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Growth, Yield and Fruit Quality of Sweet Pepper (*Capsicum annuum* L.) in Relation to Organic and Bio-Fertilizers Application.

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ABSTRACT

Organic and bio-fertilizers could be used not only to diminish the vegetable crops requirements from chemical fertilizers but also to avoid its unfavorable effect to the environment. The current study was carried out during seasons of 2013/2014 and 2014/2015 at the Experimental and Production Station of National Research Centre, El-Noubaria region, Behera Governorate, Egypt to investigate the response of sweet pepper plants cv. California Wonder to poultry or cattle manure as a nitrogen organic source at rate of 90 unit N/fed. alone or combined with Microbein or Nitrobein as bio-fertilizer applied as seedlings root dipping method. The experiment was laid out in a split-plot design with three replicates under open field conditions. The obtained results proved that applying poultry manure gave superiority of vegetative growth, total yield and its components as well as nutritional values of sweet pepper fruits than cattle manure. Poultry manure significantly enhanced most of all measured parameters in both seasons of study. Although, poultry manure caused an increase in heavy metals Pb and Ni as well as NO_3 in fruit tissues during both seasons, nevertheless such increase did not exceed the permissible limits. On the other hand, cattle manure recorded the higher values of unmarketable pods yield in the first season, P, Zn and Cu in the second season and K in both seasons. The highest values of vegetative growth parameters, total pods yield and its components were recorded with using Microbein followed by Nitrobein and then control treatment. Except of unmarketable pod yield whereas, control treatment recorded the highest value in the first season. Bio-fertilizers caused enhancement in nutritional values of pepper pods compared to control treatment. The best values of nutritional pod parameters were fluctuated between Microbein and Nitrobein. No significant differences were detected between both bio-fertilizers, significant differences were detected only between them and control treatment in both seasons. The interaction had no significant effect on most parameters. Generally, it could be stated that, pepper plants treated by Microbein and fertilized with poultry or cattle manure resulted in vigorous plants, superior fruit yield and the best chemical constituents of pepper fruits.

Keywords: Sweet pepper, Poultry and cattle manures, Bio-fertilizers, Vegetative growth, Fruit yield and quality.

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INTRODUCTION

The sweet pepper (*Capsicum annuum* L.) is commonly known as bell pepper or green pepper, the genus *Capsicum* belongs to the family Solanaceae. Sweet pepper is one of the highly favorite vegetables cultivated in most parts of the world especially in temperate regions. Pepper fruit is well known as an excellent source of bioactive compounds i.e. ascorbic acid, carotenoids and phenolic compounds which are main antioxidant constituents as well as minerals such as Ca, P, K and Fe (Marin *et al.,* 2004).

As agriculture technologies develops and becomes more intensive in its use of land and water resources in order to increase food production to meet the nutritional demand of vast growing population, its negative impacts on agricultural eco-systems was become more destructive (Millenium Ecosystem Assessment, 2005). Consequently, a great attention has been given to clean agriculture and application of eco-friendly practices. One of the most significant ways to achieve are using of organic and bio-fertilizers farming. Organic farming of vegetables is most appropriate as most of the vegetables are consumed in the fresh form and chemical residues have adverse effect on human health.

Nitrogen is a major limiting nutrient for crop production and it is an essential nutrient, constitutes 2-4 percent of plant dry matter as well as it is a constituent of many organic compounds found in living cells (Madan and Munjal, 2009). It is well known that nitrogen application even in inorganic, organic and/or biological forms plays an important role in plant vegetative growth, early and total yield as well as yield quality.

The use of organic fertilizers provides soil with essential nutrients and adsorbs nutrients against leaching (Follett *et al.,* 1981). Also improve soil texture, increase ion exchange capacity of soil, increase soil microbial populations and activity, improve moisture-holding capacity of the soil and enhanced soil fertility (Arancon *et al.,* 2005).

It was established that, the use of bio-fertilizers are cheap means for supplying grown plants with nutrients required during the different growth stages and could partially substitutes the expensive applied of synthetic fertilizers, thus leading to significant increase in the net profit. In the same time, pollution rate in the soil, water and in the produced fruits could be minimized as a result of using bio-fertilizers (El-Agory *et al.,* 1996). Often bio-fertilizers contain one or more of symbiotic and/or non-symbiotic N-fixing bacteria or phosphorus dissolving bacteria or potassium mobilizing bacteria.

Chaterjee *et al.* (2005) concluded that organic manure play a direct role in plant growth as a source of nutrients and improving physical, chemical and biological properties of soils with a positive effect on root growth. In general organic manure application improved organic carbon content, microbial biomass and metabolic microbial activity (dehydrogenase activity) in the soil as compared with the soil receiving mineral fertilization in horticultural crops (Ros *et al.,* 2007 and Gopinath *et al.,* 2009).

