J. Plant Production, Mansoura Univ., Vol. 8(11) : 1135 - 1145, 2017

Evaluation of Using Organic Fertilizer Produced from Biogas Digester under Levels from Mineral Fertilizer Recommendation of Pepper Plants on the Growth, Yield and its Quality

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ABSTRACT

The present study was carried out during the two successive summer seasons of 2016 and 2017, at private farm in Kafr El-Sheik Governorate, under clay loam soil condition using furrow irrigation system. These experiments aimed to evaluate the effect of some combinations between four levels of mineral fertilizer with two types of organic fertilizer produced from biogas digester system (dried and liquid residuals) as well as farmyard manure beside the control treatment on growth, yield and fruit quality of sweet pepper (Capsicum annum L.) cv.California wander as a local famous variety, grown under open field conditions. All organic sources gave rise to a positive effect on plant growth expressed as plant height, number of branches per plant, number of leaves per plant, leaf area per plant, foliage fresh weight and foliage dry weight per plant and increased the percentage of essential macro and micro elements in pepper plant leaves, also produced the highest values of early and total yield and enhancing the fruit quality. Moreover, it increased TSS and ascorbic acid in the fruits as compared with those plants fertilized with mineral NPK alone without organic sources (control). In this concern, dried biogas residual organic fertilizer was the superior source of organic fertilizer, used in this study, which it showed the highest results comparing with the other sources i.e., liquid biogas residual organic fertilizer or farmyard manure. In pepper plants, increasing NPK rate from 25% to 100% of the recommended dose led to an increase in plant vegetative growth. Moreover essential macro and micro elements were increased also in plant leaves. Likewise, early and total yield and the fruit quality i.e., physical fruit quality TSS and vitamin C were enhanced. The promising combination was 50% from the recommended NPK plus 20 m^2 dried biogas digester residual organic fertilizer, which gave the best values of plant growth and yield, also fruit characters were enhance.Concerning the economical evaluation, adding the 50% of recommended NPK combined with 20 m^2 dried biogas digester residual organic fertilizer led to obtain the highest total yield of pepper plants as well as total revenue as compared with the other treatments under this investigation.
Keywords: Biogas digester, organic fertilizer, mineral fertilizer, sweet pepper fruit yield, sweet pepper quality.

INTRODUCTION

Pepper is one of the most popular and widely grown vegetable crops in the world. Pepper crop are highly responsive to nitrogen (N) fertilizer application where N availability may be limited and time of the application is critical (Taber, 2001). It is known that nitrogen fertilizers are lost via nitrate reduction through the nitrification and ammonia volatilization. Moreover, some nitrogenous fertilizer can be leached to the underground water causing environmental pollution. Pollutants are transferred through the plants to human and animal's causes serious disease as well as the environmental pollution as a result of exaggeration in the application of chemical fertilizers (Casale *et al.,* 1995 and Ram Rao *et al*., 2007). Therefore adding organic manures to the soil would improve its physical – chemical and biological properties which increase soil organic matter, cations exchange capacity and available mineral nutrition (Mervat *et al*., 1995) and this intern stimulate quantitative as well as qualitative characteristics of vegetable crops. The use of organic fertilizer such as animal manures, human waste, food wastes, yard wastes, sewage sludge's and composts has long been recognized in agriculture as beneficial for plant growth, yield, and soil fertility (Joshi and pal Vig, 2010).

Biogas is a renewable energy source and typically refers to a mixture of different gases produced by the breakdown of organic matter in the absence of oxygen. It can be produced from raw materials such as agricultural waste, manure, municipal waste, plant material, sewage, green waste or food waste. Biogas can be produced by anaerobic digestion with anaerobic organisms, which digest material inside a closed system, or fermentation of biodegradable materials. Jagadabhi (2011).With the increase in price of mineral fertilizers, the biogas plant digested slurry can be utilized as a good substitute to inorganic fertilizer (Chrop, 1991). The role of organic manure as described by Singh *et al*., (1995), is very vital for sustainable agriculture, as it not only provides the nutrients, but also develops the soil structure for greater plant growth. Also, it may be considered as a good source of micro nutrients for the plant growth. El-Shimi and Badawi, (1993) added that manure obtained after gaining the biogas is larger in quantity, richer in nitrogen, potassium and calcium (NPK) contents, suitable amount of micro-nutrients, grows regulators and more free of pathogens and parasites as compared with the traditionally prepared manures. They also showed that the digested slurry application with equivalent rate of inorganic fertilizer released the yield of, wheat, rice, broad bean, cotton, carrots and spinach with 35.7, 12.5, 5.9, 6.6, 27.5, 14.4 and 20.6%, respectively.

The major advantages of biogas technology, besides cooking, lighting and electricity generation, is the utilization of effluent (residual slurry) obtained after digestion as a beneficial organic fertilizer (biogas manure). It is considered as a potential source for macro- and micronutrients. The biogas manure is free of pathogens, parasites and grass seeds as compared with the traditional manure prepared from other organic matters (El-Hadidi and Al-Turki, 2006). It is more effective by 30% than the raw manure in crop production, since it has tremendous nitrogen content in the form of ammoniacal nitrogen. Anaerobic digestion makes the effluent slurry sterile and C: N ratio is lowered to 1:21 which it is ideal for higher yields. They also, added that fertilization with slurry increased the organic matter and phosphorus content in the soil. Hydraulic conductivity has been increased, whereas bulk density is decreased. The lack of fertilizers, detrimental effects of synthetic fertilizers to soil chemistry and biology, and the huge amount of foreign exchange invested in the importation of synthetic fertilizers can be drastically reduced by using the biogas technology (Akinbami *et al*., 2001).

Many researchers reported that the use of biogas residues as soil fertilizer was more effective than using the traditional organic fertilizers (Maunuksela *et al*., 2012; Diacono & Montemurro, 2011; Haraldsen *et al*., 2011). The residues generated from biogas processes have a higher concentration from NH4+ compared with conventional animal manure and compost; hence their potential fertilization value is also higher (Zhong *et al*., 2010). In addition, most elemental nutrients such as P, K, Mg and a number of other essential trace elements from the raw material fed to the biogas process remain in the biogas residue (Abu baker, 2012). The organic compounds not broken down during the biogas process increase the carbon content of farmland and improve its biological activity as they break down in the soil (Bessam & Mrabet, 2003).

