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Research Article

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Incubation Study of Periodical Release of Nitrogen through Slow Release Nitrogen Fertilizers on Inceptisol Soils

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ABSTRACT

An Incubation study under laboratory condition were conducted during 2016 with a view to study "Influence of slow release nitrogenous fertilizers on soil nitrogen availability under Incubation study" The laboratory incubation experiment was conducted in completely randomized design with 11 treatments. The application of nitrogen through slow release fertilizers as CDU, NCU and SCU and their combination with urea and among the organic sources release the soil available nitrogen with advanced incubation period. It was decreased in treatment GRDF and RDN-CDU at 90 DAA. The release of ammonical nitrogen in all the treatments showed the similar trend to that of soil available nitrogen at all the period of incubation. The slow release nitrogen fertilizer treatment @ 50 % RDN-urea + 50 % RDN either through CDU, NCU or SCU were beneficial for release of nitrate nitrogen in soil.

Key words: *slow release nitrogenous fertilizers, incubation, available N, Ammonical Nitrogen, Nitrate nitrogen.*

INTRODUCTION

Nitrogen is essential and primary nutrient required by all crops. Urea fertilizer is most commonly used to supply N due to high percentage of N content (46%). Urea is inexpensive, safe to handle and it has a high percentage of nitrogen. But the major problem associated with the urea fertilizer is the low N –efficiency (30-40%)[4]. However, 50-70 per cent of the applied nitrogen gets lost due to different losses via volatilization, leaching etc, reducing the use efficiency of applied fertilizers[9].

The nitrogen requirements of all the field crops are comparatively higher than the other nutrients like phosphorus, potassium, sulphur etc. However, the use efficiency of applied nitrogen through fertilizers are less because of hydrolysis of nitrogen fertilizer and their transformation by means of soil chemical reactions in soil or by microbial activity within short span of time. This might be mismatched with nitrogen requirement of crop as per their crop growth stage. The unutilized nitrogen by the crop leads to losses either through leaching or volatilization process.

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This is the main threat in less use efficiency of nitrogen added through chemical fertilizers. Efforts have therefore, been made to develop slow release nitrogen fertilizers. To overcome these constrain in increasing the use efficiency of nitrogen in soil the present investigation was planned. An incubation study of periodical release of nitrogen through slow release nitrogen fertilizers under controlled condition on Inceptisol soils was studied.

MATERIALS AND METHODS

An incubation study was conducted in the laboratory under ambient conditions for 90 days. Clayey soil of surface layer (0-15cm) was collected from Soil Test Crop Response Correlation Project (ICAR) in 2016 and processed in the laboratory. The processed soil was saturated with deionized water and allowed to evaporate to attain the field capacity moisture by gravimetric method. The known quantity of soil at field capacity moisture and quantity of slow release nitrogen fertilizer were mixed with soil as per treatment (Table1). The recommended dose of P_2O_5 60 kg ha^{-1}, K_2O 40 kg ha^{-1} and 10 t ha^{-1} FYM were applied uniformly to all the treatments. These treatments were applied for 2 kg processed sieved soil filled in plastic bowl. These treated soils were filled in plastic bottles in triplicate separately for each incubation period. These bottles were kept in laboratory under ambient condition and maintained their moisture to field capacity by gravimetrically. The soils of these bottles were analyzed for soil available nitrogen, NH_4^{+}-N and NO_3^{-}-N as per incubation period by destructive methods. Triplicate soil samples were then withdrawn from incubated samples after 7, 21, 60, 90 days for N transformation. The soil samples are extracted with 2M KCl and the extracted sample was analyzed for NH_4-N and NO_3-N by stem distillation method[3]. Available nitrogen was analyzed by using alkaline potassium permanganate method[11].