Many investigations were studied the response of some vegetable crops to the application of organic manures as demonstrated by Abou-Hussein *et al*. (2003) and Shaheen *et al.* (2014) on potatoes; Arancon *et al.* (2005) and Ewulo *et al.* (2007) on vegetative growth of sweet pepper; Abd El-Aty (1997); Shehata *et al.* (2004) and Huez-Lopez *et al.* (2011) on total yield and Amor and Del (2007); Szafirowska and Elkner (2008) and Berova *et al.* (2010) on quality of sweet pepper fruits.

Salas and Ramirez (2001) observed maximum plant fresh and dry weight and fresh fruit weight in *Capsicum* treated with organic manure than inorganic fertilizers.

Positive effect of bio-fertilizers containing free living bacteria in order to increase N content in the soil and consequently N uptake by plants, on vegetative growth, yield and quality of some vegetable crops were found by Anany (2002) on bean; Abdel-Hakim *et al.* (2015) on pea; Shaheen *et al*. (2007) on okra; Hewedy (1999); Tantawy (2000) and Gajbhiye *et al.* (2003) on tomato; Abdalla *et al.* (2001); Reyes *et al.* (2008) and Bogevska *et al.* (2009) on sweet pepper.

Application of organic and biological fertilizers led to improve the growth, yield and quality of vegetable plants as reported by Abdel-Mouty *et al.* (2001) and Abou-Hussein *et al.* (2002) on potato; Fawzy *et al.* (2012) and Nahed *et al.* (2015) on sweet pepper.

Significant differences in the vegetative growth parameters due to the application of different levels of organic manures and bio-fertilizers in aubergine were realized (Anburani and Manivannan, 2004). Also Ghoname and Shafeek (2005) pointed out that application of organic manure combined with bio-fertilizer resulted in vigorous pepper plants and superior fruit parameters and total fruit yield.

Abd El-Aty (1997) showed that using pigeon or chicken manures increased N, P, and K content in pepper leaves. The concentrations of heavy metals increased due to the application of town refuse, but it did not exceed the permissible limits. All measured nutrients uptake were increased with increasing the level of organic manure level. In the same respect, Eissa (1996) reported that, organic sources led to increase of N, P, K, Fe, Zn, Mn, Cu and Ni % in pepper fruits. Also the highest values of Ni were associated with the addition of chicken manure. The addition of organic manures increased the concentrations of heavy metals, i.e. Cd and Pb although the concentrations are still less than the critical limits permitted to be found in normal plants.

The present study was undertaken to investigate the response of sweet pepper to organic nitrogen sources in combined with using bio-fertilizers as seedlings root dipping method with respect to its vegetative growth, fruit yield and quality of pepper plants grown under open field conditions.

MATERIALS AND METHODS

Two field experiments were carried out in open field during the two successive seasons of 2013/2014 and 2014/2015 in El-Noubaria region, Behera Governorate, Egypt at the Experimental and Production Station of National Research Centre, to study the effect of some organic nitrogen fertilizer sources (cattle and poultry manures) at rate of 90 unit N/fed. in combined with using some bio-fertilizers (Nitrobein and Microbein) as root dipping method at rate of 2 bags/10 L of distilled water supplemented with 1% carboxymethyl cellulose (CMC), on vegetative growth and productivity of sweet pepper plants cv. California Wonder. The chemical characteristics of the experimental soil are presented in Table (1), while the chemical analyses of used organic nitrogen sources are given in Table (2).

The experiment was laid out in a split-plot design with three replicates where, the cattle and poultry manures were distributed in the main plots and bio-fertilizer treatments (Nitrobein, Microbein and control) were randomly dispensed within the sub-plots. Each experimental sub-plot consisted of 3 ridges, 5 m in length, 80 cm in width with a net area of 12 m^2 and the sweet pepper seedlings were planted on one side of the ridge, 30 cm apart.

Organic fertilizer (cattle and poultry manures obtained from the above mentioned experimental station) at rate of 90 unit N/fed., in addition to phosphorus fertilizer which added for all experimental plots at rate of 60 units/fed. as calcium super-phosphate (15.5% P_2O_5), were applied once to the soil surface during land preparation and thoroughly mixed with the soil. While potassium fertilizer was added also for all experimental plots at rate of 90 units/fed. as potassium sulphate (48% K_2O) but divided into two equal portions and added 50 and 75 days after planting date. Concerning, the bio-fertilizers (Nitrobein and Microbein, obtained from General Authority for Agricultural Equalization Fund, Ministry of Agriculture and Land Reclamation, Egypt). A freshly prepared solution of each bio-fertilizer (2 bags of each dissolved in 10 L of distilled water supplemented with 1% carboxymethyl cellulose as an adhesive agent) was used for root dipping, roots of sweet pepper seedlings were immersed for 30 min. in the bio-fertilizer solution. Nitrobein (a bio-fertilizer containing non-symbiotic nitrogen-fixing bacteria *Azotobacter chroococcum*). whereas, Microbein (a bio-fertilizer containing non symbiotic nitrogen-fixing bacteria *Azotobacter chroccocum + Azospirillium braselence* combined with phosphorus-dissolving bacteria *Bacillus megaterium*.

