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Determination of the Amount of the Exchangeable Ammonium-Nitrogen in Soil Samples from the University of Cape Coast School Farm.

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Abstract— The amount of ammonium nitrogen (NH_4-N) were determined on two occasions (30th January and 30th March, 2012) to assess its level in various farm soils at the university of Cape Coast (U.C.C) school of Agric. Farm. The NH_4-N was extracted from the soil with 2MKCl followed by steam distillation and titration against a 0.01MHCl.On 30th January, the amount of NH_4-N at U.C.C school farm soil was high in citrus farm, followed by cassava, cabbage and pepper farms (11.0662, 10.1163, 9.845 and 9.7383mg/kg) respectively. On 30th March the amount of NH_4-N at U.C.C school farm soil increased in citrus farm followed by cassava, cabbage, and pepper farm (11.2807, 10.3344, 10.0429,9.9260 mg/kg) respectively. The intake of NH_4-N was less in citrus plants than that of cassava followed by cabbage and pepper plants respectively. Thus it is therefore advisable to practice crop rotation to ensure even distribution of NH_4-N in the soil on U.C.C school farm.

Key Terms— Ammonium nitrogen, Soil, Mineralization, aminization, Cassava, Cabbage, Pepper.

1.0 INTRODUCTION

Soil is one of the necessities of life for most plants life upon which human beings and other animals depend.

Ammonium Nitrogen is the conversion of organic N to NH_4+ which occurs through the activities of hetrotrophic microorganisms.

Alternatively the use of organic residues in replenishing the fertility status of our soils should be given prior attention. Prior to the advent of inorganic fertilizers organic sources of plant nutrients such as manure, played a significant role in the maintenance of soil fertility. The contribution of organic amendments to soil productivity include the supply of nutrients such as nitrogen and phosphorous stabilization of the soil structure and increase in cation exchange capacity of soils.

There have been considerable studies on the effect of crop residue incorporation on soil properties in the school farm.

This study was therefore carried out to determine the amount of ammonium nitrogen, hence the crops which must be incorporated to improve the soil fertility in the school farm.

Soil chemical properties such as organic matter content can influence land use management, passive pools of organic matter notably organic nitrogen and humus are more stable. The amount and quantity of organic matter retained to the soil is important for soil fertility improvements. Addition of soil organic matter facilitates transformation of fertilizer or soil N into a slowly available N source and thus improves N efficiency. Intensive cropping causes greater mineralization, and degradation of organic matter in the soil. It was observed by Banner (1994) that when organic fertilizer had been applied for many years at high rate organic matter content increased.

1.1 Mineralization of organic matter

Mineralization is the process by which organic mineral

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elements in organic matter are converted into Inorganic element. The process takes place simultaneously with humification, mainly in a layer, but also at any other part of the soil profile where organic matter is present.

1.2 N-Mineralization

Nitrogen mineralization is the conversion of N to NH4+. Mineralization of organic N compounds involves two reactions, Aminization and Ammonification which occurs through the activity of hetrotrophic micro organism

1.3 Aminization

This involves the hydrolytic decomposition of organic N compounds with the release of amino acids, amines, urea, carbon dioxide and energy which is usually facilitated by micro organisms

This step is as follows;

Protein $\longrightarrow$ R-CH (NH_2)-COOH +R-NH_2 + C $(NH_2)_2$= O + CO_2 + Energy

Bacteria Amino acid Amine Urea

1.4 **Ammonification**

It involves the breakdown of either the amino acid or with the release of ammonia. This step is represented as follows;

R-NH_2 + H_2O $\xrightarrow{\text{Bacteria}}$ NH_3 +R-OH

NH_3 +H_2O NH_4+ + OH-

Objective

To determine the level of NH_4-N in the school farm and the crops that must be incorporated to improve the soil fertility in the school farm.