Table 1: Treatment details

Tr. No.	
T_1	Control
T_2	GRDF (120: 60: 40 kg N:P_2O_5 :K_2O ha^{-1} + 10 t ha^{-1} FYM)
T_3	RDN- CDU(crotonylidene di-urea)
T_4	RDN- NCU (Neem coated urea)
T_5	RDN- SCU(Sulphur coated urea)
T_6	50% RDN- Urea + 50% N- NCU
T_7	50% RDN- Urea + 50% N- CDU
T_8	50% RDN- Urea + 50% N-SCU
T_9	50% RDN- NCU + 50% N-CDU
T_{10}	50% RDN- NCU + 50% N-SCU
T_{11}	50% RDN- CDU + 50% N-SCU

Note: a) RDF (120:60:40 NPK Kg ha^{-1})
b) Phosphorus and potassium is common to all treatments through single superphosphate and muriate of potash
c) RDN- Recommended dose of Nitrogen

Table 2: Initial physico-chemical characteristics of soil

Sr. No.	Soil properties	Value	Method
I.	**Physical properties**		
1.	Particle size distribution		
	i)Sand	10.04	International pipette method[1]
	ii)Fine sand	16.20	-do-
	iii)Silt	31.40	-do-
	iv)clay	42.36	-do-
2.	Textural class	Clayey	-
II.	**Chemical properties**		
1.	pH (1:2.5)	8.00	Potentiometric[2]
2.	EC (dS m^{-1})	0.19	Conductometric[2]
4.	Organic carbon (%)	0.43	Wet oxidation[6]
5.	Available N (kg ha^{-1})	158.30	Subbiah and Asija[11]
6.	Available P (kg ha^{-1})	15.00	Watanabe and Olsen[13]
7.	Available K (kg ha^{-1})	429.65	Flame photometorically[2]
8.	NH_4-N (kg ha^{-1})	73.17	Keeney and Nelson[3]
9.	NO_3-N (kg ha^{-1})	120.21	Keeney and Nelson[3]

RESULT AND DISCUSSION

Effect of Slow Release Nitrogenous Fertilizer on Soil Available Nitrogen, Ammonical Nitrogen and Nitrate Nitrogen

The organically bound nitrogen applied to field crops as source of nitrogen is acted upon microbial activity, soil enzyme activity and certain other parameters related with soil physical and chemical environment prevailed during crop growth period. But the microbial activity and enzyme activity has paramount importance in availability of nitrogen and their fractions as ammonical and nitrate nitrogen. Similarly, the source of nitrogen to be applied to provide the nitrogen to field crops and their forms in source also governs the release of nitrogen in available form in association with soil microbial and enzymatic activity. The effect of slow release nitrogen fertilizer on soil available nitrogen, ammonical and nitrate nitrogen were assessed periodically in laboratory incubation study under ambient condition. The results emerged from the study are presented in Table 3, 4, and 5.

Soil available nitrogen

The periodical soil available nitrogen as influenced by slow release nitrogenous fertilizers are reported in Table 3 and Fig.1 The periodical release of soil available nitrogen was significantly more in treatment GRDF at 7 and 21 DAA (80.50 and 86.80 mg kg^{-1}) than the rest of the treatments. This might be because of in GRDF treatment, nitrogen was added through urea fertilizer which was easily acted upon by the soil microbes and enzyme activity[5]. Whereas, it was decreased at 60 and 90 DAA (84.70 and 77.20 mg kg^{-1}). The decrease may be due to reduction in substrate as urea for the enzyme activity and microbial activity[7].

The release of soil nitrogen periodically was found statistically on par with each other in all the treatment except GRDF and control at 7 DAA. It was increased at 21, 60 and 90 DAA over 7 DAA. However, the release of nitrogen was increased up to 60 DAA and decreased at 90 DAA irrespective of slow release nitrogen treatment. The recommended dose of nitrogen through CDU, NCU and SCU recorded higher soil available nitrogen at 7 DAA (70.70, 66.50 and 67.90 mg kg^{-1}, respectively) and statistically on par with treatment of afforstation of nitrogen through urea and CDU, NCU and SCU. Similar trend was observed at 21, 60 and 90 DAA.

The application of nitrogen through slow release nitrogenous fertilizers as CDU, NCU and SCU and their combination with urea and among the slow release fertilizer release the soil available nitrogen with increased trend with advanced incubation period. But it was found decreased in treatment GRDF and RDN-CDU at 90 DAA as compared to other treatment. The decrease in soil available nitrogen at 90 DAA might be associated with nitrogen contain in urea fertilizer used in treatment GRDF are subjected to easily hydrolyzed as well acted upon soil microbes and enzyme activity. Whereas, the CDU contains other constituents like sugar, protein etc. which act as source of energy to soil microbes and enhanced their activity at early stage there was more release of nitrogen than at later stage[12].

