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Nitrogen Release Pattern of Nitrogenous Fertilisers in Major Soil Series of Madurai District

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Abstract: ***An incubation experiment was conducted at 2014 in the Department of Soil and environment, Agricultural college and Research Institute, Madurai with the objective to study the Nitrogen release pattern of two fertilizers in two different Soils as influenced by three manures, Via., FYM, Vermicompost and Green Leaf Manure. The treatments were replicated twice in a completely randomized block design. There were 16 treatments viz., T1 (Madhukur + Urea) Control, T2 (Madhukur + Urea + FYM), T3 (Madhukur + Urea + Vermicompost), T4 (Madhukur + Urea + GLM), T5 (Madhukur + (NH4)2 SO4) Control, T6 (Madhukur + (NH4)2SO4 + FYM), T7 (Madhukur + (NH4)2SO4 + Vermicompost), T8 (Madhukur + (NH4)2 SO4 + GLM), T¬9 (Vayalogam +Urea) Control, T10 (Vayalogam + Urea + FYM), T11 (Vayalogam + Urea + Vermicompost), T12 (Vayalogam + Urea + GLM), T13 (Vayalogam + (NH4)2SO4) Control, T14(Vayalogam + (NH4) 2 SO4 + FYM), T15 (Vayalogam + (NH4)2SO4 + Vermicompost), T16 (Vayalogam + (NH4) 2SO4 + GLM). The experiment results revealed that, Madukur series has recorded higher N release during different periods of incubation. From 5th day onwards the soil with manure application shows increase in nitrogen release. N release from Ammonium sulphate is quicker than urea. Green leaf manure is found to have higher influence in N release than other manure. N release was high in ammonium sulphate when applied in soil belonging to madukur soil series along with green leaf manure.***

Keywords: Ammoniacal Nitrogen, Nitrate Nitrogen, Ammonium sulphate, Urea.

1. Introduction

Nitrogen is the most important essential nutrient that plays a major role in achieving maximum crop yield in agriculture (Hayatsu *et al*.,2011). Therefore, nitrogen fertilizers such as ammonium sulfate and urea have been extensively used in modern agriculture. These fertilizers are generally oxidized to nitrate via nitrite by nitrifying microorganisms in the agricultural field (Ishi *et al*.,2011). Nitrogen is needed by all plants and usually in large quantities. In soils nitrogen is presented either in NH_4^+ form or NO_3^- form before plants can absorb and use it. Synchronizing the timing of fertilizer addition on the demand of plant growth while reducing nutrient loading to the surrounding environment remains a major challenge in crop management. As meeting fertilizer needs of plant in its critical period of growth is essential otherwise misleading of this could lead to nitrogen imbalance which may negatively impact plant production and the same time exact amount of fertilizer required is to be calculated and implement as overloading of fertilizer will destroy soil health and also cause pollution like NO_3 leaching. Madhukur and vayalogam are the two major soil series in Madurai district. The Agricultural college and Research Institute field contains these two series in the Farm A, B and D. Both the land forms are plain and the soil comes under Alfisols (typic haplustalf). Hence this study is taken up to determine the nitrogen release pattern of two different fertilizers namely Urea and Ammonium sulphate which are most commonly used nitrogen rich fertilizer in different combination of three manures (Farm yard manure, Vermicompost and Green leaf manure) in two soils i.e. Madhukur and Vayalogam soil series. Keeping this view the study and determination of transformation of N fertilizer in available form and influence of different manure in transformation with the following objectives 1) To monitor the transformation process of applied fertilizer N as influenced by FYM, Vermicompost and GLM 2) To quantify the NH_4-N and NO_3-N released from the added fertilizer 3) To examine the time required for the N release from the applied fertilizer and manures.

2. Material and Methods

The two major soil series of Madurai taken for experiment are Madhukur soil series and Vayalogam soil series.