There is a great debate among scientists about the role played by microorganisms in promoting plant growth, while some other investigators directed their contribution to N_2 – fixation, pork solubilization, cellulose decomposition, etc., other went to production of plant growth modifying substances by such bio-fertilizers (El- Sheekh, 1997). The application of cattle manure in farmland is an economical and environmentally sustainable mechanism for increasing crop production. Manure can increase crop yields by providing large inputs of nutrients and organic materials. It was found that the application of cattle organic manure improved tomato vegetative growth (Abd-Allah et al., 2001) and also increased early and total yield of pepper plants (Eris *et al.,* 1995). Ghoname and Shafeek (2005) reported that, organic manures significantly increased the growth characters of pepper plant expressed as plant height, number of leaves and branches, dry weight of different plant organ and leaf area. The favorable effect of organic manures on elements uptake by plants was previously explained by Eissa (1996) who reported that, concentrations of NPK in whole sweet pepper plant tissues increased by application of organic fertilizers.

Therefore, the present investigation was conducted to evaluate effect of combined application from some levels of mineral NPK fertilizer and two types of organic biogas digester residuals plus farmyard manure and control on growth, yield and quality of sweet pepper plants to obtain the highest total yield of pepper fruits as well as the total revenue comparing with the other fertilization treatments used in this study.

MATERIALS AND METHODS

The present study was carried out during the two successive summer seasons of 2016 and 2017, at private farm in Kafr El-Sheik Governorate, under clay soil condition using furrow irrigation system. These experiment aimed to evaluate the effect of some combinations between four levels of mineral fertilizer with two types of organic fertilizer produced from biogas digester system (dried and liquid residuals), beside the farmyard manure plus the control treatment (with and without organic fertilizer) on growth, yield and fruit quality of sweet pepper (*Capsicum annum* L.) cv.California wander as a local famous variety, grown under open field conditions.

Preparation of the organic fertilizer from biogas digester:

The organic biogas digester fertilizer (organic bio-fertilizer) was obtained from two biogas digester Chinese type volume of 20 m^3 for everyone with total volume of 40 m^3 Fig.(**). The biogas digesters were constructed and operated by "Development of biogas production and utilization systems project''. This project was financed by Agricultural Development Program (ADP), Agricultural Research Center, Ministry of Agriculture. It is located at Tractors and Machinery Testing and Research Station, Agricultural Engineering Research Institute, Alexandria Governorate. These digesters are feeding with fresh cattle dung and heated by solar heating system to keep the digester temperature at the methophilic condition (35-40 ºC). The digesters also, are stirred with mechanical systems at 60 rpm stirring speed and interval time of 15 min./3 hr. The retention time applied is 25 days, so the loading rate is 0.8 m^3/ digester/day with total amount of 1.6 m^3/day and average total solids of 15%. The biogas production is collected in separated floating gasholder volume of 20 m3. The amount of liquid bio-fertilizer production is about 1.6 m^3/ day with average total solids of 10% (about 160 kg dry organic fertilizers daily).

Fig. (**): biogas and bio-fertilizer production system

The physical and chemical properties of the experimental soil are presented in Table (1).The source of the two types of organic biogas digester fertilizer were cattle as animal manure (produced from local animal farm) produced from biogas digester by Development of biogas production and utilization systems. Chemical analyses of the two types of organic biogas digester dried and liquid organic bio-fertilizer as well as farmyard manure are shown in Table (2).

This experiment included 20 treatments, which were the combination of the following mineral fertilizer levels and organic manure sources:

A-mineral fertilizer treatments:

1- 100٪ of recommended dose from NPK as (750Kg ammonium sulphate-300Kg super phosphate - 200Kg potassium sulphate)/Fadden.
2- 75٪ of recommended dose from NPK as (562Kg ammonium sulphate-225Kg super phosphate - 150Kg potassium sulphate)/Fadden.
3- 50٪ of recommended dose from NPK as (375Kg ammonium sulphate-150Kg super phosphate - 100Kg potassium sulphate)/Fadden.
4- 25٪ of recommended dose from NPK as (187.5Kg ammonium sulphate-75Kg super phosphate - 50Kg potassium sulphate)/Fadden.

Table 1. Physical and chemical characteristics of soil sampled collected from the experiment location in the two seasons of 2016 and 2017.

Properties	Season 2016	Season 2017
Physical properties		
Clay %	45.2	39.5
Silt %	35.1	37.2
Sand %	21.8	23.4
Soil texture	Clay loam	Clay loam
Chemical properties		
*PH	8.5	8.3
**EC (dSm-1)	3.35	3.32
O.M.	0.82	0.85
Soluble cations (meq ll):		
Ca++	3.8	4.6
Mg+	3.6	2.9
K+	21	19
Na	7.2	7.4
Soluble anions:		
CO3--	3.1	3.3
HCO3-	1.7	1.9
CL-	5.5	5.6
SO4--	2.9	3.2
Total N%	0.19	0.18
Available phosphorus	30.9	30.7

*** measured in 1:25 soil water suspension; ** measured in the water extract of saturation soil paste.**

The mineral fertilizers were used according to the recommendation dose of pepper production i.e., 150KgN+45KgP_2O_5+96Kg K_2O/fed. in the forms of 750Kg ammonium sulfate (20.5٪N) +300Kg super phosphate (15.5٪P_2O_5) +200Kg potassium sulphate (48٪K_2O).

Table 2. Analysis of farmyard manure, dried and liquid biogas digester residual used in the experiment during the seasons of 2016 and 2017

Sample / Element	Farmyard manure		Dried biogas digester residue		Liquid biogas digester residue	
	2016	2017	2016	2017	2016	2017
N%	1.06	1.1	2.01	2.02	0.24	0.20
P%	1.80	1.63	2.60	2.90	0.26	0.24
K%	1.20	1.3	6.70	6.50	0.60	0.59
Fe (ppm)	383.0	372.0	868.0	874.0	64.00	62.00
Zn(ppm)	76.0	74.0	74.0	79.0	19.00	19.00
Cu (ppm)	20.00	22.0	60.0	63.0	5.00	5.00
Cd (ppm)	18.0	18.0	16.0	20.0	1.60	1.30
Ni (ppm)	168.0	167.0	184.0	192.0	18.40	17.88
Cr (ppm)	0.00	0.00	0.00	0.00	0.00	0.00
Pb (ppm)	96.00	94.0	54.00	51.00	9.60	7.21
Mn(ppm)	122	126	168	162	134	128
Moisture%	67,10	70.20	29.3	23.6	98.00	97.93
Organic carbon%	18.63	18.12	23.8	26.4	15.00	14.00
Organic Matter%	48.3	46.9	52.20	55.0	39.7	40.2
C/Nratio	1:16.93	1:16.77	1:18.78	1:19.20	1:15.32	1:15.44
PH	9.23	9.01	7.5	8.6	7.6	7.4
EC(dsm^{-1})	5.76	5.68	4.70	4.00	4.88	4.71

B- Organic biogas digester fertilizer treatments and farmyard manure:

1- Dried organic digester (20m^3/fed.).