Thus, the use of slow release fertilizer as a source of nitrogen alone or in combination with urea fertilizer are beneficial to release the soil available nitrogen slowly periodically in soil.

Table 3: Effect of slow release nitrogenous fertilizers on soil available nitrogen under laboratory condition

Tr. No	Treatment	Soil available N (mg kg^{-1})			
		7 DAA	21 DAA	60 DAA	90 DAA
T_1	Control	49.70	51.80	51.10	46.00
T_2	GRDF	80.50	86.80	84.70	77.20
T_3	RDN-CDU	70.70	76.30	77.00	72.80
T_4	RDN-NCU	66.50	72.80	70.70	66.30
T_5	RDN-SCU	67.90	75.60	74.20	75.80
T_6	50% RDN – Urea + 50 % NCU	70.70	77.00	84.00	79.10
T_7	50% RDN – Urea + 50 % CDU	69.30	73.50	79.10	74.20
T_8	50% RDN – Urea + 50 % SCU	67.90	72.80	81.90	73.50
T_9	50% RDN – NCU + 50 % CDU	62.30	68.60	69.30	66.70
T_{10}	50% RDN – NCU + 50 % SCU	56.70	63.00	68.60	63.70
T_{11}	50% RDN – CDU + 50 % SCU	62.30	67.90	74.20	69.30
	Initial	45.00			
	S.Em. ±	1.71	0.57	1.21	1.30
	CD at 5%	5.33	1.77	3.79	4.05

Table 4: Effect of slow release nitrogenous fertilizers on soil NH_4-N under laboratory condition

Tr. No	Treatment	NH_4-N (mg kg^{-1})			
		7 DAA	21 DAA	60 DAA	90 DAA
T_1	Control	38.50	37.10	35.00	32.90
T_2	GRDF	55.30	58.10	54.60	49.70
T_3	RDN-CDU	52.50	54.60	53.90	51.80
T_4	RDN-NCU	53.90	56.70	53.20	51.10
T_5	RDN-SCU	51.10	55.30	52.50	56.70
T_6	50% RDN – Urea + 50% NCU	49.70	52.50	58.10	55.30
T_7	50% RDN – Urea + 50 % CDU	46.90	48.30	52.50	49.70
T_8	50% RDN – Urea + 50% SCU	44.10	45.50	53.20	46.90
T_9	50% RDN – NCU + 50% CDU	48.30	51.10	50.40	50.40
T_{10}	50% RDN – NCU + 50% SCU	41.30	44.10	48.30	45.50
T_{11}	50% RDN – CDU + 50% SCU	42.70	44.80	49.70	46.90
	Initial	32.19			
	S.Em. ±	0.57	0.71	0.94	0.78
	CD at 5%	1.77	2.21	2.93	2.45

Ammonical nitrogen (NH_4-N)

The periodical release of soil ammonical nitrogen was significantly influenced by the slow release nitrogenous fertilizer in laboratory incubation study under ambient condition (Table 4 and Fig. 2).

The release of ammonical nitrogen in all the treatment showed the similar trend to that of soil available nitrogen at all the period of incubation. The release of ammonical nitrogen was more in treatment, where nitrogen was given through CDU, NCU and SCU at all the period of incubation. Urea applied treatment showed higher NH_4-N. This might be because of these treatment showed the higher population of *Nitrosomonas* soil microorganism. The soil microorganism *Nitrosomonas* are plays the role in transformation of nitrogen in ammonical (NH_4) form[8].

