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Impact of bio- and sources of organic fertilizers on sweet pepper vegetative growth, yield and quality under protected cultivation condition

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Two plastic house experiments were designed to study the effect of bio fertilization and sources of organic fertilizer on yield and fruit quality of sweet pepper under sandy soil conditions. A split plot design was used with three replicates for each treatment. Bio fertilization treatments were randomly distributed in the main plots, while sources of organic fertilizer treatments were arranged among the sub plots. Bio fertilization gave significantly higher values of vegetative growth, NPK concentration in leaves and fruits and yield. Using compost as a source of organic fertilizer resulted in greater values of vegetative growth, NPK concentration in leaves and fruits, early yield, total yield, total number of fruits per plot, and fruit length and diameter as compared to the other sources of organic manures (quail, turkey, chicken and sheep manures). The combined treatment between compost and bio fertilization gave the highest significant increase in all above mentioned characters. Fruit content of vitamin C and fruit firmness were decreased by using compost, bio fertilization alone or in combination.

Keywords: *Capsicum annuum L*, Quail, Turkey, Chicken manure, Sheep manure, Compost, Bio fertilizers

INTRODUCTION

Sweet pepper (*Capsicum annuum L*), which belongs to the Solanacea family, is one of the most important, popular and favorite vegetable crop cultivated in greenhouses in Egypt for local market and exportation. Successful production of greenhouse sweet pepper depends on various factors. Fertilizer management is one of the most important factors, which assured crop production. Because organic farming products are becoming very necessary in today's world to manage ecosystem health and to impart related human health benefits (Willer et al., 2011), efforts in Egypt should be concentrated on producing organic vegetable to increase the exportation of vegetable. Organic farming is a production system, which largely excludes the use of synthetically produced fertilizers, pesticides, growth regulators and livestock feed additives. To the maximum extent, possible organic farming system rely upon crop rotations, crop residues, animal manures, legumes, off farm organic wastes, mineral bearing rocks and bio fertilizers to maintain soil productivity and to supply plant nutrients (Jagadeesha, 2008).

In spite of the clear role of organic manure as alternative practice to mineral fertilizers (Naeem et al., 2006) for supplying the plants with all necessary macro and micronutrients (Nweke et al., 2013) and its important role in improving physical and chemical properties of soils (Chaterjee et al., 2005), and microbial biomass (Suresh et al., 2004), several investigations proved that source of organic manures had significant effect on yield and quality of different vegetable crops. In this concern, Ghimire et al., (2013) showed that application of goat manure, vermicompost and farm yard manure (FYM), gave

the highest value of fruit yield, average fruit weight and per cent fruit set, respectively. Shaheen et al., (2016) proved that applying poultry manure gave superiority of vegetative growth, total yield and its components as well as nutritional values of sweet pepper fruits (cv. California Wonder) than cattle manure. Adhikari et al., (2016) showed that the use of vermicompost was better for sweet pepper growth and yield as compared to other organic manures (goat manure; farm-yard manure, poultry manure, commercial organic fertilizer) and chemical fertilizers used in the experiment. Khandaker et al., (2017) studied the effects of different organic fertilizers (vermicompost, chicken dung, peat moss, fermented fish waste, and cow dung) on growth, yield and quality of *Capsicum annuum* L. var. Red Chili Kulai and found that application of vermicompost and chicken dung showed highest growth, quality and yield performance.

Bio-fertilizers are eco-friendly, one of the best modern tools for agriculture and are used to improve the fertility and quality of the soil (Abdel Ghany et al., 2013). Bio fertilizers include microorganisms that fix nitrogen, solubilize phosphate and potassium, secret hormone and suppress soil borne plant pathogens (Mohapatra *et al.,* 2013). Bio-fertilizers promote the adequate supply of nutrients to the host plants and ensure their proper development of growth and regulation in their physiology (Abdel Ghany et al., 2013). The results of Rezvani, et al. (2013) who studied the effect of nitrogen fixation and phosphorus solvent bacteria on growth physiology and vitamin C content of *Capsicum annum* L. revealed that the highest yield dry weight and fresh weight were obtained by applying nitrogen fixing bacteria combined with phosphate solubilizing bacteria treatment. This combination of bio fertilizers also significantly improved leaf phosphorous and increased fruit content of Vitamin C, nitrogen and calcium.

The present work aimed to evaluate the effects of different organic fertilizers with or without application of bio fertilizers on sweet pepper under plastic house conditions.

MATERIALS AND METHODS

The experiment was conducted during the two winter seasons of 2015/2016 and 2016/2017 in a plastic house at a private commercial organic Farm (Sekem), Belbeis, Sharqia Governorate, Egypt. The plastic house was 9 m width, 60 m length and 3 m height. The experiment was arranged as split plot design with treatments replicated three times to evaluate the effects of bio fertilizers mixture and sources organic fertilizers on the yield and quality of sweet pepper .The experiment consisted of 10 treatments that were combination of two bio fertilizer treatments (with or without bio fertilizers) and five sources organic fertilizers treatments (quail, turkey, chicken, sheep manures and compost). The sweet pepper variety that was used in the experiment was cv. Mazurka (red), introduced from Rijk Zewan Company**.** To achieve the purpose of the experiment, the soil of experiment was at first analyzed just after ploughing according to FAO (1980) (the results of the analysis are presented in Table 1).

