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Nainsi Naya

Department of Soil Science and
Agricultural Chemistry, Indira
Gandhi Krishi Vishwavidyalaya,
Raipur, Chhattisgarh, India

Dr. K Tedia

Department of Soil Science and
Agricultural Chemistry, Indira
Gandhi Krishi Vishwavidyalaya,
Raipur, Chhattisgarh, India

Shri Vinay Bachkaiya

Department of Soil Science and
Agricultural Chemistry, Indira
Gandhi Krishi Vishwavidyalaya,
Raipur, Chhattisgarh, India

Dr. LK Srivastava

Department of Soil Science and
Agricultural Chemistry, Indira
Gandhi Krishi Vishwavidyalaya,
Raipur, Chhattisgarh, India

Parmanand Verma

Department of Soil Science and
Agricultural Chemistry, Indira
Gandhi Krishi Vishwavidyalaya,
Raipur, Chhattisgarh, India

Corresponding Author:**Nainsi Naya**

Department of Soil Science and
Agricultural Chemistry, Indira
Gandhi Krishi Vishwavidyalaya,
Raipur, Chhattisgarh, India

Study the release pattern of nitrogen as ammonical and nitrate nitrogen from neem-coated and prilled urea in rice as a test crop

Nainsi Naya, Dr. K Tedia, Shri Vinay Bachkaiya, Dr. LK Srivastava and Parmanand Verma

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Abstract

Release pattern of nitrogen as ammonical and nitrate nitrogen from different levels of neem-coated and prilled urea applied in rice was conducted on *vertisol* during *Kharif* 2019. The concentration of ammonical and nitrate nitrogen was measured on 3, 5 and 7 days after each application of N fertilizer at 10, 30 and 50 days after transplanting. The effect of different levels of neem coated and prilled urea on concentration of ammonical ($\text{NH}_4\text{-N}$) and nitrate nitrogen ($\text{NO}_3\text{-N}$) in flood water were found significant. The increasing levels of neem coated and prilled urea increased the concentration of ammonical nitrogen and nitrate nitrogen in flood water on the different days. The peak concentration of ammonical and nitrate nitrogen in flood water was observed on 3 days after application of neem coated and prilled urea and decreased gradually on 5th and 7th days after the application. The highest concentration of ammonical and nitrate nitrogen was observed in T9(STCR based yield target 6t) treatment and the lowest was recorded in treatment T1-control. The concentration of nitrate in flood water was lower than ammonia due to the reductive condition of the flooded rice field. The results showed that neem coated urea slow down the conversion of nitrogen amide (urea) in to NH_4^+ and thus increases the time its availability for longer time as compared to the prilled urea.

Keywords: Neem-coated urea, Prilled urea, Ammonical-N, Nitrate-N

Introduction

The efficient use of nitrogen is recognized as a crucial production factor but its constant losses favours a trouble to elevate its utilization rate by rice and to extend efficiency of absorbed nitrogen for grain production.

Generally remarkable changes in N are hydrolysis of urea by urease catalyst which quickly changes over urea N to ammonium N and nitrification brought about by a gathering of nitrifying microscopic organisms that bring about transformation of ammonium N to nitrate N. Although plants can use both ammonium N and nitrate N with equal ease, ammonium N is vulnerable to loss via ammonia gas in specific conditions and nitrate N can escape soil-plant system through leaching below the rooting zone and gaseous form via denitrification resulting in reduce fertilizer nitrogen use efficiency. Further, excessive use of N fertilizers has raised problem of soil and water pollution, accelerates the decay of soil organic matter and impairs soil physico-chemical and microbial properties.

Proper N management for maximum productivity and nutrient use efficiency (NUE) keeping environmental safety is a prime need. Neem coated urea is a type of urea coated with neem oil which act as an inhibitor and slow down availability of N.

Keeping in view of the above points, present investigation was carried out to study the release pattern of nitrogen as ammonical and nitrate nitrogen from neem-coated and prilled urea in rice.

Materials and methods

The soil of the experimental field was *Vertisol*, which was fine Montmorillonite, Hyperthermic, Chromustert, also locally called as *Kanhar* and identified as Arang II series, having pH (7.5), EC (0.23 dsm^{-1}) and OC (0.60%), available N, P, K were 212, 21 and 386 kg ha^{-1} , respectively.

