Effect of Some Organic and Inorganic Soil Amendments on the Available N, P and K in Sandy and Calcareous Soils

Awad, E. A. M.; I. R. Mohamed ; S. M. M. Dahdouh and A. M. A. Merwad
Soils Science Dept., Fac. of Agric., Zagazig University

ABSTRACT

Incubation experiment was carried out to study the effect of some soil amendments i.e. biogas manure (BM), chicken manure (CM), taffla material (T) at a rate of 2% (20 ton fed^{-1}), sulfur (S) at a rate of 500 kg fed^{-1} and two water capture fertilizers (acidic and neutral WCF) at a rate of 40 kg fed^{-1} on the available N, P and K in sandy and calcareous soils. The tested materials were used separately and in different combinations. Soil samples were taken at intervals of 7, 14, 28, 42 and 56 days where available nitrogen forms, phosphorus and potassium were determined. Results showed that treating the soil with CM, BM, T, S and WCF increased the available nitrogen forms, phosphorus and potassium due to its effect on the soil reaction and the activities of soil organisms. The available nitrogen in sandy soil was higher in the treatment of BM than in the treatment of CM within 7, 14 and 42 days incubation, while the values after 28 and 56 days incubation were lower. The values of available –N in calcareous soil were higher with BM than with CM in all periods except after 14 days. The values of available (NH_4+NO_3)-N were higher in the sandy soil than in calcareous one within incubation periods except after 28 days. The available P and K were higher with CM than with BM in during the incubation periods.

Keywords: Soil Amendments, Sandy Soil, Calcareous Soil and Available N, P and K.

1. INTRODUCTION:

Most of the newly reclaimed soils in Egypt are sandy and calcareous, which are poor in their content of organic matter and available N,P and K.The pool of available P in soil can be replenished from both organic and fertilizer P pools [Sharply, 1985].Organic manures were repeatedly used as soil amendments in order to decrease soil pH and increase availability of phosphours [Negm, 2003]. The highest content of both ammonium-N and nitrate-N was recorded in the period between 3 and 5 weeks of incubation under saturation condition and the rate of nitrogen losses therefore increased from 32 to 40% with increasing the organic matter due to the increase in microbial population and activities and thus the conversion to complexed forms [El-Kased and Kamh, 1997]. The greatest concentration of ammonium was observed during the first weeks of composting organic materials (sewage sludge, municipal solid waste, brewery sludge, sorghum bagasse, cotton waste and pine bark) coinciding with the most intense period of OM degradation, and ammonium then decreased gradually to reach final values of below 0.04%. The use of urea as a nitrogen source in the mixtures led to high ammonium levels during the first week as a result of its rapid hydrolysis. The nitrification process began only when the temperature of the mixtures dropped below 40°C and its intensity depended on the quantity of ammonium present when the process began. The highest concentrations of $N0_3$-N were produced at the end of maturation. Statistically significant correlations at a high probability level were found between the NO_3-N concentration and pH and electrical conductivity, confirming that nitrification was responsible for the decreasing pH values and increasing electrical conductivity [Sanchez-Monedero et al, 2001]. There was no accumulation of ammonium in any of the soils after 42 days of incubation. Net nitrification and the rate of nitrification were found to increase linearly due to increase in moisture content from 40 to 60% of field capacity (FC) in the soil under wheat – fallow system. In contrast, a decrease in nitrate accumulation was observed soil under wheat-fallow rice (WFR) system due to increase in moisture content from 60 to 80% FC [Rahman and Rashid, 2002]. Increase in the availability of N, P and K in calcareous soil treated with different organic manures alone or combined with sulphur. Also, results indicated the superiority of FYM + sulphur for increasing the available N,P and K as compared to the chicken manure + sulpher [Basyouny et al, 2003]. The application of organic manures either alone or in combination with rock phosphate increased the available content N, P, with superiority of organic manures for increasing organic matter content in soils [Hegazi et al, 2007]. Addition of compost, taffla and rock phosphate to sandy calcareous soil increased N content P and K availability in the soil after cultivation [Mohamed et al, 2008].

The present investigation aimed to study the effect of some soil amendments on the availability of some nutrients in sandy and calcareous soils under incubation conditions.

2. MATERIALS AND METHODS:

Laboratory incubation experiment was performed to study the effect of organic and inorganic amendments on the availability of some macronutrients in concerned soils during successive intervals of time. Plastic containers were used, each one secieved hundred grams of soil samples.

