Effect of applying filter cake and biogas manures on improving some desertic soil properties and their implications on plants grown thereon. II. Implications on plant growth

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ABSTRACT

The present investigation aims at studying the implications of applying biogas manure and filter cake **(Filter mud)** as a natural soil amendments on barely plant grown on desertic soils. Two surface soil samples (0 - 30 cm) differed in their texture and calcium carbonate content were collected from El-Hammam region, north-western coast of Egypt. A pot experiment was carried out at the greenhouse of Soils and Water Department, Faculty of Agriculture, Benha University, Egypt, using perforated PVC pots of 5 kg capacity. Biogas manure and filter cake (filter mud) were added at a rate of 0, 1, and 2 % (w/w) and thoroughly mixed with the soil and incubated for two months at moisture equivalent to field capacity. Barely plant **(*Hordum vulgare* cv. Giza 123)** was used as an indicator plant. Ten grains were planted in each pot. Irrigation was done using tap water so as to reach the water holding capacity of the soil. After complete germination plants were thinned to 5 per pot. Macronutrients; N, P and K were added to all pots according to the rates recommended by the Ministry of Agriculture. The experimental design was factorial randomized complete block design with two factors in three replicates. At maturity, the number of tillers and spikes and plant height were recorded. Plants were harvested and separated into grains and straw and analyzed for N, P and K. The obtained results show that:

The number of tillers and of spikes per pot significantly increased with increasing the rate of application of both amendments from R0 up to R2, whereas plant height (cm) significantly and progressively decreased with the rate. Filter cake was more efficient than biogas manure in this respect.

Application of biogas manure and filter cake significantly and progressively increased straw and grain yields in the sandy loam soil (S1), whereas significantly and progressively increased straw yield and decreased grain yield in the loamy sand soil (S2) and there was significant difference between biogas manure and filter cake in this respect. Application of biogas manure and filter cake significantly and progressively increased N, P and K uptake in barley straw with increasing the rate of application and there was significant difference between the two amendments in this respect. Nutrients uptake in barley grains significantly and progressively increased with increasing the rate of the applied amendment except for N uptake in grains of barley plants grown on the loamy sand soil (S2), where it decreased with increasing the application rate. In the case of the sandy loam soil (S1), biogas manure was more efficient than filter cake in increasing nutrients uptake in barley grains except for P uptake where filter cake was more efficient than biogas manure in this respect. In the case of the loamy sand soil (S2) biogas manure, also, was more efficient than filter cake in increasing P and K uptake in barley grains, whereas, both amendments decreased N uptake compared with R0 (non application of amendment) and the decrease was higher with the application of filter cake than with the application of the biogas manure. In conclusion the effect of the applied amendments on barley growth parameters, yield and nutrients uptake depends on the chemical properties and the rate of the applied amendment, and the soil characteristics developed upon the application of the organic amendment.

Keyword: Biogas manure, filter cake, calcareous soil, sandy soil, physical properties, chemical properties, barley plants.

Introduction

Land is the major permanent renewable resource and faces the greatest threat of degradation which in turn lead to the desertification of land The United Nations Convention to Combat Desertification **(UNCCD, 1994 and Gad and Abdel-Samie, 2000)** defined desertification as land degradation in arid, semiarid and dry sub humid areas resulting from climatic variations and anthropogenic activities. Desertification has effect on the soil organic carbon (SOC) **(Abubakar and Eniolorunda, 2016)**. Generally, arid soils have poor quality due to very low levels of soil organic matter **(Ravi etal., 2010)**. Desert reclamation and cultivation is one of the priorities to compensate for the loss of agricultural land in Egypt **(Aldabaa *et al*., 2010).**

For the urgent need to meet food and dress demands in Egypt, more desert areas either sandy or calcareous have to be put under cultivation. Such soils are poor with respect to their nutritional status.

