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Conversion of urea placed at different depths and its subsequent impact on growth and yield of rice

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ABSTRACT

In a study on the effect of urea with depths in rice (*Oryza sativa* Linn.), conversion of urea into NH_4-N was maximum at 15 days in most of the treatments and into NO_3-N was at 7 days. But with surface placement of urea it continued up to 15 days of placement and thereafter the concentrations of both declined with time in all the treatments. Fertilizers @ 80 kg N + 60 kg P + 40 kg K/ha placed 8-cm depth produced the highest dry matter and grain yield. At this treatment, the rice plants also accumulated highest amount of N in the shoot and grain.

There is at present an increase in the high analysis of N fertilizer urea for maximizing crop production. Rice (*Oryza sativa* Linn.) plants growing under submerged condition utilize at most 60% of the applied urea, whereas the remaining 40% is lost through leaching, volatilization or denitrification (Brady *et al.*, 1974). The behaviour of urea may differ if placed at different depths. The present study was undertaken to study the mode of conversion of urea into NH_4-N and NO_3-N placed at different depths and its effect on the growth and yield of rice.

MATERIALS AND METHODS

The field experiment was conducted on a well-drained slightly acidic (pH 6.4) sandy clay soil, low in available N, P and K contents. The treatments consisted of urea applied at 80 or 120 kg N/ha, broadcast on the surface or placed 8 or 15 cm under the soil, each of the urea treatment combinations with one without 60 kg P/ha as triple superphosphate + 40 kg K/ha as murate of potash. The fertilizer was applied before flooding the plots. There were in all 13 treatments inclusive of a no-fertilizer control replicated 3 times in a completely randomized design.

The plots were of 100 cm × 105 cm, protected by bunds. Four-week-old seedlings of rice 'BR 3' were planted at 2 seedlings/hill with a spacing of 25 cm × 15 cm. Water level in the field was maintained at 3-cm depth during the period of crop growth.

Soil samples were collected at 0, 3, 7, 15, 30, 60 days after fertilizer application and analyzed in wet condition for NH_4-N and NO_3-N following the method of Bremner and Shaw (1955). Plant samples (1 hill each time) were collected at 70 and 120 days after transplanting and at harvest, data on dry weight were recorded and the plants were analysed for total N.

RESULTS AND DISCUSSION

Urea converted into NH_4-N showed different trends with time (Fig. 1). In the initial 3 days the conversion was very rapid, followed by a moderate increase up to 15 days, after which a more or less static change was observed up to 30 days in most of the treatments. However, in all the treatments a rapid fall in NH_4-N concentration was noticed 30 days after placement. Placement of 120 kg N/ha

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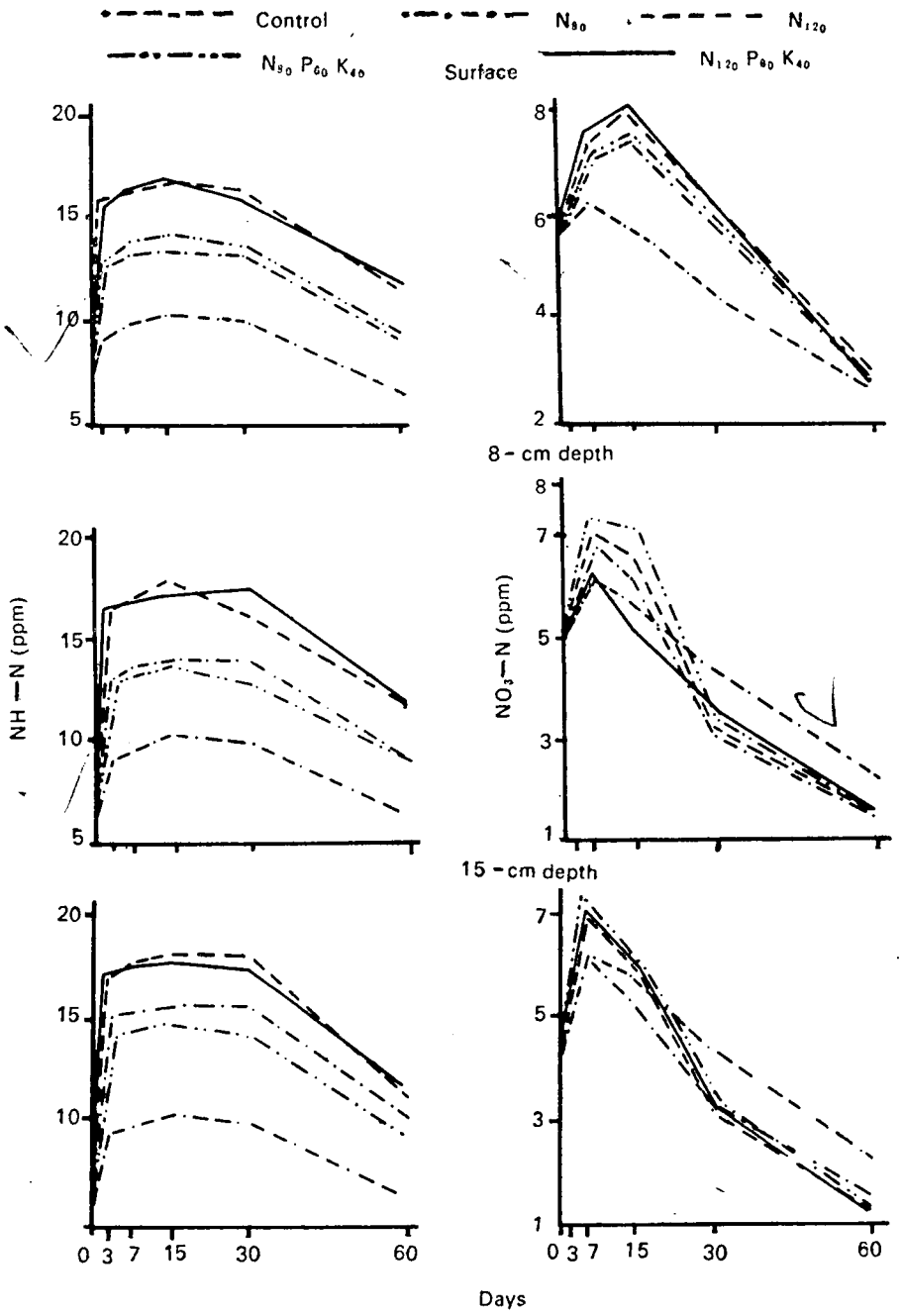