The following soil amendments treatments were applied to different soils: Control, Biogas manure (BM), Biogas manure + Taffla (BM+T), Biogas manure + Taffla + Acidic water capture fertilizer (BM+T+acidic WCF), Biogas manure + Taffla + neutral water capture fertilizer (BM+T+ neutral WCF), Biogas manure + Taffla + sulphur(BM+T+S), Biogas manure + Taffla + sulphur + Acidic water capture fertilizer (BM+T+S+ acidic WCF), Biogas manure + Taffla + sulphur + neutral water capture fertilizer (BM+T+S+neutral WCF), Chicken manure (CM), Chicken manure + Taffla (CM+T), Chicken manure + Taffla + Acidic water capture fertilizer (CM+T+ acidic WCF), Chicken manure + Taffla + neutral water capture fertilizer (CM+T+ neutral WCF), Chicken manure + Taffla + sulphur (CM+T+S), Chicken manure + Taffla + sulphur+ Acidic water capture fertilizer (CM+T+S+ acidic WCF), Chicken manure + Taffla + sulphur+ neutral water capture fertilizer(CM+T+S+ neutral WCF)

The treatments of Biogas and chicken manures and taffla material were added to the soils at a rate of 20 tons/fed. The acidic and neutral water capture fertilizers were added at a rate of 40 kg /fed., while the treatment of elemental sulphur was applied at a rate of 500 kgs/fed.

Soil amendments treatments were mixed thoroughly with soil samples at the same rates. Nitrogen, phosphorus and potassium were added at rates 200 kgs N/fed, 30 kgs P_2O_5/fed and50 kgs K_2O/fed. As ammonium nitrate, monosodium phosphate and potassium sulphate. Treatments were replicated two times and containers were kept under laboratory temperature. The soil moisture content was adjusted around the field capacity through the experiment period. The plastic containers were incubated at room temperature (± 29^o C approximately). Soil samples were taken at intervals of 7, 14, 28, 42 and 56 days where available NH_4^+-N, NO_3^-–N, phosphorus and potassium were determined using method described by [Cottenie et al, 1982; Watanabe and Olsoen, 1965; Jackson, 1958].

Physical and chemical analyses of investigated soils, Taffla material, water capture fertilizer and organic materials are presented in Tables (1, 2 and 3).Physical and chemical properties in the soil samples were determined using the methods described by (Piper, 1950; Cottenie et al, 1982; Black, 1965].

3. RESULTS AND DISCUSSION:

1. Available nitrogen:

a. Sandy soil:

Data presented in Table (4) show the available nitrogen forms released during sandy soil incubation within 56 days. At the first period of incubation (7 days), the concentrations of NH_4-N were more than NO_3-N using all treatments except the treatment of (BM + T). In this period the total concentration of (NH_4^+ + NO_3^-) – N was the highest with the control without amendment followed by (BM + T +S + acidic WCF) and CM treatments, while the lowest concentration was found with the treatment of (CM + T + S + acidic WCF).

The increase of the total available nitrogen form, (NH_4^+ + NO_3^-) – N in the control reflecting the effect of native nitrogen content of the soil, due to the activities of soil organisms responsible for the processes of ammonification of the soil nitrogen. [El-Kased and Kamh, 1997] found similar trend. After 14 days, the concentration of NH_4^+ – N were more thanNO_3^- – N using all treatments except the treatment of (BM + T). In this period, the total concentration of (NH_4 + NO_3) – N was the highest with the control followed by (BM + T + neutral WCF), while the lowest concentration was found with the treatment of (CM + T + S). this may be attributed to the increase of the process of immobilization during the break of compost manure by the responsible microorganisms. After 28 days, the concentration of NH_4 – N were more than NO_3 – N using all treatments. In this period, the total concentration of (NH_4 + NO_3) – N was the highest with the treatment of (CM + T + S), while the lowest concentration was found with the treatment of control followed by (CM + T + S + acidic WCF). The reduction of available nitrogen forms in this period with the control may be attributed to the conversion of ammonium-N to other forms and / or losses of ammoniacal form through volatilization while in the presence of (CM and T) and S the ammonium-N was adsorbed on the adsorptive sites of organic material and taffla amendment which reduced the volatilized ammonia. After 42 days, of incubation, the values of NH_4 – N and NO_3 – N were approximately similar in total treatments except the treatment of biogas manure alone or mixed with Taffla material, sulfur and water capture fertilizer.

In this period, results revealed that the soil organic matter may not be the only factor responsible for the ammonification processes. Other factors such as the population of soil organisms may be equally responsible for delaying such processes [Hassan et al, 2002]. After 56 days, the concentration of NH_4 – N were more than NO_3-N using all treatments. In this period, the total concentration of (NH_4 + NO_3)-N was the highest with the treatment of (BM + T + S + acidic WCF), while the lowest concentration was found with the treatment of (CM + T + S + neutral WCF).

This result may be due to the increase in the microbial activities accompanying the availability of organic matter and the role of WCF in increasing the efficiency of microorganisms.

