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Study of Nitrogen Release Pattern in Different Oil Coated Urea Fertilizers in Light Textured Soils

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ABSTRACT

Keywords

Maize, Nitrogen, Neem coated urea, Pongamia oil coated urea, Castor oil coated urea, Release pattern, Incubation.

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The incubation study was conducted during the *Kharif* 2015 at Agronomy field laboratory, College of Agriculture, University of Agricultural and Horticultural Sciences, Navile, Shivamogga to study the release pattern of nitrogen from different natural oil coated urea fertilizers in soil. The incubation study was conducted by using light textured sandy loam soil by adopting Complete Randomised Design. The treatments consisted three different coated urea products viz., neem coated urea, pongamia oil coated urea and castor oil coated urea were applied each bags and replicated 7 times. Treatments which received Nitrogen through neem coated urea was recorded significantly higher availability of nitrogen (412.48 Kg ha^{-1} at 0-20 cm and 277.03 Kg ha^{-1} at 20-40 cm) at 45 and 60 DAI (Days after incubation) due to slow solubility and slow release of nitrogen in urea fertilizers resulted in slow release pattern. There after availability of nitrogen becomes steady.

Introduction

Nitrogen (N) is a vital element found in all living things. Crops require nitrogen in relatively large amounts making it the nutrient most often deficient in crop production. Despite nitrogen being one of the most abundant elements on in the universe, nitrogen deficiency is probably the most common nutritional problem affecting plants worldwide. Healthy plants contain 3-4 per cent nitrogen in their aboveground tissues. It is a major component of chlorophyll, amino acids and building blocks of proteins. Nitrogen is a component of energy-transfer compounds, such as ATP (adenosine triphosphate) which allows cells to conserve and use the energy released in metabolism. Soil nitrogen can be divided into three categories viz., (i) small inorganic components consisting of ammonical, nitrate and nitrite nitrogen (ii) large organic components consisting of the residues of plant and other organics and (iii) elemental nitrogen component in the soil atmosphere. Plants absorb nitrogen in the form of nitrate and ammonium ions. Soil nitrogen changes rapidly from one form to another compared to any other mineral nutrients (Mahorana *et al.*, 2015). The concentration of any such product at any given point of time depends on various factors such as soil type, climate, organic matter content, soil microbial population, moisture, aeration and inorganic inputs like fertilizers. The inorganic soil nitrogen component is usually small and easily depleted and hence cannot support plant growth for a long time.

However release of organically bound nitrogen from urea fertilizers by coating with slow soluble materials like natural oils, tar, mud etc by the process of mineralization makes sure the unabated supply of nitrogen in simple forms. Therefore, evaluation of nitrogen release pattern is essential to have a rational basis for developing sound nitrogen management practice

Urea can be taken up by plant roots and leaves. Once entered inside the plant, it is converted to ammonium and assimilated as amino acids and amides.

The form of N uptake is mainly determined by its abundance and accessibility, which make NO_3^- and NH_4^+ the most important N forms for plant nutrition under agricultural conditions (Vyas *et al.,* 1991). With minor importance, the form of N uptake is also subject to plant preferences, by which plants maintain their cation/anion balance during uptake. However, some species seem to have an obligatory preference which even prevents their growth on certain other N sources.

In general, uptake of a certain N form closely matches the growth-related demand of the plant, at least when N transport to the root surface is not limiting. In addition, many plants accumulate large pools of N during vegetative growths which are remobilized in the generative stage. As a consequence, systems responsible for N transport need to be tightly regulated in their expression and activity upon sensing N availability and plant demand (Duann *et al*., 2009).