Uniform healthy sweet pepper seedlings (six-week old seedlings) were hand-planted immediately after bio-fertilizer treatments (seedlings root dipping) on one side of drip irrigated ridge on the second week of October in both seasons of 2013/2014 and 2014/2015. The normal agricultural practices commonly used for sweet pepper production under El-Noubaria region conditions involved, hoeing, pest and diseases control as well as irrigation were followed according to the recommendations of Ministry of Agriculture.

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Table (1): Physical and chemical properties of experimental soil.

Properties	Values
Soil texture	Sandy loam
Clay %	4.2
Silt %	23.4
Sand %	72.4
pH	7.9
ECe ds/m.	3.12
N %	Traces
P %	0.443
K %	0.21
Ca (Meq/L)	2.8
Mg (Meq/L)	1.35
Na (Meq/L)	0.21
$CaCO_3$ %	6.6
SO_4 (Meq/L)	4.46
HCO_3 (Meq/L)	0.94
Cl (Meq/L)	1.2

Table (2): Chemical analysis of organic fertilizers cattle and poultry manures added to experimental soil.

Parameter	Cattle manure	Poultry manure
pH	8.85	8.26
EC (ds/m)	2.62	4.66
N %	1.22	2.33
P %	0.30	0.94
K %	2.90	2.39
Fe ppm	1720	2300
Mn ppm	446	226
Zn ppm	70	180
Cu ppm	52	36
Pb ppm	7.8	2.0
Cd ppm	3.0	2.0
Co ppm	2.0	8.0
OM %	20.3	46
C/N ratio	9.67	7.4
Moisture %	17.6	16.5

At the end of vegetative growth stage and at the beginning of flowering stage (after 85 days from transplanting date), six plants from each replicate were randomly chosen, then transferred to the laboratory to record the following vegetative growth parameters, plant length (cm), number of shoots and leaves per plant, total fresh and dry weight (g) of sweet pepper plant and its different organs. At harvesting stage, sweet pepper pods were harvested at the green mature stage weekly and the following data were determined the average pod number per plant, average weight of pod (g), weight of pods per plant (g), size of pod (cm^3), total pods yield, marketable and un-marketable pods as kg/100 m^2.

At the fourth harvesting, fruit samples from each sub-plot were randomly selected to determine pepper fruit quality i.e. total acidity as g/L was determined by titration against 0.1 N NaOH and vitamin C as mg/100 gm fresh weight was measured by classical titration method using 2, 6-dichlorophenol indophenol solution according to the method of A.O.A.C. (1984). Also, dried fruit tissue samples were fine grinded, wet digested and used to determine the nutritional values on a dry weight basis. In acid digested solution of dried fruit tissue samples nitrogen, phosphorus and potassium contents were analyzed according to the methods of Pregl (1945) by Kjeldahl method, Trough and Mayer (1939) by spectrophotometry (SPECTRONIC 20D, Milton Roy Co. Ltd., USA), and Brown and Lilleland (1946) by flame photometry method (JENWAY, PFP-7, ELE Instrument Co. Ltd., UK), respectively. However, Fe, Mn, Zn and Cu contents were determined using flame

ionization atomic absorption (Analyst 200, Perkin Elmer, Inc., MA, USA) according to the method of Chapman and Pratt (1982). Whereas, Pb and Ni were determined according to the method of Cottenie *et al*. (1982). Nitrate (NO_3) content in dried fruit tissue samples was determined as described by Cataldo *et al.* (1975) using spectrophotometry (SPECTRONIC 20D, Milton Roy Co. Ltd., USA),

Statistical analysis

All data set were tabulated and subjected to statistical analysis using the analysis of variance method ANOVA with M-Stat package software. Least significant differences test (LSD) was used to compare the significant differences among mean of the treatments at 0.05 level of probability according to the method described by Gomez and Gomez (1984).