Sandy soils are mainly infertile with poor physical chemical properties and require addition of organic manure **(Foth, 1990 and Campbell et al., 2002)** to improve their fertility. The productivity of sandy soils is mostly limited by their low capacity of retaining

water and nutrients due to excessive deep percolation losses, which reduce the efficiency of water and fertilizer use by plants. Organic manure increases structural stability and water retention of sandy soils **(Nyamangara et al., 2001)**. Thus, soil conditioners have been recommended to be effective tools for increasing water holding capacity, reducing infiltration rate and cumulative evaporation and improving water conservation of sandy soils. In Egypt, improving sandy soils is considered as an important part of the agricultural security program. Sandy soils represent about 90% of the Egyptian soils. Such soils represent a great hope for the agriculture expansion.

Calcareous soils cover more than 30% of the earth's surface and their $CaCO_3$ content varies from a few percent to 95% **(Balba, 1989)**. Calcareous soils occur naturally in arid and semi-arid zones as well as in humid and semi-humid zones particularly where their parent materials is rich in $CaCO_3$ **(Brady, 1990).** Organic and mineral soil amendments are soil improving agents. Among the natural soil conditioners, which have been used in Egypt for reclamation of sandy and sandy calcareous soils are organic manures and composts.

Organic and inorganic soil amendments are commonly added to soil for improving its physical and chemical characteristics which promote plant growth. Soil physical and chemical characteristics are affected by soil amendments and production system **(Tejada and Gonzalez, 2004 and Aksakal et al., 2012))**. Thus, the organic soil amendments are usually mixed with soil to provide the optimal physical and chemical environment to the growing plants **(Yangyuoru et al., 2006)**.

According to **El-Banna et al. (2011),** barley is the most appropriate choice in Egypt for the risky conditions such as in poor soils and in newly reclaimed areas, which suffer from water shortage and water quality. Barley (*Hordeum vulgare* L.) is the main crop grown in a large scale in the north coastal region of Egypt and also in the newly reclaimed lands with saline soils and shortage of fresh water. Barley production area increased in the new reclaimed lands under different irrigation systems. Thus, the main objective of the current study was to investigate the implications of applying biogas manure and filter cake as a natural organic amendments to desertic soils differed in their texture and calcium carbonate content on barley plant growth parameters, yield and nutrients and uptake.

Materials and Methods

A pot experiment was carried out under the greenhouse conditions at soils and water department, Faculty of Agricultural, Benha University during the winter season of 2015-2016 to assess the effect of applying the filter cake and biogas manure, as a natural soil amendments on barley plants grown on desertic soils. Two surface soil samples (0 - 30 cm) differed in their texture and calcium carbonate content, were collected from El-Hammam region, north-western coast of Egypt located between latitudes 30° 45′ - 31° 00′ N and longitudes 28° 30′ 29° 00′ E.

The collected soil samples were air dried, crushed and sieved to pass through a 2 mm sieve. Physical and chemical properties of the studied soils **(Table 1)** were determined according to the methods cited by **Klute (1986) and Page *et al*. (1982).**

Table 1. Physical and chemical properties of the studied soils .

Property	Soil 1	Soil 2
Particle size distribution		
C. Sand (%)	27.87	30.40
F. Sand (%)	37.43	48.60
Silt (%)	30.65	14.00
Clay (%)	4.05	7.00
Soil texture *	**Sandy loam**	**Loamy sand**
Saturation percentage (%)	47.90	30.60
Field capacity (%)	24.41	5.49
Wilting point (%)	2.76	0.33
Available water (%)	21.65	5.16
Bulk density (Mg m^{-3})	1.24	1.59
Hydraulic conductivity (cm h^{-1})	0.99	1.11
OM (g kg^{-1})	24.81	32.12
CEC ($cmmol_c$ kg $soil^{-1}$)	34.68	25.10
Ca CO_3 (g kg^{-1})	327.00	291.00
pH	7.80	7.70
EC (dS m^{-1})	12.70	1.00
Soluble ions ($mmol_c$ L^{-1}) (in Saturated soil paste extract)		
HCO_3^-	6.89	3.30
CO_3^{2-}	0.00	0.00

Cl^-	63.63	3.13
SO_4^{2-}	56.16	3.85
Ca^{2+}	36.61	5.88
Mg^{2+}	21.76	2.30
Na^+	65.35	1.66
K^+	2.96	0.44
Available nutrients (mg kg^{-1})		
Available N	129.5	66.5
Available P	11.26	11.90
Available K	688.00	526.00

pH and EC: were measured in the saturated soil paste extract and SO_4^{2-}: was calculated by the difference between the sum of cations and the sum of anions .