In general, comparing the values of total available nitrogen in sandy soil, data presented in Table (4) show that (NH_4 + NO_3) – N were higher in the treatments of biogas manure than in the treatments of chicken manure in periods of 7, 14 and 42 days incubation. While, after 28 and 56 days of incubation, the values were lower.

b. Calcareous soil:

Data presented in Table (5) show the available nitrogen forms released during calcareous soil incubation within 56 days. The organic manures wither biogas manure or chicken manure clearly affected the total available ammonium- N form during the incubation period of eight weeks. At the first period (7 days) and the last one (56 days), the concentrations of NH_4 – N were more than NO_3 – N using all treatments. In the first period, the total concentration of (NH_4+ NO_3) – N was the lowest with control, wheel the highest concentration was found with the treatment of BM mixed with Taffla material and neutral WCF but after 56 days the highest value was found with biogas manure alone while, the lowest value was found with chicken manure combined with taffla material, sulfur and water capture fertilizer.

The reducing of available-N during this period of incubation may be attributed to the transformation of NH_4 – N to other forms and / or losses of ammoniacal form through volatilization as reported by [El-Kased and Kamh, 1997]. After 14 days, the concentrations of NH_4 – N were more than the NO_3 – N using all treatments except the treatments of (CM + T + acidic WCF), (CM + T + S + acidic WCF) and (CM + T + S + neutral WCF). That may be due to the effect of acidic WCF which affected the biological processes of N – transformation as stated by [Osman.Fatma and EL-Mogy, 2005]. In this period, the total concentration of (NH_4 + NO_3) – N was the higher with (CM + T) followed by (CM +T + S + acidic WCF), while the lowest concentration was found with the treatments of chicken manure alone. After 42 days of incubation, the values of NH_4 – N and NO_3 – N were approximately similar the total concentration of (NH_4 + NO_3) – N was the higher with (BM + T + neutral WCF), while the lowest concentration of was found with treatment of CM followed by (CM + T).

In general, comparing the values of total available nitrogen in calcareous soil, data presented in Table (5) showed that (NH_4 + NO_3) – N were higher in the treatments of biogas manure than in the treatments of chicken manure in all periods incubation except period after 14 days.

Comparing the values of total available nitrogen in sandy soil and calcareous soil, data presented in Table (4 and 5) showed that (NH_4 + NO_3)- N were higher in the sandy soil than in calcareous one, in all periods of incubation except the period after 28 days. These results were in agreement with these obtained by [Shabayek, 1997] who mentioned that there were significant changes in all N-fractions depending on C/N ratio and mineralization – immobilization processes, according to the application of organic and inorganic amendments.

2. Available potassium:

a. Sandy soil :

Data presented in Table (6) show the available potassium released during sandy soil incubation with in 56 days. At the first period of incubation (7 days) and period after 28 days third periods), the concentration of available potassium was found with the treatment of control. That may be due to the effect of these materials on reducing soil reaction. Then increasing the available potassium as reported by [Abdel- Kader et al, 2007]. After 14 days, the concentration of available potassium was the highest with (CM + T + S + acidic WCF), while the lowest concentration was found with the treatment of (BM + T + S). After 42 days, the value of available potassium was the greatest with chicken manure while, the lowest value was found with the treatment of control. After 56 days, the concentration of available potassium was the greatest with (CM+ T+S+ neutral WCF), while the lowest concentration was found with the treatment of (CM + T + neutral WCF).

In general, comparing the values of available potassium in sandy soil, data presented in Table (6) show that available potassium were higher in the treatments of chicken manure than in the treatments of biogas one, in all periods incubation.

b. Calcareous soil:

Data presented in Table (6) show that available potassium released during calcareous soil incubation with 56 days. After 7, 28 and 42 days, the value of available potassium was the highest with (CM+ T+ S + neutral WCF), while the lowest concentration was found with the treatment of control. After 14 days, the concentration of available potassium was the greatest with (CM + T + S + neutral WCF), while the lowest concentration was found with the treatment of (CM + T + S). After 56 days, the concentration of available potassium was the highest with (CM + T + S + acidic WCF), while the lowest value was found with the treatment of control.

In general, comparing the values of available potassium in calcareous soil, data presented in Table (6) show that available potassium was higher in the treatments of chicken manure than in the treatments of biogas one in all periods of incubation.

Comparing the values of available potassium in sandy soil and calcareous soil, data presented in Table (6) show that available potassium values were higher in the calcareous soil than in sandy one, in all periods.