RESULTS AND DISCUSSION

A. Plant vegetative growth characteristics

Data presented in Tables (3 and 4) sharply indicated that applying poultry manure gave superiority of vegetative growth parameters than using cattle manure in both seasons of study. However, the heaviest fresh and dry weight of whole pepper plant recorded with using poultry manure. The increments in total fresh and dry weight were amounted by 7.5, 4.5% and 10.2, 18.5% in the first and second seasons, respectively. Using poultry manure as organic nitrogen source for sweet pepper plant significantly enhanced all plant growth parameters, i.e. plant height, number of leaves/plant, fresh and dry weight of whole plant and its different organs (leaves and shoots) in both seasons of 2013/2014 and 2014/2015. Except for number of shoots/plant and shoot fresh and dry weight in the first season, but for number of shoots/plant, leaves dry weight and whole plant dry weight in the second season. These might be attributed to the rich content of available minerals and organic matter in poultry manure compared with the cattle manure as shown in Table (1), which reflected on the plant vegetative growth and led to significant increases of plant growth measurements.

Application of organic manure (cattle or poultry) as an organic source of nitrogen could be decreased the demand of the plant for chemical fertilizers and has been used for many centuries to increase soil fertility (Tagoe *et al*., 2008). Many researchers have mentioned the beneficial effects of organic fertilizer on soil physical, chemical and biological properties (Arancon *et al.,* 2005; Ros *et al.,* 2007; Tagoe *et al.,* 2008 and Gopinath *et al.,* 2009). Also, using of organic manure has been reported as a potential factor for better vegetative growth and yield in many crops (Al-Moshileh and Motawe, 2005 and Alam *et al.,* 2007). The obtained results are in good accordance with Salas and Ramirez (2001); Abou-Hussein *et al*. (2003); Arancon *et al.* (2005); Ewulo *et al.* (2007); Djilani and Mourad (2013) and Shaheen *et al.* (2014). They observed maximum vegetative growth of plants supplied with organic manure than inorganic fertilizers.

Bio-fertilizers used (Microbein or Nitrobein) resulted in a significant increase in all plant growth characters if compared with the control treatment (without bio-fertilizer). The highest values of vegetative growth of pepper plants were recorded with using Microbein followed by Nitrobein treatment. Whereas, control treatment gave the lowest values of vegetative growth parameters in both seasons. No significant differences were realized on number of shoot/plant, shoot fresh weight and shoot dry weight in both seasons, in addition to fresh weight of total plant and leaves dry weight in second season only as presented in Tables (3 and 4). Moreover, the statistical analysis of the obtained data revealed that, the significant differences among treatments were detected between bio-fertilizers and control treatment in both seasons. Although, in most parameters no significant difference were detected between both bio-fertilizers applied.

The superiority in vegetative growth of pepper plants treated with bio-fertilizers as seedlings root dipping, may be due to that the bio-fertilizers had a stimulating effect on plant growth through producing plant growth promoting substances like IAA, GA and/or Cytokines **(Tien *et al.,* 1979 and Yang *et al.,* 2009).** Moreover, bio-fertilizers play a positive effect on increasing N content in the rhizosphere and consequently N uptake by plants and on plant growth.

The results recorded by Al-Moshileh and Motawe (2005) and Ahmed *et al.* (2009) on potato; Tantawy (2000) and Gajbhiye *et al.* (2003) on tomato; Abdalla *et al.* (2001); Ghoname and Shafeek (2005); Reyes *et al.* (2008) and Bogevska *et al.* (2009) on sweet pepper are in good support for the obtained results.

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Table (3): Effect of some nitrogen organic sources and bio-fertilizers on plant growth characters of sweet pepper plants during the first season of 2013/2014.

Treatments		Plant height	No./plant		Fresh weight g/plant			Dry weight g/plant		
N sources	Bio fertilizers		Leaves	Shoots	Leaves	Shoots	Total	Leaves	Shoots	Total
Cattle manure	Without	81	60.1	8.0	165	98.5	263.5	33.6	25.1	58.7
	Nitrobein	85	61.9	8.2	177	103.5	280.5	36.4	27.9	64.3
	Microbein	87	66.0	8.6	179	108.0	287.0	37.5	27.8	65.3
Mean		**84.3**	**62.7**	**8.3**	**173.7**	**103.3**	**277.0**	**34.8**	**26.9**	**62.7**
Poultry manure	Without	85	55.6	7.3	176	111.5	247.5	38.6	27.5	66.1
	Nitrobein	87	67.6	7.7	186	119.7	305.7	45.2	30.5	75.7
	Microbein	89	69.1	7.9	193	122.0	315.0	45.9	35.1	81.0
Mean		**87**	**64.1**	**7.6**	**185**	**117.7**	**289.4**	**43.3**	**31.0**	**74.3**
Average	Without	83	57.8	7.65	170	105	256	36.1	26.3	62.4
	Nitrobein	86	64.7	7.95	181	112	293	40.8	29.2	70.0
	Microbein	88	67.6	8.25	186	115	301	41.7	31.5	73.2
L.S.D. at 5%	N-organic	**4.5**	**3.75**	**N.S.**	**5.31**	**N.S.**	**16.4**	**2.66**	**N.S.**	**3.35**
	Bio-F	**5.5**	**7.3**	**N.S.**	**6.6**	**N.S.**	**10.1**	**2.75**	**N.S.**	**2.75**
	Interactions	**N.S.**	**N.S.**	**N.S.**	**7.3**	**N.S.**	**10.1**	**3.8**	**N.S.**	**6.3**