*** According to international soil texture triangle.**

The greenhouse experiment:

Perforated PVC pots with dimensions of 10 cm depth and 25 cm diameter, and a capacity of 5 kg were used in the current study. Each pot was uniformly packed with 5 kg of soil. Biogas manure and filter cake and were added at a rate of 0, 1, and 2 % and thoroughly mixed with the soil and incubated for two months at moisture content equivalent to field capacity. Chemical and physical properties of the organic amendments used in the current study are shown in **Table 2**. Barely plant **(*Hordum vulgare* cv. Giza 123)** was used as a test plant. Ten grains were planted in each pot on November 1st 2015. Macronutrients, N, P and K were added to all pots according to the recommended rates of the Egyptian Ministry of Agriculture. Irrigation was done with tap water so as to reach water holding capacity of the soil (about field capacity). After complete germination plants were thinned to 5 per pot.

Table 2. Chemical and physical properties of the organic amendments used in the current study.

Properties	**Biogas manure**	**Filter cake**
Moisture content (%)	19.1	9.65
Bulk density (Mg m^{-3})	410.00	0.27
pH at (1:10 suspension)	7.80	6.60
EC (dS m^{-1}) at (1:10 suspension)	5.50	4.30
$CaCO_3$ (g kg^{-1})	80.00	115.00
CEC ($mmol_c$ kg^{-1})	155.94	451.39
Organic carbon (g kg^{-1})	28.29	17.67
Organic matter (g kg^{-1})	49.00	30.39
Total nitrogen (g kg^{-1})	1.90	2.8
C: N ratio	15 : 1	6.31 : 1
Total P (g kg^{-1})	11.50	18.40
Total K (g kg^{-1})	8.00	10.50

*Filter cake or mud is one of the waste materials available from the industries of sugar can, composted and used as natural organic amendment.

Fertilization:

N was added at 200 mg N kg^{-1}, while P and K were added at 15 and 50 mg $kg^{-1,}$ respectively. Fertilizer sources were ammonium sulphate, calcium superphosphate and potassium sulphate. N was added in 3 doses (20% at sowing, 40 % with the first irrigation and 40 % with the second irrigation), while P and K were added during soil preparation, immediately before seeding.

The experimental design was factorial randomized complete block design with two factors in three replicates as follows:

Factor A : Organic amendment (O), two organic amendments as follows:

(i) Biogas manure **(O_1)**

(ii) Filter cake (Filter mud) **(O_2).**

Factor B: Rate of application (R), three rates as follows:

i. **R_0 :** No application of amendment
ii. **R_1** 1 % organic amendment (w/w)
iii. **R_2** 2 % organic amendment (w/w)

At maturity, plant height, the number of tillers and spikes were recorded, then, plants were harvested and separated into grains and straw, oven dried at 70 °C for 24 hours and the dry weight was recorded.

Plant analysis:

Plant materials were dried at 70 °C for 24 hours then samples (0.5 gram) were ground and wet digested by a concentrated H_2SO_4 and $HClO_4$ mixture, and diluted to 100 ml volume. Digests were subjected to N, P and K determination. N by the Kyldahel method,

K by flame photometer and P by the colormetric method **(Murphy and Riley, 1962)** modified by **He and Honeycutt (2005)**.

Results and discussion

Effect on growth parameters:

Results in Tables 3a, 3b and 3c show the effect of application of the studied organic amendments on barley plant growth parameters.

The main effect of the rate (Table 3a , 3b and 3c) show that application of organic manure and filter cake significantly increased the number of tillers and the number of spikes per pot with increasing the rate of application from R0 up to R2, whereas significantly decreased plant height (cm). The decrease in plant height could be attributed to the increase in soil salinity upon the application of the studied amendments. This pattern of response occurred in both of the two studied soils.