Nitrate nitrogen (NO_3-N)

The nitrate nitrogen content in soil was significantly influenced by the slow release nitrogen fertilizer at all the period of incubation (Table 5 and Fig.3). The treatment GRDF recorded significantly higher content of nitrate nitrogen at 7, 21, 60 and 90 DAA (25.20, 28.70, 30.10 and 27.50 mg kg^{-1} respectively). It was statistically on par with treatment 50% RDN-urea + 50% SCU (23.80, 27.30, 28.70 and 26.60 mg kg^{-1} respectively). The least amount of nitrate nitrogen was found in control treatment (11.20, 14.70, 16.10 and 13.10 mg kg^{-1} respectively) and RDN-NCU (12.60, 16.10, 17.50 and 15.20 respectively) followed by 50% RDN-NCU + 50% SCU (14.00, 17.50, 18.90 and 16.30 mg kg^{-1} respectively). The least nitrogen content of nitrate nitrogen might be because of neem cake and sulphur may inhibit the microbial activity responsible for release of nitrate nitrogen in soil[10]. The afforstation of nitrogen as 50% RDN-urea + remaining 50% RDN through CDU, NCU or SCU treatment were found statistically on par with each other for periodical release of nitrate nitrogen. However, it was numerically more than the treatment RDN-CDU, RDN-NCU and RDN-SCU respectively.

In general, slow release nitrogenous fertilizer treatment as 50% RDN-urea + 50% RDN either through CDU, NCU or SCU were beneficial for release of nitrate nitrogen slowly in soil.

Table 5: Effect of slow release nitrogenous fertilizers on soil NO_3-N under laboratory condition

Tr. No	Treatment	NO_3-N (mg kg^{-1})			
		7 DAA	21 DAA	60 DAA	90 DAA
T_1	Control	11.20	14.70	16.10	13.10
T_2	GRDF	25.20	28.70	30.10	27.50
T_3	RDN-CDU	18.20	21.70	23.10	21.00
T_4	RDN-NCU	12.60	16.10	17.50	15.20
T_5	RDN-SCU	16.80	20.30	21.70	19.10
T_6	50 % RDN – Urea + 50 % NCU	21.00	24.50	25.90	23.80
T_7	50 % RDN – Urea + 50 % CDU	22.40	25.20	26.60	24.50
T_8	50 % RDN – Urea + 50 % SCU	23.80	27.30	28.70	26.60
T_9	50 % RDN – NCU + 50 % CDU	14.00	17.50	18.90	16.30
T_{10}	50 % RDN – NCU + 50 % SCU	15.40	18.90	20.30	18.20
T_{11}	50 % RDN – CDU + 50 % SCU	19.60	23.10	24.50	22.40
	Initial	50.12			
	S.Em. $\pm$	1.14	0.54	0.64	0.99
	CD at 5%	3.55	1.69	2.00	3.08

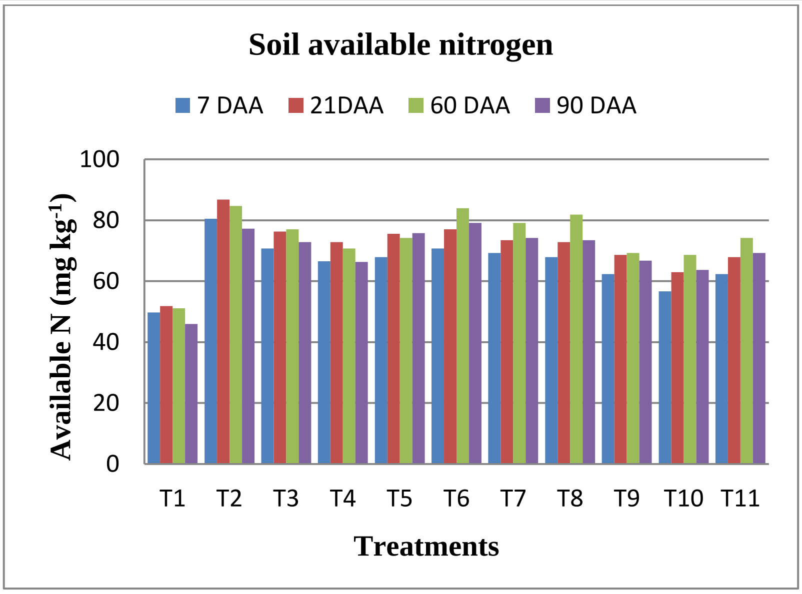

Fig. 1: Effect of slow release nitrogenous fertilizers on soil available nitrogen under laboratory condition