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Table (4): Effect of some nitrogen organic sources and bio-fertilizers on plant growth characters of sweet pepper plants during the second season of 2014/2015.

Treatments		Plant height	No./plant		Fresh wt. g/plant			Dry wt. g/plant		
N sources	Bio fertilizers		Leaves	Shoots	Leaves	Shoots	Total	Leaves	Shoots	Total
Cattle manure	Without	64	49.0	6.45	119	74.3	193.3	23.0	20.5	43.5
	Nitrobein	72	53	6.55	125	76.7	201.7	24.8	21.7	46.5
	Microbein	79.0	55	6.89	131	79.8	210.8	28.3	22.3	50.6
Mean		**71.7**	**52.3**	**6.63**	**125**	**76.9**	**201.9**	**25.4**	**21.5**	**46.8**
Poultry manure	Without	71	47.5	6.91	135	90.3	225.3	31.1	27.8	58.9
	Nitrobein	79	54.9	6.99	141	85.9	226.9	31.9	29.4	61.3
	Microbein	85	60.7	7.3	153	84.5	237.5	32.5	30.2	62.7
Mean		**78.3**	**54.4**	**7.1**	**143**	**86.9**	**230**	**31.8**	**29.1**	**61.0**
Average	Without	67	48	6.68	127	82.3	209.3	27.1	24.1	51.2
	Nitrobein	76	54	6.77	133	81.3	214.3	28.3	25.6	53.9
	Microbein	82	58	7.11	142	82.2	224.1	30.4	26.3	79.9
L.S.D. at 5%	N-organic	**6.5**	**1.66**	**N.S.**	**3.5**	**4.7**	**10.5**	**N.S.**	**5.4**	**N.S.**
	Bio-F	**5.5**	**5.1**	**N.S.**	**3.6**	**N.S.**	**N.S.**	**N.S.**	**N.S.**	**3.66**
	Interactions	**6.71**	**N.S.**	**N.S.**	**11.5**	**7.1**	**N.S.**	**N.S.**	**N.S.**	**6.77**

Concerning the interaction effect between the two nitrogen organic sources (cattle or poultry manure) and application of the bio-fertilizers (Microbein, Nitrobein or control treatment) on vegetative growth parameters of sweet pepper plant during both experimental seasons are shown in Tables (3 and 4). The interaction had significant differences only on fresh weight of leaves and total plant in the first season and on plant height, fresh weight of leaves and shoot, and total plant dry weight in the second season.

In spite of no significant differences on most of plant growth characters were noticed, the presented data showed that, the highest values of plant growth parameters were recorded when pepper plants fertilized with poultry manure as nitrogen organic source and Microbein as bio-fertilizer. In contrast, pepper plant fertilized with cattle manure and control treatment (without bio-fertilizer) gave the lowest values of plant growth characters. These trends were true in both seasons of 2013/2014 and 2014/2015.

B. Total pods yield and its components

Using poultry manure as nitrogen organic source for sweet pepper plant gained the higher values of the number of pods/plant, average weight of pod, weight of pods yield per plant, pod size and total pod yield (kg/100 m^2) as well as marketable and unmarketable pods if compared with pepper plants received cattle manure. Similar trends were observed during both seasons of study, except for unmarketable pods in the first season only as shown in Table (5).

Data shown markedly revealed that applied of poultry manure led to significant increase in number of pods/plant, weight of pods yield per plant and total pod yield in both seasons of study, in addition to fruit size and marketable pods in the first season only. The superiority in total pods yield which resulted from applying poultry manure over cattle manure amounted by 19.7 and 9.6% in the first and second seasons, respectively.

