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FORMS OF SOIL NITROGEN AND AVAILABLE NITROGEN STATUS IN RELATION TO RICE NUTRITION IN ALLUVIAL SOILS OF THANJAVUR DISTRICT

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The role of different organic N fractions in soils on nitrogen nutrition of rice and their inter-relationship with conventional soil test methods were investigated under field condition on alluvial soils of Thanjavur District in both Kuruvai and Thaladi seasons. The changes in available N status due to cropping and N fertilisation were monitored. These studies revealed that amino-acid fraction is quantitatively more important among the hydrolysable nitrogen forms for rice nutrition. The fixed NH_4 in the alluvial soil contributes about 6 per cent of total N and also significantly correlates with yield. The content of non-hydrolysable and unidentified N forms, though quantitatively important are not directly related to the immediate N availability to the rice crop. The different forms of organic N are better related with organic carbon status than with $KMnO_4$-N, leading to scope for improvement in the modification of these methods. Since N fertilisation and its transformation have a direct bearing with the changes in available N status, it is possible to monitor the N fertility status of soil from the initial analysis as revealed from the study.

It is well known that the level and rate of mineralisation of nitrogen containing organic matter provides the immediately available nitrogen required for the plant growth. Although this is a continuous process, conventional estimates of soil available N take into account the status of inorganic nitrogen-exchangeable NH_4 and or NO_3 -N and N liberated from oxidation/hydrolysis of organic nitrogen under laboratory conditions of incubation/digestion. In the estimate of mineralised N, the role of the qualitative nature of organic matter in the soil has been emphasised by Tinsley (1969). Cheng and Kurtz (1963) observed that N fertiliser added to the soil for two seasons underwent transformation and the three fractions viz., soluble, alkali stable components including amino acid, amino sugar and hydrolysable NH_4 accounted for more than 90 per cent of added fertilizer N. Recent studies have also centred around identifying particular fractions of organic N, which are preferentially

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contributing to the N nutrition of crops (Cornforth, 1968); Ramamoorthy and Aggarwal, 1972). The nature of organic N fractions in the Kaveri alluvial soils of Thanjavur, their contribution to the N nutrition of rice and their relationship to soil test methods are discussed in this paper.

MATERIALS AND METHODS

Two field experiments were conducted at Kabisthalam of Thanjavur District representing 'Adanur soil series' in an area of 1.5 acre. In the first season-Kuruvai (June-September) the field was divided into four strips and four graded doses of NPK fertilisers were added to the four strips as follows, to create as large a variation as possible in soil fertility.

Table 1. Graded doses of fertiliser

Strip	Fertility	N	P_2O_5	K_2O
		(kg/ha)		
I	N_0 P_0 K_0	—	—	—
II	$N_{\frac{1}{2}}$ $P_{\frac{1}{2}}$ $K_{\frac{1}{2}}$	75	50	50
III	N_1 P_1 K_1	150	100	100
IV	N_2 P_2 K_2	300	200	200

An exhaust crop of rice (Karuna) was grown. Subsequently, each strip was divided into 43 plots and 21 fertiliser treatments were randomly distributed in each strip. Each treated plot was flanked by control plots in both sides. Rice IR 20 was grown during Thaladi season (October-February).

The soil samples from two depths (0-15 cm and 15-30 cm) taken from all the plots (172) before the application of fertilisers were analysed for available N by organic carbon method (Datta *et al.,* 1962) and alkaline permanganate method (Subbiah and Asija, 1956). Total N and N fractions in 36 control plots of the field were determined in portions of soil samples ground and passed through 0.2 mm sieve. The N fractionation flow-sheet adopted from Cheng and Kurtz (1963) and Keeney and Bremner (1964) was followed for characterising the N fractions. The individual N fractions were determined as per the scheme recommended by Bremner (1965). Total nitrogen in soil and N uptake by the plant (grain and straw) were determined by Kjeldahl's procedure as described by Jackson (1973).

RESULTS AND DISCUSSION

1. The data of distribution of organic N fraction in the control plots, orgainc C%, $KMnO_4$ N - uptake and yield [Q/ha] are given in Table 2.