Table 1. Initial Characteristics of two soil series

Characteristics	Madhukur	Vayalogam	Reference
A. Particle Size Distribution			
Coarse sand	23.25	22.89	Robinson (1922)
Fine sand	31.33	32.71	
Silt	16.31	22.63	
Clay	27.54	20.01	
Texture	Sandy clay loam	Sandy Loam	
B. Physical properties			
Bulk density	1.21 g/cc	1.17 g/cc	Piper (1966)
Particle density	2.5 mg m^{-3}	2.2 mg m^{-3}	Piper (1966)
Pore space	52%	47 %	Piper (1966)
C. Physico-chemical properties			
pH	7.26	7.62	Jackson (1973)
EC	1.0 dSm^{-1}	1.04 dSm^{-1}	Jackson (1973)
CEC	12.7 c mol(P^+) / kg soil	9.8 c mol(K^+)/Kg soil	Jackson (1973)

D. Available nutrient status			
Available Nitrogen	285.4 Kg/ ha	229 kg/ha	Subbiah and Asija (1956)
Available Phosphorus	18Kg/ha	17.5 Kg/ha	Olsen *et al.* (1954)
Available Potassium	540 kg/ha	631 Kg/ha	Jackson (1973)
Organic Carbon	0.72%	0.48 %	Walkley and Black (1934)

To study Nitrogen release pattern we took two major soil series of Madurai i.e Madhukur (S_1) and Vayalogam (S_2),two fertilizer Urea (F_1) and Ammonium Sulphate (F_2) & 3 Manure control (M1) Farm Yard Manure (M_2) Vermicompost (M_3) and Green leaf manure (Glyricida) (M_4) . totally 16 treatments is taken. The treatment structure is as follows: $S_1F_1M_1$– T_1 (Madhukur + Urea) Control, $S_1F_1M_2 – T_2$ (Madhukur + Urea + FYM), $S_1F_1M_3 – T_3$ (Madhukur + Urea + Vermicompost), $S_1F_1M_4 – T_4$ (Madhukur + Urea + GLM), $S_1F_2M_1 – T_1$ (Madhukur + $(NH_4)_2 SO_4$) Control, $S_1F_2M_2 – T_2$ (Madhukur + $(NH_4)_2SO_4$ + FYM), $S_1F_2M_3 – T_3$ (Madhukur + $(NH_4)_2SO_4$ + Vermicompost), $S_1F_2M_4 – T_4$ (Madhukur + $(NH_4)_2 SO_4$ + GLM), $S_2F_1M_1 – T_1$ (Vayalogam +Urea) Control , $S_2F_1M_2 – T_2$ (Vayalogam + Urea + FYM), $S_2F_1M_3 – T_3$ (Vayalogam + Urea + Vermicompost), $S_2F_1M_4 – T_4$ (Vayalogam + Urea + GLM), $S_2F_1M_1 – T_1$ (Vayalogam + $(NH_4)_2SO_4$) Control, $S_2F_1M_2 – T_2$(Vayalogam + $(NH_4)_2 SO_4$ + FYM), $S_2F_1M_3 – T_3$ (Vayalogam + $(NH_4)_2SO_4$ + Vermicompost), $S_2F_1M_4 – T_4$ (Vayalogam + $(NH_4)_2SO_4$ + GLM). The two soils are taken from their respective block and the soil processing is done. The ammoniacal nitrogen and nitrate nitrogen is to be estimated for 7 days or (7 lots) in 15 days duration as follows:

1st estimation – after 24 hrs of fertilizer and manure application

2 nd estimation - after 48 hrs of fertilizer and manure application

3 rd estimation - after 72 hrs of fertilizer and manure application

4 th estimation - after 5 th day of fertilizer and manure application

5 th estimation - after 7 th day of fertilizer and manure application

6 th estimation - after 10 th day of fertilizer and manure application

7 th estimation - after 15 th day of fertilizer and manure application

So for this totally 112 beaker is taken with 16 treatment/day. In each beaker 100g soil is taken and according to treatment structure Urea is applied at 0.011g/100g soil, Ammonium sulphate is applied at 0.558g/100g of soil, FYM is applied at 0.558g/100g of soil, Vermicompost is applied at 0.22g/100g of soil, Green Leaf Manure (Glyricidia) is applied at 0.275g/100g of soil. As urea and $(NH_4)_2SO_4$ requirement per 100g soil is very less and exact application is not possible. So to avoid error urea and $(NH_4)_2SO_4$ is applied in percentage solution form by mixing 1.65g of urea in 1500 ml of water and 3.9g of $(NH_4)_2SO_4$ in 1500ml of water so that 10ml of each of them is applied to meet the desired requirement. Then soil in each beaker is maintained at field capacity level. The field capacity of water is maintained in soil till 15th day by regular application of desired distilled water. The soil physical and Physico-chemical properties are analysed as per procedures.

3. Experimental Results

3.1. Composition of Manures:

Manures	N%	P%	K%
FYM	0.5	0.22	0.40
Vermicompost	1.2	0.6	1.0
GLM	2.4	0.10	0.56

From the composition of manure it has been found out that highest N % is present in GLM (2.4 %) among GLM, FYM and Vermicompost. Phosphorus percentage is found to be highest in FYM among all three manure. While K % is found to be highest in GLM among three manure. Based on this observation GLM is found to be best manure among three.

3.2. Nitrogen transformation

3.2.1. NH_4-N and NO_3-N releases as influenced by fertilizers in two soil series

The interaction effect of soil series viz., Madhukur and vayalogam with fertilizers namely urea and ammonium sulphate, the highest value recorded (252 kg/ha and 91 kg/ha) in ammonium sulphate treated samples after 72 hrs incubation of NH_4-N and after 48 hrs incubation of NO_3-N (Table 2). It has been founded in all the day of estimation both madhukur and vayalogam soil series showed higher value of NH_4-N.

Table 2: NH_4-N and NO_3-N releases as influenced by fertilizers in different periods

Treatments	NH_4- N (Kg/ha)		NO3-N (Kg/ha)	
SOIL/FERTILIZER	F1	F2	F1	F2
				24 Hrs
S1	154	224	77	77
S2	154	224	77	77
				48 Hrs
S1	161	224	84	91
S2	154	224	77	77
				72 Hrs
S1	231	252	133	161
S2	168	259	98	140
				5th DAY
S1	196	210	168	161
S2	154	210	126	140
				7th DAY
S1	168	196	168	161
S2	140	203	126	140
				10th DAY
S1	133	189	196	203
S2	147	175	161	168
				15th DAY
S1	98	168	245	224
S2	133	161	175	196

But there is reduction in ammoniacal nitrogen after 5th day of incubation. There is no reduction in nitrate nitrogen; it increases upto 224 kg/ha in madhukur and 196 kg/ha in vayalogam series from the initial value of 77 kg/ha.

3.2.2. NH_4-N and NO_3-N releases as influenced by fertilizers and manures in different periods

On observing the interaction of fertilizers urea and ammonium sulphate with three manures i.e. FYM, Vermicompos

Table 3: Interaction of manures and fertilizers in NH_4-N and NO_3-N under different periods of incubation

TREATMENTS	NH_4 – N (Kg/ha)		NO_3 -N(Kg/ha)	
MANURES/ FERTILIZERS	F1	F2	F1	F2
			24 Hrs	
M1	196	252	112	112
M2	112	196	56	56
M3	154	224	56	56
M4	154	224	84	84
			48 Hrs	
M1	210	252	112	116
M2	112	196	56	56
M3	154	224	70	70
M4	154	224	84	98
			72 Hrs	
M1	224	252	154	196
M2	168	224	98	126
M3	196	252	98	126
M4	210	294	112	154
			5th DAY	
M1	182	210	154	126
M2	182	196	126	140
M3	168	224	140	154
M4	168	210	168	182
			7th DAY	
M1	154	196	154	126
M2	112	196	126	140
M3	140	196	140	154
M4	210	210	168	182
			10th DAY	
M1	140	168	196	154
M2	112	168	154	182
M3	126	196	140	182
M4	182	196	224	224
			15th DAY	
M1	112	168	210	182
M2	84	140	182	210
M3	112	168	210	21
M4	154	182	238	238