3. Available phosphorus:

a. Sandy soil :

Data presented in Table (7) show the available phosphorus released during sandy soil incubation with in 56 days. At the first period of incubation (7 days), the concentration of available phosphorus was the greatest with the control while, the lowest values was found with the treatment of (CM + T + S + neutral WCF). After 14, 28 and 42 days, the concentration of available phosphorus was the greatest with (CM + T + S + acidic WCF), while the lowest value was found with the treatment of control. Similar results were obtained by [Osman.Fatma et al, 2004] who stated that using acidic WCF increased the availability of soil phosphorus. In the present investigation, the combination of chicken manure, sulphur and acidic WCF affected the soil reaction, therefore, the available phosphorus increased. After 56 days, the value of available phosphorus was the highest with (CM + T + S + acidic WCF), while the lowest value was found with the treatment of biogas manure alone. Comparing the value of available phosphorus in sandy soil, data presented in Table (7) show that the values of available phosphorus were higher in the treatments of chicken manure than in the treatments of biogas one, in all periods incubation. These results may be due to the accumulated CO_2 evolution values from chicken manure than other organic ones as reported by (Mahmoud and Salem, 2005).

b. Calcareous soil:

Data presented in Table (7) show the available phosphorus released during calcareous soil incubation with in 56 days. At the first period of incubation (7 days), the value of available phosphorus was the highest with the (CM + T + S + neutral WCF), while the lowest value was found with the treatment of (CM + T + neutral WCF).After 14 days, the concentration of available phosphorus was the greatest with (CM + T + S + neutral WCF), while the lowest value was found with the treatment of control. After 28 days, the concentration of available phosphorus was the highest with the (CM + T + S + acidic WCF), while the lowest was found with the treatment of control. These results may be attributed to the release of amino acid due to the decomposition of chicken manure as well as the acidic effect of WCF as reported by [Osman.Fatma and El-Mogy, 2005]. After 42 day, the concentration of available phosphorus was the greatest with the (BM + T), while the lowest value was found with the treatment of control.

After 56 days, the value of available phosphorus was the highest with (CM + T + S), while the lowest concentration was found with the treatment of (BM+ T + S + neutral WCF). Comparing the concentration of available phosphorus in calcareous soil, data presented in Table (7) show that the value of available phosphorus were higher in the treatments of chicken manure in the treatments of biogas one, in all periods incubation.

Comparing the values of available phosphorus in sandy soil and calcareous soil, data presented in Table (7) show that the available phosphorus were higher in the calcareous soil than in sandy one, in total periods except period after 42 days incubation the values were lower. These results may be attributed to the rate of organic breakdown as well as the effect of acidic WCF as reported [Abdel- Kader et al, 2007; El-Alla, 1997].

REFERENCES

Sharply, A. N. (1985). Phosphorus cycling in unfertilized and agricultural soils. Soil SCi. Soc. Am. J., 49: 05-911.

Negm, M. A.; M. G. M. Rifoat and A. N. Estefanous (2003). Impact of composted saw-dust and some nitrogenous source on the production of squash and table beet crops grown on soil calcareous in nature. Fayoum J. Agric., Res. 24 (1): 116-137.

El-Kased, F. A. and R. N. Kamh (1997). Transformation of soil native and applied nitrogen in relation to organic matter and tiem under saturation in calcareous soil. Egypt. J. Appl. Sci.; 12(3): 235 – 244.

Sanchez-Monedero, M. A.; A. Roig; C. Paredes and M.P. BcrnaI (2001). Nitrogen transformation during organic waste composting by the Rutgers system and its effects on pH, EC and maturity of the composting mixtures. Bioresource-Technoloiiv. 2001, 78: 3. 301-308.

Rahman, M. S.;G. H. Rashid (2002). Nitrogen mineralization at different moisture levels in soils under wheat cropping systems. Communications - in – Soil - Science and plant Analysis,33: 9-10,1363-1374.

Basyouny, E. A.: Sh. El.Borhamy and S.A. Eisa (2003). Response of corn plants grown on calcareous soil to organic fertilization and sulpher. Egypt. J. Appli. Sci., 18 (9): 360-372.

Hegazi, I. M. A.; A. A. Afifi and G. A. Rashad (2007). Nutritional status of N and P as affected by adding some organic manures and rock phosphate in both sandy and calcareous soils. J. Agric. Sci., Mansoura. Univ., (6): 4977-4998.

Mohamed, W.S.; M.A. Sherif and I.A. Youssef (2008). Effects of some natural organic and inorganic materials on some soil properties and growth in sandy calcareous soil. Minia J. of Agric. Res. Vol. (28) : No. (2) : 331 – 349.

Cottenie, A.; Verloo, M.; Velghe, M. and Camerlynck, R. (1982). Chemical Analysis of Plant and Soil. Laboratory of Analytical and Agrochemistry State Univ. Ghiv. Ghent-Belgium.