2.0 MATERIALS AND METHODS

Soil samples were collected from the entire selected site using the randomized soil sampling method. A metal sampling tube typically 15cm diameter was driven into the soil and removed. The core was pushed out of the tube. The samples for each plot were bulked and mixed thoroughly. Representative samples were collected from the plot at a depth of 0- 20cm.

The number of samples: The distribution of mineral nitrogen can very variable in the field, particularly in well-structured soils. To obtain a measurement which represents a given area, replication is essential. Thus 4 cores were taken per plot (area) and bulked to give 2 replicates for analysis.

Extraction was carried out on the moist soil immediately after sampling (within a few hours). In emergencies samples can be stored by chilling to +20^{o}C to restrict mineralization. Once in KCl solution, extracts can stored for up to about 2 month in a refrigerator at 20^{o}C the soil was gentle crumbled, leaving out the stones and a representative of 40g of each sample for each area was taken for analysis. The water content of 10g of each sample was determined.

1L of distilled water was boiled to expel carbon dioxide gas.40g of boric acid was added and allowed to cool. 0.05g Bromocresol green was weighed and dissolved in 50ml ethanol. 0.05g of methyl-red was also weighed and dissolved in 50ml of ethanol. 10ml of methyl-red and 10ml bromocresol green solutions were then added to the boric acid solution.

Potassium chloride (2M. 149g of KCl was dissolved in distilled water in 1dm3 volumetric flask up to the mark.)

40g of moist soil sample was placed in 250ml conical flask for extraction. The mass of the dry soil was calculated from the water content. 200ml of 2M KCl was added and shaken for one hour. The suspension was then filtered. The mineral-N content of this extract was determined by steam distillation.

Two methods are currently in use for determining the ammonium content of a solution one depends upon alkaline steam distillation; the ammonia being absorbed in acid and titrated with an acid. The other depends upon the reaction of ammonia with Nessler's reagent to give a coloured solution.

Nessler's reagent is an alkaline solution of mercury (ii) iodide in potassium iodide, when the reagent is added to the dilute solution of ammonium salt; ammonia is liberated and reacts to produce a colloidal orange- brown solution which is then

ISSN 2229-5518

compared with standards. If too much ammonium is present in the test solution the reagent produces cloudiness and the colour of the complex is also affected by soluble salts. Thus the use of mercury in this test warrants its deletion;

$$2K_2(HgI_4) + 2NH_3 \longrightarrow NH_2Hg2I_3 + 4KI + NH_4I$$

Magnesium oxide, ignited. MgO was heated in a muffle furnace at 800°C overnight. This ensured that any $MgCO_3$ present was converted to MgO. It was then cooled and stored in a tightly stoppered bottle in a desicator. Octan-2-ol. This was used to prevent excessive frothing during distillation.

20ml of extract was pipetted into a distillation flask. 10ml of fresh boric acid solution was placed in the receiving and inserted under the condenser. One drop of octan-2-ol and 0.5g of MgO was added to the extract. Steam was passed and 50ml of distillate was collected. The receiving flask was removed and retained for titration. Each distillate was titrated against 0.01M HCL solution using methyl red-bromocresol green indicator. A blank determination was carried out using 20ml of 2M KCl solution.

3.0 RESULTS AND DISSCUSION

Farm plots	Mass of empty crucible a	Mass of moist soil/g b	Mass of crucible +moist soil/g a+b	Mass of crucible + oven dry soil/g (C)	Moisture mass/g a+b-c=d	Mass of dry soil/g C-a=e	moisture content d/e × 100 =β
Citrus	25.7047	10.0407	35.7454	34.5220	1.0889	8.9518	12.1640
Cabbage	24.1175	10.1333	34.2508	32.8666	1.2497	8.8836	14.0675
Cassava	25.6730	10.3245	35.9975	34.6651	1.1979	9.1266	13.1254
Pepper	25.5288	10.0233	35.5521	34.4654	0.9522	9.0711	10.4970

Table. 1. Show the moisture content crops.

Blank	Titre value
1	0.050
2	0.100
Average	0.075

Table. 2. Shows the blank titre values.