and green leaf manure. The results revealed that in all the days of estimation ammonium sulphate shows better interaction with different manures rather than urea. In case of ammoniacal nitrogen there is no changes upto 72 hrs of incubation, only control shows higher values. On 3rd day (72 hrs) there is tremendous increase in ammoniacal nitrogen especially in ammonium sulphate with green leaf manure treatment shows higher amount of NH_4-N.After 72 hrs, there is a reduction in ammoniacal nitrogen in all manure treatments and control. There is a gradual increase in nitrate nitrogen upto 238 kg/ha from 84 kg/ha (Table 3). Best interaction observed while considering two soil madhukur and vayalogam in combination with different it has been observed that ammonium sulphate with shows best interaction i.e. highest value of NH_4-N and NO_3-N.

4. Discussion

4.1. Influence of Soil Series on N release

After experiment it has been found out that based on particle distribution madukur soil has sandy clay loam texture while vayalogam soil has sandy loam texture. As madukur soil series has more clay content it has more exchange capacity as displayed by its CEC value. Madhukur soil has been found to notice more organic carbon than vayalogam soil. As a result of these properties madukur soil has recorded higher N release during different periods of incubation (Table 1).

4.2. Influence of Fertilizers on N release

Ammonium sulphate $(NH_4)_2$ $SO_{4)}$ as it already contains nitrogen in NH_4^+ (ammonium form) it can directly be converted to NO_3^- (nitrate form) while urea contains nitrogen in amide form so first it has to be converted into NH_4^+ (ammonium form) then only it will get converted into NO_3^- (nitrate form) (Cabrera *et al*.,1991). So the ammonium sulphate shows quicker release of nitrogen as displayed by value of ammoniacal nitrogen and nitrate nitrogen from the result of experiment of different period of incubation (wahhab *et al*.,1956). On fifth day onwards there is increase in nitrate nitrogen and decrease in NH_4 N.

4.3. Influence of Manure application on N release

It has been found out that there is no significant release of nitrogen during first three days, during first three days, only control shows good release of Nitrogen. This may be due to the reason that control does not contain any manure so there is no immobilization while other treatment with manure will have microbial activity and for this microbial activity micro organism needs nitrogen and for meeting its N requirements. It will take nitrogen present in soil as well as nitrogen released by fertilizers. Increasing the N rates of manures above 120 kg N ha^{-1} will improve their potential as plant nutrient sources. Complementing the manures with inorganic N fertilizers in integrated nutrient management will also improve its quality and effectiveness (Azez and Averbeke, 2010) . So all the treatments other than control show decrease in N release up to third day after incubation. From fifth day onwards there is increase in N release in the soil with manure application as rate of immobilization reduces and net mineralization occurs. It is proposed by Juan et al., 2002, that green manure that decomposed and released N slowly resulted in high N uptake when they were used at pre-sowing in soil. Apart from this it has been found that green leaf manure is found to have higher influence on N release than other manure. It may be due to the reason that green leaf manure has least C: N ratio as compared

to FYM and vermicompost. So in case of green leaf manure net mineralization will be more and sooner than other manure.

5. Conclusion

N release was high in ammonium sulphate when applied in soil belonging to madukur soil series along with green leaf manure. But urea is most common nitrogenous fertilizer used in India because of its high N % resulting in low cost of cultivation. So as conclusion if farmers will apply urea along with green leaf manure in madukur soil before five days it will increase the nitrogen use efficiency and finally yield of critical period of growth of rice.

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