Minufiya J. Agric. Res. Vol.37 No. 6(2):1583-1596 (2012) **"http://www.mujar.net"**

EFFECT OF PARTIAL REPLACEMENT FOR MINERAL FERTILIZERS WITH BIOGAS MANURE ON SOIL PROPERTIES, FERTILITY AND PRODUCTIVITY OF SWEET POTATO

M. A. H. Mohamad and Manal F. Tantawy
Soils, Water and Environment Res. Inst., Agric. Res. Center, Giza, Egypt

(Received: Oct. 30 , 2012)

ABSTRACT: *A field experiment was carried out at Experimental Farm Barrage, Horticultural Res. Inst., Agric. Res. Center, through two successive grown seasons of 2011 and 2012 to study the effect of partial replacement for mineral fertilizers by biogas manure on soil physical and chemical properties and its content of available macro and micronutrients. Several vegetative, tuber roots, yield parameters and chemical and mineral composition of sweet potato (Ipomoea batata L.), Minufiya 6/96 cv. were determined.*

The obtained data showed that:-

The increase of added biogas manure was associated by decrease of soil bulk density, pH and the content of CaCO3 and increase of soil total porosity, EC (dS m^{-1}), CEC, the content of OM and available macro and micronutrients, except available N which increased with the increase of added mineral nitrogen. Also, the high values of the measured vegetative, tuber roots and yield parameters were resulted obtained from the treatment of 50 % mineral fertilizers + 50 % biogas manure. Except tuber roots content of N and protein, the contents of total carbohydrates, total sugar, carotein, vitamin C, P and K of tuber roots were increased with the increase of added biogas manure.

Key words: *Sweet potato, Mineral fertilizer, Biogas manure, Soil properties, Growth and yield parameters and Chemical and mineral composition.*

INTRODUCTION

Fertilizer is one of the most important inputs of increasing the productivity of crops (Anonymous, 1997). In order to obtain good yield, modern varieties of different crops require relatively high quantity of fertilizer compared to the traditional cultivars. However, the economic condition of Egyptian farmers often does not support them to use required quantity of fertilizers due to its high cost. On the other hand, the organic matter content of most soils of Egypt is very low (0.2 – 1.8 %) as compared to desired (2.5 % and above) levels (Balba, 1995 and Alaam, 2001). Therefore, it becomes an immense need to formulate an optimum fertilizer recommendation that would produce satisfactory yields and would maintain soil health to ensure sustainable crop production. One of the alternatives to economize the use of mineral fertilizer is to incorporate crop residues or farmyard manure in combination with mineral fertilizers (Sarker *et al*., 1996 and Hati *et al*., 2007).

The amount of residues generated by biogas production has increased dramatically due to worldwide interest in using renewable energy. Biogas residues originate from anaerobic degradation of different types of rural and urban organic wastes and have been proposed as organic fertilizers because of their high content of ammonium and other valuable macro and micronutrients (Abubaker, 2012).The biogas is a good source of plant nutrients and way improving the physical, chemical and biological soil properties. The physical soil properties mainly constitute texture, structure, porosity, bulk density and water holding capacity, which in turn control the oxygen availability and soil drainage capacity (Marinari *et al*., 2000 ; Grag *et al*., 2005 and Odlare *et al*., 2011). The common chemical soil properties are pH, salinity (EC), cation exchange capacity (CEC), organic matter (OM) and C/N ratio were clearly affected by biogas manure additives (Lehmann *et al*., 2003 and Darilek *et al*., 2009). There, any change in these properties can cause a direct or indirect effect on the soil microorganisms. Some microbial activities, such as nitrification, are particularly sensitive to changes in soil properties, which make them suitable as indicators of disturbance in the soil system (Dick, 1992 and Ciarlo *et al.,* 2007). But also presents challenges, as the beneficial effects of these material may be accompanied by risks to both the soil and the environment due to contaminants (Albihn, 2002 and Bationo *et al.*, 2007).

Sweet potato (*Ipomoea batata L*.) is considered the sixth most important food crops in the world (Morrison *et al*., 1993). It is widely grown in many countries and produces a considerable yield under a wide range of environments. It is also considered the dominant food crop in the tropical and subtropical countries. On the world scale, sweet potato provides significant amounts of energy and protein; it contains carbohydrates, protein, vitamin C, carotene and some minerals nutrient. Its production efficiency of edible energy and protein is out – standing in the developing world (Salem *et al*., 2009). Sweet potato comes the 8th of important developing world crops in terms of the quality of energy per hectare per day which they can produce. Sweet potato also has higher energy than the cereals. The average energy output/input rations for rice and sweet potato on Fijian farms were 17:1 and 60:1, respectively (Woolfe, 1992).