Cabbage farm Replicate	Moist Wt. of soil sample /g Y	Dry soil sample/g (100-β)/100×Y	Titre value/cm	Corrected titre value/cm	Amount of NH_4^+-N of oven dry soil (T-B)/mass ×280 /$mgKg^{-1}$
CA_1	10.4307	8.9634	0.40	0.325	10.1524
CA_2	10.1194	8.6958	0.45	0.375	12.0748
CA_3	10.0605	8.6452	0.30	0.225	7.2873
Average	10.2035	8.7681	0.3833	0.3083	9.8452

Table.3. Shows the corrected titration volumes and amount of NH_4^+-N of the Oven dry soil(Cabbage Farm).

Cassava farm Replicate	Moist Wt. of soil sample /g Y	Dry soil sample/g (100-β)/100×Y	Titre value/cm	Corrected titre value/cm	Amount of NH_4^+-N of oven dry soil (T-B)/mass ×280 /$mgKg^{-1}$
Ca_1	10.4164	9.0492	0.40	0.325	10.0561
Ca_2	10.1728	8.8376	0.45	0.375	11.8811
Ca_3	10.4744	9.0996	0.35	0.275	8.4619
Average	10.3545	8.9954	0.40	0.325	10.1163

Table.4.Shows the corrected titration volumes and amount of NH_4+-N of the Oven dry soil (Cassava Farm).

Citrus farm Replicate	Moist Wt. of soil sample /g Y	Dry soil sample/g (100-β)/100×Y	Titre value/cm	Corrected titre value/cm	Amount of NH_4^+-N of ovendry soil (T-B)/mass ×280 /$mgKg^{-1}$
CI_1	10.5862	9.2985	0.450	0.3750	11.2921
CI_2	10.2597	9.0117	0.450	0.3750	11.6515
CI_3	10.1179	8.8871	0.400	0.3250	10.2396
Average	10.3213	9.0658	0.433	0.3583	11.0662

Table.5. Shows the corrected titration volumes and amount of NH_4+-N of the Oven dry soil (Citru Farm).

ISSN 2229-5518

Pepper farm Replicate	Moist Wt. of soil sample /g Y	Dry soil sample/g (100-β)/100×Y	Titre value/cm	Corrected titre value/cm	Amount of NH_4^+-N of oven dry soil (T-B)/mass ×280 /$mgKg^{-1}$
P_1	10.6408	9.5238	0.45	0.375	11.0250
P_2	10.0905	9.0313	0.40	0.325	10.0761
P_3	10.5899	9.4783	0.35	0.275	8.1238
Average	10.4404	9.3445	0.40	0.325	9.7383

Table.6. Shows the corrected titration volumes and amount of NH_4+-N of the Oven dry soil (Pepper Farm).

Farm plots	Mass of empty crucible a	Mass of moist soil/g b	Mass of crucible +moist soil/g a+b	Mass of crucible + oven dry soil/g (C)	Moisture mass/g a+b-c=d	Mass of dry soil/g C-a=e	moisture content d/e × 100 =β
Citrus	25.7047	10.0407	35.7454	34.5220	1.2234	8.8173	13.8750
Cabbage	24.1175	10.1333	34.2508	32.8666	1.3842	8.7491	15.8211
Cassava	25.6730	10.3245	35.9975	34.6651	1.3324	8.9921	14.8175
Pepper	25.5288	10.0233	35.5521	34.4654	1.0867	8.9366	12.1601

Table.7. Shows the corrected titration volumes and amount of NH_4+-N of the Oven dry soil (Pepper Farm).

Blank	Titre value
1	0.050
2	0.100
Average	0.075

Table.8. shows the titre value of the blank solution.

