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AMMONIUM AND NITRATE RELEASE PATTERN FROM RESIDUE INCORPORATED RICE SOILS

Green manuring with leguminous crops is a well-known practice for sustaining crop productivity. But considering the cost and time involved in raising a green manure crop, inclusion of dual purpose legumes in cropping systems becomes imperative. Besides producing an economic seed yield, these legume residues can add considerable amount of N to the soil (Buresh and De Datta, 1991) and their inclusion in cropping systems could reduce the fertilizer N requirement of succeeding cereals (George and Prasad, 1989). A sound

Table 1. Biomass yield and N accumulation of preceding crops

Crops	Biomass (t ha^{-1})		N content	N accumulation	C:N
	Fresh	Dry	%	kg ha^{-1}	ratio
Cowpea	343	6.8	1.96	133.3	18:1
Groundnut	28.5	7.0	1.68	117.6	28:1
Sesbania	24.0	7.0	1.68	117.6	16:1

knowledge about N release pattern of the organic sources is of primary importance for efficient management of nitrogen. Field experiments were conducted during summer and kharif seasons at the Agricultural Research Station, Mannuthy, Kerala on a sandy loam soil having pH 5.5, total N 0.09 per cent, available P 75 kg ha^{-1} and available K 196 kg ha^{-1}. The experiment was laid out in split plot design with four replications. The main plot

Table 2. Extractable ammonium in the soil as influenced by preceding crops and N levels (kg ha^{-1})

Treatments	On the day of transplanting	5 DAT	15 DAT	25 DAT	40 DAT	60 DAT	At harvest
Preceding crops (C)							
Cowpea	29.57	64.82	56.15	19.50	17.58	6.94	3.75
Groundnut	24.03	59.06	45.98	18.44	12.89	7.17	2.79
Sesbania	31.69	64.59	60.36	22.31	15.96	6.77	3.36
Fallow	19.67	48.71	35.83	12.96	12.36	5.50	3.24
N levels, kg ha^{-1}							
0		48.34	32.75	15.83	11.81	6.50	3.20
35		57.12	42.75	16.80	12.10	7.03	2.91
70		66.36	55.20	19.02	15.77	6.39	3.38
105		65.35	67.82	21.55	19.09	647	3.64
SEm for C	2.17	3.70	3.22	1.29	0.91	0.60	0.51
SEm for N		3.46	2.50	0.99	1.36	0.43	0.21
CD (0.05) for C	6.94	10.37	9.23	3.67	2.61	NS	NS
CD (0.05) for N		9.92	7.17	2.84	3.90	NS	NS

treatments were four pre-rice crops viz., cowpea var. Kanakamony, groundnut var. VRI-3, *Sesbania rostrata* and weedy fallow. Cowpea and groundnut were grown to maturity, pods harvested and residues were incorporated during land preparation of rice. The green manure sown two months later than that of the legume crops was also incorporated during the same period. In the fallow plots the existing weeds were incorporated. The subplot treatments (levels of N viz. 0, 35, 70 and 105 kg ha^{-1} as urea) were applied to rice var. Annapurna (110 days duration) planted 10 days after incorporation. N and K were given in two splits. P and K were applied at the rate of 35 kg ha^{-1}. Soil samples were collected on the day of transplanting, 5, 15, 25, 40 and 60 days after transplanting and at harvest to a depth of 15 em for the estimation of ammonium N and nitrate N. Wet soil sample (40 g) was extracted for 1 h with 0.5 *M* KCl and the extract was analyzed for ammoniacal N and nitrate N by steam distillation (Bremner, 1965).

Table 3. Extractable nitrate N in the soil as influenced by preceding crops and N levels (kg ha^{-1})

Treatments	On the day of transplanting	5 DAT	15 DAT	25 DAT	40 DAT	60 DAT	At harvest
Preceding crops (C)							
Cowpea	2.27	4.57	4.49	5.56	3.40	1.55	1.39
Groundnut	5.43	3.60	5.58	5.20	3.60	2.01	1.33
Sesbania	2.37	3.07	5.36	3.63	3.51	2.24	3.76
Fallow	1.81	3.34	4.50	3.81	2.58	1.91	1.09
N levels, kg ha^{-1}							
0		3.13	3.92	4.45	2.53	1.61	1.63
35		3.00	3.87	5.35	2.91	1.75	2.11
70		3.78	5.53	4.43	3.92	2.15	2.52
105		4.67	6.62	3.96	3.79	2.20	2.29
SEm for C	0.37	0.42	0.65	0.77	0.45	0.33	0.14
SEm for N		0.47	0.75	0.51	0.51	0.22	0.25
CD (0.05) for C	NS	NS	NS	NS	NS	NS	0.40
CD (0.05) for N		NS	2.15	NS	NS	NS	NS