Thereafter, the soil of plastic house was divided into five ridges (1 m width x 60 m length). However, the experiment was conducted on the three middle rows, each represented a replicate. Each ridge was divided into two equal divisions (1 m width x 30 m length), one division was treated with a mixture of bio fertilizers, and the another division was left without bio fertilizer treatment. These two divisions represented the main plots. Each main plot was divided into five equal subplots (1 m width x 6 m length) representing five organic fertilizer treatments. The amount of each source was added at a rate of 7.5kg N/100m^2. On the other hand, P and K were adjusted to 4and 10 kg/100 m^2, respectively(as is recommended by El-Sayed,2006) for greenhouse sweet pepper production in sandy soil), by adding rock phosphates (22.8% P_2O_5) and feldspar (10.6% K_2O), respectively for all sources of organic manure, each according to the chemical analysis presented in Table 2.Quail and turkey manures were obtained from the experimental farm of Faculty of Agriculture Farm, Cairo University, while chicken manure and compost were obtained from Sekum Company. On the other hand, sheep manure was obtained from a private farm.

The respective amounts of each fertilizer were incorporated into ridges one week before transplanting. The plot area was 6 m^2in a form of a ridge. Bio fertilizers were used as mixture of *Azotobacter chroococcum, Azospirillium brasilense* (nitrogen fixing bacteria), *Bacillus megaterium* (phosphate dissolving bacteria) and *Bacillus circulans* (potassium releasing bacteria). All bio fertilizers were produced by Central Lab of Organic Agriculture, Agricultural Research Center

Table 1. Physical and chemical analyses of the experimental soil before pepper growing

Experiment year	Sand %	Silt %	Clay %	Texture	pH	EC dS/m	Cations meq/l				Anions meq/l			
							Ca^{++}	Mg^{++}	K^{+}	Na^{+}	$Co_3^{=}$	HCO_3^{-}	Cl^{-}	$SO_4^{=}$
2015/2016	90.7	4.2	5.1	Sandy	7.4	0.9	2.30	1.60	1.7	4.3	Zero	1.5	5.7	1.8
2016/2017	91.5	3.5	5.0	Sandy	7.5	1.0	2.50	1.80	1.8	4.2	Zero	1.9	5.9	2.1

Table 2. Chemical analyses of the different organic fertilizers

Type	Hum %	pH	EC (ds/m^2)	OM %	Macro elements (%)			Micro elements (ppm)			
					N	P	K	Fe	Zn	Mn	Cu
Quail	10.0	7.6	8.8	55.1	3.8	1.3	2.3	1080	667	330	58
Turkey	10.0	7.7	6.5	52.4	3.0	1.6	1.4	755	256	335	60
Chicken	12.5	6.7	5.17	60.6	2.8	1.02	2.3	1700	195	265	39
Sheep	40	7.9	5.3	26.3	1.8	0.9	1.2	3335	195	185	33
Compost	25.0	7.2	2.5	49.4	0.98	0.6	1.6	1031	20	154	41

Transplant production and transplanting

The seeds of sweet pepper were sown in the seedling trays, filled with peat moss, vermiculite and compost at a ratio of 1.5:1.5:1.0 (v: v: v) on July 22nd and 28th in first and second seasons, respectively, and kept in the nursery under plastic house conditions.The seedlings were transplanted in the soil of the plastic house onSeptember1st and 7thin first and second seasons, respectively. The plot included 24 plants in 2 rows; the space within plants and between rows was 50 cm, while the space between ridges was 75 cm.

Biofertilization and plant managements

Bio fertilizers were supplemented to the soil surface beside plants after 2 and 4 weeks from transplanting by using liquid cultures at a rate of 20 ml/plant (1ml contains 10^8cell) after diluted by water without Chlorine at 1: 20 rate. The plants were irrigated by drip irrigation (4L /hr) daily according to water rations program for pepper plants under plastic houses at Giza Governorate (Ministry of Agriculture and Land Reclamation, 1988). No chemical means of pest control were used in this study. For powdery mildew, micronic Sulfur (Dow Agro Science, USA, and imported by Wady El-Nile for Agric. Development) was sprayed every 14 days at 250 g/100 l water as protection and 500 g/100 l water for diseases control. leaf aphid were controlled using M-Pede (49% Potassium salts of fatty acids, "Dow Agro Science", USA, and imported by Wady El-Nile for Agric. Development) at a rate of 1.5 l/100 l water, while White fly, broad mites, trips and red spider were controlled by using Biofly (*Beauveria bassiana,* produced by Bio Co for Bio-Fertilizers and Biological control products, Sadat city)at 100 ml/100 l water. Additionally, sticky yellow and blue cards were used to trap winged white fly, and aphids, respectively.

Data Recorded

Plant growth measurements and Mineral concentration in leaves

The four center plants in each plot were labeled, 120 days after transplanting, to record vegetative growth characters, i.e., plant height and number of leaves/plant, Chlorophyll reading and minerals (N, P and K) concentration in leaves. Plant height was measured from the soil surface to the last node of the tallest stem on each of the four plants in each plot. Chlorophyll reading was measured in the most recently fully expanded leaf of the four center plants in each plot using a SPAD-501 plus Minolta Chlorophyll Meter. The most recently twelve l fully expanded leaves were collected from the four center plants in each plot and combined into one composite leaf sample per plot and dried in a forced-air oven at 80 ˚C for 72 h for mineral (N, P and K) determination . Nitrogen concentration in was determined by “Kjeldahl method” according to the procedure described by FAO (1980). Phosphorus percent was determined using spectrophotometer according to Cottenie et al. (1982). Potassium percent was determined by using a Gallen Kamp flame photometer as mentioned by Cottenie et al., (1982).