This study was carried out to evaluate the effect of partial replacement of mineral fertilization by organic fertilizers (biogas) on soil physical and chemical properties and its content of available macro and micronutrients. Also, this effect on some vegetative, tuber roots and yield parameters and chemical and mineral composition of sweet potato was studied

MATERIALS AND METHODS

A field experiment was carried out through two successive grown seasons of 2011 and 2012 at Experimental Farm, Barrage, Horticultural Research Inst., Agric. Res. Center, to study the effect of partial replacement of mineral fertilizers (N, P and K) by biogas manure on alluvial soil properties and its content of available nutrients and sweet potato (*Ipomoea batata L.*), Minufiya 6/96 cv. growth, productivity and quality. Before planting, surface (0–30 cm) soil samples were taken from the studied soil, air – dried, ground, good mixed, sieved through a 2 mm sieve and analyzed for some physical and chemical properties and its content of available macro – and micronutrients according to the methods described by Cottenie *et al*. (1982) ; Page *et al*. (1982) and Kim (1996). The obtained data were recorded in Table (1). The used biogas manure was obtained from the "Biogas Training Center", at Moshtohor Village Qalyubia Governorate. Chemical analysis of this biogas manure was carried out according to the methods described by Page *et al*. (1982) and the obtained data were recorded in Table (2).

Table (1). Physical and chemical properties and the content of available macro - and micronutrients of the studied soil.

Physical properties	Particles size distribution (%)				Textural grade	Bulk density (Mg/m^3)	Total porosity (%)	Field capacity (%)
	Coarse sand	Fine sand	Silt	Clay				
	7.90	13.90	33.20	43.00	Clayey	1.31	50.06	40.50

Chemical properties	pH 1:2.5 soil : water susp.	EC (soil Ext.) dS m^{-1}	Soluble cations (meq/l)				Soluble anions (meq/l)			OM (%)	CEC cmol /kg	CaCO3 (%)
			Na^+	K^+	Ca^{2+}	Mg^{2+}	Cl^-	$HCO3^-$	$SO4^{2-}$			
	7.50	0.59	2.55	0.61	1.53	1.21	3.72	0.43	1.75	1.92	41.80	2.50

Available nutrients	Macronutrients (mg/kg)			Micronutrients (mg/kg)			
	N	P	K	Fe	Mn	Zn	Cu
	56.80	5.95	682	3.52	4.87	1.86	0.77

Table (2). Some chemical characters of the biogas manure used.

pH (1:5) susp.	EC (1:5) extract (dS m^{-1})	Total solid (%)	OM (%)	OC (%)	Total N (%)	C/N ratio	Total P (%)
6.50	2.80	13.30	50.00	29.07	1.50	19.38	0.83
Total K (%)	Total S (%)	Micronutrients (mg/kg)				Moisture content (%)	
		Fe	Mn	Zn	Cu		
0.89	0.11	556	264	103	33	23.5	

This experiment including six treatments. The studied treatments and the used mineral (N, P and K) fertilizers and biogas manure and their application rates were listed in Table (3). The recommended doses of N, P and K for sweet potato plants according to Ministry of Agriculture, Egypt were 40 kg N, 46.5 kg P_2O_5 and 100 kg K_2O per feddan as ammonium nitrate (33.5 % N), ordinary super phosphate (15.5 % P_2O_5) and potassium sulphate (48 % K_2O), respectively.

The studied treatments were distributed through the experimental plots in a randomized complete block design with three dispersed replications. The area of each experimental plot was 12 m^2 (4 m length × 3 m width) divided into fifth lines with 60 cm width. The used variety of sweet potato in this study was Minufiya 6/96. Vine of sweet potato was transplanted in lines at the spacing of 60 cm × 30 cm. Vines of terminal and semi–matured portions were used for trans planting. The cutting was about 15 cm in length with 5–6 nodes. One weeding was done at 30 days after transplanting. All applications of biogas and ordinary super phosphate and half of added other mineral fertilizers were applied at final land preparation. Remaining the mineral fertilizers was added in two equal doses at 35 and 60 days after transplanting. The harvest was done at full maturity (about 145 days after transplanting).

Plant samples (5 plants) were randomly selected after 130 days from transplanting. The following characters were determined; plant height (cm), number of branches/plant, number of phalanges/main stem and the mean leaves on main stem were measured and recorded. Before harvesting stage (after 140 days from transplanting), other plant samples (5 plants) were taken from each experimental plot. The stems of each selected plant were separated from the tubers. The yield (kg/plant) of the stem was weighted. Some parameters such as number of tuber roots/plant, tuber length and diameter (cm) and weight of each tuber roots (gm) were measured. Other total yield of tuber roots weight (kg/plant and ton/feddan) and tuber roots dry yield as a percent (%) of fresh yield (ton/feddan) were estimated.

After sweet potato plants harvesting, soil sample (0–30 cm) was taken from each experimental plot and prepared for the studied determinations as described with the initial soil sample (Cottenie *et al*., 1982; Page *et al*., 1982 and Kim, 1996).

At the harvest, the tuber roots samples were collected, washed, air - dried, oven – dried at 70^{o} C for 72 hrs, weighted, ground and used to determine the content of total soluble sugars and total carbohydrates which determined calorimetrically using the phenol sulfuric acid method of Dubois *et al.* (1956). Carotein was estimated as described by Witham *et al.* (1971). The content of vitamin C was determined according to the methods described by (A. O. A. C., 1975). Finally, the content of some macro and micronutrients was determined in tuber roots digestion using the methods described by Jackson (1973); Cottenie *et al*. (1982) and Page *et al*. (1982). Content of protein (%) obtained by multiple the content of N (%) by 5.75 (A.O.A.C., 1985).