Experimental details

The field experiment was conducted in randomized block design with four replications and ten treatments in rice variety rajeshwari as a test crop. The treatments were different levels of nitrogen applied through neem coated and prilled urea namely T1-control, T2- N0 P60 K40, T3-N80 prilled P60 K40, T4- N80 neem P60 K40, T5- N100 prilled P60 K40, T6- N100 neem P60 K40, T7- N120 prilled P60 K40, T8- N120 neem P60 K40, T9- STCR prilled based (6t), T10- STCR neem based (6t).

STCR equations used for STCR dose is

$$FN = 4.05 Y - 0.57 SN - 0.78 ON$$

$$FP = 1.46 Y - 3.09 SP - 0.31 OP$$

$$FK = 1.61 Y - 0.10 SK - 0.14 OK$$

The entire quantity of P and K were applied as basal dose through SSP and MOP. Nitrogen fertilizers were applied in 3 split doses.

Collection of water samples

Flood water sample collect just after the each N fertilizer application at 10, 30 and 50 days after transplanting. In field volume of water was maintained at 5-7 cm. Sample collection began just after fertilizer application and collect from day 1st to 7th day. A composite surface water sample consisting of nearly 5-6 samples was randomly picked up from each plot at morning in sealed plastic bottle and the sample immediately bought to laboratory for chemical analysis. The ammonical and nitrate nitrogen analysis in soil water (leachates) was done as described by Keeney, D.R., and Nelson, D.W. (1982) [3].

Results and discussion

The effect of different levels of neem coated and prilled urea on the concentration of ammonical nitrogen in flood water is presented in the table and figure 1. The concentration of ammonical nitrogen was measured on 3, 5 and 7 days after the each N fertiliser application at 10, 30 and 50 days after transplanting. The effect of the treatments applied was found significant. The increasing levels of neem coated and prilled urea increased the concentration of ammonical nitrogen in flood water on the different days and time measured. The highest concentration of ammonical nitrogen was observed in T9(STCR based yield target 6t) treatment and the lowest was recorded in treatment T1-control. The peak concentration of ammonia was observed on 3 days after application with and without coated urea and decreased gradually on 5th and 7th days after application. The availability of ammonical nitrogen

by different levels of N was lower in neem coated urea compared to prilled urea. The trend of ammonical nitrogen was in order of T9-STCR prilled yield target 6t > T10-STCR neem yield target 6t > T7-N₁₂₀ prilled > T8-N₁₂₀ neem > T5-N₁₀₀ prilled > T6-N₁₀₀neem>T3-N₈₀prilled>T4-N₈₀neem>T2-N₀P₆₀K₄₀>T1-control.

The table and figure 2 showed the concentration of nitrate nitrogen after the application of different levels of neem coated and prilled urea on different and times. The effect of the treatments applied was found significant. The increasing levels of neem coated and prilled urea increased the concentration of nitrate nitrogen in flood water. The highest concentration of nitrate nitrogen was observed in T9(STCR based yield target 6t) treatment and the lowest was recorded in treatment T1-control. The peak concentration of nitrate in flood water was observed on 3 days after application with and without coated urea and decreased gradually on 5th and 7th days after the application. The availability of nitrate nitrogen in different levels of N was lower in neem coated urea compared to prilled urea.

The concentration of nitrate in flood water was lower than ammonia due to the reductive condition of the flooded rice field. The trend of nitrate nitrogen was in order of T9-STCR prilled yield target 6t > T10-STCR neem yield target 6t > T7-N₁₂₀ prilled > T8-N₁₂₀ neem > T5-N₁₀₀ prilled > T6-N₁₀₀neem>T3-N₈₀prilled>T4-N₈₀neem>T2-N₀P₆₀K₄₀>T1-control.

The results showed that neem coated urea slow down the conversion of nitrogen amide (urea) in to ammonical N and thus increases its availability for longer time as compared to the prilled urea. However in our study it was not notices because the observation was taken only up to 7 days after fertilizer application.

The results of study was similar to the work of pengfai *et al.* (2018), Latifah omar *et al.* (2015) [4] concluded that concentration of NH₄-N and NO₃-N was higher and leaching losses measured for 30 days was higher where prilled urea was applied compared to prilled urea mixed with clinoptilolite or Zeolite or compost treatments. Ji Xiong-hui *et al.* (2007) [2] concluded that TN and ammonium nitrogen concentrations in floodwaters reached peak on the first and third days, respectively when urea was applied in the paddy field which decreased over time. The nitrate nitrogen concentrations of all flood waters were low by application of urea, whereas the mobility of ammonical nitrogen in the flood waters gradually increased with the controlled release nitrogen fertilizer (CRNF) especially within 15 days after application.