Cabbage farm Replicate	Moist Wt. of soil sample /g Y	Dry soil sample/g (100-β)/100×Y	Titre value/cm	Corrected titre value/cm	Amount of NH_4^+-N of oven dry soil (T-B)/mass ×280 /$mgKg^{-1}$
CA_1	10.4307	8.7804	0.40	0.325	10.3634
CA_2	10.1194	8.5184	0.45	0.375	12.3263
CA_3	10.0605	8.4688	0.30	0.225	7.4391
Average	10.2035	8.5892	0.3833	0.3083	10.0429

Table.9. Shows the corrected titration volumes and amount of NH_4+-N of the Oven dry soil (Cabbage Farm)

Cassava farm Replicate	Moist Wt. of soil sample /g Y	Dry soil sample/g (100-β)/100×Y	Titre value/cm	Corrected titre value/cm	Amount of NH_4^+-N of oven dry soil (T-B)/mass ×280 /$mgKg^{-1}$
Ca_1	10.4164	8.8729	0.40	0.325	10.2559
Ca_2	10.1728	8.6654	0.45	0.375	12.1172
Ca_3	10.4744	8.9224	0.35	0.275	8.62997
Average	10.3545	8.8202	0.40	0.325	10.3344

Table. 9. Shows the corrected titration volumes and amount of NH_4+-N of the Oven dry soil (Cassava Farm).

Citrus farm Replicate	Moist Wt. of soil sample /g Y	Dry soil sample/g (100-β)/100×Y	Titre value/cm	Corrected titre value/cm	Amount of NH_4^+-N of ovendry soil (T-B)/mass ×280 /$mgKg^{-1}$
CI_1	10.5862	9.1174	0.450	0.3750	11.5164
CI_2	10.2597	8.8362	0.450	0.3750	11.8829
CI_3	10.1179	8.7140	0.400	0.3250	10.4429
Average	10.3213	8.8892	0.433	0.3583	11.2807

Table. 10. Shows the corrected titration volumes and amount of NH_4+-N of the Oven dry soil (Citru Farm).

Pepper farm Replicate	Moist Wt. of soil sample /g Y	Dry soil sample/g (100-β)/100×Y	Titre value/cm	Corrected titre value/cm	Amount of NH_4^+-N of oven dry soil (T-B)/mass ×280 /$mgKg^{-1}$
P_1	10.6408	9.3469	0.45	0.375	11.2337
P_2	10.0905	8.8635	0.40	0.325	10.2668
P_3	10.5899	9.3022	0.35	0.275	8.2776
Average	10.4404	9.1709	0.40	0.325	9.9260

Table.11. Shows the corrected titration volumes and amount of NH_4+-N of the Oven dry soil (Pepper Farm).

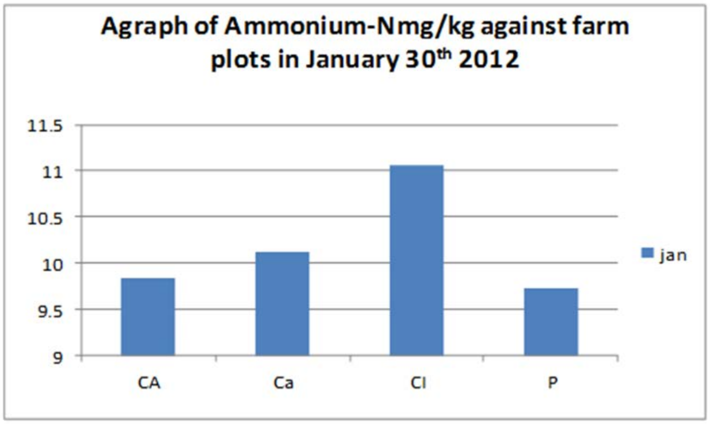

Fig.1. Shows a graph of ammonium-Nmg/Kg against farm plots in Jan 30th 2012.