Yield Measurements

Marketable and total mature fruits yield per square meter

Pepper fruits of the all plants in each replicate were harvested at mature stage (at red color), which began on 5 and 10 of January and finished on 28 and 31of May, in the first and second seasons, respectively. Fruits from each harvest were counted and weighed for estimating yield per plots and thereafter per square meter. Thereafter, nonmarketable fruits were isolated and discarded. Nonmarketable fruit were less than 55 mm in diameter or had at least one of the six major bell pepper external defects: blossom end rot, sunscald, radial cracking, flat shape, misshapen or russeting, The rest of the fruits was weighed as marketable fruits. The first two harvests were considered as early yield, while the data of marketable and all fruits that harvested throughout the season were summed to estimate marketable and total yield per plot then per square meter.

Physical and chemical characters of mature fruits

During the middle of the harvest period, six uniform fruits (at fully color stage) were selected from each replicate (one per plant) for fruit quality (average of weight, diameter, firmness, TSS, vitamin C and N, P and K concentration) determination. The six fruits of each replicate were divided into two subgroups of three fruits each. Average of weight, diameter, firmness, TSS, vitamin C were measured in the first subgroup (three fresh fruits) in each replicate, while N, P, and K were determined in oven dried fruits (in the second subgroup) .

Fresh fruit

Fruit firmness was determined using a penetrometer (Bertuzzi FT 011) fitted with an 8 mm diameter probe. Ascorbic acid (vitamin C) was determined by using the 2, 6 Di chlorophenolindophenol method as described in A. O. A. C. (1990). Percentage of total soluble solids (TSS %) was determined using a hand re fractometer (JENA178512-U. K.) according to the method described in A.O.A.C (1990).

Dry fruit

Fruit samples were oven dried at 70° C just before chemical analysis. Percentages of N, P and K in the dry fruits were determined as was described before in the leaves.

Statistical analysis

Data of the two seasons were arranged and statistically analyzed using SAS program version 2004 for statistical analysis. The differences among means for all traits were tested by LSD at 5 % level of probability according to the procedure described by Snedecor and Cochran (1980).

RESULTS

Vegetative growth

Data in Table 3 showed that using bio fertilizers significantly increased vegetative growth characters (plant height and number of leaves per plant) and chlorophyll reading in leaves of sweet pepper plants after 120 days from transplanting, compared without applying bio fertilizers.

Source of organic fertilizers showed significant influence on vegetative growth characteristics. In this regard, compost and chicken treatments gave the highest values of plant height and number of leaves/plant after 120 days from transplanting; turkey manure treatments came in the second order, then sheep manure treatment; finally the lowest plant height was obtained by using quail manure. The highest reading of chlorophyll in pepper leaves was observed in plants treated with compost, chicken and turkey manures, while the lowest reading of chlorophyll was obtained by quail and sheep manure treatments.

The interaction between organic fertilizers and bio fertilizers on vegetative growth characteristics and chlorophyll reading of sweet pepper leaves was significant. The highest values of plant height and number of leaves/plant and chlorophyll reading were recorded for compost and with bio fertilizers. On the contrary, quail manure without bio fertilizers gave the lowest values.

Mineral concentration in leaves

Data presented in Table 4 show clearly that percentage of NPK in leaves obtained from plants got organic fertilizer combined with bio fertilizer was higher than those received organic fertilizers without bio fertilizers.

Organic fertilizers showed significant effect on mineral concentration in leaves of sweet pepper plants. It was clear in this concern the highest concentration of N, P and K in the leaves of sweet pepper plants was preceded by compost, while the lowest concentration was resulted from using quail manure. Meanwhile chicken and turkey manure treatments came in the second order, and then sheep manure treatment.

Table 3. Effect of bio fertilizers and some organic fertilizers on growth characters of sweet pepper plants, 120 days after transplanting during 2015/2016 and 2016/2017 seasons

Treatments		First season			Second season		
		Plant height (cm)	No. of Leaves /plant	Chlorophyll reading (Spad)	Plant height (cm)	No. of Leaves /plant	Chlorophyll reading (Spad)
Without bio fertilizers		75.61	89.00	57.13	79.09	89.07	57.20
With bio fertilizers		83.09	93.00	58.60	90.42	97.40	62.10
LSD at 5%		2.42	1.96	0.78	3.62	2.79	1.33
Without bio fertilizers	Quail	66.17	84.67	55.00	64.33	85.67	56.33
	Turkey	84.17	91.67	58.50	86.17	95.00	60.08
	Chicken	85.39	94.00	59.50	89.39	97.00	61.83
	Sheep	75.33	87.67	56.50	76.17	89.84	57.17
	Compost	95.77	97.00	59.83	94.67	98.67	62.83
LSD at 5%		6.08	3.03	2.43	6.32	5.63	2.75
With bio fertilizers	Quail	62.33	85.67	54.33	64.33	81.67	54.00
	Turkey	83.00	89.33	57.67	84.00	90.67b	58.33b
	Chicken	82.77	91.33	58.67	85.77	92.67	59.33
	Sheep	74.33	85.67	56.00	72.33	86.00	55.00
	Compost	92. 77	93.00	59.00	89.00	94.33	59.33
	Quail	70.00	83.67	55.67	69. 77	89.67	56.33
	Turkey	85.33	94.00	59.33	88.33	99.33	61.67
	Chicken	88.00	96.67	60.33	93.00	101.33	64.67
	Sheep	76.33	89.67	57.00	80.00	93.67	60.00
	Compost	95.77	101.00	60.67	100.33	103.00	65.00
	LSDat5%	8.88	6.12	3.51	10.21	7.81	3.81