Table 1: Effect of different levels of neem coated and prilled urea on concentration of ammonical nitrogen (NH₄-N) in flood water

Treatment	Concentration of NH ₄ -N in lechates(mg/L)								
	Fertilization application at 10 DAT			Fertilization application after 30 DAT			Fertilization application at 50 DAT		
	After 3 days	After 5 days	After 7 days	After 3 days	After 5 days	After 7 days	After 3 days	After 5 days	After 7 days
T1 (N0 P0 K0)	0.84	0.76	0.56	0.78	0.75	0.73	0.76	0.72	0.70
T2 (N0 P60 K40)	0.96	0.86	0.56	0.89	0.85	0.84	0.86	0.84	0.82
T3 (N80 P60 K40)	1.26	0.98	1.12	1.78	0.98	0.98	0.98	0.94	0.96
T4 (N80(NEEM) P60 K40)	0.98	0.92	0.58	1.42	0.95	0.95	0.96	0.92	0.94
T5 (N100 P60 K40)	2.86	2.48	1.36	2.32	1.98	1.98	1.98	1.87	1.98
T6(N100(NEEM) P60 K40)	2.8	1.98	1.24	1.96	1.84	1.84	1.82	1.80	1.78
T7 (N120 P60 K40)	4.42	3.43	1.52	4.34	2.82	2.82	5.04	3.68	2.80
T8(N120(NEEM) P60 K40)	3.68	3.2	1.42	4.06	2.46	2.46	3.92	2.76	1.98
T9 STCR BASED (6t)	5.04	4.46	2.24	6.16	5.60	5.6	6.64	5.60	3.36
T10 STCR(Neem)(6t)	4.84	3.8	1.68	5.62	4.32	4.32	6.16	5.26	3.20
SEm±	0.001	0.022	0.001	0.005	0.009	0.010	0.021	0.012	0.014
CD(P=0.05)	0.003	0.066	0.003	0.015	0.028	0.030	0.006	0.037	0.043

Table 2: Effect of different levels of neem coated and prilled urea on concentration of nitrate nitrogen ($\text{NO}_3\text{-N}$)

Treatment	Concentration of $\text{NO}_3\text{-N}$ in lechates(mg/L)								
	Fertilization application at 10 DAT			Fertilization application at 30 DAT			Fertilization application at 50 DAT		
	After 3 days	After 5 days	After 7 days	After 3 days	After 5 days	After 7 days	After 3 days	After 5 days	After 7 days
T1 (N0 P0 K0)	0.56	0.56	0.42	0.42	0.46	0.47	0.42	0.40	0.38
T2 (N0 P60 K40)	0.56	0.56	0.48	0.58	0.53	0.50	0.46	0.43	0.40
T3 (N80 P60 K40)	0.72	0.68	0.56	0.67	0.63	0.58	0.69	0.67	0.63
T4 (N80(NEEM) P60 K40)	0.60	0.58	0.48	0.64	0.63	0.59	0.56	0.52	0.48
T5 (N100 P60 K40)	0.98	0.94	0.85	0.94	0.89	0.84	0.92	0.90	0.78
T6 (N100(NEEM) P60 K40)	0.83	0.78	0.74	0.75	0.70	0.73	0.84	0.70	0.68
T7 (N120 P60 K40)	1.18	1.13	0.97	1.98	1.92	1.43	1.80	1.76	1.40
T8 (N120(NEEM) P60 K40)	1.12	1.04	0.95	1.76	1.58	1.32	1.64	1.42	1.24
T9 STCR BASED (6t)	1.49	1.28	1.14	2.82	2.74	1.90	2.64	2.40	1.82
T10 STCR(Neem)(6t)	1.26	1.20	1.10	2.40	2.24	1.50	2.43	1.98	1.53
SEm±	0.017	0.010	0.019	0.010	0.019	0.015	0.010	0.021	0.014
CD(P=0.05)	0.052	0.032	0.033	0.031	0.057	0.045	0.032	0.063	0.043

Fig 1: Effect of different levels of neem coated and prilled urea on concentration of ammonical nitrogen ($\text{NH}_4\text{-N}$) **Fig 2:** Effect of different levels of neem coated and prilled urea on concentration of nitrate nitrogen ($\text{NO}_3\text{-N}$)

Conclusion

Results from present investigation indicate that increase the doses of nitrogen fertilizer concentration of ammonium-N and nitrate-N also increases. Prilled urea hydrolyzed faster and hence more concentration will be recorded compared to neem coated urea which slow down the mineralization process.

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