Table (3). The studied treatments and application rates of the used biogas and mineral fertilizers.

Treatments	Ratio of the used fertilizer		Added biogas (ton/fed.)	Nitrogen application (kg/fed.) (N)	Phosphorus application (kg/fed.) (P_2O_5)	Potassium application (kg/fed.) (K_2O)
	Mineral N (%)	Biogas (%)				
1	0	0	0	0	0	0
2	100	0	0	40	60	96
3	75	25	0.7	30	45	72
4	50	50	1.4	20	30	48
5	25	75	2.1	10	15	24
6	0	100	2.8	0	0	

All obtained data from this study were statistically analysis with the help of COSTAT – C program, and least significant difference (LSD) at 0.05 probability level to make comparisons among treatment means according to Duncan (1996).

RESULTS AND DISCUSSION

1- Soil Properties:-

A- Bulk density and total porosity.

The presented data in Table (4) showed that the soil bulk density (mg/m^3) as affected by the studied treatments was decreased with the increase of added biogas, but its unaffected by individual application of mineral fertilizers. The relative change values (RC, %) of bulk density were negative with the different treatments of biogas where these value ranged between – 1.53 and – 5.34 % compared with control treatment. On the other hand, and with different treatments of biogas, the values of total porosity were increased, where the percentage (RC, %) of these increases ranged from 1.48 to 5.22 % compared with unfertilized soil. The individual treatment of mineral fertilizers had no effect on the total porosity. Reduction of the soil bulk density and the increase in total porosity as the results of organic manures (biogas) application may be referred to one or both of the two following reasons, (1) density of organic particles is lower than that those of the mineral soil ones and (2) organic substances facilitate soil aggregation, thereby increasing soil porosity or reducing the bulk density. In this respect Marinari *et al*. (2000); Grag *et al.* (2005); El–Sedfy (2008); El–Shouny *et al.* (2008) and Mohamad (2009), they found that presence of organic matter in soil acts as cementing materials, thus both flocculation and cementation help in aggregate formation and increasing void ratio.

B- Soil reaction and salinity.

Regarding the effect of the studied treatments on soil pH recorded in Table (4), it could be noticed that, slight and insignificant decrease in soil pH occurred after addition of biogas manure, due to the buffering capacity of soil controlling the effect of organic acids produced as metabolites through decomposition of organic matter, as well as, such metabolites are further broken down in soil. All calculated values of relative change (RC, %) were negative where it's increased negatively with the increase of added biogas manure. These values ranged between – 0.27 and – 1.60 % compared with the untreated soil. Liberation of H^+ as result of biodegradation of organic manures leads to the formation of carbonic acid (H2CO3) which enhances the dissolution of insoluble compounds in soil. These findings are in agreement with those reported by Hati *et al*. (2007) and Odlare *et al*. (2011).

Table 4

Also, the data in Table (4) show slight and insignificant increase of soil salinity measured as EC (dS m^{-1}) as a result of the studied treatments, where the occurred increase was higher with the high additives of biogas manure. The calculated values of RC (%) for EC were ranged between 1.72 and 20.69 % compared with the control treatment. These increases were resulted from the dissolving effect of organic manures decomposition products specially H^+ for some insoluble compounds such as gypsum, calcium carbonate and others. Mohamad (2009) and Odlare *et al*. (2011) obtained on similar results.

C- Organic matter (OM).

The presented data in Table (4) showed that, except the treatments number 2 and 3, the soil content (%) of OM was increased with the increase of added biogas. The calculated RC (%) of OM varied from – 2.63 % with the treatment of 100 % mineral fertilizers to 7.89 % with 100 % biogas additives compared with the control treatment. The negative RC value of OM content in the mineral fertilizers treatment was resulted from the occurred decomposition of soil organic matter. Odlare *et al*. (2011) and Abou Hussien *et al.* (2012) obtained on similar results with many types of organic manures under different soil conditions.

D- Cation exchange capacity (CEC).

The studied fertilization treatments have a positive effect on soil CEC (cmol/kg), except the treatment of 100 % mineral fertilizers, where its increased from 42.10 to 43.25 cmol/kg corresponding RC values of 0.72 and 3.47 % over the control and unmanured soil. These findings were resulted from the high CEC of organic particles compared with that of mineral particles. Similar findings were reported by Mohamad (2009) and Abou Hussien *et al.* (2012).

E- Calcium carbonate (CaCO3).

Concerning the effect of the studied treatments on soil content (%) of CaCO3 it can be noticed that, the treatment of 100 % mineral fertilizers not have any effect on the soil content of CaCO3 (Table, 4), where RC value calculated for this treatment was 0.0 %. On the other hand, biogas manure additives resulted in a decrease of CaCO3 content, where the found decrease was increased at high rates of added biogas. The values of RC for CaCO3 (%) ranged from 0.00 to – 8.00 % compared with unfertilized soil. This decrease due to the dissolving effect of organic matter and its decomposition products specially H^+ and H2CO3 for CaCO3. In this respect, Sarker *et al*. (1996) and Bationo *et al*. (2007) obtained on similar results.

2- Soil Content of Available Nutrients:-

A- Available macronutrients.