Table 4.Effect of bio fertilizers and some organic fertilizers on NPK concentrations in leaves of sweet pepper plants 120 days after transplanting during 2015/2016 and 2016/2017 seasons

Treatments		First season			Second season		
		N (%)	P (%)	K (%)	N (%)	P (%)	K (%)
Without bio fertilizers		5.696	0.400	4.378	4.23	0.34	4.20
With bio fertilizers		6.101	0.560	4.506	4.60	0.39	4.62
LSD at 5%		0.401	0.07	0.061	0.31	0.03	0.22
Quail		4.823	0.350	3.945	3.73	0.31	4.18
Turkey		5.890	0.380	4.390	4.56	0.35	4.48
Chicken		6.628	0.455	4.415	4.70	0.38	4.60
Sheep		5.430	0.415	4.565	4.00	0.32	3.89
Compost		6.720	0.490	4.895	5.00	0.46	4.91
LSD at 5%		1.174	0.122	0.207	0.64	0.04	0.54
Without Bio fertilizers	**Quail**	4.820	0.320	3.870	3.61	0.28	4.11
	Turkey	5.930	0.370	4.260	4.43	0.32	4.33
	Chicken	6.310	0.440	4.380	4.49	0.36	4.37
	Sheep	5.240	0.420	4.530	3.75	0.30	3.66
	Compost	6.180	0.450	4.850	4.85	0.43	4.53
With Bio fertilizers	**Quail**	4.827	0.380	4.020	3.88	0.34	4.24
	Turkey	5.850	0.390	4.520	4.73	0.38	4.63
	Chicken	6.947	0.470	4.450	4.89	0.40	4.83
	Sheep	5.620	0.410	4.600	4.23	0.35	4.12
	Compost	7.260	0.530	4.940	5.18	0.50	5.28
LSD at 5%		1.660	0.270	0.416	1.03	0.07	0.76

Table 5.Effect of bio fertilizers and some organic fertilizers on yield component of sweet pepper plants during 2015/2016 and 2016/2017 seasons

Treatments		First season				Second season			
		Early yield (kg/m^2)	Marketable yield (kg/m^2)	Total yield /m^2		Early yield (kg/m^2)	Marketable yield (kg/m^2)	Total yield /m^2	
				Weight (kg)	Number			Weight (kg)	Number
Without bio fertilizers		0.70	3.21	5.27	39.22	2.28	5.39	7.20	50.13
With bio fertilizers		1.66	4.86	7.481	49.55	2.76	6.96	8.31	55.93
LSD at 5%		0.04	0.62	0.01	6.17	0.06	0.90	1.02	3.82
Quail		1.01	3.42	5.68	47.01	1.58	5.38	5.87	45.78
Turkey		1.19	3.70	5.71	35.95	2.51	5.81	7.95	54.50
Chicken		1.21	4.48	7.02	43.99	2.80	6.57	8.52	55.42
Sheep		0.86	3.67	6.29	44.78	2.22	5.95	6.82	50.06
Compost		1.60	4.90	7.17	50.66	3.49	7.17	9.61	59.41
LSD at 5%		0.20	0.41	0.74	4.89	0.24	0.79	0.99	3.31
without bio fertilizers	Quail	0.42	2.82	4.17	35.47	1.40	4.88	5.63	44.56
	Turkey	0.57	2.80	4.87	32.61	2.33	4.87	7.39	51.55
	Chicken	0.79	3.65	6.06	41.75	2.62	5.53	7.95	52.19
	Sheep	0.80	3.27	5.77	38.48	1.91	5.76	6.24	46.56
	Compost	0.92	3.53	5.97	48.75	3.13	5.93	8.78	55.81
with bio fertilizers	Quail	1.61	4.02	7.20	58.54	1.76	5.88	6.11	47.00
	Turkey	1.82	4.61	6.55	39.30	2.69	6.74	8.52	57.44
	Chicken	1.64	5.31	7.96	46.23	2.98	7.62	9.09	58.64
	Sheep	0.92	4.07	6.81	51.09	2.52	6.15	7.41	53.56
	Compost	2.27	6.27	8.37	52.57	3.84	8.4 0	10.44	63.01
LSD at 5%		0.37	0.72	1.04	7.74	7.74	0.37	1.12	4.53

The interaction between organic fertilizers and bio fertilizers had significant effect on NPK percent of bell pepper plants. Using compost with bio fertilizers showed the highest N% in the leaves, whereas the lowest one was obtained by quail manure with or without bio fertilizers and sheep manure without bio fertilizers. The highest P and K% was recorded by using compost with bio fertilizers. On the contrary, the lowest P and K% was obtained by quail manure without bio fertilizers in the first season, and quail manure and sheep manure without bio fertilizers, respectively, in the second season.