Watanabe, F. S. and S. R. Olsoen (1965). Acid method for determineing phosphorus in water and NaHCO3 extracts from soil. Soil. Soc. Am. Proc.; 29: 677-678.

Jackson, M. L. (1958). Soil Chemical Analysis Prentice Hall, Ic., Englewood califfs, New Jersy.

Piper, C. S. (1950). Soil and plant Analysis. Interscience Pubi. Inc. New York. plant and soil. 91(3): 429-432.

Black, C. A. (1965). Methods of Soil Analysis Amer. Soc. of Agro, Madison, Wis consin, U.S.A.

Hassan, M. A. M.; R. K. Rabie and E. R. Marzouk (2002). Effect of some combination of organic wastes and biofertilizer on phosphoreus availability certain soils of North Sinai. ZAgazig J. Agric. rEs. Vol. 29(6) : 2051 – 2070.

Osman. Fatma A. A. and E. A. M. EL-Mogy (2005). Evaluation of fast and slow –release nitrogen fertilizers with or without water catpture fertilizer (WFC) and N-fixing bacteria on coriander plants on sandy soil.Egypt.J.A.ppi.Sci.,20(3):274-291.

Shabayek, A. A. (1997). Sources of mineralizable soil nitrogen as affected by different torganic amendments in sandy soils. Zagazig J. Agric. Res. Vol. 24(1): 149 – 168.

Abdel- Kader, N; N. El-Baroudy, A. and Lamyaa Abdel Rahman (2007). Residual effects of different organic and inorganic fertilizers on spinach(spinacia oleracea L.) Plant grown on clay and sandy soils .J .Agric. Tanta Uni.Env. Sci. December.

Osman, Fatma, A.A.; M.A. Khalil and A. Salem (2004). Effect of water capture fertilizer (WCF) soil conditioner combined with different levels of nitrogen and potassium on Faba been plants grown on a soil having some problems. Egypt. J. Appli. Sci., 19 (10): 374-389.

Mahmoud, E. K. and H. A. Salem. (2005). The compost quality and its use as a growing media. J. Agric. Res. Tanta Sci., 30 (6): 3469-3477.

El-Alla, H. I. (1997). Interaction between modified uera and organic matter on nitrogen transformation in low land rice. Zagazig J. Agric. Res., Vol. 24, No. (5): 875 – 890.

تأثير بعض مصلحات التربة العضوية والمعدنية تيسر النيتروجين والفوسفور والبوتاسيوم فى الأراضى الرملية والجيرية

السيد عوض محمد عوض إبراهيم رمضان محمد صلاح محمود محمد دحدوح

عبد الرحمن محمد أمين مرواد

قسم علوم التربة –كلية الزراعة – جامعة الزقازيق –مصر

أجريت تجربة تحضين لدراسة تأثير بعض مصلحات التربة مثل سماد البيوجاز وسماد الدواجن والطفلة بمعدل ٢٪ (٢٠ طن/ فدان) والكبريت بمعدل ٥٠٠ كجم/ فدان ونوعين من السماد الماسك للماء (حامضى ومتعادل) بمعدل ٤٠ كجم/ فدان على تيسر النيتروجين والفوسفور والبوتاسيوم واستخدمت المعاملات بصورة منفردة مع عمل توليفات مختلفة منها. وأخذت عينات التربة على فترات ٧-١٤-٢٨-٤٢-٥٦ يوم مع تقدير النيتروجين والفوسفور والبوتاسيوم الميسر بها. أوضحت النتائج أن معاملة التربة بسماد الدواجن وسماد البيوجاز

والطفلة والكبريت والأسمدة الماسكة للماء يزيد من صلاحية صور النيتروجين والفوسفور والبوتاسيوم ويمكن إرجاع ذلك إلى تأثيرها على درجة تفاعل التربة ونشاط أحياء التربة. وأوضحت النتائج أيضاً أن النيتروجين المتاح فى التربة الرملية كان أعلى عند معاملة التربة بسماد البيوجاز مقارنة بسماد الدواجن فى الفترات ٧-١٤-٤٢ يوم، بينما كانت هذه القيم منخفضة بعد ٢٨ و٥٦ يوم وكانت قيم النيتروجين المتاح فى التربة الجيرية أعلى فى معاملة سماد البيوجاز مقارنة بمعاملة سماد الدواجن فى جميع فترات التحضين ماعدا الفترة بعد ١٤ يوم، كما وجد أن النيتروجين الميسر بصورتية (الأمونيومية والنتراتية) كان أعلى فى التربة الرملية مقارنة بالتربة الجيرية فى جميع مراحل التحضين ماعدا الفترة بعد ٢٨ يوم، بينما الفوسفور والبوتاسيوم الميسر كان أعلى فى معاملات سماد الدواجن مقارنة بسماد البيوجاز فى جميع فترات التحضين.