The presented data in Table (5) show the soil content (mg/kg) of available N, P and K affected by the studied treatments. With the treatment of 100 % mineral fertilizers, the soil contents (mg/kg) of available P and K were decreased, where RC values for there nutrients were – 3.45 and – 1.48 compared with unfertilized soil, respectively. These decreases due to high amounts absorbed from these nutrients added in mineral or soluble form by plants and also other amounts leached to deeper layers of soil profile or transferred into unavailable forms. On the other hand, the same treatment was resulted in an increase of available N by 5.05 % over the control treatment. Biogas manure additives were associated by increase of soil content of available N, P and K, except at 25 % biogas manure treatment with both P and K. So, RC values for the content of available N, P and K in the soil treated by biogas manure were positive and ranged from 6.49 to 12.61 %, – 0.86 to 3.97 % and – 0.74 to 3.70 % for N, P and K in the biogas manure treatments compared with unfertilized soil, respectively. The content of available N have a high value of RC (%) compared with P and K at different biogas manure treatments. This may be resulted from the high content of N in the biogas manure compared with either of P or K (Table, 2). These findings are in agreement with those obtained by Lehmann *et al*. (2003); Darilek *et al*. (2009) and Abubaker (2012) under different soil conditions manure by different types of organic manures.

Table 5

B- Available micronutrients.

The soil content (mg/kg) of available Fe, Mn, Zn and Cu as affected by the studied treatments which recorded in Table (5) show that, with the treatments number 2 and 3 (100 and 75 % mineral fertilizers + 25 % biogas manure), the soil contents of the determined micronutrients were decreased. So, the values of RC for these micronutrients at the treatments 2 and 3 were negative. On the other hand, the soil contents of Fe, Mn, Zn and Cu in the treatments number 4, 5 and 6 (50, 75 and 100 % biogas manure) were increased by different rates varied from nutrient to another compared to the control treatment. The RC values for the content of Fe, Mn, Zn and Cu with the treatments number 4, 5 and 6 were ranged from 1.47 to 12.35, 2.11 to 7.37, 2.75 to 11.54 and 5.00 to 17.50 % over the control treatment, respectively. The increase effect of biogas manure on the soil content of available micronutrients was attributed to biogas manure considered as a good source for such these nutrients and this manure play a major role in the improve soil properties specially its effect on the decrease of soil pH. These findings are in agreement with those obtained by El–Shouny *et al.* (2008) and Abubaker (2012) under different soil conditions manure by different manures types.

3- Sweet Potato Growth and Yield:-

A- Vegetative growth parameters.

The presented data in Table (6) show some vegetative growth parameters of sweet potato and its relative change (RC, %) affected by the studied treatments. All vegetative growth parameters under study greater and wide affected by the fertilization treatments under study. These parameters were increased as a result of the experimental treatments. The high value of the fourth vegetative growth parameters were resulted from the treatment number 4 (50 % mineral fertilizers + 50 % biogas manure). All calculated values of RC for the measured vegetative growth parameters were positive, where these values were ranged from 8.33 to 100.00, 3.95 to 34.48, 10.56 to 38.92 and 25.87 to 100.70 % for number of branches/plant, stem length (cm), number of nodes/main stem and mean leaves on main stem with the treatments number 2 and 4 over the control treatment, respectively. The high response for the studied fertilization treatments was found with mean leaves on main stem followed by number of branches/plant and the lowest response was found with stem length (cm). This positive effect was resulted from the effect of added fertilizers on the improve soil properties and increase its content of available macro and micronutrients. Similar results were obtained by Sarker *et al*. (1996) and Ali *et al*. (2009).

B- Tuber roots parameters.

Regarding to the effect of the studied fertilization treatments on some tuber roots parameters of sweet potato recorded in Table (7), it may be noticed that, the measured tuber roots parameters. i. e. number of tuber roots/plant, tuber roots length (cm), tuber root diameter (cm) and weight of tuber root (gm) were increased significantly with all fertilization treatments under study. The high values of these four parameters were associated the treatment number 4 (50 % mineral fertilizers + 50 % biogas manure). Generally, increasing biogas manure additive resulted in more increase of the tuber roots parameters compared with that associated the increase of added mineral fertilizers. These increases were resulted from the enhancement of added fertilizers on plant growth and increase the activity of enzymatic activity and metabolize processes. All values of RC (%) calculated for the estimated tuber roots parameters were positive. The RC values for number of tuber roots/plant, tuber roots length, tuber root diameter and weight of tuber root ranged from 40.24 to 130.33, 8.96 to 23.11, 7.14 to 40.48 and 3.12 to 45.30 % over the control treatment, respectively. The high values of RC were associated the treatment number 4 (50 % mineral fertilizers + 50 % biogas manure) and the lowest ones were resulted from the treatment number 2 (100 % mineral fertilizers), except the control treatment. Also, the calculated RC values show that, the high response for the measured tuber roots parameters to the studied fertilization treatment was found with number of tuber roots/plant, followed by tuber roots length and the lowest one was recorded with weight of each tuber roots. Sarker *et al*. (1996) and Ali *et al*. (2009) obtained on similar results.

