. + Azolla extract 10 L/fed. + 75% (recommended NPK) , T5: compost tea 20 L/fed. + Azolla extract 20 L/fed. + 75% (recommended NPK), T6: compost tea10 L/fed. + yeast 10 L/fed. + 75% (recommended NPK), T7: compost tea 20 L/fed. + yeast 20 L/fed. + 75% (recommended NPK), T8: compost tea 10 L/fed. + Azolla extract 10 L/fed. + yeast 10 L/fed. + 75% (recommended NPK) and T9: compost tea 20 L/fed. + Azolla extract 20 L/fed. + yeast 20 L/fed. + 75% (recommended NPK).

On the other hand the control treatments recorded 0.35 and 0.38 % respectively at two seasons. The effect of the combined mixture was also cleared in fruits K%. Whereas, the control recorded 4.16 and 4.41% at 2013 and 2014 seasons, respectively, while (T8) caused significant increase in K content (5.05 and 5.25 % at 2013 and 2014 seasons, respectively). Furthermore, significant increase was more cleared T9 which recorded 5.11 and

5.30 % at 2013 and 2014 seasons, respectively. Vitamin C concentration in the sweet pepper fruits obtained from the plants inoculated with mixture of compost tea + azolla extract + yeast showed significant increases and also under using the all treatments of organic and microbial fertilizer as shown in Table (2). The highest increases reached with T9 which recorded 144.79 and 148.50 mg/100g fresh weight at 2013 and 2014 seasons, respectively, while the control recorded 96.03 and 100.98 mg/100g fresh weight at 2013 and 2014 seasons, respectively.

Economic return:

The economic performances of sweet pepper plants as affected by adding organic and bio-fertilizers are demonstrated in Table (7). The results showed that, the highest net return (22553£E/fed.) was obtained under combined addition of T9 (compost tea+ azolla extract + yeast at high level + 75% recommended NPK); such treatment return the highest benefit-cost ratio (3.35) in comparison with other treatments, thus this treatment proved to be the economical for sweet pepper production under the condition of this study.

Table 7: Economic performance of sweet pepper plants as affected by adding of organic and bio-fertilizer during the average of two seasons of 2013 and 2014.

Treatments	Total yield (t/fed) (1)	Gross return (£E /fed) (2)	Treatment cost (£E /fed) (3)	Total variable cost (£E /fed) (4)	Net return (£E /fed) (5)	Benefit cost ratio (6)	Order
T1	8.485	25455	2410	10025	15430	2.53	3
T2	5.520	16560	1827	9442	7118	1.75	9
T3	5.77	17310	1847	9464	7848	1.82	8
T4	6.82	20460	1827	9442	11018	2.17	6
T5	7.00	21000	1847	9462	11538	2.21	5
T6	6.835	20505	1877	9492	11013	2.16	7
T7	7.795	23385	1947	9562	13823	2.44	4
T8	8.285	24855	1877	9462	15363	2.61	2
T9	10.705	32115	1947	9562	22553	3.35	1

*(1)Total yield (t/fed) as average of two seasons,(2) Gross return as total yield (t/fed) x 3000 £E /ton, (3) Treatment cost as fertilizers cost + compost tea, azolla and yeast as the following prices : compost tea =2 £E /L., azolla=0£E /L., yeast =5£E /L. ,super phosphat=40 £E /50 kg, potassium sulphate =240 £E /50 kg, Ammonium sulphate =100 £E /50 kg,**(4)** Total variable cost (£E /fed) including**:** Treatment cost plus agricultural practices which equal nearly 7615(£E /fed**), (5) = (**2) - (4), **(6)** = (2) / (4).*

Discussion

For a sustainable agriculture system, it is necessary to utilize renewable inputs which can maximize the ecological benefits and minimize the environmental hazards. The results of this study evaluating the influence of adding microbial and organic fertilizer by soil inoculation with different rats of compost tea alone or combined with azolla extract or *S. cerevisiae* plus 75% from the recommended mineral fertilization (NPK) on the growth parameters and productivity of sweet pepper.