Similar results were detected by other workers such as Abdel-Mouty *et al.* (2001); Powan *et al.* (2006); Sidhu *et al.* (2007) and Balemi (2012) on potato; Abd El-Aty (1997); Shehata *et al.* (2004); Ghoname and Shafeek (2005) and Huez-Lopez *et al.* (2011) on total yield of sweet pepper. In general, the improvement of fruit quality may be attributed to better growth of plant supplied with organic fertilizer, which might have favored the production of better quality fruit (Rajbir *et al.,* 2008). Shaheen *et al*. (2014) reported that chicken manure gained the better plant growth characters which reflected on total yield and its components. Thus might be attributed to that macro and micro-nutrients supplied to the soil from chicken manure are more than cattle ones (Tirol-Padre *et al.,* 2007).

Regarding, the response of total pods yield of sweet pepper plant and its components to the application of bio-fertilizers, the presented data in Table (5) indicated clearly that, Microbein recorded the highest values of average number of pods/plant, average weight of pod, weight of pods yield/plant, pod size and total pods yield as kg/100 m^2 as well as marketable and unmarketable pods followed by Nitrobein and then control treatment. These findings were true during both seasons. With the exception of unmarketable pod yield, control treatment recorded the highest value in the first season and the lowest value in the second season. The total pods yield of sweet pepper was increased with using Microbein over Nitrobein by 26.3 and 17.7% in the first and second season, respectively. A significant difference among bio-fertilizer treatments were detected only on unmarketable pod yield in the first season and on average pod weight, weight of pods yield/plant, total pods yield as kg/100 m^2 and unmarketable pod yield in the second season.

The obtained results are in line with findings of Anburani and Manivannan (2004) on eggplant; Hewedy (1999); Tantawy (2000) and Gajbhiye *et al.* (2003) on tomato; Abdalla *et al.* (2001); Ghoname and Shafeek (2005); Reyes *et al.* (2008) and Bogevska *et al.* (2009) on sweet pepper.

The interaction effect between organic nitrogen sources and application of some bio-fertilizers recorded significant differences on all measured parameters in both seasons. Except for marketable and unmarketable pods yield in the first season and for average pod weight, pod size and marketable pods yield in the second season.

It is of interest to note that using bio-fertilizer, Microbein with both nitrogen organic sources gave the highest values of total pods yield and its components followed in descending order by Nitrobein and control treatment. Application of Microbein with poultry manure gave the superior results than with cattle manure.

Application of organic manure combined with bio-fertilizer resulted in vigorous pepper plants and superior fruit yield (Ghoname and Shafeek, 2005). Also Yue *et al.*(2015) demonstrated that combination of organic and bio-fertilizers significantly increased pepper yield compared to control treatment.

C. Nutritional values of pods

The nutritional values of sweet pepper pods expressed as element contents as well as the total acidity and vitamin C in pods as responded to the effect of nitrogen organic source (cattle or poultry manure) and some bio-fertilizers (Microbein and Nitrobein) are presented in Tables (6 and 7). The obtained data showed that poultry manure application gave the higher mineral contents of N, P, Fe, Mn, Zn, Cu, Pb, Ni, NO_3, total acidity and vitamin C in pepper fruit in first season and N, Fe, Mn, Pb, Ni, NO_3, total acidity and vitamin C in the second season compared to application of cattle manure. On the other hand, application of cattle manure recorded the higher values of K in both seasons and P, Zn, Cu in the second seasons. Using poultry manure caused insignificant increase in heavy metals Pb and Ni in sweet pepper fruit tissues during both seasons, but fortunately such increment did not exceed the permissible limits.

It could be demonstrated that, the higher nutritional values of sweet pepper pods were associate with those plants supplied with poultry manure. Although, the application of poultry manure led to significant increase in N, P, K and NO_3 in the first season and in N, K, Mn, Zn, Cu and NO_3 in the second season. The improvement of nutritional values of pepper pods due to use of poultry manure could be explained by its higher content of nutrients and organic matter than cattle manure, consequently the availability and solubility of elements in the soil increased, hence absorbed by roots system, to the edible parts.

The obtained results are in conformity with those of Shaheen *et al.* (2014) on potato; Tagoe *et al.* (2008) on soybean; Eissa (1996); Abd El-Aty (1997) and Ghoname and Shafeek (2005) on sweet pepper. They concluded that using organic sources led to increase nutrients uptake N, P, K, Fe, Zn, Mn and Cu and increase the concentrations of heavy metals Cd, Pb and Ni but the concentrations are still less than the critical limits permitted to be found in plants.

Applying of Microbein or Nitrobein resulted in higher nutritional values of sweet pepper pods if compared with control treatment (without bio-fertilizer), These trends were true in both seasons, except for K and Ni in the second season only. Using bio-fertilizer Microbein gave significant increase in N percentage in both seasons and NO_3 in the first season only. While, NO_3 content in pepper fruit was significantly increased with Nitrobein application in the second season.