Table (6). Some vegetative growth parameters of sweet potato affected by the studied fertilization treatments and its relative change (RC) as a percent (%) of control data as mean values of two grown seasons.

Treatments	Number of branches/plant		Stem length (cm)		Number of nodes/main stem		Mean leaves on main stem	
	No.	RC (%)	(cm)	RC (%)	No.	RC (%)	No.	RC (%)
1	12		210.00		34.67		14.30	
2	13	8.33	218.30	3.95	38.33	10.56	18.00	25.87
3	18	50.00	236.60	12.67	43.00	24.03	21.30	48.95
4	24	100.00	282.40	34.48	49.33	38.92	28.70	100.70
5	20	66.67	254.00	20.95	47.67	37.50	26.70	86.71
6	19	58.33	246.70	17.48	46.67	34.61	23.00	60.84
LSD at 5% level	1.747		9.029		3.002		2.065	

Table (7). Some tuber roots parameters of sweet potato affected by the studied fertilization treatments and its relative change (RC) as a percent (%) of control data as mean values of two grown seasons.

Treatments	Number of tuber roots/plant.		Average of tuber root length		Average of tuber root diameter		Average weight of tuber root	
	No.	RC (%)	(cm)	RC (%)	(cm)	RC (%)	(gm)	RC (%)
1	3.33		21.20		4.20		426.70	
2	4.67	40.24	23.10	8.96	4.50	7.14	440.00	3.12
3	5.33	60.06	23.30	9.91	4.80	14.29	470.00	10.15
4	7.67	130.33	26.10	23.11	5.90	40.48	620.00	45.30
5	7.00	110.21	25.40	19.81	5.30	26.19	573.30	34.36
6	5.67	70.27	24.30	14.62	5.30	26.19	566.70	32.81
LSD at 5 % level	0.6354		0.3639		0.1286		16.4300	

C- Sweet potato (straw and tuber roots) yield.

The determined sweet potato yield parameters recorded in Table (8) appeared a wide variations in their affected by fertilization treatments under study (Table, 8). For example, the high straw yield (kg/plant) was associated to the treatment number 4 (50 % mineral fertilizers + 50 % biogas manure), where the high dry yield of tuber roots as a percentage (%) of fresh weight was resulted from the treatment number 6 (100 % biogas manure). The yield of fresh tuber roots/plant and its response to fertilization treatments under study were lower than those for straw fresh yield (kg/plant). This trend was more clearly in the treatments having high application percent of mineral fertilizers. Also this trend means that, biogas manure additives were associated by increase of tuber roots yield and also increased the dry yield of tuber roots as a percent (%) of fresh weight. Except the dry yield of tuber roots, the high yields of other parameters were found with the fertilization treatment number 4 (50 % mineral fertilizers + 50 % biogas manure). The values of RC (%) of the determined five yield parameters as affected by fertilization treatments under study were positive. At the same fertilization treatments and according to the RC (%) values, the determined yield parameters take the order : straw fresh yield (kg/plant) > biologically yield (kg/plant) > tuber roots fresh yield (ton/feddan) > tuber roots fresh yield (kg/plant) > tuber roots dry yield as a percent (%) of fresh yield. These findings are in agreement with those obtained by Woolfe (1992) and Ali *et al*. (2009).

D- Chemical composition of tuber roots.

The tuber roots content of total carbohydrates (%), total sugar (%), carotein (mg/100g) and vitamin C (mg/100g) present in Table (9) reveals that, these four determinations were increased significantly as resulted for fertilization treatments under study, where the high contents of these determinations were resulted from the treatment number 6, except the content of total carbohydrates. Also, these determinations were more response for biogas manure additives than those of mineral fertilizers applications. This trend was attributed to the improve effect of added biogas manure on soil properties and increased nutrients availability associated with high uptake of these nutrients. So, all values of RC (%) for these four determinations were positive. The high values of RC for the contents of total sugar, carotein and vitamin C were recorded with the treatment of 100 % biogas manure, except that of the content of total carbohydrates which was found with the treatment of 50 % mineral fertilizers + 50 % biogas manure. Also, the calculated values of RC reveal that, the content of total sugar followed by the content of vitamin C appeared high response to biogas manure additives and the lowest response was found with the content of total carbohydrates. The data in this respect show that, biogas manure additives improved the tuber roots quality. These findings are in agreement with those obtained by Woolfe (1992) and Ali *et al*. (2009).

E- Mineral composition of tuber roots.

The presented data in Table (10) show the tuber roots content (%) of N, P, K and protein and their relative changes (RC, %) affected by the fertilization treatments under evaluation: These data show that, the high contents (%) of both N and protein and their RC (%) were associated the treatment number 2 (100 % mineral fertilizers) which attributed to the high available amounts of N and its uptake by plant with this treatment. On the other hand, the high contents of P and K and their RC (%) were resulted from the treatment number 6 (100 % biogas manure), where this treatment resulted in an increase of P and K availability. Similar results were obtained by Sarker *et al*. (1996) and Ali *et al*. (2009).

Table (8). Yield parameters of straw and tuber roots of sweet potato affected by the studied treatments and its relative change (RC %) of control data as mean values of two grown seasons.