Materials and Methods

A incubation study was conducted to study the nitrogen release pattern of different coated urea fertilizers such as neem coated urea, pongamia oil coated urea and castor oil coated urea The sandy clay loam soil of the experimental area was filled in polyethylene bags, each having an average weight of 15 kg and analysed for initial NPK status. It was kept for 15 days for settlement with frequent watering. The oil coated urea such as neem coated (T_1), Pongamia oil (T_2) and Castor oil coated urea (T_3) were placed at 10 cm below the surface and watered twice a week in order to maintain field capacity. These three oil coated urea fertilizers were replicated seven times and kept in green house conditions. The bags were marked at 20 and 40 cm below the placements of fertilizers. The soil samples were drawn at 0-20 and 20-40 cm depth at15 day's intervals up to 75 DAI.

Collected soil samples were analysed for its available NPK status by using standard methods as follows. Available nitrogen is estimated by alkaline potassium permanganate method and determined by using Kjeldahl's distillation method (Jackson, 1973), available phosphorus was estimated by brays method and determined by spectrophotometer (Jackson, 1973) and available potassium was estimated by flame photometry by using Neutral normal ammonium acetate as extractant. The experiment was carried out in a complete Randomized design and analysed statistically as per procedure suggested by Gomez and Gomez (1978).

Results and Discussion

Yield maximization of any crop demands on the process associated with uptake of nutrients, translocation, partitioning, assimilation and mobilization of nutrients at different growth stages of crop. These multitude processes is influenced by genetic potential of the variety, cultural practices, soil manipulation and climatic factor.

In the present study, the results of satellite experiment on available NPK status of experimental soil as influenced by incorporation of different slow release nitrogenous fertilizers at various depths indicate the following trends (Tables 1, 2 and 3).

Available nitrogen (Kg ha^{-1})

At 0-20 cm depth

Available nitrogen status did not differ significantly due to application of slow release nitrogenous fertilizers at 15 DAI (Days after incubation). At 30 DAI, at a depth of 0-20 cm, the higher available nitrogen status was observed in treatment which received COCU (329.63 kg ha^{-1}). Whereas in treatment which received POCU was recorded higher available nitrogen (291.17 kg ha^{-1}) compared to treatment which received NCU (280.84 kg ha^{-1}). 45 and 60 DAI, soil nitrogen status differed significantly. However, significantly higher available nitrogen was recorded in treatment which received NCU (392.48 and 412.48 kg ha^{-1}) followed by POCU (384.70 and 399.70 kg ha^{-1}). While, lower available nitrogen was recorded in treatment which received COCU (369.43 and 381.43 kg ha^{-1}).

At 75 and 90 DAI, nitrogen differed significantly due to incorporation of different slow release nitrogenous fertilizers. The higher available nitrogen was recorded in the treatment which received NCU (402.48 and 342.62 kg ha^{-1}) followed by treatment which received POCU (386.70 and 323.42 kg ha^{-1}). While lower available nitrogen was registered in treatment which received COCU (367.43 and 302.43 kg ha^{-1}).

At 20-40 cm depth

At a depth 20-40 cm also, available nitrogen status did not differ significantly due to application of slow release nitrogenous fertilizers at 15 DAI and 30 DAI.

At 45 DAI and 60 DAI, nitrogen status in soil was varied significantly among the treatments. The higher nitrogen was recorded in T_3 i.e. COCU (279.29 and 292.15 kg ha^{-1}) followed by treatment which received POCU (270.37 and 279.79 kg ha^{-1}). However, lower available nitrogen was registered in treatment which received NCU (267.89 and 277.03 kg ha^{-1}).

At 75 DAI and 90 DAI, available nitrogen status was differed significantly. The higher nitrogen was recorded in treatment which received COCU (283.58 and 273.43 kg ha^{-1}) and it was seconded by treatment which received POCU (270.65 and 260.37 kg ha^{-1}). However, lower nitrogen status was recorded with treatment which received NCU (266.17 and 257.60 kg ha^{-1}).

It is observed from the data that the release pattern of nitrogen studied varied due to applied treatments T1 (Neem coated urea), T2 (Pongamia oil coated urea), T3 (Castor oil coated urea). From all the sources, it is evident that initially there was a slow buildup of nutrients studied. Nitrogen steadily increased in its status till 60 days after incorporation of slow release nitrogenous fertilizers, then started showing decreased trend.