Regardless of insignificant increase of nutritional parameters of pepper pods in both seasons, the best values of nutritional pod parameters were fluctuated between application of bio-fertilizers Microbein and Nitrobein.

It could be abstracted that the bio-fertilizer application caused an enhancement in nutritional values of sweet pepper pods compared to control treatment. It might be attributed to that bio-fertilizer caused an improvement in plant vegetative growth and led significantly to increase the availability and content of nutrients in the soil. Therefore, increased nutrients uptake from soil solution, hence increase the nutritional values in pods tissues. In addition, Pesakovic *et al.* (2013) reported that bio-fertilizers increment the size and the volume of the plant roots, which in turn, make the plants capable to obtain more water and nutrients.

The previous studies of Hewedy (1999) on tomato; Shaheen *et al.* (2007) on okra; Ghoname and Shafeek (2005) on sweet pepper, all of them recorded results are in good agreement with that written herein.

Concerning the interaction effect, significant differences were detected only on the percentages of N and K in pepper fruit tissues in the first and second seasons and on NO_3 content in the second season only. It is of interest to mention that the interaction had no significant effect on the rest of measured nutritional parameters of pepper fruits as shown in Tables (6 and 7).

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Table (5): Effect of some nitrogen organic sources and bio-fertilizers on fruit properties and total fruit yield of sweet pepper plants during both seasons of 2013/2014 and 2014/2015.

Treatments		First season (2013/2014)							Second season (2014/2015)						
		Fruit properties				Fruit yield (kg/100m^2)			Fruit properties				Fruit yield (kg/100m^2)		
N sources	Bio fertilizers	No. of pod/ plant	Pod Wt. (g)	Yield/ plant (g)	Size (cm^3)	Total	Mark.	Un-mark.	No. of pod/ plant	Pod Wt. (g)	Yield/ plant (g)	Size (cm^3)	Total	Mark.	Un-mark.
Cattle manure	Without	17.8	72.2	1286	94.5	357	242	115	12.95	70.0	907	87	278	221	57
	Nitrobein	20.4	71.8	1465	98.0	379	276	103	13.75	85.0	1169	98	321	229	92
	Microbein	21.2	84.1	1783	96.0	378	310	68	16.75	93.0	1558	95	359	258	101
Mean		**19.8**	**76.0**	**1511**	**96.2**	**371.3**	**276**	**95.3**	**14.5**	**82.7**	**1211**	**93.3**	**319.3**	**236**	**83.3**
Poultry manure	Without	20.1	83.3	1675	100	396	312	84	16.0	84	1344	93	333	254	79
	Nitrobein	22.9	88.8	2034	107	463	384	79	18.0	93	1674	95	359	258	101
	Microbein	23.1	81.4	1880	104	474	391	83	18.0	93	1674	97	359	271	88
Mean		**22.03**	**84.5**	**1863**	**104**	**444.3**	**362.3**	**82**	**17.3**	**90**	**1564**	**95**	**350**	**261**	**89.3**
Average	Without	18.9	77.7	1570	97.3	376.5	277	99.5	14.5	77	1164	90	305	237	68
	Nitrobein	21.7	80.3	1672	102.5	421	330	91	15.9	89	1379	96	340	244	96
	Microbein	22.15	82.7	1876	100.0	426	350	75.5	17.4	93	1482	96	359	264	95
L.S.D. at 5%	N-organic	**1.25**	**N.S.**	**165**	**4.75**	**35**	**21**	**N.S.**	**1.31**	**N.S.**	**113**	**N.S.**	**16.5**	**N.S.**	**N.S.**
	Bio-F	**N.S.**	**N.S.**	**N.S.**	**N.S.**	**N.S.**	**N.S.**	**3.66**	**N.S.**	**7.7**	**136**	**N.S.**	**11.7**	**N.S.**	**5.88**
	Interactions	**1.75**	**3.33**	**166**	**8.8**	**36.5**	**N.S.**	**N.S.**	**7.66**	**N.S.**	**75.6**	**N.S.**	**20.3**	**N.S.**	**16.6**

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Table (6): Effect of some nitrogen organic sources and bio-fertilizers on the nutritional values of sweet pepper fruit during the first season of 2013/2014.