The main effect of the organic amendment show that filter cake was significantly more efficient than the biogas manure in increasing the number of tillers and the number of spikes and resulted in higher plant height compared with biogas manure in the two soils. The higher efficiency of filter cake, in increasing the growth parameters of barely plants could be attributed to its high content of nutrients compared with the biogas manure.

There was an interaction effect between the kind of the organic amendment and the rate of application on the number of tillers, number of spikes and plant height. In the case of number of tillers, application of filter cake to the sandy loam soil (S1) resulted in number of tillers at R1 and R2 higher than that obtained due to the application of biogas manure at the same rates whereas, application of filter cake to the loamy sand soil (S2) resulted in number of tillers at R1 higher than that obtained with the application of biogas manure. At R2 of application the biogas manure was more efficient than filter cake in increasing the number of tillers. Concerning the interaction effect on the number of spikes and plant height, results show that application of biogas manure to the sandy loam soil (S1) gave number of spikes at R1 equal to that obtained at R2 and the lowest plant height at R2 of application, whereas, application of filter cake to the same soil gave the highest number of spikes and the lowest plant height at R2 of application.

Table 3. Effect of application of biogas manure and filter cake as a natural organic amendments on some growth parameters of barley plants grown on a desertic soils.

a: Numbers of tillers.

Organic amendment (O)	No. of tillers							
	Soil (1)				Soil (2)			
	Rates of addition (R)							
	R_0	R_1	R_2	Mean	R_0	R_1	R_2	Mean
O_1	7.00	13.00	15.00	**11.66**	5.33	8.67	11.33	**8.44**
O_2	7.00	15.67	19.00	**13.89**	5.33	10.67	10.00	**8.67**
Mean	**7.00**	**14.34**	**17.00**		**5.33**	**9.67**	**10.66**	
LSD at 5%	**O = 0.17 R = 0.21 O x R =1.41**				**O = 0.18 R = 0.71 O x R = 0.41**			

O_1 = biogas manure; O_2= Filter cake; R_0= 0 % ; R_1 = 1% ; R_2 = 2%; S1= sandy loam; S2= Loamy sand

b: Number of spikes

Organic amendment (O)	Number of spikes							
	Soil (1)				Soil (2)			
	Rates of addition (R)							
	R_0	R_1	R_2	Mean	R_0	R_1	R_2	Mean
O_1	5.33	6.67	9.00	**7.00**	4.67	6.00	6.33	**5.67**
O_2	5.33	9.67	9.67	**8.22**	4.67	6.33	7.00	**6.00**
Mean	**5.33**	**8.17**	**9.33**		**4.67**	**6.02**	**6.67**	
LSD at 5%	**O = 0.12 R = 0.15 O x R = 0.26**				**O = 0.13 R = 0.29 O x R = n.s**			

See footnotes of Table 3a.

c: Plant height

Organic amendment (O)	Plant height (cm)							
	Soil (1)				Soil (2)			
	Rates of addition (R)							
	R_0	R_1	R_2	Mean	R_0	R_1	R_2	Mean
O_1	56.00	48.00	47.67	**50.56**	57.33	53.67	49.33	**53.44**
O_2	56.00	51.00	46.67	**51.22**	57.33	51.33	52.67	**53.78**
Mean	**56.00**	**49.50**	**47.17**		**57.33**	**52.50**	**51.00**	
LSD at 5%	**O = 0.42 R = 0.52 O x R = 0.89**				**O = 0.30 R = 1.01 O x R = 0.90**			

See footnotes of Table 3a.

Effect on barely plant yield:

Results in Tables 4a and 4b show the effect of application of biogas manure and filter cake at increasing rate on straw and grain yields of barley plants grown on the studied soils. The main effect of the rate of application show that application of biogas manure and filter cake to the two studied soils significantly increased straw and grain yields in the sandy loam soil (S1) whereas significantly increased straw yield and decreased grain yield in the loamy sand soil (S2). The increase in the straw yield could be attributed to the increase in plant height which would be reflected on the straw yield.

The main effect of the applied organic amendments show that there was significant difference between biogas manure and filter cake in increasing straw and grain yields in the studied soils. In the sandy loam soil (S1), filter cake gave straw yield higher than that obtained due to the application of biogas manure, and visa versa occurred with the grain yield. In case of the loamy sand soil (S2), application of biogas manure gave straw and grain yields higher than those obtained due to the application of filter cake.