Fig. 1. Conversion of urea into NH_4-N and NO_3-N with time.

with P and K at surface and 8-cm depth showed the peak values. The initial increase in NH_4-N was owing to the rapid hydrolysis of urea, whereas the final decrease might be owing to absorption by soil microbes and growing crops. N losses through NH_3 volatilization from urea reached maximum within the 4th to 10th days of application (Enikov and Ivanov, 1971; Idris *et al.*, 1974). Mukasa *et al.* (1973) reported that transformation of urea into NH_4-N placed in the surface soil reached maximum within 10–20 days and almost disappeared after 60 days. However, a very sharp change in NO_3-N concentration was followed, reaching the maximum 7 days after placement of urea, except in the surface placement where the increase continued up to 15 days and then fell rapidly with time irrespective of the treatments (Fig. 1). The initial increase was owing to partial oxidation of NH_4-N ions owing to hydrolysis of urea. But with time the value decreased, probably owing to assimilation by soil anaerobes and decrease in oxygen concentration. Mikkelson and Finfrock (1956) also noted that when the concentration of oxygen in a soil solution fell below 1 ppm, anaerobes began to use nitrate as electron acceptor during their respiration, showing a decrease in the amount.

The dry weights of shoot, grain yield, and N contents of shoot and grain as influenced by the placement of urea alone and in combination with P and K fertilizer varied significantly (Table 1).

Table 1. Effect of urea placed at different depths on the dry weight, yield and N content of shoot and grain of 'BR 3' rice

Treatment	Dry weight (g/hill)		Harvesting (g/hill)		N (%) in plant			Grain N (g/hill)
	70 days	120 days	Grain	Straw	70 days	120 days	Straw	
Control	0.52	26.5	49.2	25.6	0.83	0.96	1.27	1.34
80 kg N/ha (surface)	0.72	32.6	52.1	30.3	1.47	1.81	1.48	1.95
120 kg N/ha (surface)	0.60	40.2	59.6	25.4	1.47	1.11	1.38	1.84
80 kg N/ha+PK (surface)	1.04	45.2	62.5	33.8	1.03	1.11	1.33	2.03
120 kg N/ha+PK (surface)	1.12	36.2	58.7	33.7	1.12	2.04	1.40	2.27
80 kg N/ha (8-cm depth)	1.39	35.5	63.0	34.8	1.34	2.73	1.73	2.76
120 kg N/ha (8-cm depth)	0.61	36.3	68.3	29.4	1.27	2.57	1.78	2.75
80 kg N/ha+PK (8-cm depth)	0.98	43.4	69.1	39.0	1.27	2.88	1.94	3.32
120 kg N/ha+PK (8-cm depth)	1.44	46.9	68.4	34.9	1.33	1.83	1.55	2.71
80 kg N/ha (15-cm depth)	0.77	28.5	55.2	34.3	1.15	2.11	1.57	2.13
120 kg N/ha (15-cm depth)	0.48	31.6	44.1	31.0	1.15	2.35	1.55	2.19
80 kg N/ha+PK (15-cm depth)	0.44	30.5	52.8	32.1	1.24	2.66	1.43	2.23
120 kg N/ha+PK (15-cm depth)	0.36	25.9	42.4	33.8	1.11	2.22	1.55	1.85
CD at 5%	0.18	7.27	6.51	3.91	0.095	0.176	0.176	0.135

The best dry weight of straw was obtained at the vegetative and maturity stage when 120 and 80 kg N/ha, respectively, was placed, along with P and K 8-cm deep. The data were statistically significant. Grain yield significantly increased at 5% level by different treatment combinations. The highest (69.1 g/hill) yield was obtained when 80 kg N/ha + 60 kg P/ha + 40 kg K/ha placed at 5-cm depth. The highest grain yields in general were obtained when the fertilizers were placed at 8-cm depth. Wahhab and Azim (1958) reported that highest dry matter and grain yield of paddy were obtained when urea was placed at 5-cm depth. Dalal (1975) observed that urea placed at 5-cm depth was more efficient in maize production than when applied on the surface.

Rice plants showed a significant uptake of N and progressive accumulation of N throughout the growing period. However, the rate of uptake was higher at the growth stage between 70 and 120 days. This suggests that rice plants assimilated more N up to flowering stage for later utilization during the synthesis of body materials in the seed-forming stage. Rice plants accumulated the highest amount of N in the shoot (at 120 days and at maturity) and grain when 80 kg N/ha + P + fertilizers were placed 8 cm deep.

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