Treatments		%			ppm							Total acidity	Vitamin C
N sources	Bio fertilizers	N	P	K	Fe	Mn	Zn	Cu	pb	Ni	NO_3		
Cattle manure	Without	0.78	0.23	0.84	330	17	29	4.4	1.01	0.18	129	177	106
	Nitrobein	1.15	0.29	1.34	328	21	33	5.0	1.21	0.17	133	173	108
	Microbein	1.66	0.27	0.66	388	23	30	6.2	1.11	0.15	130	175	107
Mean		**1.19**	**0.26**	**0.95**	**348**	**20**	**30.7**	**5.2**	**1.11**	**0.16**	**131**	**131**	**107**
Poultry manure	Without	1.67	0.33	0.48	388	30	31	6.4	1.31	0.16	145	166	110
	Nitrobein	1.84	0.30	0.57	432	28	36	6.3	1.29	1.21	141	173	116
	Microbein	1.75	0.28	0.83	410	31	33	6.9	1.33	1.33	151	178	113
Mean		**1.75**	**0.30**	**0.63**	**410**	**29.7**	**33.3**	**6.5**	**1.31**	**0.90**	**146**	**146**	**113**
Average	Without	1.22	0.28	0.66	359	24	30	5.4	1.16	0.17	137	171.5	108
	Nitrobein	1.49	0.29	0.96	380	25	34	5.6	1.25	0.69	137	173	112
	Microbein	1.71	0.27	0.74	399	27	32	6.5	1.22	0.67	141	176	110
L.S.D. at 5%	N-organic	**1.25**	**0.06**	**0.31**	**N.S.**	**N.S.**	**N.S.**	**N.S.**	**N.S.**	**N.S.**	**4.9**	**N.S.**	**N.S.**
	Bio-F	**0.31**	**N.S.**	**N.S.**	**N.S.**	**N.S.**	**N.S.**	**N.S.**	**N.S.**	**N.S.**	**3.7**	**N.S.**	**N.S.**
	Interactions	**0.11**	**N.S.**	**0.16**	**N.S.**	**N.S.**	**N.S.**	**N.S.**	**N.S.**	**N.S.**	**N.S.**	**N.S.**	**N.S.**

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Table (7): Effect of some nitrogen organic sources and bio-fertilizers on the nutritional values of sweet pepper fruit during the second season of 2014/2015.

Treatments		%			ppm							Total acidity	Vitamin C
N sources	Bio fertilizers	N	P	K	Fe	Mn	Zn	Cu	pb	Ni	NO_3		
Cattle manure	Without	1.09	0.25	1.33	291	29	28	8.1	1.07	0.21	186	133	98
	Nitrobein	1.13	0.27	1.41	285	33	34	8.5	1.31	0.17	196	137	94
	Microbein	1.12	0.26	1.37	311	33	28	8.3	1.19	0.21	191	146	98
Mean		**1.11**	**0.26**	**1.37**	**296**	**31.7**	**30**	**8.3**	**1.19**	**0.19**	**191**	**191**	**96.7**
Poultry manure	Without	1.77	0.25	1.33	288	36	18	4.1	1.27	0.27	255	146	98
	Nitrobein	1.81	0.22	0.96	306	34	22	5.5	1.19	0.24	297	150	102
	Microbein	1.92	0.27	1.06	311	35	20	5.7	1.21	0.25	276	155	101
Mean		**1.83**	**0.25**	**1.11**	**301**	**35**	**20**	**5.1**	**1.22**	**0.25**	**276**	**276**	**100.3**
Average	Without	1.43	0.25	1.33	289	32.5	23	6.1	1.17	0.24	221	139	98
	Nitrobein	1.47	0.24	1.19	296	33	28	7.0	1.25	0.21	246	144	98
	Microbein	1.52	0.26	1.21	311	34	24	7.0	1.20	0.23	233	151	99
L.S.D. at 5%	N-organic	**0.11**	**N.S.**	**0.09**	**N.S.**	**2.15**	**3.75**	**1.67**	**N.S.**	**N.S.**	**25.7**	**N.S.**	**N.S.**
	Bio-F	**0.66**	**N.S.**	**N.S.**	**N.S.**	**N.S.**	**N.S.**	**N.S.**	**N.S.**	**N.S.**	**15.5**	**N.S.**	**N.S.**
	Interactions	**0.39**	**N.S.**	**0.08**	**N.S.**	**N.S.**	**N.S.**	**N.S.**	**N.S.**	**N.S.**	**13.6**	**N.S.**	**N.S.**

Generally, it could be stated that, pepper plants treated by Microbein and fertilized with poultry or cattle manure resulted in the best chemical constituents of sweet pepper pods. In this respect, Ghoname and Shafeek (2005) decided that application of organic manure combined with bio-fertilizer resulted in superior fruit quality parameters.

CONCLUSIONS

The results of this work demonstrated that application of poultry manure combined with bio-fertilizer, Microbein had the abilities for enhancing the growth, yield and nutritive quality of sweet pepper plants under field conditions. Furthermore, soil fertility could be enhanced and production of safe and clean crops for human health could be achieved as well as unfavorable effect to the environment could be minimized as a result of using organic manure combined with bio-fertilizer.

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