الكلمات المفتاحية: مصلحات التربة، الأرض الرملية، الأرض الجيرية، النيتروجين وافسفور والبوتاسيوم الميسر

Table 1: Some physical and chemical properties of the investigated soils and Taffla

Characteristic	Sandy soil	calcareous soil	Taffla
Soil particles distribution			
Sand ,%	81.91	36.17	**44.60**
Silt,%	12.06	29.79	**4.26**
Clay,%	6.03	34.04	**51.14**
Textural class	Loamy sand	Clay loam	**Clay**
Field capacity (FC),%	11.85	26.25	**33.04**
$CaCO_3$, (g kg^{-1})	4.8	355	**48.8**
Organic matter, (g kg^{-1})	4.8	6.4	**4.8**
pH*	8.01	7.74	**7.25**
EC dSm^{-1}**	0.34	0.88	**1.88**
Soluble cations and anions, mmolc/L**			
Ca^{2+}	1.3	3.2	**3.5**
Mg^{2+}	0.6	1.9	**3.2**
Na^{+}	1.25	3.0	**9.43**
K^{+}	0.30	1.35	**0.39**
$CO_3^{=}$	-	-	**-**
HCO_3^{-}	1.12	1.28	**1.6**
Cl^{-}	0.99	3.78	**8.19**
$SO_4^{=}$	1.34	4.39	**6.73**
Total N, (g kg^{-1})	3.6	3.4	**3.7**
Total P, (g kg^{-1})	1.6	2.4	**2.1**
Total K, (g kg^{-1})	**0.8**	**1.0**	**1.5**

* Soil-water suspension 1: 2.5 ** Soil water extract 1:5

Table 2: The chemical composition of water capture fertilizer (WCF).

Nutrient	N	P	K	Zn	Fe	Mn	Mg	Cu	Mo
Value(gkg^{-1})	**130**	**50**	**110**	**1.3**	**0.85**	**0.7**	**0.6**	**1.5**	**0.15**

Table 3: Some chemical composition of biogas and chicken manure

Characteristic	EC** (dSm^{-1})	pH*	Organic matter, (g kg^{-1})	Total N (g kg^{-1})	Total p (g kg^{-1})	Total K (g kg^{-1})	C/N raio
Chicken manure	4.8	7.58	234	31.5	55.3	3.9	**4.32**
Biogas manure	**3.1**	**7.84**	**403**	**24.8**	**18.2**	**2.0**	**9.42**

*Soil-water suspension 1: 2.5 ** Soil water extract 1:5

Table 4: Effect of soil amendments on available nitrogen (mgkg^{-1}) forms in sandy soil during incubation.

Treatments	Incubation periods (days)														
	7			14			28			42			56		
	NH_{4}-N	NO_{3}-N	Total	NH_{4}-N	NO_{3}-N	Total	NH_{4}-N	NO_{3}-N	Total	NH_{4}-N	NO_{3}-N	Total	NH_{4}-N	NO_{3}-N	Total
Control	269.0	188.3	457.3	80.69	80.1	161.36	44.83	26.9	71.72	53.79	80.6	134.4	89.6	35.8	**125.5**
BM	242.0	53.8	295.8	67.24	53.8	121.03	71.72	8.97	80.69	17.93	107	215.1	125.5	8.97	**134.4**
BM + T	108.0	161.4	268.9	80.69	94.1	174.8	80.69	6.26	89.65	89.65	35.8	125.5	134.4	8.97	**143.4**
BM + T + acidic WCF	242.0	53.8	295.8	80.69	53.7	134.48	62.76	26.9	89.65	98.62	8.96	107.5	116.5	8.96	**125.5**
BM + T + neutral WCF	134.4	80.7	215.1	67.24	94.2	161.37	71.72	8.99	80.69	62.76	35.8	98.62	116.5	8.96	**125.5**
BM + T + S	161.3	00.0	161.37	67.24	66.9	94.13	80.69	0.00	80.69	62.76	71.7	134.4	71.72	35.8	**107.5**
BM + T + S + acidic WCF	188.2	134.5	322.7	67.24	67.2	134.48	71.72	8.97	80.69	71.72	71.7	143.4	161.3	17.9	**179.3**
BM + T+ S +neutral WCF	215.1	26.9	242.0	67.24	67.2	134.48	80.69	18.0	98.60	53.79	53.7	107.5	107.5	26.9	**134.4**
CM	242.0	80.7	322.7	80.69	13.4	94.13	80.69	6.26	89.65	62.76	26.8	89.6	80.69	44.8	**125.5**
CM + T	215.1	53.8	268.9	94.13	13.4	107.58	80.69	0.00	80.69	62.76	26.9	89.6	116.5	26.8	**143.4**
CM + T + acidic WCF	161.3	26.9	188.3	80.69	53.7	134.48	92.76	26.9	89.65	53.79	53.7	107.5	98.62	35.8	**134.4**
CM + T + neutral WCF	215.1	26.9	242.0	80.69	13.4	94.13	89.65	9.02	98.62	44.83	44.8	89.65	116.5	17.9	**134.4**
CM + T + S	161.3	26.8	188.3	53.79	26.9	80.69	89.65	17.9	107.5	53.79	62.7	116.65	89.65	44.8	**134.4**
CM + T + S + acidic WCF	107.6	26.9	134.5	107.58	13.5	121.03	53.79	17.9	71.70	62.76	26.8	89.65	116.5	44.8	**161.3**
CM + T+ S +neutral WCF	**107.6**	**53.7**	**161.4**	**67.24**	**67.3**	**134.48**	**71.72**	**26.9**	**89.62**	**44.83**	**44.8**	**89.65**	**80.69**	**26.8**	**107.5**