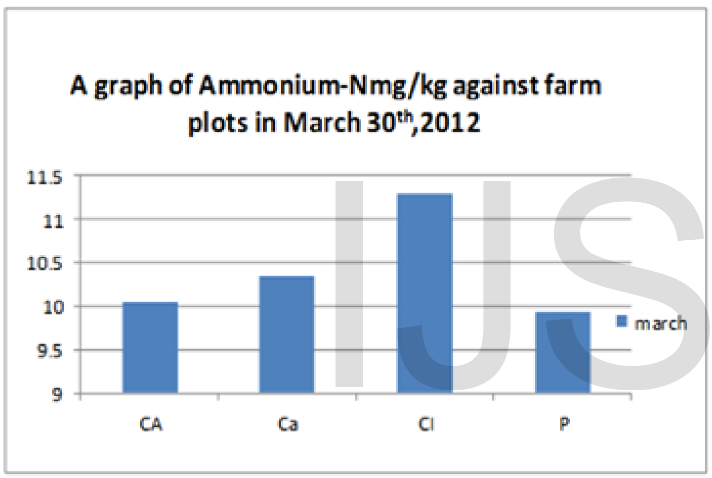

Fig.2.Shows a graph of ammonium-Nmg/Kg against farm plots in Jan 30th 2012.

Analysis of 30th Jan 2012 results

SOURCE OF VARIATION	D.F	SS	MSS	F-RATIO
Treatments	3	3.3949	1.1316	0.3794
Error	8	23.8612	2.9827	
Total	11	27.2561		

Table. 13.shows the Anova Table for 30th Jan 2012.

Analysis of 30th March 2012 results

SOURCE OF VARIATION	D.F	SS	MSS	F-RATIO
Treatments	3	3.2600	1.0866	0.3793
Error	8	22.9159	2.9827	
Total	11	26.1759		

Table.14. shows the Anova Table for 30th March 2012

Significance level: 5%

$F0.05\ (3, 8) = 4.07$

HYPOTHESIS:

$\mu 0$: No mean difference in NH_4-N among the four farm lands.

$\mu 1$: There is a mean difference in at least one of the four farm lands.

Significance level: 5%

$F0.05\ (3, 8) = 4.07$

HYPOTHESIS:

$\mu 0$: No mean difference in NH_4-N among the four farm lands.

$\mu 1$: There is a mean difference in at least one of the four farm lands.

Analysis for significant difference between January and March results

Paired T-Test and CI: Jan, March

Paired T for Jan – march

Time/Month	N	Mean	St Deviation	SE Mean
Jan	4	10.1915	0.6044	0.202200
March	4	10.3960	0.6143	0.207100
Difference	4	-0.20450	0.0143	0.007150

95% CI for mean difference: (-0.227254, -0.181746)
T-Test of mean difference = 0 (vs not = 0):
T-Value = -28.60
P-Value = 0.000

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4.0 DISCUSSION

From the table and graph of results of 30th January, 2007, it could be seen that the level of NH4-N at the University of Cape Coast School farm was high in citrus farm followed by cassava, cabbage, and pepper farms (11.0662,10.1163,9.8452, and 9.7383mg/kg) respectively. The differences in level of NH_4-N on various farm soils were confirmed by ANOVA analysis which gave an F-Ratio of 0.3794 over a significance level of 5%

From the table and graph of results of 30th March 2007, it was also seen that the level of NH4-N at U.C.C school farm was also high in citrus farm followed cassava, cabbage and pepper farms (10.49429, 10.3344, 10.0429, 9.9260 mg/kg) respectively. The differences in level of NH_4-N on various farm soils were also confirmed ANOVA analysis which also gave an F-Ratio of 0.3793 over a significance level of 5%

Analysis of January and March results using the paired t-test at 95%confidence interval gave a probability value of 0.00 which indicated a high significance difference between the level of NH_4-N in January and March.

From the moisture content table, the moisture content of all the farms in March was far greater than those of January. This was due to change in climatic condition; thus in January there was less rain than in March, hence mineralization of NH_4-N was very high during the raining season.

5.0 CONCLUSION

The level of ammonium nitrogen in March at the University of Cape Coast School farm was very high in Citrus farm followed by cassava, cabbage and pepper farms respectively than that of January.

Thus the intake of NH_4-N was less in citrus plants than that of cassava followed by

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