This ensures continuous and optimal supply of nitrogen to match the requirements of crops at different stages of growth and increased nitrogen efficiency in soil. Neem coated urea helps in gradual increase in NO_2 $^{+}$ NO_3–N levels in soil up to a period of one month, where as a sharp increase in NO_2^{+} NO_3–N levels within a period of 7-15 days was observed in the soil treated with uncoated urea (Vyas *et al.*, 1991).

Neem coated urea releases ammonical form of nitrogen by hydrolysis process and provide available form which in turn increase availability of nitrogen in soil. Depth wise observations clearly indicated that there are little leaching losses of nitrogen observed in neem coated urea compared to the treatments which received pongamia and castor oil coated urea due to regulation and retardation of nitrification process with steady release of nutrients.

The results are in conformity with findings of Nhamo *et al.*, (1997), Ashara Pengnoo *et al.*, (2001), Gurcan *et al.*, (2007), Vimlesh and Giri (2009) and Mubarak *et al.*, (2010) and controversy with results of Virendra Singh (2013) and Thimmaiah (2015).

Available Phosphorus (Kg ha^{-1})

At 0-20 cm depth

Available phosphorus status did not differ significantly due to application of slow release nitrogenous fertilizers at 15 DAI. At 30 DAI, Soil phosphorus status did not differed significantly.

The higher phosphorus was recorded in treatment which received NCU (82.90 kg ha^{-1}) followed by treatment which received POCU (82.08 kg ha^{-1}). Whereas, lower available phosphorus was recorded in treatment which received COCU (79.29 kg ha^{-1}).

At 45 and 60 DAI, phosphorus status was varied significantly among the treatments. The higher phosphorus was recorded in treatment which received NCU (105.56 and 111.98 kg ha^{-1}) followed by treatments which received POCU (103.35 and 109.35 kg ha^{-1}). However, lower phosphorus was registered in treatment which received COCU (96.75 and 102.75 kg ha^{-1}).

At 75 and 90 DAI, available phosphorus status was differed significantly. The higher available phosphorus was recorded in treatment which received NCU (101.84 and 81.84 kg ha^{-1}) and it was seconded by treatment with incorporation of POCU (99.35 and 79.35 kg ha^{-1}).

However, lower phosphorus status was recorded with treatment which received COCU (92.75 and 72.75 kg ha^{-1}). Phosphorous maintained its steady increment till end of the study.

At 20-40 cm depth

At a depth 20-40 cm also, available phosphorus status did not differ significantly due to application of slow release nitrogenous fertilizers at 15 DAI and 30 DAI,

At 45 DAI and 60 DAI, phosphorus status in soil was varied significantly among the treatments.

The higher phosphorus was recorded in T_1 *i.e.* NCU (80.56 and 88.27 kg ha^{-1}) followed by treatment which received POCU (78.35 and 86.35 kg ha^{-1}). However, lower available phosphorus was registered in treatment which received COCU (71.75 and 79.32 kg ha^{-1}). At 75 DAI and 90 DAI, available phosphorus status was differed significantly.

The higher phosphorus was recorded in treatment which received NCU (78.70 and 67.70 kg ha^{-1}) and it was seconded by treatment which received POCU (76.35 and 65.92 kg ha^{-1}). However, lower phosphorus status was recorded with treatment which received COCU (69.89 and 59.75 kg ha^{-1}).

Table.1 Available nitrogen status (kg ha^{-1}) in soil at different intervals and depths in incubation study for release pattern of nitrogen as influenced by incorporation of different slow release nitrogenous fertilizers