BM: Biogas manure, T:Taflla , WCF: water capture fertilizer, S:Sulphur, CM:Chicken manure

Table 5: Effect of soil amendments on available nitrogen forms ($mgkg^{-1}$) in calcareous soil during incubation.

Treatments	Incubation periods (days)														
	7			14			28			42			56		
	$NH_{4\text{-}N}$	$NO_{3\text{-}N}$	Total	$NH_{4\text{-}N}$	$NO_{3\text{-}N}$	Total	$NH_{4\text{-}N}$	$NO_{3\text{-}N}$	Total	$NH_{4\text{-}N}$	$NO_{3\text{-}N}$	Total	$NH_{4\text{-}N}$	$NO_{3\text{-}N}$	Total
Control	82.37	54.91	137.28	107.58	26.9	134.48	71.72	17.9	89.65	53.79	35.86	89.65	57.99	32.22	**90.21**
BM	109.82	137.2	247.10	121.03	26.89	147.92	89.65	35.8	125.5	53.79	53.79	107.58	90.21	25.78	**115.99**
BM + T	164.73	54.92	219.65	80.69	26.89	107.58	53.79	35.8	89.65	71.72	71.72	143.44	90.21	25.78	**115.9**
BM + T + acidic WCF	137.28	27.53	164.73	67.24	53.79	121.03	71.72	62.7	134.4	80.69	26.89	107.58	83.77	25.78	**109.54**
BM + T + neutral WCF	137.28	192.2	329.47	107.58	13.45	121.03	62.76	71.7	134.4	53.79	98.62	152.41	64.44	25.78	**90.21**
BM + T + S	137.28	54.99	192.19	80.69	40.34	121.03	62.76	71.7	134.4	62.76	26.89	89.65	70.88	25.78	**96.66**
BM + T + S + acidic WCF	137.28	109.9	247.10	67.24	53.79	121.03	62.76	89.6	152.4	53.79	53.79	107.58	70.88	25.78	**96.66**
BM + T+ S +neutral WCF	219.65	27.45	247.10	80.69	67.23	147.92	62.76	53.7	116.5	44.83	80.68	125.51	70.88	19.33	**90.21**
CM	192.19	0.00	192.19	0.69	13.44	94.13	89.65	17.9	107.5	35.86	35.86	71.72	77.32	32.22	**109.54**
CM + T	247.1	27.4	274.65	107.58	53.79	161.37	80.69	26.8	107.5	44.83	26.89	71.72	70.88	32.22	**103.10**
CM + T + acidic WCF	164.73	54.95	219.65	40.34	80.79	121.03	116.5	26.8	143.4	80.69	98.61	179.3	83.77	12.83	**96.66**
CM + T + neutral WCF	137.28	54.95	192.19	79.53	54.95	134.48	107.5	8.97	116.5	80.69	17.93	98.62	64.44	32.22	**96.66**
CM + T + S	164.73	27.49	192.19	67.24	67.24	134.48	62.76	26.8	89.55	53.79	80.69	134.48	57.99	32.22	**90.21**
CM + T + S + acidic WCF	137.28	109.8	247.10	67.24	94.13	161.37	62.76	62.7	125.5	80.69	35.86	116.55	57.99	25.78	**83.77**
CM + T+ S +neutral WCF	**219.65**	**27.45**	**247.10**	**67.24**	**80.68**	**147.92**	**62.76**	**62.7**	**125.5**	**89.65**	**26.9**	**116.55**	**64.44**	**19.33**	**83.77**

BM: Biogas manure, T:Taflla , WCF: water capture fertilizer, S:Sulfur, CM:Chicken manure.