Our results showed that all growth parameters of sweet pepper plants were significantly enhanced as the result of application yeast in soil amended with compost tea and azolla extract. The increase of total microbial count and total yeast count in the rhizosphere of sweet pepper plants proved that inoculation with yeast, compost tea and azolla extract increased the microbial populations (Botha, 2011 and Fierer *et al*. 2007). Yeasts in the root zone may influence plant growth indirectly by encouraging the growth of other plant growth promoting rhizo-microorganisms, through vitamin B12 production (Medina *et al.* 2004).

The increase of total microbial count, yeast and total nitrogen fixer count populations in soil amended with organic fertilizer could be attributed to the act of simple organic compounds found in compost tea and azolla extract associated with root exudates of sweet pepper plants that are readily assimilated by yeast and other microorganisms (Kannaiyan, 1992; Cloete *et al*., 2009 and Botha, 2011). Concerning the activity of dehydrogenase activity, data cleared a close correlation between activity of dehydrogenase activity and microbial populations (Tolba *et al.,* 2010).

Our study illustrated that the inoculation of sweet pepper with *S. cerevisiae* and amended soil with compost tea, azolla extract led to enhancement of the plant growth, as yeasts are capable of directly enhancing the plant growth by the production of plant growth regulators (El-Tarabily and Sivasithamparam, 2006 and Cloete *et al*. 2009). Recently, many authors (Gomaa and Mohamed, 2007 and Abd El-monem *et al*. 2008) studied a wide diversity of soil yeasts for their potential as bio-fertilizers. Organic fertilizers consisting of combinations of yeast are already commercially available, with declares that some of the products are capable of re-establishing the sustainability of ecosystems, as well as enhancing the productivity of farmland for various crops (Botha, 2011 and Pang *et al*., 2003). *Saccharomyces cerevisiae* can produce the auxin indole-3-acetic acid (IAA) and gibberellins (Morsy *et al.,* 2014). The auxin indole-3-acetic acid is best known for its role in plant cell elongation, division, and differentiation (Reeta *et al.,* 2010). Plant performance can also be increased as a result of the production of plant growth regulators compounds includes indole-3-acetic acid, indole-3-pyruvic acid, gibberellins and polyamines by yeasts (Botha, 2011).

Many researchers have been focused on plant bio-stimulants due to the increasing attention about the use of natural substances to potentiate crop. In particular, compost tea can show this particular bioactivity on plants due to its content in aromatic, hormone-like organic molecules and useful microorganisms. Many reports regarded the direct implication of compost tea treatments on the chemical, physical and, especially, on the sensory properties of vegetables such as lettuce (Masarirambi *et al.,* 2010) and potato (Wszelaki *et al.,* 2005). Moreover, application of azolla not only increases the growth and yield of crops but also improves the soil fertility (Awodum, 2008).