Yield component

Data in Table 5 revealed that the treatment of bio fertilizer gave the highest values of early, marketable and total yield (number and weight per square meter) of sweet pepper fruits compared with organic fertilizers without bio fertilizers.

Source of organic fertilizers had significant effect on yield component. The highest values of early, marketable and total yield of sweet pepper fruits in both seasons were produced by using compost treatment, followed by chicken manure treatment. In contrast, in the first season, sheep manure and turkey manure showed the lowest values of early yield and fruits number of total yield, respectively, while quail manure produced the lowest weights of marketable and total yield. In the second season, the lowest values of early, marketable and total yield were produced by using quail manure

The interaction between organic fertilizers and bio fertilizers on early marketable total yield/m^2 of bell pepper was significant. However, the highest values of early, marketable and total yield/m^2 and fruit number/plant were recorded by using compost with bio fertilizers. On the contrary, the lowest value of early yield and total fruits weight in both seasons and total fruits number in the second season was obtained by using quail manure without bio fertilizers. Meanwhile, the lowest value of marketable yield in both seasons and total fruits number in the first season was recorded for turkey manure without bio fertilizers.

Fruit quality

Physical Fruit quality

Data recorded in Table 6 show that the combination of organic fertilizers with bio fertilizers produced fruits of sweet pepper that having bigger diameter and average fruit weight than organic fertilizers alone,

Table 6.Effect of bio fertilizers and some organic fertilizers on physical characters of sweet pepper fruits during 2015/2016 and 2016/2017 seasons

Treatments		First season				Second season			
		Fruit diameter (cm)	Fruit length (cm)	Fruit firmness (kg/cm$^{2)}$	Average fruit weight (g)	Fruit diameter (cm)	Fruit length (cm)	Fruit firmness (kg/cm$^{2)}$	Average fruit weight (g)
Without bio fertilizers		8.21	9.35	2.78	136.85	8.29	8.99	2.83	142.33
With bio fertilizes		9.19	9.25	2.09	151.00	8.45	9.17	3.26	148.00
LSD at 5%		0.50	NS	0.61	0.14	0.14	NS	0.45	6.03
Quail		8.32	9.68	2.27	120.25	7.83	8.55	3.02	128.17
Turkey		9.15	9.84	2.90	157.90	8.60	9.20	3.00	145.83
Chicken		8.70	8.79	2.12	158.75	8.63	9.35	3.06	153.67
Sheep		8.36	8.82	2.48	141.65	8.02	8.67	2.98	136.17
Compost		9.00	9.30	2.40	140.85	8.77	9.63	3.17	161.50
LSD at 5%		0.35	NS	0.57	32.50	0.78	0.41	0.18	NS
without bio fertilizers	Quail	7.70	9.50	2.67	117.50	7.73	8.47	2.80	126.33
	Turkey	8.99	10.55	2.63	149.15	8.53	9.07	2.75	143.33
	Chicken	8.16	8.58	2.57	145.00	8.53	9.30	2.83	152.33
	Sheep	8.33	8.99	3.30	150.00	7.93	8.60	2.77	134.00
	Compost	7.85	9.10	2.73	122.50	8.70	9.53	3.00	157.33
with bio fertilizers	Quail	8.93	9.87	1.87	123.00	7.93	8.63	3.23	130.00
	Turkey	9.31	9.13	3.17	166.65	8.67	9.33	3.25	148.33
	Chicken	9.23	8.99	1.67	172.50	8.73	9.40	3.29	155.00
	Sheep	8.32	8.65	1.67	133.35	8.10	8.73	3.20	138.33
	Compost	10.15	9.49	2.07	159.15	8.83	9.73	3.33	165.67
LSD at 5%		0.59	1.46	1.11	37.15	0.80	0.66	0.30	12.33

Table 7. Effect of bio fertilizers and some organic fertilizers on organic content of sweet pepper fruits during 2015/2016 and 2016/2017 seasons

Treatments		First season		Second season	
		TSS (%)	Vit. C (mg/100g)	TSS (%)	Vit. C (mg/100g)
Without bio fertilizers		7.55	166.72	7.60	172
With bio fertilizers		7.85	142.88	7.93	154
LSD at 5%		0.20	0.08	0.61	12
Quail		7.52	165.30	7.40	172
Turkey		7.65	150.32	7.75	160
Chicken		7.90	150.56	7.97	159
Sheep		7.48	160.72	7.57	170
Compost		7.94	147.2	8.15	155
LSD at 5%		0.41	0.12	0.71	15
Without Bio fertilizers	Quail	7.37	181.80	7.27	180
	Turkey	7.50	152.60	7.63	168
	Chicken	7.77	168.00	7.80	168
	Sheep	7.33	173.20	7.40	180
	Compost	7.77	157.84	7.93	166
With Bio fertilizers	Quail	7.67	149.24	7.53	164
	Turkey	7.80	148.04	7.87	152
	Chicken	8.03	132.20	8.13	150
	Sheep	7.63	148.24	7.73	160
	Compost	8.10	136.56	8.37	144
LSD at 5%		0.62	0.27	0.82	19