Table 6: Available potassium (mgkg^{-1}) in different soils as influenced by soil amendments during incubation.

Treatments	Sandy soil					Calcareous soil				
	Incubation periods (days)									
	7	**14**	**28**	**42**	**56**	**7**	**14**	**28**	**42**	56
Control	142.4	333.3	208.7	167.0	395.6	468.5	701.4	409.3	357.1	**421.4**
BM	290.6	478.2	341.7	321.2	246.3	636.9	937.1	583.7	463.9	**504.6**
BM + T	288.6	457.9	400.2	265.4	352.5	593.6	781.2	562.5	504.6	**476.2**
BM + T + acidic WCF	268.4	372.3	449.6	348.6	332.5	680.2	648.5	562.5	516.8	**493.2**
BM + T + neutral WCF	218.4	346.4	365.9	376.0	319.3	587.8	605.2	582.6	494.2	**486.6**
BM + T + S	244.4	239.6	399.2	330.6	451.6	689.8	462.8	548.4	460.2	**557.5**
BM + T+ S + acidic WCF	271.5	248.2	419.4	383.6	375.6	640.7	938.1	589.7	514.3	**513.1**
BM + T+S+ neutral WCF	253.9	355.0	417.1	363.7	362.8	713.9	882.3	519.2	600.0	**529.1**
CM	341.5	499.3	514.1	581.1	489.4	466.6	938.1	675.4	444.1	**652.0**
CM + T	334.8	589.8	536.3	498.9	561.2	744.7	911.1	706.6	655.8	**597.2**
CM + T + acidic WCF	351.2	669.0	552.4	485.7	496.9	651.3	843.8	656.2	667.1	**616.1**
CM + T + neutral WCF	409.0	660.0	532.3	425.2	515.9	704.3	930.4	706.6	567.9	**644.5**
CM + T + S	289.6	702.3	604.8	578.3	517.8	599.4	936.1	769.1	727.6	**623.7**
CM + T+ S+ acidic WCF	456.0	835.1	743.9	523.5	516.8	742.7	938.1	770.1	736.2	**697.4**
CM + T+S+neutral WCF	**425.3**	**728.3**	**514.1**	**556.6**	**563.2**	**854.3**	**938.1**	**853.7**	**833.5**	**592.5**

BM: Biogas manure, T: Taflla, WCF: water capture fertilizer, S: Sulphur, CM: Chicken manure

Table 7: Available phosphorus (mgkg^{-1}) in different soils as influenced by soil amendments during incubation.

Treatments	Sandy soil					Calcareous soil				
	Incubation periods (days)									
	7	**14**	**28**	**42**	**56**	**7**	**14**	**28**	**42**	56
Control	43.96	14.01	3.08	6.57	16.0	56.42	39.11	21.86	29.0	**59.96**
BM	59.01	34.47	18.87	22.69	6.86	93.14	48.72	40.97	42.46	**39.87**
BM + T	72.20	33.64	23.03	31.99	30.4	75.03	64.80	50.44	51.43	**55.45**
BM + T + acidic WCF	62.01	84.02	20.86	31.50	51.5	85.33	62.97	35.81	22.03	**60.37**
BM + T + neutral WCF	69.54	38.61	23.03	37.31	23.2	55.42	47.89	41.46	33.61	**42.74**
BM + T + S	68.21	32.15	25.35	24.02	16.2	61.74	111.2	37.48	15.88	**44.79**
BM + T+ S + acidic WCF	53.01	38.61	19.87	18.04	17.5	59.01	47.39	44.12	25.35	**52.99**
BM + T+S+neutral WCF	52.76	39.94	24.52	21.36	14.4	56.26	45.41	41.96	14.38	**37.82**
CM	107.6	72.92	71.17	69.08	84.5	128.9	90.49	70.37	36.15	**123.5**
CM + T	91.64	63.97	67.22	56.42	85.1	101.4	83.69	73.86	33.32	**132.5**
CM + T + acidic WCF	84.66	86.34	79.84	71.20	93.5	43.46	81.70	65.89	44.62	**70.22**
CM + T + neutral WCF	101.1	66.45	71.37	71.87	101	130.4	88.83	88.98	32.99	**73.71**
CM + T + S	101.3	79.71	78.85	42.13	92.3	126.2	45.24	87.32	117.4	**145.2**
CM + T+ S+ acidic WCF	140.5	95.79	98.78	100.1	123	152.9	90.16	101.7	36.65	**97.01**
CM + T+ S+ neutral WCF	**141.6**	**77.23**	**65.55**	**59.08**	**87.6**	**137.2**	**109.2**	**82.83**	**44.95**	**140.3**

BM: Biogas manure, T: Taflla, WCF: water capture fertilizer, S: Sulphur, CM: Chicken manure