Treatments	Straw fresh yield/plant		Total yield of tuber roots/plant (kg.)		Biological fresh yield/plant (kg)		Total yield of tuber roots/ feddan (ton)		Tuber roots dry yield	
	(kg)	RC (%)	(kg)	RC (%)	(kg)	RC (%)	(ton)	RC (%)	(%)	RC (%)
1	0.60		1.15		1.75		10.25		22.30	
2	1.57	161.67	1.28	11.30	2.85	62.86	19.59	91.12	25.30	13.45
3	1.68	180.00	1.37	19.13	3.05	74.29	20.55	100.49	26.25	17.71
4	3.30	450.00	2.28	98.26	5.58	218.86	26.05	154.15	28.75	28.92
5	2.35	291.67	1.60	39.13	3.95	125.71	22.13	115.90	30.11	35.02
6	2.30	283.33	1.47	27.83	3.77	115.43	20.75	102.44	32.75	46.86
LSD at 5 % level	0.115		0.081		0.100		0.141		0.115	

Table (9). Chemical composition of sweet potato tuber roots as affected by the studied fertilization treatments and its relative change (RC %) of control data as mean values of the two grown seasons.

Treatments	Total carbohydrate %		Total sugar %		Carotein content mg/100 g fresh weigh*		Vitamin C content mg/100 g fresh weigh *	
	(%)	RC (%)	(%)	RC (%)	(mg)	RC (%)	(mg)	RC (%)
1	70.43		2.42		8.41		26.50	
2	77.50	10.04	2.85	17.77	12.03	43.04	31.85	20.19
3	80.23	13.91	3.70	52.89	13.34	58.60	33.67	27.06
4	86.40	22.67	3.90	61.16	16.70	98.60	38.13	43.89
5	84.75	20.33	4.70	94.21	18.30	117.60	39.50	49.06
6	82.18	16.68	4.80	98.35	20.14	139.50	40.40	52.45
LSD at 5 % level	0.9312		1.3160		1.612		0.8357	

* Based on fresh weight

Table (10). Nitrogen, P, K and protein content of sweet potato tuber roots as affected by the studied fertilization treatments and its relative change (RC) as a percent (%) of control data as mean values of the two grown seasons.

Treatments	N.		P		K		Protein	
	(%)	RC (%)	(%)	RC (%)	(%)	RC (%)	(%)	RC (%)
1	0.85		0.65		2.10		4.89	
2	2.80	229.41	0.72	10.77	2.75	30.95	16.10	229.24
3	2.15	152.94	0.77	18.46	2.85	35.71	12.36	152.76
4	2.15	152.94	0.79	21.54	2.99	42.38	12.36	152.76
5	2.08	144.71	0.84	29.23	3.18	51.43	11.96	144.58
6	2.04	140.00	0.87	33.85	3.40	61.90	11.73	139.88
LSD at 5 % level	0.1522		0.0182		0.0814		0.8416	

CONCLUSION

Based on the obtained results and its discussion may be concluded that, biogas manure has good beneficial effects on soil physical and chemical properties and its content of available nutrients compared with mineral fertilizers. Sweet potato growth, yield and quality appeared high response to fertilization treatments, where the response to biogas manure additives was higher than that associated the mineral fertilization.

REFERENCES

Abou Hussien, E. A., Y. B. El–Koumey, F. S. El–Shafiey and H. M. Gohar (2012). Effect of composted plant residues on newly reclaimed soils properties and its productivity. Minufiya J. Agric. Res. 37 (1): 231 –245.

Abubaker, J. (2012). Effects of fertilization with biogas residues on crop yield, soil microbiology and greenhouse gas emissions. Ph. D. Thesis, Fac. of Agric. Natural Resources and Agricultural Sciences, Swedish Univ.

Alaam, M. N. E. (2001). Water and Agricultural Land in Egypt, The Past, The Present and The Future, Academic Bookshop, Cairo, Egypt.

Albihn, A. (2002). Recycling bio-waste–human and animal health problems. Acta Veterinaria Scandinavica, 43 (1): 69 – 75.

Ali, M. R., D. J. Costa, M. J. Abedin, M. A. Sayed and N. C. Basak (2009). Effect of fertilizer and variety on the yield of sweet potato Bangladesh J. Agric. Res. 34 (3) 473 – 480.

Anonymous, S. (1997). "Fertilizer Recommendation Guide". Bangladesh Agricultural Research Council, Farm gate, New Airport Road, Dhaka-1215. p. 22.

A.O.A.C. (1975). Association of Official Agriculture Chemists. Official Methods Analysis 12th Ed. Washington, D. C.

A.O.A.C. (1985). Association of Official Agriculture Chemists. Official Methods Analysis 14th Ed. Washington, D. C.

Balba, A. M. (1995). "Management of Problem Soils in Arid Ecosystems". Txt. Bk., Congress Cataloging Libr., p. 115.

Bationo, A., J. Kihara, B. Vanlauwe, B. Waswa and J. Kimetu (2007). Soil organic carbon dynamics, functions and management in West African agro–ecosystems. Agricultural Systems, 94 (1): 13 – 25.

Ciarlo, E., M. Conti, N. Bartoloni and G. Rubio (2007). The effect of moisture on nitrous oxide emissions from soil and the $N_2O/(N_2O + N_2)$ ratio under laboratory conditions. Biology and Fertility of Soils, 43 (6): 675 – 681.