2- Liquid organic digester (20 L/fed.), this amount was applied to the plants as drenching around the plants area.

3- Farmyard manure (20m^3).

4-Control (with and without addition of farmyard manure).

All organic additions were applied during soil preparation and mixed with it before transplanting. Mineral fertilizers were added in doses during the growth stages according to the general recommendation of pepper plantation.

Seeds were sown in seedbed on the 1st and 5th of April of the first and second seasons respectively, seedlings of 52 days old were transplanted in both seasons in the open field at 40 cm. apart between plants. The plot area was 4m^2 including 4rows: 2m length and 50 cm width. The experimental design was split plot with 3 replications, where the levels of mineral fertilizers treatments (100, 75, 50 and 25% NPK) +control (without NPK) were distributed in the sub plots. Meanwhile the two types of organic biogas digester fertilizer beside the farmyard manure and control (without organic fertilizer) were arranged in the main plots. Other agriculture practices were done as the recommended of the Ministry of Agricultural.

Data recorded

1-Plant growth:

At 75 days after transplanting, random samples of five plants from each plot were taken for determination of:

a - Plant height (cm)

b - Number of main branches and leaves per plant.

C- Leaf area per plant was measured after the first fruit harvest according to Yousri (1990).

d- Average fresh and dry weight of plant (gm/plant) (including stem and leaves).

2- Mineral element either macro or micro in the leaves:

Mineral elements were determined in all leaves after 15 days from last addition of fertilizer doses, however; samples were dried at 70 ^{0}C to determine total nitrogen, phosphorus and potassium content according to the methods described by Black (1983), Watanabe and Olsen(1965) and Jackson(1965), respectively. Whereas, Fe, Zn and Mn were determined using atomic absorption spectrophotometer according to the methods described by Chapman and Pratt (1961).

3-Fruit yield and its quality:

Pepper fruits were picked weekly through the harvesting period for estimation of yields parameters, i.e., early (the first three pickings) and total yield per feddan and also average fruit weight. For physical fruit quality determination, a random sample of 20 fruits from each plot was taken at fourth picking and the fruit length as well as diameter was recorded.

4-Chemical properties of fruits:

Chemical properties of fruits i.e., TSS, ascorbic acid (vitamin C) were recorded according to the method by A.O.A.C. (1980).

5- The economical evaluation:

The economical evaluation to study any one of the used treatments led to obtain the highest net revenue.

Statistical analysis:

The obtained data were subjected to the combined analysis of variance procedure and means compared using

L.S.D. methods at 5% level of significance according to Snedecor and Cochran (1980).

RESULTS AND DISCUSSION

1-Plant growth:

A-Effect of NPK levels:

Data in Table (3) reveal that the plant height, number of branches / plant, number of leaves/plant, leaf area/ plant as well as fresh and dry weight of pepper plants were significantly responded with the increment of the rates from NPK addition. Whereas , It could be summarized that , the growth characteristics of pepper plants recorded superiority results when adding NPK to the soil at the high rate (100%) comparing with the addition of low rate (25%) from the recommended dose or the control(without NPK). The obtained results may be due to the structure of the experimental soil (Table 1), which had low organic matter and some mineral nutrition in order of using over dose of mineral fertilizer under furrow irrigation which transfers the elements in lower layer of the soil. Therefore, increasing the levels of mineral fertilizers activated the cell division and cell enlargement hence the stimulation growth of pepper plants was occurring. Same trend of these results was observed by (Said, 1997) on pepper plants.

B- Effect of different sources of organic manures:

The results presented in Table (3) show that the vegetative growth of pepper plants was affected significantly by addition of different sources of organic fertilizer to the soil in the two experimental seasons. The results reveal that the two types of biogas digester organic fertilizer encouraged the vegetative growth expressed as plant height, number of branches / plant, number of leaves/plant, leaf area/ plant as well as fresh and dry weight compared with those plants not fertilized with organic fertilizer (control). Since the experimental soil had low organic matter content as well as some macro and micronutrients (Table 1). Therefore adding organic fertilizer to the soil has been a successful practice for improving the physical, chemical and biological properties, which increase soil organic matter, cations exchange capacity available mineral nutrition and this in turn stimulate the growth of plants (Ghoname and Shafeek, 2005). Same results were recorded by Abd El-Raman and Hosny (2001) on eggplant. Data also show clearly that, the highest values of vegetative plant growth were obtained with the addition of dried biogas digester organic fertilizer followed by farmyard manures then liquid biogas digester organic fertilizer. The obtained data could be attributed to the increasing in the amount of several essential elements i .e, nitrogen, phosphorus, potassium and organic matter in the biogas digester organic fertilizer as presented in Table (2), which stimulate the meristematic activity of tissue. Whereas, nitrogen may increase number of leaves / plant, thereby leaf area could be favored, also nitrogen may enhance the simulative leaf area by increasing cell division and leaf dimensions. In the same time high level of phosphorus is important to the activity of cell division. Potassium is favorable in cell turgidity, size. Moreover, higher content of essential elements and microorganisms contained in biogas which play a vital role in promoting plant growth, while some other investigators directed their contribution to N2 – fixation, solubilization, cellulose decomposition, etc., other went to production of plant growth modifying substances by such bio-fertilizers (El- Sheekh, 1997). Therefore, digester organic fertilizer had a beneficial effect on the vegetative growth of pepper plants.

Table 3. Vegetative growth of pepper plants as affected by different sources of organic fertilizer and NPK levels and their interactions during 2016 and 2017 seasons