Treatment	15 DAI		30 DAI		45 DAI		60 DAI		75 DAI		90 DAI	
	Depth (cm)											
	0-20	20-40	0-20	20-40	0-20	20-40	0-20	20-40	0-20	20-40	0-20	20-40
T_1	259.39	247.60	280.84	258.46	392.48	267.89	412.48	277.03	402.48	266.17	342.62	257.60
T_2	263.91	253.79	291.17	263.79	384.70	270.37	399.70	279.79	386.70	270.65	323.42	260.37
T_3	268.81	257.29	329.63	265.43	369.43	279.29	381.43	292.15	367.43	283.58	302.43	273.43
S. Em $\pm$	6.58	4.03	3.55	4.30	6.80	4.06	7.98	4.18	4.15	5.09	4.19	5.01
CD at 5 %	NS	NS	10.53	NS	20.21	12.07	23.72	12.41	12.34	15.13	12.46	14.90

Table.2 Available phosphorus status (kg ha^{-1}) in soil at different intervals and depths in incubation study for release pattern of nitrogen as influenced by incorporation of different slow release nitrogenous fertilizers

Treatment	15 DAI		30 DAI		45 DAI		60 DAI		75 DAI		90 DAI	
	Depth (cm)											
	0-20	20-40	0-20	20-40	0-20	20-40	0-20	20-40	0-20	20-40	0-20	20-40
T_1	72.90	57.90	82.90	72.90	105.56	80.56	111.98	88.27	101.84	78.70	81.84	67.70
T_2	72.37	57.37	82.08	72.37	103.35	78.35	109.35	86.35	99.35	76.35	79.35	65.92
T_3	69.58	54.58	79.29	69.58	96.75	71.75	102.75	79.32	92.75	69.89	72.75	59.75
S. Em $\pm$	1.55	1.55	1.63	1.55	1.24	1.24	1.08	1.29	1.34	1.26	1.12	1.36
CD at 5 %	NS	NS	NS	NS	3.67	3.67	3.21	3.84	4.00	3.74	3.33	4.03

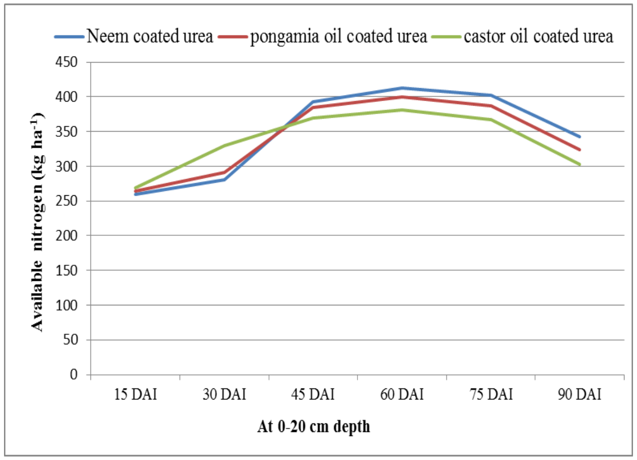
DAI: Days after incubation T_1: Neem coated urea T_2: Pongamia oil coated urea T_3: Castor oil coated urea NS: Non- significant

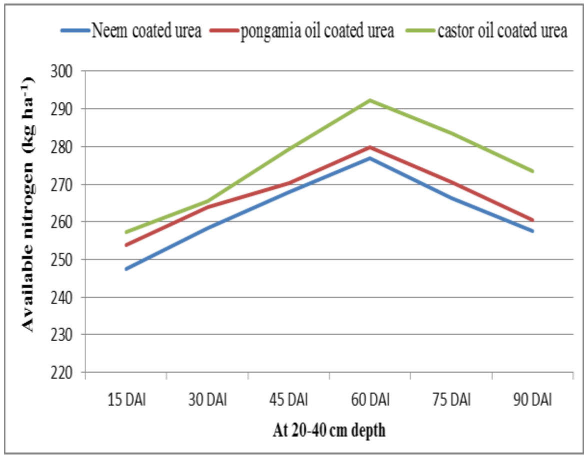
Table.3 Available potassium status (kg ha^{-1}) in soil at different intervals and depths in incubation study for release pattern of nitrogen as influenced by incorporation of different slow release nitrogenous fertilizers