Furthermore, contents of N, P and K were also higher in plants and fruits treated with compost tea, yeast and azolla. It could be attributed to, soil yeasts representing the genera *Candida*, *Saccharomyces, Geotrichum, Rhodotorula*, and *Williopsis* have the potential to contribute to the nitrogen and sulpher cycles within soil (Al-Falih, 2006 and Botha, 2011). Increases in the level of inorganic nutrition after decomposition of *S. cerevisiae* inoculums enhanced biologically derived CO_2 production were proposed to explain partly the multiple effect of yeast culture (Nikolay *et al.,* 2001). In addition, these yeasts may be able to solubilize insoluble phosphates thus making these nutrients more readily available to plants (Al-Falih, 2005 and Botha, 2011). Furthermore, contents of N, P and K were also higher in plants inoculated with S. *cerevisiae* in soil amended with compost tea and azolla extract. The increasing N, P and K levels affected positively the plant growth, in addition to the increase of total yeast count in the pepper rhizosphere. This could be explained on the basis that yeasts are capable of indirectly enhancing the plant growth (El-Tarabily and Sivasithamparam, 2006 and Cloete *et al*. 2009). Singh *et al*. (1991) found that inoculation of legumes with *S. cerevisiae* increases nodulation as well as *Arbuscular mycorrhiza* (AM) fungal colonization therefore a variety of yeasts are known to occur in the rhizosphere (Botha, 2006 and Botha. 2011), and the interaction between mycorrhizal fungi and soil yeasts is expected. Thus, the mutualistic symbioses between mycorrhizae and plant roots may facilitate uptake of up to 80% of the phosphorus and 25% of the nitrogen requirements of the host plant (Marschner and Dell, 1994). Compost tea is a very important source of plant nutrients, including micronutrients (Beltran *et al.* 2002). The application of compost tea actually increased the use efficiency of mineral N fertilizer by crops when the two were applied in combination (Nyamangara *el al,* 2003 and Siddiqui *et al*, 2011). Also, the use of azolla as organic fertilizer will increase soil organic matter and total-N content (Sudadi and Sumarno, 2014). Moreover, Simmi *et al.,* (2014) indicated that *Withania somnifera* plants respond better with respect to root and shoot growth, chlorophyll and protein content in plants treated with combination of Cyanobacteria, *Azolla pinnata* and Vermicompost. In the organic management systems that refrain from the use of synthetic chemicals, soil microorganisms become major determinants of nutrient cycling and plant growth, and also interaction between biological and chemical fertilizers caused to significant differences in the yield (Fraser *et al*., 1988). According to the results of our study it can say that, the using of combination of compost tea, azolla extract and *S. cerevisiae* and mineral fertilizers showed and produced maximum yield. Compost tea, azolla extract and *S. cerevisiae* amended soil with organic matter led to enhancement of the plant growth, as yeast are capable of directly enhancing the plant growth and yield by the production of plant growth regulators (Cloete *et al*., 2009). So use of azolla is particularly important to increase the efficiency of soil nitrogen for higher yield (Yadavi *et al.,* 2014). This aquatic fern can be exploited as a potential source of bio-fertilizer to increase the production of plants (Saurabh *et al.,* 2014). Compost tea is largely reported to be complementary to conventional methods of crop management for the enhancement of the quality associated to the agricultural products (Naidu *et al.,* 2013). In the present study the NPK% as well as vitamin C in the fruit were significantly increased in all treatments. In agreement with previous findings reported on tomato (Thybo *et al.,* 2006) and early potato (Lombardo *et al.,* 2012) growing systems organic management may positively affects sensory quality and nutritional value of the products regardless of the yield. Many researchers have been focused on plant bio-stimulants due to the increasing attention about the use of natural substances to potentiate crop. In particular, compost tea can show this particular bioactivity on plants due to its content of aromatic, hormone-like organic molecules and beneficial microorganisms. Many reports regarded the direct implication of compost-based treatments on the chemical, physical and, especially, on the sensory properties of vegetables such as lettuce (Masarirambi *et al.,* 2010) and potato (Wszelaki *et al.,* 2005). Thus further investigations are required to provide clear information about the effects of compost tea in promotion of eat quality among the worldwide consumed vegetables.

Ascorbic acid (AA) has long been considered an important nutritional component of the pepper. The concentration of vitamin C in pepper's flesh depends on several factors such as cultivar, environmental conditions and cultural practices. The differences found for vitamin C, but also for the other quality parameter investigated, among fruit samples treated by compost tea with respect to their control, may be attributed to a different concentration and/or release of potassium salt to the plant. Lester *et al*. (2005) showed that firmness, ascorbic acid was positively influenced in muskmelon fruits by a higher K salt application. In this respect, Fawzy *et al.* (2012) found that, using bio fertilizer increased Ascorbic acid on sweet pepper fruits. Also, Gaafar

(2014) mentioned that, used yeast as soil application showed significant response, on growth, yield and good quality on snap bean pods.

Conclusion

As a general recommendation from this study it can say that, adding organic and bio-fertilizer (compost tea, azolla extract and *Saccharomyces cerevisiae*) combined with 75% from the recommended mineral fertilization (NPK) of sweet pepper plants led to obtain high yield either early or total with the best quality. Also, this mean that decreasing the quantity of mineral fertilization by 25% without any reduction effect on sweet pepper fruit yield, at the same time, it increased the yield with high net income to the growers.

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