Table 8. Effect of bio fertilizers and some organic fertilizers on concentration of NPK in sweet pepper fruits during 2015/2016 and 2016/2017 seasons

Treatments		First season			Second season		
		N (%)	P (%)	K (%)	N (%)	P (%)	K (%)
Without bio fertilizers		3.41	0.38	3.11	3.47	0.29	3.02
With bio fertilizers		4.52	0.43	4.05	4.64	0.32	3.90
LSD at 5%		0.72	0.05	0.59	0.51	0.03	0.34
Quail		3.46	0.34	3.02	3.80	0.26	3.24
Turkey		3.91	0.40	3.73	3.99	0.31	3.32
Chicken		3.89	0.39	3.23	3.77	0.29	3.59
Sheep		4.09	0.40	3.49	3.99	0.28	3.41
Compost		4.48	0.51	4.44	4.45	0.39	3.73
LSD at 5%		1.01	0.09	0.86	0.58	0.07	0.41
Without Bio fertilizers	Quail	2.94	0.31	2.57	3. 04	0.24	2.80
	Turkey	3.17	0.37	3.26	3.42	0.28	2.87
	Chicken	3.43	0.35	2.80	3.37	0.27	3.16
	Sheep	3.51	0.38	2.96	3.16	0.27	3. 00
	Compost	4.01	0.49	3.94	3.91	0.37	3.23
With biofertilizers	Quail	3.97	0.37	3.47	4.55	0.28	3.67
	Turkey	4.65	0.43	4.20	4.55	0.33	3.76
	Chicken	4.36	0.42	3.65	4.17	0.30	4.01
	Sheep	4.67	0.41	4.01	4.81	0.28	3.82
	Compost	4.95	0.53	4.93	5.11	0.41	4.23
LSD at 5%		1.31	0.13	1.27	1.04	0.12	0.58

While the reverse was recorded regarding fruit firmness. On the other hand, there were no significant differences between using organic fertilizers with or without bio fertilizers on the fruit length.

Except for average fruit weight which was the highest by using chicken manure, applying turkey in the first season led to producing the best physical fruit quality (highest values of fruit diameter, weight and firmness), while using compost in the second season gave the highest values of fruit diameter, length, firmness and average weight. In contrast, the lowest values of all physical fruit quality in both seasons were registered for fruits harvested from plants received quail, chicken and turkey manures.

The interaction between organic fertilizers and bio fertilizers had significant effect on the physical fruit quality of sweet pepper. However, the results of the two seasons were not completely identical. In the first season, the highest values of fruit diameter and average fruit weight were recorded by using bio fertilization with compost and chicken manure, respectively. Meanwhile, using turkey and sheep manure without bio fertilizers gave the highest values of fruit length and fruit firmness, respectively. On the contrary, the lowest values of fruit diameter, length, and average weight were obtained by using quail, chicken and quail without bio fertilizers, respectively. Meanwhile, using chicken or sheep manure with bio fertilizers gave the lowest values of fruit firmness.

In the second season, using compost with bio fertilizers led to producing the highest values of all physical characters of fruits. Conversely, applying quail without bio fertilizers and turkey with bio fertilizers resulted in producing the lowest values of fruit dimensions (fruit diameter, fruit length, and average fruit weight) and fruit firmness, respectively**.**

Organic content of pepper fruits

Data recorded in Table 7 indicate that the combination of organic fertilizers and bio fertilizers significantly increased percentage of TSS, while it

decreased sweet pepper fruits content of vitamin C as compared to using organic fertilizers alone without bio fertilizers.

Applying compost or chicken manures gave the highest value TSS%, and the lowest value of vitamin C content of sweet pepper fruits. On the contrary, fertilizing pepper plants with sheep and quail manure showed reverse results, i.e., gave the lowest value of TSS%, and the highest value of vitamin C content of sweet pepper fruits.

As shown in table 9, the interaction between organic fertilizers and bio fertilizers organic content of fruits was significant. The combination between bio fertilizers and utilizing compost or chicken manure revealed the highest values of TSS%, and the lowest value of vitamin C, whereas using quail or sheep manure alone without bio fertilizers produced fruits with highest vitamin 0C contents and lowest concentration of TSS.

N, P and K concentration in pepper fruits

Data recorded in Table 8 show clearly that using bio fertilizers produced higher concentration of NPK in fruits as compared with using compost without adding bio fertilizers. Using compost manure produced highest content of N, P and K of fruit of pepper, while the lowest content of P and K of fruit was recorded in quail in both seasons. On the other hand, the lowest N concentration in fruits was detected in quail treatment in the first season and chicken followed by quail treatment in the second season. The interaction between organic fertilizers and bio fertilizers had significant effect on the N, P and K content of bell pepper. The highest values of N, P and K of fruit was recorded by using compost with or without bio fertilizers, while the lowest of N, P and K was recorded by quail with or without bio fertilizers