Treatment	15 DAI		30 DAI		45 DAI		60 DAI		75 DAI		90 DAI	
	Depth (cm)											
	0-20	20-40	0-20	20-40	0-20	20-40	0-20	20-40	0-20	20-40	0-20	20-40
T_1	315.96	275.96	362.80	315.96	422.54	335.96	453.40	354.53	361.50	336.39	305.00	311.67
T_2	267.06	227.06	323.97	266.34	377.77	287.06	407.77	308.49	372.86	286.91	297.33	262.77
T_3	234.77	194.77	294.76	233.34	339.27	251.62	369.27	273.62	359.73	252.91	296.07	230.48
S. Em $\pm$	4.55	4.55	4.80	4.95	5.04	3.86	5.13	5.46	1.37	5.97	1.56	5.91
CD at 5 %	NS	NS	NS	NS	14.98	11.45	15.24	16.22	4.06	17.72	4.64	17.56

DAI: Days after incubation $T_{1:}$ Neem coated urea T_2: Pongamia oil coated urea T_3: Castor oil coated urea

Fig.1 Release pattern of nitrogen in soil at different intervals and depths in incubation study as influenced by incorporation of different slow release nitrogenous fertilizers





Available potassium (Kg ha^{-1})

At 0-20 cm depth

Available potassium status did not differ significantly due to application of slow release nitrogenous fertilizers at 15 and 30 DAI.

At 45 and 60 DAI, potassium status was varied significantly among the treatments. The higher potassium was recorded in treatment with incorporation of NCU (422.54 and 453.40 kg ha^{-1}) followed by POCU (377.77 and 407.77 kg ha^{-1}). However, lower potassium was registered in treatment with application of COCU (339.27 and 369.27 kg ha^{-1}). At 75 and 90 DAI, available potassium status of soil was differed significantly. The higher available potassium was recorded in treatment with incorporation of NCU (361.50 and 305.0 kg ha^{-1}) and it was seconded by treatment with application of POCU (372.86 and 297.33 kg ha^{-1}). However, lower potassium status was recorded with treatment with application of COCU (359.73 and 296.07 kg ha^{-1}).

At 20-40 cm depth

At a depth 20-40 cm, available potassium status did not differ significantly due to application of slow release nitrogenous fertilizers at 15 DAI and 30 DAI.

At 45 DAI and 60 DAI, potassium status in soil was varied significantly among the treatments. The higher potassium status was recorded in T1 *i.e.* NCU (335.96 and 354.53 kg ha^{-1}) followed by treatment which received POCU (287.06 and 308.49 kg ha^{-1}). However, lower available potassium was registered in treatment which received COCU (251.62 and 273.62 kg ha^{-1}). At 75 DAI and 90 DAI, available potassium status was differed significantly. The higher available potassium was recorded in treatment which received NCU (286.91 and 262.77 kg ha^{-1}). However, lower potassium status was recorded with treatment which received COCU (252.91 and 230.48 kg ha^{-1}). Potassium followed the similarity to that of nitrogen (Fig. 1). Again, in respect of different sources, neem coated urea showed little higher values than other in test due to its higher nitrification inhibition efficiency. On the other hand, castor oil coated recorded relatively lower values for all nutrients. Pongamia oil coated urea at all stages of observation showed little higher values to that of castor oil coated urea, however for potassium it is higher.

In the present study, results clearly indicate that with regard to release pattern of nitrogen, slow and steady release of nitrogen was observed in the treatment which received neem coated urea where as little faster release of nitrogen in soil was observed with respect to the treatment which received pongamia oil coated urea and castor oil coated urea. This might due to their difference in regulation efficiency of nitrification and mineralization process. In general with increase in incubation period the release of N significantly increased from 30 days after incubation up to 60 days then after it decreased probably due to loss of nitrogen by volatilization. In this study moisture status was maintained at field capacity so that inorganic fertilizers easily dissolved and released the nutrient. Early mineralization of inorganic component was the main reason behind releasing nitrogen form. For 60, 75 and 90 days after incubation also, higher value of available nitrogen was obtained by the treatment which received neem coated urea.

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