Treatments / Characters		Foliage fresh weight/plant (gm)		Foliage dry weight/ plant (gm)		Plant height (cm)		No. of branches/ plant		Leaf area/ plant (cm2)		No. of l eaves/ plant	
Organic sources	**NPK- levels, (Kg/Fed)**	**2016**	**2017**	**2016**	**2017**	**2016**	**2017**	**2016**	**2017**	**2016**	**2017**	**2016**	**2017**
Without organic fertilizer	0	341	600	47.36	64.90	61.42	76.62	3.42	4.76	1510	1754	40.5	41.3
	25%	400	642	51.02	68.60	67.17	80.50	4.50	4.88	1948	2012	47.8	43.9
	50%	439	748	55.01	73.50	72.17	91.66	4.92	4.83	2691	2566	45.9	45.2
	75%	448	755	57.05	76.00	73.00	90.16	4.62	4.52	2715	2654	54.4	50.3
	100%	456	763	57.23	75.44	70.32	89.53	4.53	4.50	1967	2532	52.5	49.3
L.S.D. at 5%		13.03	79.0	3.5	10.94	4.64	8.1	N.S.	N.S.	1176	900	1.4	1.6
Farmyard manures ($20m^3$/Fed.)	0	306	511	45.34	60.81	59.11	77.22	4.31	4.66	1481	1653	43.5	46.1
	25%	345	639	49.11	64.55	65.53	83.45	4.52	4.58	1966	2110	46.9	46.4
	50%	453	751	53.10	69.56	71.52	93.44	4.56	4.73	2199	2421	45.7	50.2
	75%	503	762	55.43	73.32	75.51	95.43	4.75	4.56	2518	2655	53.5	52.5
	100%	512	759	54.80	72.34	75.92	95.82	4.55	4.75	2386	2450	53.3	50.1
L.S.D. at 5%		12.03	79.0	3.5	10.94	4.64	8.1	N.S.	N.S.	1037	768	1.9	1.9
Dried biogas organic residuals	0	653	719	49.72	71.23	68.33	79.92	5.52	5.54	2323	2534	59.5	65.4
	25%	769	789	56.96	78.43	79.67	82.66	5.50	5.63	2382	2662	60.4	66.5
	50%	789	897	66.50	85.10	83.33	95.66	5.60	5.73	2858	2964	65.4	65.4
	75%	763	823	66.74	84.74	84.33	96.66	5.63	5.80	2865	2911	65.4	63.7
	100%	762	819	68.45	85.64	84.65	95.43	5.59	5.99	2741	2945	64.9	65.5
L.S.D at5%		16.5	13.4	4.3	3.0	3.1	2.5	N.S.	N.S.	530	300	2.00	N.S.
Liquid biogas organic residuals	0	374	613	42.41	59.81	67.30	78.34	4.56	5.01	1188	1511	41.6	44.1
	25%	412	657	49.98	62.31	68.30	89.65	4.80	5.22	1503	1746	45.9	44.5
	50%	554	723	55.13	70.52	79.90	93.41	4.90	5.30	1540	1760	46.7	51.2
	75%	556	781	57.34	72.89	79.80	94.61	4.80	5.50	1611	1698	54.5	52.5
	100%	549	783	57.50	71.32	78.63	93.55	4.82	5.62	1749	1612	54.3	55.1
L.S.D. at 5%		17.02	83.2	8.70	8.60	3.2	2.5	N.S.	N.S	240	200	1.9	1.9

***N.S. not significant**

C-Effect of the interaction between mineral fertilizer levels and organic manures:

Data in Table (3) illustrate that pepper plants growth were affected as a result of the different combinations between mineral fertilizers and organic sources. The vigorous vegetative growth was recorded with the combination between (farmyard manures + 75% NPK), also (dried biogas digester + 50% NPK) and (liquid biogas digester +75%NPK) respectively as compared with the other treatments .Because of the experimental soil type and using furrow irrigation system, which not allow organic matter to cleat mineral elements and turned it low percentage of organic matter, therefore the application of organic and mineral fertilizers together may increase the exchangeable water soluble of NPK and the uptake of these elements (Cook, 1972), consequently increase cell division and cell enlargement may occur. Moreover, the combination ratio between organic and mineral fertilizers may facilitate maximum utilization of the both sources. Data also in Table(3) suggest that using 50% of mineral fertilizers combined with dried biogas digester organic fertilizer was the best combination to achieve the best growth of pepper plants as compared with other combinations also decrease the pollutions and save of 5% from mineral fertilizer.

2-Mineral elements in the leaves:

A-Effect of NPK levels:

(a)- Macro-elements (nitrogen, phosphorus and potassium):

It could be conclude from Table (4) that the percentage of nitrogen, phosphorus and potassium in pepper leaves are correlated positively with the full dose of recommended mineral fertilizers i.e., 100%. However it is well known that increasing the levels of NPK raised the availability of these elements in the soil solution, which favored the NPK uptake and hence increased its concentrations in the leaves. The obtained data are in agreement with those results of Abdel-Maksoud *et al.*, (1975), Fatahallah, (1992) and Midan (1995).

Table 4. Macro and micro elements of pepper plants leaves as affected by different sources of organic fertilizer and NPK levels and their interactions during 2016and 2017 seasons.

Characters / Treatments		N%		P%		K%		Fe (ppm)		Mn (ppm)		Zn (ppm)	
Organic sources	NPK-levels, (Kg/Fed)	2016	2017	2016	2017	2016	2017	2016	2017	2016	2017	2016	2017
Without organic fertilizer	0	2.12	1.69	0.37	0.21	3.16	3.76	103.3	100.1	18.9	18.5	43.8	42.1
	25%	2.94	2.47	0.38	0.31	3.30	4.04	100.1	101.2	19.5	17.9	43.6	41.9
	50%	3.50	2.72	0.38	0.26	3.37	3.39	102.0	102.0	19.8	18.8	42.9	42.2
	75%	3.67	3.02	0.39	0.27	3.52	4.15	101.0	100.1	21.6	18.8	42.7	42.3
	100%	3.98	3.88	0.39	0.33	3.58	4.56	102.1	100.0	22.5	19.8	42.9	41.9
L.S.D. at 5%		0.79	0.65	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
Farmyard manures ($20m^3$/Fed)	0	2.14	2.11	0.43	0.35	3.03	3.77	108.3	113.4	12.8	12.9	45.7	46.6
	25%	3.45	3.45	0.42	0.35	3.33	3.76	132.1	132.1	13.1	15.4	45.9	47.5
	50%	3.97	3.99	0.44	0.38	3.50	3.68	122.4	140.3	17.9	18.5	56.4	59.4
	75%	3.99	3.87	0.44	0.39	3.45	3.73	143.5	145,7	18.5	19.4	64.3	67.4
	100%	3.95	3.88	0.44	0.43	3.44	3.74	142.4	144.5	23.7	22.5	65.8	69.8
L.S.D. at 5%		0.79	0.65	N.S.	N.S.	N.S.	N.S.	12.2	13.1	4.5	5.6	5.1	6.4
Dried biogas organic residuals	0	2.86	2.76	0.53	0.41	3.28	3.89	132.5	150.3	23.3	24.4	76.5	80.3
	25%	2.86	2.92	0.55	0.49	3.16	4.25	154.7	176.5	22.2	27.4	82.7	89.9
	50%	3.60	3.81	0.63	0.48	3.43	3.86	168.5	186.8	30.1	34.5	88.4	88.9
	75%	3.63	3.85	0.63	0.49	3.39	4.28	166.1	185.4	33.6	38.3	78.9	93.5
	100%	4.77	4.54	0.66	0.48	3.45	4.30	165.3	188.6	33.7	38.0	89.8	95.7
L.S.D at 5%		0.35	o.33	N.S.	N.S.	N.S.	N.S.	14.1	16.5	6.7	9.4	7.4	9.7
Liquid biogas organic residuals	0	2.41	2.15	0.61	0.40	3.30	3.54	115.4	127.7	18.4	19.8	73.8	75.4
	25%	2.51	2.25	0.59	0.41	3.21	3.99	126.4	140.7	23.5	24.6	72.4	75.3
	50%	2.60	2.31	0.61	0.45	3.11	3.73	138.4	149.5	24.8	24.6	75.6	78.7
	75%	2.62	2.41	0.60	0.42	3.01	4.10	145.9	158.4	28.4	30.5	78.5	83.2
	100%	3.04	3.33	0.63	0.45	3.33	4.02	144.4	157.5	29.5	30.4	78.9	83.0
L.S.D. at 5%		0.1	0.1	N.S.	N.S.	N.S.	N.S.	10.1	11.2	4.2	5.4	5.8	6.9