DISCUSSION

Organic agriculture is a holistic production management system which promotes and enhances agro-ecosystem health, including biodiversity, biological cycles, and soil biological activity. It emphasizes the use of management practices in preference to the use of off-farm inputs, taking into account that regional conditions require locally adapted systems. This is accomplished by using, where possible, agronomic, biological, and mechanical methods, as opposed to using synthetic materials, to fulfill any specific function within the system (FAO 1999). To the maximum extent, possible organic farming system rely upon crop rotations, crop residues, animal manures, legumes, green manures, off farm organic wastes, mineral bearing rocks and bio fertilizers to maintain soil productivity and to supply plant nutrients and biological means to control insects, weeds and pests (Jagadeesha, 2008)

In the present work the effect of two sources of soil enrichments (bio fertilizers, five sources of organic manures and their combination) on vegetative growth, mineral concentration, yield and fruit quality of pepper was studied. Bio fertilizers in the present experiment were used as mixture of *Azotobacter chroococcum, Azospirillium brasilense* (nitrogen fixing bacteria), *Bacillus megaterium* (phosphate dissolving bacteria) and *Bacillus circulans* (potassium releasing bacteria). The results indicated that compared with applying no bio fertilizers, bio fertilizers significantly increased vegetative growth characters and chlorophyll reading in leaves and NPK in leaves of sweet pepper plants after 120 days from transplanting. It was also clear that the treatment of organic fertilizer combined with bio fertilizer gave higher values of early, marketable and total yield of sweet pepper fruits compared with organic fertilizers without bio fertilizers.This treatment produced fruits of sweet pepper that having bigger diameter and average fruit weight than organic fertilizers alone, while the reverse was recorded regarding fruit firmness and vitamin C. The combination of organic fertilizers and bio fertilizers significantly increased percentage of TSS and NPK in fruits, while it decreased sweet pepper fruits content of vitamin C as compared to using organic fertilizers alone without bio fertilizers. The simulative effect of bio fertilizers mixture for the vegetative growth and NPK concentration in leaves may be attributed to increasing mineral elements in the soil, where the organisms found in bio-fertilizers solubilize the unavailable forms of inorganic-P (Venkateswarlu et al., 2007) and potassium rock through production and secretion of organic acids (Bin Zakaria 2009). *Azotobacter spp.*fix nitrogen and produce different growth hormones (IAA and other auxins, such as gibberellins and cytokinins) and vitamins. *Azotobacter* is able to converting nitrogen into ammonia, which, in turn, is taken up by the plants (Kahlil, 2008). *Azotobacter spp*. can also produce antifungal compounds that may fight many plant pathogens (Jen- Hshuan, 2006). *Azospirillum spp.* mainly change growth and morphology of roots, by increasing the number of lateral roots and root hairs; the enlargement of the root surface results in better nutrient uptake and

an improved water status that may be the main factor enhancing plant growth (Bottini et al.,2004). So, bio fertilizers not only improve soil fertility through increasing its contents of mineral elements, but also have a stimulating effect upon plant growth and development (Kute et al., 1997).

The great vegetative growth of pepper plants, due to applying the bio fertilizers mixture, was reflected as a higher early and total yield per plants, and consequently per square meter. The increased vegetative growth was accompanied with more NPK uptake in leaves and in fruits as well as a higher chlorophyll contents that led to effective photosynthesis resulting in more accumulation of TSS in fruits.

Application of organic manures has been a noble and traditional practice of maintaining soil health and fertility. The importance of organic manures is, now-a-days realized because of high cost of fertilizers and their inherent capacity to supply most essential nutrients for a balanced nutrition to the crop growth. Organic nutrients generally facilitate crop rooting; improve water retention capacity and results in the even distribution of nutrients in soil profile. (Jagadeesha, 2008).

Regarding organic fertilizers, five sources of organic fertilizers were used in in our experiments. These fertilizers were quail, turkey, chicken, sheep manures and compost). All fertilizers were applied at a rate of 7.5 kg N/100m^2, while P and K amounts were adjusted to 4 and 10 kg/100 m^2, respectively by adding rock phosphates (22.8% P_2O_5) and feldspar (10.6% K_2O), respectively for all sources of organic manure, each according to its P and K contents.