Particulars	N P K 0 0 0 strip A	B	N P K ½ ½ ½ strip A	B	N P K 1 1 1 strip A	B	N P K 2 2 2 strip A	B	Whole field A	B
	[Kg/ha]									
Inorganic - N										
Exch. NH_4^+	104	8 2	157	10.3	176	10.0	179	9.9	154	9.7
NO_3-N	14	1.1	17	1.1	20	1.1	22	1.2	18	1.1
Fixed-NH_4^+	75	5.9	89	5.8	94	5.3	99	5.5	89	5 6
Organic-N										
Total Hydro-N	775	61.1	869	56.9	1055	59.8	1104	61.4	951	59.8
Hydroly.NH_4-N	121	9.5	149	9.8	169	9.6	193	10.7	158	9.9
Hexosamine	74	5.8	84	5.5	88	5.0	91	5.1	84	5.3
A.Acid	160	12.6	182	11.9	270	15.3	314	17.4	232	14 6
Unidentified (Acid soluble)	420	33.1	454	29.7	529	30.0	506	28 1	477	30.0
Non-hydroly (Acid-insol).(humin)	229	23.6	296	25.9	421	23.9	398	22.1	379	23.8
Total-N	1268	—	1527	—	1765	—	1803	—	1591	—
* N uptake	47.2	—	52.9	—	66.9	—	81.6	—	62 2	—
* Yield q/ha	32.3	—	34.4	—	36.5	—	39.3	—	45.6	—
Organic C%	0.93	—	1.02	—	1.11	—	1.13	—	1.04	—
$KMnO_4$-N	269	—	339	—	376	—	353	—	334	—

(A = mean value*, B = Per cent of total N in respective strip)

* The N uptake by crop and yield are mixed up in soil analysis data in the middle and also not mentioned in the title of Table. These are separate items, they may be given in a separate table.

The inorganic N constitutes about 16 per cent of the total N. Among the organic N fractions, the hydrolysable N constitutes 60 per cent and non-hydrolysable N about 24 per cent. Among the hydrolysable N, the distribution of different fractions are as; unidentified hydrolysable N, N (UH-N) = 30 per cent, amino acid (AA) : 14.6 per cent, hydrolysable NH_4 (HA) : 9.9 per cent and hexosamine (H) : 5.3 per cent.. The levels of N added to the exhaust crop ranging from 0-300 kg/ha and its transformation in the soil reveals that there is proportionate increase in the hydrolysable N as well as in the non-hydrolysable N. Significant change, however has occurred in the distribution of amino acid (AA) and hydrolysable NH_4 (HA) N fractions The AA varies from 160 kg/ha in the control strip to 314 kg/ha in the strip with the level of 300 kg/ha Corresponding figures of HA are 121 and 193 kg/ha respectively.

ii. Relationship between forms of N with yield/uptake soil test methods. Correlation coefficients between above factors are given in Table 3.

Table 3. r—values

	Yield	N-uptake	Organic-C	$KMnO_4$ - N
Hydrolysable - NH_4	0.71**	0.89**	0.84**	0.66**
Amino acid	0.70**	0.86**	0.74**	0.59**
Hexosamine	0.37*	0.39*	0.45**	0.33**
Fixed - NH_4	0.76**	0.81**	—	—
Exch. NH_4	0.56**	—	—	—

** 1 per cent significance

* 5 per cent significance

The important fractions of organic N significantly contributing to yield are AA, HA, H and fixed NH_4 and exch. NH_4 among the inorganic N fractions. In terms of quantitative distribution, AA fraction is more important than the other two fractions. These three organic N fractions mostly contribute to N uptake also. The contribution of fixed NH_4 in the alluvial soil is also revealed.

The multiple regression of different N fractions on grain yield and N uptake give significant R^2 value of 0.64** and 0.86** respectively. The corresponding regression equation for N uptake is also as follows:

N-uptake = 1.27-0.031 Exch. NH_4 -0.056 NO_3 - N-0.036 Fixed NH_4 + 0.32 HA** -0.14 Hex + 0.099 AA** + 0.0067 UH + 0.012 NH (R^2 = 0.86**) .... Eqn. 1

Similar relationship of the forms of N with organic C and $KNnO_4$ - N give R^2 values of 0.75** and 0.64** respectively.

Organic-C = 0.76 + 0.00059 Exch. NH_4 + 0.00011 NO_3 - N-0.0030 fixed NH_4 + 0.003 HA**-0.0093 Hex + 0.00014 AA + 0.000 13 UH - 0.00041 NH (R^2 = 0.75**) .... Eqn. 2

$KMnO_4$ -N = 29.80 + 0.33 Exch. NH_4 + 0.87 NO_3 -N + 1.19 fixed NH_4 + 0.089 HA-0.19 Hex-0.12 AA + 0.26 UH + 0.091 NH (R^2 = 0.64**) .... 3 Eqn.

The multiple regression equation 1 also reveals the predominent role of HA and AA for N nutrition of rice.