There was an interaction effect between the kind of amendment and the rate of application on the straw and grain yields in both of the studied soils. In the sandy loam soil (S1), application of filter cake gave the highest straw yield at R2 whereas gave the highest grain yield at R1, and visa versa occurred with the application of biogas manure. In the case of the loamy sand soil (S2) application of biogas manure gave the highest straw and grain yields at R1. On the other hand, application of filter cake gave the highest straw yield at R1 and the highest grain yield at R2 of application. The decrease in grain yield due to the application of both amendments at increased rate, compared with R0 (no application of amendments) could be attributed to the increase in soil salinity upon their application.

Table 4. Effect of application of biogas manure and filter cake as a natural organic amendments on the straw and grain yields (g Pot^{-1}) of barley plants grown on a desertic soils.

a : Straw yield

Organic amendment (O)	Straw yield (g Pot^{-1})							
	Soil (1)				Soil (2)			
	Rates of addition (R)							
	R_0	R_1	R_2	Mean	R_0	R_1	R_2	Mean
O_1	10.60	15.17	15.03	**13.60**	10.68	12.13	11.17	**11.32**
O_2	10.60	15.00	17.57	**14.39**	10.68	11.36	11.22	**11.09**
Mean	**10.60**	**15.08**	**16.30**		**10.68**	**11.75**	**11.19**	
LSD at 5%	**O = 0.30**	**R = 0.37**	**O x R = 0.64**		**O = 0.22**	**R = 0.34**	**O x R = 0.56**	

See footnotes of Table 3a.

b. Grain yield

Organic amendment (O)	Grain yield (g Pot^{-1})							
	Soil (1)				Soil (2)			
	Rates of addition (R)							
	R_0	R_1	R_2	Mean	R_0	R_1	R_2	Mean
O_1	7.81	10.48	11.59	**9.96**	10.05	9.84	9.07	**9.65**
O_2	7.81	10.00	9.39	**9.25**	10.05	8.83	9.79	**9.56**
Mean	**7.81**	**10.24**	**10.76**		**10.05**	**9.33**	**9.43**	
LSD at 5%	**O = 0.31**	**R = 0.37**	**O x R = 0.65**		**O = n.s**	**R =0.57**	**O x R = 0.59**	

See footnotes of Table 3a.

Effect on nutrients (N, P and K) uptake by barley plants:

1. Effect on nutrients uptake in straw:

Results in Table 5a, 5b and 5c show the effect of application of biogas manure and filter cake on N, P and K uptake in straw of barley plants, respectively.

The main effect of the application rate show that N, P and K uptake in barley straw significantly and progressively increased with increasing the rate of the applied biogas manure and filter cake and the highest increase was obtained due to the application of the studied amendments at R2, except for K uptake where the highest K uptake occurred with the application of R1 in the sandy loam soil (S1) and with R2 in the loamy sand soil (S2).

The main effect of the kind of amendment show that the highest N uptake in barley straw was obtained with the application of filter cake to both soils under study, whereas the highest P and K uptake was obtained with the application of biogas manure to both soils. The highest N uptake in barley straw due to the application of filter cake could be attributed to its high content of N compared with the biogas manure, while the lowest P uptake in barley straw occurred due to the application of filter cake could be attributed to its high content of $CaCO_3$ compared with the biogas manure

which decrease the availability of P to the growing plants (See Table 2).

There was an interaction effect between the kind of the amendment and its rate of application on nutrients uptake especially with K uptake where the application of biogas manure gave the highest K uptake in the straw of barley plants grown on the sandy loam soil (S1) at R1 application, whereas, application of filter cake to the same soil gave the highest K uptake at R2 of application and visa versa occurred in the loamy sand soil (S2).