Cottenie, A., M. Verloo, L. Kiekens, G. Velghe and R. Camerlynck (1982). "Chemical Analysis of Plants and Soils". Laboratory of Analytical and Agro-chemistry State Univ., Ghent, Belgium.

Darilek, J. L., B. Huang, Z. Wang, Y. Qi, Y. Zhao, W. Sun and X. Shi (2009). Changes in soil fertility parameters and the environmental effects in a rapidly developing region of China. Agriculture, Ecosystems and Environment, 129 (1–3): 286 – 292.

Dick, R. P. (1992). A review: Long–term effects of agricultural systems on soil biochemical and microbial parameters. Agriculture, Ecosystems and Environment, 40 (1 – 4): 25 – 36.

Dubois, M., M. A. Gilles, J. Hamilton, R. Robbers and F. Smith (1956). Colorimetric method for determination of sugars and related substances. Anal. Chem., 28:350 – 356.

Duncan, C. (1996). "Basic Statistics for Social Research": Step by step calculations and computer techniques using minitab. Electronic book, Edition 1. New York 10001. United States of America.

El–Sedfy, O. F. (2008). Effect of organic fertilizers and irrigation regime of nutrient availability and soybean productivity. Minufiya J. Agric. Res., 33 (1): 181–194.

El–Shouny, M. M., S. A. Shikha and M. Abd El–Warth (2008). Impact of farmyard manure and superphosphate on some soil properties and its productivity of wheat. Minufiya J. Agric. Res., 33 (5): 1249 – 1267.

Grag, R. N., H. Pathak, D. K. Das and R. K. Tomar (2005). Use of flyash and biogas slurry for improving wheat yield and physical properties of soil. Environmental Monitoring and Assessment, 107: 1– 9.

Hati, K.M., A. Swarup, A.K. Dwivedi, A.K. Misra and K.K. Bandyopadhyay (2007). Changes in soil physical properties and organic carbon status at the topsoil horizon of a vertisol of central India after 28 years of continuous cropping, fertilization and manuring. Agriculture, Ecosystems and Environment, 119 (1– 2): 127 – 134.

Jackson, M. L. (1973). "Soil Chemical Analysis". Prentice Hall of Indian Private Limited. New Delhi.

Kim, H. T. (1996). "Soil Sampling, Preparation and Analysis". Marcel Dekker Inc., New York, p. 391.

Lehmann, J., S. J. Pereira, C. Steiner, T. Z. W. Nehls and B. Glaser (2003). Nutrient availability and leaching in an archaeological Anthrosol and a Ferralsol of the Central Amazon basin: Fertilizer, manure and charcoal amendments. Plant and Soil, 249 (2): 343 – 357.

Marinari, S., G. Masciandaro, B. Ceccanti and S. Grego (2000). Influence of organic and mineral fertilizers on soil biological and physical properties. Bioresource Technology, 72 (1): 9 – 17.

Mohamad, M. A.H. (2009). Effect of organic and chemical amendments on soil properties and yield production. Ph. D. Thesis, Fac. of Agric. Minufiya Univ.

Morrison, T. A., R. Pressey and S. J. Kaks (1993). Changes in Alpha and Beta amylase during storage of sweet potato lines with varying starch hydrolysis potential. J. Amer. Soc. Hort. Sci., 118: 236 – 242.

Odlare, M., V. Arthurson, M. Pell, K. Svensson, E. Nehrenheim and J. Abubaker (2011). Land application of organic waste - Effects on the soil ecosystem. Applied Energy, 88 (6): 2210 – 2218.

Page, A. L., R. H. Miller and D. R. Keeney (1982). "Methods of Soil Analysis". II. Chemical and Microbiogical Properties 2nd Ed. Madison, Wisconsin, U.S.A.

Salem, A.A., S.M. El–Gamal and M.K. Hatem (2009). Effect of irrigation water salinity levels on growth, chemical composition and yield of some new sweet potato cultivars which there is true seeds. Arab Univ., J. Agric. Sci., Ain Shams Univ., Cairo, 17 (1): 137 – 150.

Sarker, N.I., S. Jaman, M.S. Islam, A. Bari and T.M. Shamsuddin (1996). Effect of chemical fertilizers and organic manure on the growth and yield of potato in Non– Calcareous Grey Flood Plain Soil. Progress. Agric., 7 (1): 63– 68.

Witham, F. H., D. F. Blaydes and P. M. Devlin (1971). " Experiments in Plant Physiology ". Pp. 55 – 58 Van Nosland Reinhold Co., New York.

Woolfe, J. A. (1992). "Sweet Potato an Untapped Food Resource". Pp. 1-13. Published in Collabora – Cambridge University Press, New York.