***N.S. not significant**

(b)-Micro-elements (Fe, Mn and Zn):

Data in Table (4) reveal that the different levels of mineral fertilizers caused a significant effect on the concentrations of Fe, Mn and Zn in leaves of pepper plants. The obtained data show that the content of all the previous microelements were accumulated gradually in the leaves with increasing the level of mineral fertilizers from 25 to 100 % of the recommended dose ,also the results pointed to a significant increment from first to second season. These superiority results may be due to the abundance of nutritional elements in the root zone, which encourage the absorption of them, and consequently increased their concentrations in the leaves (Said, 1997).

B- Effect of different sources of organic manures:

(a)- Macro – elements (nitrogen, phosphorus and potassium):

The obtained data in Table (4) show that the different sources of tested organic manure were significantly affected on the concentrations of N, P and K in pepper leaves. The differences between using the two types of biogas organic digester fertilizers and organic farmyard manure were enough to reach the significant level of 5 %. However, the dried type is considered the most superior source to raise nitrogen, phosphorus and potassium in plant leaves than the liquid type or farmyard manure under investigation. This may be attributed to the higher content of available N, P and K in dried type over than liquid type or farmyard manure (Table 2). Because of the dried type of biogas fertilizer involved higher concentrations of essential elements such as N, P and K this may enhance metabolic activity within plant and promote the migration of metabolites through roots and stem toward the leaves thereby it may increase the percentage of K in leaves. Besides increasing the available soluble potassium in soil solution thus it may enhance higher rate of its absorption (Eissa, 1996).

(b)- Micro-elements (Fe, Mn and Zn):

Micro - nutrients concentration of Fe, Mn and Zn in the leaves of pepper plants significantly responded to the different organic sources as shown in Table (4).The highest concentrations of the previous microelements were found in leaves of pepper plants, which fertilized by dried type of biogas digester organic fertilizer followed in descending order by cattle manure and wet type of biogas digester organic fertilizer. This may be due to the rich content of those microelements found in dried type than other treatments as shown in Table (2) as well as the higher release of those microelements.

C- Effect of the interaction between mineral fertilizer levels and organic manures:

(a)- Macro – elements (nitrogen, phosphorus and potassium):

Pepper plants which received the two kinds of fertilizers i. e. , mineral fertilizers at high dose (100 %) combined with organic fertilizer contained high concentrations of N ,P and K in its leaves compared with that plants fertilized with lower dose of mineral fertilizer (75, 50, 25 %) as presented in Table (4). The superiority results was recorded in the leaves of plants fertilized with 50% of mineral fertilizers combined with dried type of biogas digester fertilizer which gave the highest concentrations of those three macro elements (N, P and K). Adding mineral fertilizers particularly NPK with the organic fertilizer may enhance chemical activities within organic fertilizer and promote the releasing of N, P and K thereby it may increase these elements in the root zone consequently increasing their absorption. Also, it could be stated that, the addition of mineral fertilizers to the organic fertilizer may increase the exchangeable water soluble of NPK, consequently the uptake of these elements increased. In other meaning the presence of organic fertilizer especially dried type of biogas digester fertilizer caused an increase in the concentrations of NPK in the root zone, which encouraged NPK absorption, and consequently its concentrations in the leaves.

(b)- Micro- elements (Fe, Mn and Zn):

The results in Table (4) indicate that the concentrations of Fe, Mn and Zn in leaves of pepper plants were significantly increased by adding mineral fertilizers with organic fertilizer combined together. Generally plants fertilized with high dose of mineral fertilizer (50 %) combined with dried type of biogas digester fertilizer had the highest concentrations of all estimated microelements as compared with the other combinations. These increments may be due to the enhancement of the decomposition of organic fertilizer (dried type) as well as the higher release of these elements when combined with chemical fertilizers.

3- Fruit Yield and its components:

A-Effect of NPK levels:

Data in Table (5) showed that there was significant variation between adding (25%) of the total dose of NPK and the full dose (100 %) in the amount of early and total yield as well as fruit quality expressed as average fruit weight. The highest total yield and best fruit quality were obtained from the plants fertilized with the full recommended dose of NPK. The superiority of total yield by using the full dose of NPK recommended 2.7 and 3.5 ton/fed. Compared with 1.5 and 1.6 ton/fed. By using the half recommended dose of NPK in the first and second seasons respectively. These results may be due to the previous results of increment vegetative growth of those plants fertilized presented with full dose of NPK which possessed much number of shoots and leaves per plant as well as leaf area beside high concentrations of NPK in their leaves ,this in turn induced more photosynthetic rates that built high yield of carbohydrates which promote cell division and enlargement inducing superiority vegetative vigorous plants , this reflect to produce more fruit yield than those of plants fertilized with the half dose of NPK (Said, 2007).

B- Effect of different sources of organic fertilizer:

Data about early and total yield as well as fruit quality in Table (5) show clearly that there was significant results were achieved due to the application of different types of organic fertilizer in both seasons. As general, all organic types were sufficient to encourage the capability of plants to produce high total yield and enhanced the fruit characters as compared with the plants fertilized with mineral fertilizers alone. However, when evaluate the results obtained from the three applied organic sources (farmyard manure, dried biogas digester residuals and liquid biogas digester residuals), it is obvious that the plants fertilized with dried biogas digester residuals gave the heaviest total weight as ton/ fed. In the two seasons followed by liquid biogas digester residuals while the farmyard manure gave the lowest amount throughout the two seasons. The highest yield obtained by the addition of liquid biogas digester residuals may be due to the high rate of NPK as well as organic matter and pH degree as shown in Table (2). This is in turn led to increase the estimated attributes either in leaves or branches.

However, the reflected a significant increase in number of branches and leaves, leaf area, N, P and K Contents. So, these increments in the obtained results may lead to the favored increase in building up carbohydrates and this in turn resulted in more plant growth characters and yield component of pepper plant. In this concern, Cook (1972) reported that the addition of suitable organic manure in the soil improves the soil structure. This structural improvement can encourage the plant to produce good roots development in the soil , which lead to higher uptake and this reflect on yield of plants (Abd El-Maksoud *et al.*, (1975) and (Chindo & Khan (1986).