Table 5. Effect of application of biogas manure and filter cake as a natural organic amendments on the nutrients uptake by barley straw (mg Pot^{-1}) of a desertic soils.

a: N-uptake

Organic amendment (O)	N- uptake (mg Pot^{-1})							
	Soil (1)				Soil (2)			
	Rates of addition (R)							
	R_0	R_1	R_2	Mean	R_0	R_1	R_2	Mean
O1	122.83	206.13	222.90	**183.75**	81.53	96.30	139.75	**105.86**
O2	122.83	176.78	347.08	**215.56**	81.53	82.16	188.75	**117.48**
Mean	**122.83**	**191.46**	**284.69**		**81.53**	**89.23**	**164.24**	
LSD at 5%	**O** = 7.87	**R** = 9.62	**O x R** = 13.62		**O** = n.s	**R = 15.16**	**O x R =21.41**	

See footnotes of Table 3a.

b: P-uptake

Organic amendment (O)	P- uptake (mg Pot^{-1})							
	Soil (1)				Soil (2)			
	Rates of addition (R)							
	R_0	R_1	R_2	Mean	R_0	R_1	R_2	Mean
O1	16.11	47.42	45.58	**36.39**	24.20	31.59	32.95	**29.58**
O2	16.11	31.48	51.39	**32.99**	24.20	28.94	31.66	**28.27**
Mean	**16.11**	**39.45**	**48.48**		**24.20**	**30.27**	**32.30**	
LSD at 5%	**O = 2.07**	**R = 2.52**	**O x R = 3.44**		**O =** 0.82	**R** = 1.01	**O x R = n.s**	

See footnotes of Table 3a.

c : K-uptake

Organic amendment (O)	K- uptake (mg Pot^{-1})							
	Soil (1)				Soil (2)			
	Rates of addition (R)							
	R_0	R_1	R_2	Mean	R_0	R_1	R_2	Mean
O1	128.67	742.77	648.76	**506.73**	311.48	334.93	423.89	**356.77**
O2	128.67	464.30	516.86	**369.94**	311.48	387.15	368.20	**355.61**
Mean	**128.67**	**603.53**	**582.81**		**311.48**	**361.04**	**396.04**	
LSD at 5%	**O** = 49.87	**R** = 61.08	**O x R = 86.39**		**O = n.s**	**R** = 27.30	**O x R = 38.61**	

See footnotes of Table 3a.

2. Effect on nutrients uptake in grains:

Results in Tables 6a, 6b and 6c show the effect of application of the studied organic amendments on nutrients uptake; i.e N, P and K in grains of barley plants grown on the soils under study.

The main effect of the rate of the applied amendments show that nutrients uptake in barley grains significantly and progressively increased with increasing the rate of the applied amendment except for N uptake in grains of barley plants grown on the loamy sand soil (S2), as it decreased with increasing the application rate. This decrease could be attributed to the obtained low grain yield. However, the decrease was significant only at R2 of application. The highest N uptake was obtained with the application of R2 to the sandy loam soil (S1) while the highest P uptake was obtained with the application of R2 to the loamy sand soil (S2), whereas the highest K uptake occurred with the application of R1 to the sandy loam soil (S1).

The main effect of the applied amendment show that, in case of the sandy loam soil (S1), there were significant differences in nutrients uptake due to the application of biogas manure where it was more efficient than filter cake in increasing nutrients uptake in barley grains except for P uptake where filter cake was more efficient than biogas manure in this respect. In case of the loamy sand soil (S2), biogas manure also was more efficient than filter cake in increasing P and K uptake in barley grains whereas both amendments decreased N uptake compared with R0 (non application of amendment).

There was an interaction effect between the kind of the applied organic amendment and its rate of application. In the case of the sandy loam soil (S1) N uptake increased with increasing the application rate of both amendment and the highest N uptake occurred with the application of biogas manure at the highest (R2), whereas, P and K uptake increased with the rate and the highest P uptake occurred with the application of filter cake at R1, whereas, the highest K uptake occurred with the application of biogas manure at R2 of application. In the case of the loamy sand soil (S2), P and K uptake increased with increasing the application rate of the biogas manure and the highest P and K uptake was obtained at R2 of application, while application of filter cake increased P and K uptake with increasing the application rate and the highest uptake was obtained at R1 and R2, respectively.

Table 6. Effect of application of biogas manure and filter cake as a natural organic amendments on the N- uptake by barley grains (mg Pot^{-1}) of a desertic soils.