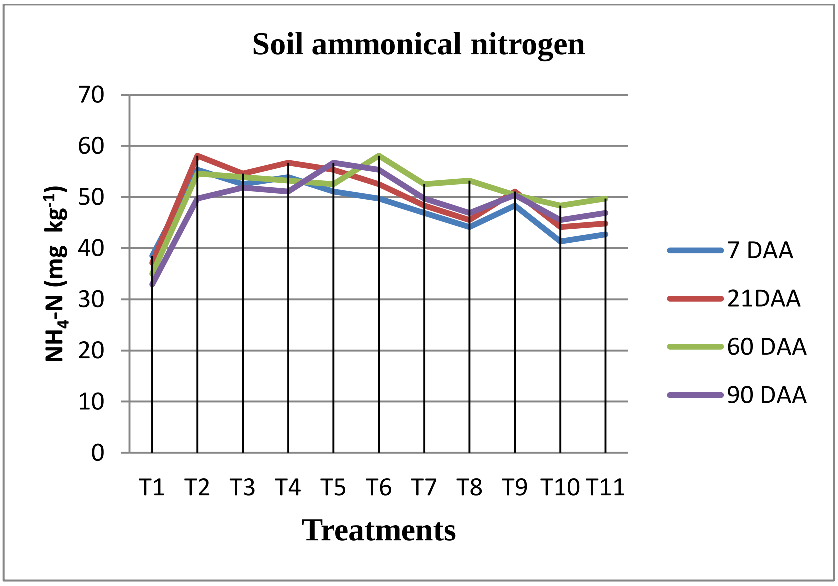

Fig. 2: Effect of slow release nitrogenous fertilizers on soil ammonical nitrogen under laboratory condition

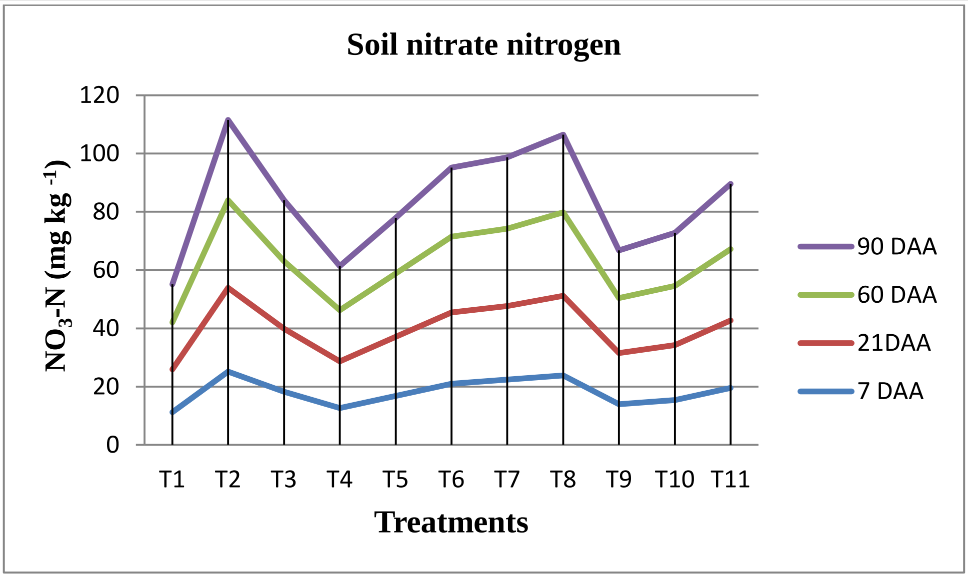

Fig. 3: Effect of slow release nitrogenous fertilizers on soil nitrate nitrogen under laboratory condition

CONCLUSION

The use of slow release fertilizer as a source of nitrogen alone or in combination with urea fertilizer are beneficial to release the soil available nitrogen slowly periodically in soil. Recommended dose of nitrogen 50% -urea + 50% RDN either through CDU, NCU or SCU were beneficial for release of nitrate nitrogen slowly in soil. Urea hydrolysis and N mineralization (ammonification and nitrification) have been delayed with the addition of slow release nitrogenous fertilizers thereby increasing the availability of urea-N over a longer period of time as compared to urea applied alone otherwise which would have been rapidly converted to NH_4+-N and NO_3 –N.

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