A comparison of partial regression co-efficients of the above mentioned five forms in the regression set with organic carbon, against those in N uptake indicate that improvement in organic carbon method could be made in such a way that more proportion of hydrolysable NH_4, amino acid, and unidentified hydrolysable forms of N could be extracted by this procedure.

A similar comparison of the partial regression co-efficients of $KMnO_4$ method shows that this could be also improved considerably by modifying in such a way that it will extract to a less extent from unidentified hydrolysable and non-hydrolysable forms and to a greater extent from amino acid and hydrolysable NH_4 fractions. If the above mentioned changes in the extraction pattern of these two methods are achieved, they would in effect perform in the laboratory what the root extraction pattern does in the field, as judged form equation 1.

The relationship of different organic-N forms significantly influencing yield and uptake is most strong with organic C than with $KMnO_4$ -N. This is also reflected in the relationship with yield and uptake by organic-C method which has a "r" values of 0.62** and 0.76**, as compared to $KMnO_4$ - N which has a "r" - values of 0.48** and 0.57**, respectively. However, since there is a direct relationship between organic-C and $KMnO_4$ - N in these soils the possibility of interconversion from one method to another is possible, from the regression equation, which has a highly significant "r" value of 0.95**.

iii. Changes in available N status due to cropping. An estimate of changes during the season in organic-C and $KMnO_4$-N due to fertilisation from these trials show that the resultant organic C varied from 0.93 per cent in the control strip, to 1.13 per cent in the strip with 300 kg added N/ha. Similar values for the $KMnO_4$-N ranged from 269 to 379 kg/ha (Table 2).

For the rice grown in Thaladi season which received graded doses of N from 0 to 200 kg/ha at 50 kg interval the changes in the available N status are as follows: the highest build up of organic C (0.32 pre cent) is associated with 150-100-100 NPK treatment $N_0 P_0 K_0$ strip, while the highest depletion (-0.38 pre cent) is for the treatment 0-50-50 in $N_{\frac{1}{2}} P_{\frac{1}{2}} K_{\frac{1}{2}}$ strip. In terms of highest build up of available N by $KMnO_4$ methods treatment 200-150-100 gives a build up of +63 kg/ha while treetment 50-0-0 in $N_2 P_2 K_2$ or treatment 0-50-50 in $N_{\frac{1}{2}}P_{\frac{1}{2}}K$ strip gives a highest depletion of -63 kg/ha.

The changes in available nitrogen status for control plots in surface and sub-soils respectively show that the depletion during one season is of the order of -0.16 per cent and -10 kg/ha for organic-C and $KMnO_4$-N surface and -0.17 per cent and -16 kg/ha in sub-soil.

Studies on the changes in available N status between pre-sowing and post-harvest soil samples also bring out the possibility of predicting the post-harvest status of available N based on the initial values and the level of N fertilisation. Such significant relationship for organic C and $KMnO_4$ - N are as follows :

Organic-C% (post-harvest) = -0.14 + 0.002 (FN) + 0.86 (O.C) (Initial soil) (R^2 = 0.82**) .... Eqn. 4.

$KMnO_4$ - N (post-harvest) = 12.9 + 0.37 FN** + 0.84 $KMnO_4$ - N (Initial soil) (R^2 = 0.916*) .... Eqn. 5

The calculated soil test values ($KMnO_4$ - N) for all the treated plots in $N_1 P_1 K_1$ strip using the equation 5, and the experimental value agree very closely namely 427, 438 kg/ha respectively.

The distribution of organic N fraction indicates that amino acid fraction is quantitatively more important among the hydrolysable N forms for rice nutrition. The fixed NH_4 in the alluvial soil contributes about 6 per cent of total N and also significantly correlates with yield. The non-hydrolysable N and unidentified hydrolysable N, though quantitatively important are not directly related to the immediate N availability to the rice crop.

The different forms of organic N are better related with organic C status than with $KMnO_4$ - N leading to scope for improvement in the modification of these methods. Sinco N fertilisation and its transformation have a direct bearing with the changes in available N status, it is possible to monitor the N fertility status of soil from the initial analysis as revealed from study.

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MANAGEMENT OF RICE GALL MIDGE *Orseolia oryzae* (WOOD-MASON) WITH REFERENCE TO TIME OF PLANTING AND VARIETAL RESISTANCE

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The incidence of rice gall midge was maximum when CO 40 was planted on 1st September during samba season and when IR 20 was planted on 16th September during thaladi season. The incidence was less when the plantings were made during August or October. Of the 41 varieties tested, IET 3231 was free from gallmidge infestation while CR 1009, IR 20, Jaya, CO 25, CO 40 and Pankaj recorded 5.91, 9.13, 9.80, 13.22, 14.83 and 34.69% respectively.

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