Table 5. Yield and its components of pepper plants as affected by different sources of organic fertilizer and NPK levels and their interactions during 2016 and 2017 seasons

Treatments / Organic sources	Characters / NPK- levels (Kg/ Fed.)	Average fruit weight (gm) 2016	Average fruit weight (gm) 2017	Yield / plant (gm) 2016	Yield / plant (gm) 2017	No. of fruits / plant 2016	No. of fruits / plant 2016	Fruit dry weight (%) 2016	Fruit dry weight (%) 2017	Early yield / fed.(kg) 2016	Early yield / fed.(kg) 2017	Yield / fed (ton) 2016	Yield / fed (ton) 2017
Without organic fertilizer	0	34.5	32.11	199.4	203.6	1.5	1.5	6.01	7.24	598.2	610.8	1.5	1.6
	25%	35.54	33.84	248.1	241.3	1.9	1.9	6.42	7.41	744.3	723.9	1.9	1.9
	50%	37.21	35.91	303.6	329.0	2.4	2.4	7.44	7.68	910.8	987.0	2.4	2.6
	75%	41.11	40.95	331.9	366.6	2.6	2.6	6.96	8.22	995.7	1099.8	2.6	2.9
	100%	42.01	41.65	339.7	448.3	2.7	2.7	6.98	8.01	1019.1	1344.9	2.7	3.5
L.S.D. at 5%		1.77	1.86	74.5	82.12	N.S.	1.43	1.43	N.S.	223.5	246.3	1.43	1.52
Farmyard manures ($20m^3$/Fed.)	0	43.06	45.02	239.9	265.4	1.9	1.9	6.09	7.91	719.7	796.2	1.9	2.1
	25%	56.21	56.00	347.8	388.6	2.7	2.7	6.36	8.08	1043.4	1165.8	2.7	3.1
	50%	54.54	58.21	343.2	418.3	2.7	2.7	6.32	7.82	1029.6	1254.9	2.7	3.3
	75%	55.06	56.43	394.3	484.5	3.1	3.1	5.88	8.06	1182.9	1453.5	3.1	3.8
	100%	54.00	55.34	375.0	543.8	3.0	3.0	6.20	8.32	1125	1631.4	3.0	4.3
L.S.D. at 5%		1.77	1.86	74.5	82.12	N.S.	1.1	1.1	N.S.	223.5	246.3	1.1	1.2
Dried biogas organic residuals	0	57.21	60.43	563.9	556.7	4.5	4.5	7.33	7.91	1691.7	1670.1	4.5	4.4
	25%	60.41	65.42	511.0	553.5	4.0	4.0	7.43	8.08	1533	1660.5	4.0	4.4
	50%	64.71	69.44	657.3	645.7	5.2	5.2	7.32	7.82	1971.9	1937.1	5.2	5.1
	75%	65.71	70.56	639.3	669.9	5.1	5.1	6.88	8.06	1917.9	2009,7	5.1	5.3
	100%	64.14	70.59	623.8	672.4	4.9	4.9	6.86	8.54	1871.4	2017.2	4.9	5.3
L.S.D at5%		1.1	0.5	78.9	71.4	0.5	0.5	N.S.	N.S.	236.7	214.2	0.5	0.5
Liquid biogas organic residuals	0	36.23	44.25	326.7	316.8	2.6	2.6	6.11	8.12	980.1	950.4	2.6	2.5
	25%	44.34	45.63	393.8	355.2	3.1	3.1	6.47	8.15	1181.4	1065.6	3.1	2.8
	50%	53.63	55.53	501.1	489.6	4.0	4.0	6.43	7.95	1503.3	1468.8	4.0	3.9
	75%	53.99	54.61	596.8	587.4	4.7	4.7	5.85	8.15	1790.4	1762.2	4.7	4.9
	100%	55.80	56.05	547.9	611.0	4.3	4.3	6.51	7.54	1643.7	1833.0	4.3	4.8
L.S.D. at 5%		0.51	0.44	89.5	78.4	N.S.	1.0	1.0	N.S.	268.5	235.2	1.0	1.1

***N.S. not significant**

C- Effect of the interaction between mineral fertilizer levels and organic manures:

Both total yield and fruit quality were significantly responded to the interaction between mineral at 50% from the recommendation and manure fertilizers in both seasons as shown in Table (5). Whereas the addition of full dose of NPK (100 %) combined with all tested sources of organic manures were enough to increase total yield and enhanced the fruit characters in both seasons' .The favorable results were recorded with the addition of 50 % NPK plus dried biogas digester residuals together to the soil as compared with other combination. These results may be due to the increasing in nutrition elements in root zone consequently its uptake. So this increase reflects on increasing the growth and yield of plants.

4-Chemical properties of fruits:

A-Effect of NPK levels:

Data in Table (6) indicate that the amount of mineral fertilizer at the level of 50% or 100 % NPK added to the soil significantly influenced on the fruit concentrations from TSS, acidity, dry matter and vitamin C.

Table 6. Chemical properties of pepper fruits as affected by different sources of organic fertilizer and NPK levels and their interactions during 2016and 2017 seasons

Treatments / Organic sources	Characters / NPK- levels (Kg/ Fed.)	Titratable acidity (%) 2016	Titratable acidity (%) 2017	Vitamin C (mg/100ml juice) 2016	Vitamin C (mg/100ml juice) 2017	T.S.S (%) 2016	T.S.S (%) 2017	Dry matter (%) 2016	Dry matter (%) 2017
Without organic fertilizer	0	0.348	0.360	69.9	70.1	5.05	5.27	7.31	7.81
	25%	0.300	0.300	60.3	59.8	4.80	4.73	7.46	6.91
	50%	0.390	0.390	62.3	63.0	4.60	4.47	9.64	9.57
	75%	0.340	0.340	69.4	69.2	5.20	5.27	6.01	5.84
	100%	0.340	0.344	67.9	67.8	5.40	5.31	6.88	6.55
L.S.D. at 5%		0.050	0.045	3.4	1.1	0.5	0.40	1.1	1.8
Farmyard manures ($20m^3$/Fed.)	0	0.328	0.333	68.0	68,3	4.80	4.87	6.01	6.00
	25%	0.300	0.300	64.1	64.5	5.76	5.80	5.50	5.18
	50%	0.377	0.377	62.6	62.7	5.27	5.33	5.46	5.28
	75%	0.328	0.327	61.1	60.4	5.57	5.54	5.50	6.35
	100%	0.331	0.330	62.7	62.7	5.54	5.60	6.23	6.33
L.S.D. at 5%		0.069	0.041	3,5	3.9	0.1	N.S.	0.4	1.1
Dried biogas organic residuals (20m3/Fed.)	0	0.335	0.333	61.6	62.0	61.6	5.27	5.17	4.72
	25%	0.300	0.300	69.4	69.5	69.4	5.27	4.43	4.36
	50%	0.360	0.360	68.9	68.3	68.9	4.80	6.53	6.19
	75%	0.348	0.347	67.4	67.0	67.4	5.07	6.91	6.91
	100%	0.367	0.358	67.8	67.8	67.5	5.44	6.99	6.89
L.S.D at5%		0.034	0.029	4.1	3.9	4.5	1.3	2.1	2.1
Liquid biogas organic residuals (20L/Fed.)	0	0.365	0.363	62.0	62.2	62.0	4.93	9.26	8.59
	25%	0.400	0.400	68.8	68.0	68.8	4.87	4.45	4.07
	50%	0.340	0.340	67.2	67.1	67.2	3.80	6.37	5.89
	75%	0.328	0.327	62.1	61.9	62.1	5.07	5.84	6.32
	100%	0.330	0.333	62.9	62.4	65.9	5.32	6.88	6.54
L.S.D. at 5%		0.034	0.023	4.6	5.2	2.3	1.1	2.9	2.5