The result obtained from the present study revealed that the combined treatment between compost and bio fertilization produced highest values of vegetative growth, fruit yield, physical characters of fruit, percentage of TSS in fruits, chlorophyll reading and minerals (N, P and K) concentration in leaves 120 days after transplanting and NPK concentration in fruits as well as the lowest values of fruit firmness and fruit contents of vitamin C. In contrast, quail manure showed a completely reverse trend to the results of compost. The comparison among the different sources of organic manures indicated that quail followed turkey by had the highest content of N (3.8, and 3.0, respectively), whereas compost had the lowest contents of N (0.98%). Meanwhile, chicken followed by quail had the highest content of organic matter, whereas compost had the lowest contents of organic matter. Due to such analysis, and to have N in all sources of organic manure at a rate of 7.5 kg N/100m^2, compost was added at a rate of 9.566 kg/m^2, i.e.7.174 kg as a dry weight /m^2, while quail was applied a rate of 2.171 kg/m^2, i.e. 1.973 kg as a dry weight /m^2. According to the chemical analysis of different sources of organic manures (Table 2), the organic matter that was added to the soil through compost application was about 3.543 kg, while quail was about 1.087 kg. So, the amount of organic matter that was added through compost application was about 3.25 fold that added in the case of quail. Adding high amounts of compost may contribute in improving the sandy soil structure to keep the irrigation water and nutrient elements, especially nitrogen from leaching and consequently more nutrient uptake by pepper plants. It was reported that organic manure has important role in improving physical and chemical properties of soils (Chaterjee et al., 2005), and microbial biomass (Suresh et al., 2004). It was also previously reported that application of organic manure play an important role on yield and its attributes as well as nutrient uptake and directly increase the soil physical condition. It lowers soil bulk density; increases water holding capacity, CEC, build up beneficial soil microbes, improve good soil structure and enhance stable soil aggregates (Doran, 1995; Drinkwater et al., 1995). Leng (2006) attributed yield increase resulting from the addition of organic manure to increase in cation exchange capacity and to increase in water holding capacity. When organic manure is applied in sufficient quantity to the soil, it can supply all the necessary primary and secondary nutrient required for crop growth. Similar results were reported by Adhikari et al., (2016) who showed that the use of vermicompost was better for sweet pepper growth and yield as compared to other organic manures (Goat manure; Farm-yard manure; Poultry manure; Commercial organic fertilizer) and chemical fertilizers used in the experiment. Adhikari et al., (2016) attributed their results due to retaining vermi-compost nutrients for long time while the conventional compost fails to deliver the required amount of macro and micronutrient including the vital NPK to plants in shorter time. Also, increasing availability of NPK in the soil in the present experiment led to significant increase in NPK uptake from the soil, and consequently increasing NPK concentration in the leaves. Increasing N concentration resulted in significant increase in chlorophyll reading. According the results of Khandaker et al., (2017), nitrogen involves in the formation of chlorophyll

which lead to an effective photosynthesis rate of chili plant. They added that the positive response of the fruit yield to the vermicompost and chicken dung treatment over the other manure sources (peat moss , fermented fish waste, and cow dung) could be due to the synthesis of more assimilate that played significant role in the production of more and bigger economic chilli fruits.

Contra results were reported by Shaheen et al., (2016) who proved that applying poultry manure in sandy soil gave superiority of vegetative growth, total yield and its components as well as nutritional values of sweet pepper fruits (cv. California Wonder) than cattle manure, in spite adding cattle manure at higher rate than poultry manure. The contradiction in the results may be attributed to the period of life cycle of pepper cultivar in the field and the rate of mineralization of nitrogen from the manure. In the present study, cv. Mazurka stayed in the plastic house was about 7.5 months, while maximum staying of California Wonder is 4.5 months. For long time pepper season, its prefer to apply organic fertilizer that have slow release of nitrogen to cover nutrition of the entire season, while in the case of short time pepper season, such as California Wonder, it is prepare to use organic fertilizer that have quick release nitrogen to give a bush for vegetative the plant grow and the short season harvest period.

Generally, the combined treatment between compost and bio fertilization gave the highest significant increase in all above studied characters in the present study, except fruit content of vitamic C and fruit firmness which were decreased by using compost, bio fertilization alone or in combination. The study conducted by Prasad et al., (2017) revealed that the use of organic manures, viz. farmyard manure, vermicompost forest litter and bio fertilizers viz. Azotobacter, phosphate solubilizing bacteria reduced the cost of cultivation and supplement the secondary and micronutrients to crops. Bio-fertilizers combined with organic manure influences the plant growth by enhancing root biomass; total root surface facilitates higher absorption of nutrients and increase in yield by reducing consumption of natural sources of energy. The organic fertilizers have proved that their application has the potential to increase the biomass and productivity of a wide range of crops

Fruit content of vitamin C and fruit firmness were decreased by using compost, bio fertilization alone or in combination. The increases in the vegetative growth which was resulted from using such treatments may lead to shading of sweet pepper fruits and reducing light intensity, that results in a reduction in the fruit contents of vitamin C. Lee and Kader (2000) mentioned that the higher the intensity of light during the growing season, the greater is vitamin C content in plant tissues. Fawzy et al., (2012) proved that adding nitrogen fertilizers at high rates tend to increase the vegetative growth and decrease the vitamin C content in pepper fruits. Aminifard et al., (2012) indicated that the amount of sunlight striking a plant exerts the most influence and in heavily fertilized crops vitamin C is less than in unfertilized crops with less foliage and more exposure to sunlight

The decrease in fruit firmness due to using compost, bio fertilization alone or in combination may be due to increasing of fruit size and fruit diameter. The increase in the fruit diameter may results in a decrease in sickness of fruit wall that consequently decreased fruit firmness. Similar results were found by De Salvador et al., (2006) who proved occurrence a positive correlation between seize and firmness of apple fruits. Del Amor et al., (2008) proved that pericarp thickness (mm) of sweet pepper was reduced after using plant-associative bacteria (*Azospirillum* and *Pantoea*) under limited nitrogen supply as compared applying complete rate of mineral nitrogen.

CONCLUSION

Generally, the combined treatment between compost and bio fertilization gave the highest significant increase in vegetative growth, fruit yield, physical characters of fruit, percentage of TSS in fruits, chlorophyll reading and minerals (N, P and K) concentration in leaves 120 days after transplanting and NPK concentration in fruits as well as the lowest values of fruit firmness and fruit contents of vitamin C.

CONFLICT OF INTEREST

The present study was performed in absence of any conflict of interest.

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AUTHOR CONTRIBUTIONS

All authors contributed equally in all parts of this

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