تأثير الإحلال الجزئي للأسمدة المعدنية بسماد البيوجاز علي خواص الأرض وإنتاجية نبات البطاطا

محمد عبد الفتاح حسن محمد و منال فتحي عبد السلام طنطاوي

معهد بحوث الأراضي و المياه و البيئة – مركز البحوث الزراعية – الجيزة – مصر

الملخص العربي

أجريت تجربة حقلية بالمزرعة البحثية بمحطة بحوث البساتين بالقناطر الخيرية – معهد بحوث البساتين – مركز البحوث الزراعية وذلك خلال موسمي نمو متتاليين لدراسة تأثير الإحلال الجزئي للأسمدة المعدنية بسماد البيوجاز

علي الخواص الطبيعية والكيميائية للأرض وكذلك محتواها من المغذيات الكبري والصغرى الميسرة. كما تم تقدير العديد من مقاييس النمو الخضري والدرنات وكذلك المحصول والتركيب الكيميائي والتركيب المعدني للبطاطا.

وأوضحت النتائج المتحصل عليها الآتي:-

أدت زيادة المضاف من البيوجاز إلي نقص في الكثافة الظاهرية للأرض ورقم الحموضة وكذلك المحتوي من كربونات الكالسيوم، بينما إزدادت المسامية الكلية بالأرض وقيمة التوصيل الكهربي والسعة التبادلية الكاتيونية وكذلك المحتوي من المادة العضوية والمحتوي من المغذيات الكبري والصغرى الميسرة بإستثناء النيتروجين الميسر الذي زاد بزيادة المضاف من النيتروجين المعدني. وكذلك فقد كانت أعلي القيم لكل من القياسات الخضرية والدرنات ومحصول البطاطا مصاحبة للمعاملة ٥٠ ٪ أسمدة معدنية + ٥٠ ٪ بيوجاز. كما أنه وبإستثناء المحتوي الكلي من النيتروجين والبروتين فإن محتوي الدرنات من الكربوهيدرات الكلية والسكريات الكلية والكاروتين وفيتامين ج والفوسفور والبوتاسيوم قد إزدادت بزيادة المضاف من البيوجاز.

وتوصي الدراسة بأهمية إستخدام البيوجاز وإضافته للأرض كمحسن ومخصب حيث أنه يحسن في معظم خواص الأرض ويزيد خصوبتها وبالتالي يؤدي إلي زيادة إنتاجيتها من المحاصيل. وتعتبر إضافته بنسبة ٥٠ ٪ مع 50 % من الإحتياجات السمادية لنباتات البطاطا من أفضل معدلات الإضافة.

Table (4): Effect of the studied treatments on some physical and chemical properties of soil and its relative change (RC* %) of control data (mean values in the two grown seasons).

Treatments	Bulk density		Total porosity		pH, 1: 2.5 (soil water) susp.		EC (soil extract)		O.M.		CEC		$CaCO_3$	
	mg/m^3	RC (%)	%	RC (%)	pH	RC (%)	dS/m	RC (%)	%	RC (%)	Cmol	RC (%)	%	RC (%)
1	1.31		50.57		7.50		0.58		1.90		41.80		2.50	
2	1.31	0.00	50.27	0.00	7.48	-0.27	0.59	1.72	1.85	-2.63	41.80	0.00	2.50	0.00
3	1.29	-1.53	51.32	1.48	7.47	-0.40	0.61	5.17	1.90	0.00	42.10	0.72	2.46	-1.60
4	1.26	-3.82	52.45	3.72	7.45	-0.67	0.64	10.34	1.95	2.63	42.62	1.96	2.40	-4.00
5	1.25	-4.58	52.83	4.47	7.40	-1.33	0.66	13.79	1.98	4.21	42.95	2.75	2.35	-6.00
6	1.24	-5.34	53.21	5.22	7.38	-1.60	0.70	20.69	2.05	7.89	43.25	3.47	2.30	-8.00
L.S.D at 5 % level	0.02		0.06		0.018		0.019		0.02		0.0117		0.021	

$$RC^*(\%) = \frac{\text{the values of treated soil – the value of untreated soil}}{\text{The value of the untreated soil}} \times 100$$

Table (5): Effect of the studied treatments on the soil content (mg/kg) of available macro and micronutrients and its relative change (RC %) of control data (mean values in the two grown seasons).

Treatments	Available macronutrients						Available micronutrients							
	N		P		K		Fe		Mn		Zn		Cu	
	mg/kg	RC (%)	mg/kg	RC (%)	mg/kg	RC (%)	mg/kg	RC (%)	mg/kg	RC (%)	mg/kg	RC (%)	mg/kg	RC (%)
1	55.50		5.80		675.00		3.40		4.75		1.82		0.80	
2	58.30	5.05	5.60	-3.45	665.00	-1.48	3.20	-5.88	4.50	-5.26	1.65	-9.34	0.72	-10.00
3	59.10	6.49	5.75	-0.86	670.00	-0.74	3.28	-3.53	4.70	-1.05	1.78	-2.20	0.75	-6.25
4	60.42	8.86	5.90	1.72	682.00	1.04	3.45	1.47	4.85	2.11	1.87	2.75	0.84	5.00
5	61.10	10.18	5.98	3.10	695.00	2.96	3.70	8.82	5.03	5.89	1.95	7.14	0.90	12.50
6	62.50	12.61	6.03	3.97	700.00	3.70	3.82	12.35	5.10	7.37	2.03	11.54	0.94	17.50
L.S.D at 5% level	0.1627		0.3986		4.9490		0.0575		0.0603		0.0182		0.0199	