***N.S. not significant**

The high amount of nitrogen, phosphorus and potassium added as 100% of full-recommended dose produced plants characterized with fruit contained high concentrations from vitamin C, acidity, dry matter and TSS as compared with those plants fertilized with half dose of NPK.This superiority data of full levels of NPK might attribute to the high concentration of macro elements, which encourage the plant to have a good roots, that is mean high nutrition absorption and these lead to higher yield and chemical properties of fruits such macro-elements participate in the synthesis of organic acids and photosynthesis products which increased the content of TSS and vitamin C(Cook, 1972 and Said,1997).

B-Effect of different sources of organic manures:

It is obvious from Table (6) that, there was a significant effect of various organic manure on the fruit content of TSS, acidity, dry matter and vitamin C in both seasons, whereas the highest value of the four constituents previously mentioned were obtained in most cases by applying organic manure in form of dried biogas digester residuals followed by liquid biogas digester residuals and farmyard manure, respectively. On the contrary, the lowest contents were obtained from the plants fertilized with mineral fertilizers only without organic manures (control).In addition, using organic manure as general in soil improves the soil structure. The structural improvements can encourage the plant to have a good root developed which lead to higher yield and physical properties of fruits (Cook, 1972).

C-Effect of the interaction between mineral fertilizer levels and organic manures:

Concerning the effect of mineral fertilizers combined with different sources of organic manures as shown in Table (6) indicate that the highest values TSS, vitamin C, acidity and dry matter were obtained from fruit tissues of pepper plants that fertilized with 50% of recommended dose of NPK combined with dried biogas residue organic fertilizer. These results are in agreement with those data produced by Midan (1995) and Said (1997) who suggested that, when organic manure added with NPK, the TSS, VC, dry matter and acidity in fruits show significant increase.

5-The economical evaluation:

Data in Table (7and 8) illustrated that the different agricultural management costs per feddan of pepper plants growing under four levels of NPK mineral fertilizer i.e., 25%,50%,75% and 100% from the recommended dose combined with three sources of organic manures to evaluate the final results and the total cost price.

Table 7. Total cost of different agricultural management for one feddan peppers

Items	**Egyptian pound**
A- Capital cost	
Soil management	500
Soil preparation	400
Transplanting (Seedlings +Labor cost)	600
Pesticides + Foliar sprays	1000
Harvesting	1000
Soil rental / 6 months	3000
Total cost	6500
B-Variable cost	
1- Mineral fertilizers	
A-25%NPK from the recommended dose	
187.5 kg of N (ammonium sulphate)	1312
75kg of P(super phosphate)	105
50 kg of K(potassium sulphate)	500
Total cost	1917
B-50% NPK from the recommended dose	
375 kg of N (ammonium sulphate)	2625
150 kg of P(super phosphate)	210
100 kg of K(potassium sulphate)	1000
Total cost	3835
C- 75% NPK from the recommended dose	
562 kg of N (ammonium sulphate)	3934
225 kg of P(super phosphate)	315
150 kg of K(potassium sulphate)	15oo
Total cost	5749
D- 100% NPK from the recommended dose	
750 kg of N (ammonium sulphate)	5250
300 kg of P(super phosphate)	420
200 kg of K(potassium sulphate)	2000
Total cost	7670
2-Organic sources	
20m^3farmyard manure	3000
20m^3dried biogas residue	1600
20L liquid biogas residue	400
3- Mineral fertilizers +Organic sources	
25%NPK+ farmyard manure	4917
25% NPK + dried biogas residue	3517
25% NPK + liquid biogas residue	2317
50% NPK + farmyard manure	6835
50% NPK + dried biogas residue	5435
50% NPK + liquid biogas residue	4235
75% NPK + farmyard manure	8749
75% NPK + dried biogas residue	7349
75% NPK + liquid biogas residue	6149
100% NPK + farmyard manure	10670
100% NPK + dried biogas residue	9270
100% NPK + liquid biogas residue	8070

Table 8. Total cost of one feddan (contained capital and variable cost) fertilized with two levels of mineral fertilized and three sources of organic manures.

Treatments Levels of mineral fertilizer	**Sources of organic manures**	**Total cost price (Egyptian pound) (Capital +Variable cost)**
25%NPK from the Recommended dose	Without(control)	6500+1917=8417
	Farmyard manure	6500+4917=11417
	Dried bio residue	6500+3517=10017
	Liquid biogas residue	6500+2317=8817
50%NPK from the Recommended dose	Without(control)	6500+3835=10335
	Farmyard manure	6500+6835=13335
	Dried biogas residue	6500+5435=11935
	Liquid biogas residue	6500+4235=10735
75%NPK from the Recommended dose	Without(control)	6500+5749=12249
	Farmyard manure	6500+8749=15249
	Dried biogas residue	6500+7349=13849
	Liquid biogas residue	6500+6149=12649
100%NPK from the Recommended dose	Without(control)	6500+7670=14170
	Farmyard manure	6500+10670=17170
	Dried biogas residue	6500+9270=15770
	Liquid biogas residue	6500+8070=14570

Data mentioned that the lowest costs noticed by using 50% from NPK dose combined with dried biogas residue organic fertilizer. Regarding the net revenue, data in Table (9) show that the superior treatment, which gave the highest net revenue, was 75% NPK mineral fertilizer combined with dried biogas residue arranged in descending order by liquid biogas residue , farmyard manure and finally 100%NPK only without organic manures.