Table 4. Yield of rice as influenced by preceding crops and N levels (kg ha^{-1})

Treatments	Grain yield (t ha^{-1})	Straw yield (t ha^{-1})
Preceding crops (C)		
Cowpea	3.23	5.42
Groundnut	2.82	2.84
Sesbania	3.24	3.29
Fallow	2.57	2.94
N levels, kg ha^{-1}		
0	2.39	2.47
35	2.95	3.11
70	3.18	3.42
105	3.34	3.49
SEm for C	0.12	0.11
SEm for N	0.09	0,09
CD(0.05) for C	0.34	0.32
CD(0.05) for N	0.26	0.26

The preceding grain legume cowpea and oil seed groundnut produced a grain yield of 0.7 and 1.4 t ha^{-1}, respectively. Groundnut and sesbania added an equal amount of above ground biomass (7 t ha^{-1}) but cowpea contributed more N (133 kg ha^{-1}) (Table 1). *S. rostrata* being a short-day plant (Visperas *et al.*, 1987), the longer day length (>12 hours) during the summer extended the vegetative phase resulting in higher biomass production. The cowpea variety Kanakamony used in this experiment was characterized by indeterminate growth habit. All the cowpea pods were not ready for harvesting at the time of incorporation. Due to weekly irrigation, cowpea continued flowering even at the time of incorporation resulting in higher percentage of N than sesbania and groundnut.

Nitrogen mineralization patterns of green manure and residues were studied in terms of ammonium and nitrate N accumulation in the soil (Table 2 and 3). On the date of transplanting of rice i.e., 10 days after incorporation of green manure or residues the ammonium accumulation in the 0-15 cm soil layer was significantly higher than that of pre-rice fallow indicating N release from added plant materials. There was an increased ammonium N status in all the treatments after five DAT due to the addition of basal fertilizer nitrogen. The difference between pre-rice fallow and plant material incorporated treatments continued till 40 DAT. Ammonium N accumulation was at the peak at 5 DAT in all the treatments and steadily declined. Sur *et al.* (1993) reported that the peak ammonium N accumulation in general occurs 15 days after green manure incorporation.

The ammonium N accumulation was similar in cowpea and sesbania incorporated plots compared to groundnut residue indicating slow mineralization of groundnut. The reason might be the wide C:N ratio of groundnut residue (28:1) and narrow ratio of cowpea residue (18:1) and sesbania (16:1). The marked influence of C:N ratio on decomposition and release of N from plant materials was reported (John *el al.*, 1989 and Buresh and De Datta, 1991).

The higher ammonium N level in soil was maintained only up to 15 DAT and then started declining. Since 5-6 cm water level was maintained in the field, nitrification and subsequent loss by denitrification or leaching was minimum and the decline in ammonium status was possibly due to plant uptake.

The extractable nitrate N content in soil was low compared to ammonium N (Table 3) and among pre-rice treatments, noticeable difference was absent. The nitrate N content was high up to 25 DAT and thereafter decreased. In continuously flooded soil, the nitrate N content is expected to be minimum due to denitrification of the nitrate present initially and stopping of the nitrification due to the anaerobic situation. Low level of nitrification, however, is possible in the oxidized layer of flooded soil and in the rhizosphere. Ponnamperuma (1955) reported nitrification in the flooded soil due to the oxygen transport to the rhizosphere through rice culm and roots. N levels has a significant positive influence on ammonium N accumulation in the soil, showing higher values with increasing levels of N in general up to 40 DAT, whereas N levels had no marked effect on extractable nitrate N content of the soil except 15 DAT.

Sesbania and cowpea residue incorporation resulted in a significant grain yield increase over fallow (Table 4). The mean yield increase for the application of 35 kg N ha ' was 15 kg grain per kg of N over control whereas it was only 6.6 kg grain for the next 35 kg and further declined to 4.5 kg grain for the last 35 kg N. Declining rate of response of rice to increasing levels of added N had been well documented (Reddy, 1988). After incorporation of sesbania green manure and cowpea residue, application of basal dose of N can be reduced since mineralized N is available from the incorporated biomass. These two were equally effective in increasing the grain yield of rice by 660 kg ha^{-1} over fallow.

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