A: N-uptake

Organic amendment (O)	N- uptake (mg Pot^{-1})							
	Soil (1)				Soil (2)			
	Rates of addition (R)							
	R_0	R_1	R_2	Mean	R_0	R_1	R_2	Mean
O1	34.79	64.95	102.5	**67.53**	43.37	40.86	29.82	**38.02**
O2	34.79	55.66	66.81	**52.42**	43.37	36.63	27.97	**35.99**
Mean	**34.79**	**60.30**	**84.83**		**43.37**	**38.74**	**28.89**	
LSD at 5%	O = 5.19 R = 6.39 O x R = 9.01				O = n.s R = 6.57 O x R = n.s			

See footnotes of Table 3a.

b: P- uptake

Organic amendment (O)	P- uptake (mg Pot^{-1})							
	Soil (1)				Soil (2)			
	Rates of addition (R)							
	R_0	R_1	R_2	Mean	R_0	R_1	R_2	Mean
O1	2.50	6.14	7.40	**5.34**	5.27	7.03	11.35	**7.88**
O2	2.50	8.41	7.35	**6.10**	5.27	7.62	7.50	**6.80**
Mean	**2.50**	**7.27**	**7.37**		**5.27**	**7.32**	**9.42**	
LSD at 5%	**O = 0.34 R = 0.42 O x R = 0.61**				**O = 0.40 R = 0.50 O x R = 0.69**			

See footnotes of Table 3a.

c: K-uptake

Organic amendment (O)	K- uptake (mg Pot^{-1})							
	Soil (1)				Soil (2)			
	Rates of addition (R)							
	R_0	R_1	R_2	Mean	R_0	R_1	R_2	Mean
O1	516	765	825	**702**	641	730	748	**706**
O2	516	731	641	**629**	641	612	715	**656**
Mean	**516**	**748**	**733**		**641**	**671**	**732**	
LSD at 5%	**O = 16 R = 19 O x R = 27**				**O = 22 R = 26 O x R = 37**			

See footnotes of Table 3a.

Conclusion

The effect of the applied organic amendments on barley growth parameters, straw and grain yields and nutrients uptake depends on the chemical properties and the rate of the applied amendment, and the soil characteristics developed upon the application of the organic amendment i.e. the increase in soil salinity, organic matter content, total porosity available nutrient contents and available water content where the effect of these properties was reflected on the growing plants.

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تأثير إضافة روث الغاز الحيوى (سماد البيوجاز) وطينة التصفية على تحسين بعض خواص الاراضى الصحراوية وتداعيتها على النبات النامى عليها.

٢ – التداعيات على النبات النامى

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يهدف البحث الحالي إلى دراسة تأثير إضافة روث الغاز الحيوي (Biogas manure) وطينة التصفية Filter cake or filter mud على النباتات المزروعة على أراضى صحراوية. لتحقيق هذا الهدف جُمعت عينتان من الطبقة السطحية (٠ – ٣٠ سم) لأرضين من منطقة الحمام، الساحل الشمالي الغربي لمصر تختلفان في القوام وفى محتواها من كربونات الكالسيوم، لتمثل الأراضى الصحراوية. وقد أُجريت تجربة أصص تحت ظروف الصوبة باستخدام أصص بلاستيكية سعة ٥ كجم حيث تم إضافة روث الغاز الحيوي وطينة التصفية بمعدل صفر ، ١ و ٢٪ (وزنية / وزنية) وخلطهما تماما مع التربة وحُضنت التربة لمدة شهرين لإعطاء فرصة لتحلل المواد المضافة بالتربة وإستخدم نبات الشعير كنبات اختبار. وأضيفت المغذيات الكُبرى (نيتروجين – فوسفور بوتاسيوم N و P و K) إلى جميع الأصص بمعدلات تُعادل تلك التي أوصت بها وزارة الزراعة المصرية. ثم تم زراعة عشرة حبات شعير في كل أصيص وتم الري باستخدام مياه الصنبور حتى الوصول إلى السعة الحقلية للتربة. بعد تمام الإنبات خُفت النباتات إلى ٥ بكل أصيص. وكان تصميم التجربة تصميم قطاعات كاملة العشوائية مع عاملين، في ثلاثة مكررات. عند النضج، تم تسجيل عدد الأشطاء والسنابل كما تم قياس ارتفاع النبات، ثم تم حصاد النباتات وفصلها إلى الحبوب والقش، وجففت وتم تسجيل الوزن الجاف القش والحبوب. تم هضم عينات ممثلة من القش والحبوب وتحليلها لتقدير الكمية الممتصة من كل من N، P و K بكل منهما. والنتائج التي تم الحصول عليها تبين ما يلي:

- أظهر التأثير العام (الرئيسي) لمعدل الإضافة أن إضافة روث الغاز الحيوي وطينة التصفية لكل من التربتين أدت إلى زيادة عدد الأشطاء وعدد السنابل بكل أصيص وكانت الزيادة معنوية وتدريجية مع زيادة معدل الإضافة من R0 حتى R2، بينما حدث إنخفاض معنوى وتدريجى لارتفاع النبات (سم) ، وكانت طينة التصفية أكثر كفاءة من روث الغاز الحيوي في هذا الصدد. أدت إضافة روث الغاز الحيوي وطينة التصفية بمعدل متزايد إلى كل من التربتين تحت الدراسة إلى حدوث زيادة معنوية وتدريجية فى محصول القش والحبوب لنبات الشعير النامى على الأرض الرملية اللومية (S1)، بينما زاد بشكل معنوى وتدريجي محصول القش وإنخفض محصول الحبوب لنبات الشعير النامى على الأرض اللومية الرملية (S2) ، وكان هناك فرق معنوى بين روث الغاز الحيوي وطينة التصفية في زيادة محصول القش والحبوب لنباتات الشعير المزروعة على كلا التربة. أدت إضافة روث الغاز الحيوي وطينة التصفية إلى زيادة إمتصاص كل من N و P و K في قش الشعير زيادة معنوية وتدريجية مع زيادة معدل الإضافة. وقد حدث أعلى امتصاص لـ N مع إضافة طينة التصفية لكلا التربة، في حين حدث أعلى إمتصاص لـ P و الـ K مع إضافة روث الغاز الحيوي إلى كل من التربتين. ازداد إمتصاص المغذيات في حبوب الشعير زيادة معنوية وتدريجية مع زيادة معدل الإضافة باستثناء النتروجين الممتص في حبوب نباتات الشعير المزروعة على التربة اللومية الرملية (S2) حيث إنخفض مع زيادة معدل الاضافة ، وكانت هناك فروق معنوية في امتصاص العناصر الغذائية بسبب إضافة كلا المحسنين إلى الأراضى المدروسة. ففي حالة التربة الرملية اللومية (S1) ، كان روث الغاز الحيوي أكثر كفاءة من طينة التصفية في زيادة امتصاص المغذيات في حبوب الشعير باستثناء امتصاص الفوسفور (P) حيث كانت طينة التصفية أكثر كفاءة من روث الغاز الحيوي في هذا الصدد. أما في حالة التربة اللومية الرملية (S2)، روث الغاز الحيوي كان أيضا أكثر كفاءة من طينة التصفية في زيادة امتصاص P و K في حبوب الشعير، في حين أن كلا المحسنين أدوا إلى خفض كمية الـ N الممتصة مقارنة مع R0 (عدم إضافة المحسن) و كان الانخفاض أعلى مع إضافة طينة التصفية مقارنة مع إضافة روث الغاز الحيوي.

الخاتمة

ويمكن إستنتاج أن تأثير المحسنات المضافة على مؤشرات نمو نبات الشعير، والمحصول، وامتصاص العناصر الغذائية يعتمد على الخواص الكيميائية للمحسن ومعدل إضافته ، وخصائص التربة المتطورة نتيجة إضافة المحسن العضوي مثل زيادة محتوى التربة من الأملاح والمادة العضوية والمسامية الكلية وزيادة المحتوى الميسر من العناصر الغذائية بالتربة والمحتوى الرطوبى الميسر للنبات ، حيث أنعكس تأثير كل ذلك على النبات النامى.