Table 9. Total profits (net revenue) of sell the total yields of pepper fruits

Treatments		**Average of the two years 2016 and 2017**		
Levels of mineral fertilizer	**Levels of mineral fertilizer**	**Total yield (ton/fed.)**	***Total income (Egyptian pound)**	****Total profit (Net revenue) (Egyptian pound)**
25%NPK from the Recommended dose	Without(control)	3.8	30400	21983
	Farmyard manure	5	40000	28583
	Dried biogas residue	5.5	44000	33983
	Liquid biogas residue	6.2	49600	40783
50%NPK from the Recommended dose	Without(control)	5.8	46400	36065
	Farmyard manure	6	48000	34665
	Dried biogas residue	6.9	55200	43265
	Liquid biogas residue	7.3	58400	47665
75%NPK from the Recommended dose	Without(control)	8.4	67200	54951
	Farmyard manure	10.3	82400	67151
	Dried biogas residue	10.4	83200	69351
	Liquid biogas residue	10.2	81600	68951
100%NPK from the Recommended dose	Without(control)	5.9	47200	33030
	Farmyard manure	7.9	63200	46030
	Dried biogas residue	9.6	76800	61030
	Liquid biogas residue	9.1	72800	58230

Price of sell one ton fruits of pepper during the season =10000 pounds : Total income= Price of sold one ton fruits × Total yield per ton: **Net revenue =Total income – Total cost price (Table B)**

CONCLUSION

It can be conclude that under clay soil condition and furrow irrigation adding 100%from the recommended NPK to pepper plants was the best than lower doses under the condition of not adding organic manure, while the superior results i.e., growth, chemical contents as well as fruit yield and its quality were obtained from the treatment of the level 50%NPK combined with dried biogas residue organic fertilizer at 20m^3/fed. In addition, to obtain the highest net revenue, it can be recommended to fertilize pepper plants with 75% of the recommendation of pepper fertilization combined with 20m^{3}dried biogas residue organic fertilizer per feddan.

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تقييم إستخدام السماد العضوى الناتج من مخمرات الغاز الحيوى مع مستويات من التسميد المعدنى الموصى به لنباتات الفلفل على النمو و المحصول وجودته

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تم إجراء هذا البحث خلال الموسم الصيفى لعامى ٢٠١٦ ، ٢٠١٧ على نباتات الفلفل الرومي (صنف كاليفورنيا وندر) المنزرع في أرض طينية بإحدى المزارع الخاصة بمحافظة كفر الشيخ بإستخدام نظام الرى بالغمر. و تهدف هذه التجربة الى تقييم تأثير بعض المعاملات المتداخلة بين أربعة مستويات من الأسمدة المعدنية (٢٥% - ٥٠%-٧٥%-١٠٠%) من كميات النيتروجين و الفوسفور و البوتاسيوم من التوصية السمادية لإنتاج الفلفل و ذلك بتداخلها مع ثلاثة مصادر من الأسمدة العضوية و هى سماد الماشية (٢٠م^{٣} /فدان) و سماد البيوجاز الجاف(٢٠م^{٣}/فدان) و السماد السائل للبيوجاز(٢٠لتر/فدان) وهذه الأسمدة ناتجة من وحدة إنتاج الغاز الحيوى و ذلك على النمو و المحصول وصفات الثمار الناتجة وذلك بهدف إستخدام روث الحيوانات فى وحدات لانتاج غاز حيوى والحصول على مصادرعضوية ذات تأثير إيجابى على نمو المحاصيل الزراعية وعدم إحتوائها على المسببات المرضية نتيجة الظروف الغير هوائية ودرجة الحرارة والضغط المرتفع المستخدمة فى وحدات إنتاج الغاز الحيوى، وخفض التكلفة الاقتصادية للسماد المستخدم عن طريق العائد الناتج من بيع أسطوانات الغاز الحيوى.وكانت النتائج كالتالى:كانت جميع الاسمدة العضوية المستخدمة خاصة مع توليفات من الأسمدة المعدنية و التى كان أفضلها مع ٥٠% و٧٥% من معدل التوصية السمادية مع البيوجاز الجاف و السائل يلى ذلك مع سماد الماشية و ذلك فى إحداث تأثير إيجابى على نمو النباتات و زادت نسبة العناصر الكبرى و الصغرى الهامة فى أوراق النباتات وكذلك أعطت أعلى قيم للمحصول المبكر والكلى مع تحسين صفات و جودة الثمار و زيادة محتواها من حامض الأسكوربيك و المواد الصلبة الذائبة الكلية (TSS) مقارنة بتلك النباتات التى تم تسميدها باسمدة معدنية فقط بدون اضافة أسمدة عضوية ،حيث كانت معاملة السماد العضوى البيوجاز الجاف مع معدل ٥٠% من الأسمدة الكيماوية قد أدت الى زيادة معنوية مرتفعة جدا من معدل الإنتاج عن ١٠٠%من توصية السماد المعدنى كذلك الحال مع صفات الثمار و جودتها.وكانت المخلفات الجافة الناتجة من وحدات انتاج الغاز الحيوى هى افضل المصادر العضوية حيث أعطت افضل النتائج.أدى زيادة معدلات النيتروجين و الفوسفور و البوتاسيوم من ٢٥% الى٥٠% و ٧٥% و١٠٠% على التوالى من الكميات الموصى بها للفلفل الى زيادة فى النمو الخضرى متمثلا فى إرتفاع النبات وعدد الأفرع و عدد الأوراق و المساحة الورقية، كما أدت الى زيادة الوزن الطازج والجاف للنمو الخضرى . و زيادة نسبة محتوى الأوراق من العناصر الكبرى (النيتروجين ، الفوسفور ، و البوتاسيوم) و الصغرى (حديد ، منجنيز ، زنك) مع زيادة المحصول المبكر و الكلى للثمار بالاضافة الى تحسين صفات جودتها و زيادة محتواها من حامض الأسكوربيك و المادة الصلبة الذائبة TSS)). كما كان هناك فرق كبير معنوي بين إستخدام معدل ١٠٠% من التوصية السمادية لنباتات الفلفل مقارنة مع سائر المستويات من (٢٥%-٥٠%-٧٥%) و ذلك فى النمو و المحصول و مواصفاته. و بالنسبة لدراسة الجدوى والتقييم الإقتصادى كانت أقل تكلفة ناتجة من معاملة التسميد بمعدل ٥٠% من التوصية السمادية مع إستخدام السماد العضوى البيوجاز الجاف بمعدل ٢٠م^{٣}/فدان، أما أعلى عائد إقتصادى فقد تم الحصول عليه من معاملة التسميد المعدنى٧٥% من التوصية السمادية مع التسميد العضوى من سماد البيوجاز الجاف بمعدل ٢٠م^{٣}/فدان.