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# Effect of Organic Sources and Urea on N Transformation and Yield of Lowland Rice Grown in Clay Loam Soil

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**Abstract:** Field experiments were conducted during Kharif 2006 and 2007 in clay loam soil to study the effect of organic sources and urea on N transformation and yield of rice. The treatments consisted of addition of different organics viz., composted coir pith (CCP), green manures (GM), sugarcane trash compost (STC), vermicompost (VC), poultry manure (PM) and FYM applied at 100% RDN and combination of above organics @50% N and urea@50%N besides 100% RDN as urea and control. The results revealed that addition of organics or mineral N or both significantly improved rice yields over control in both years. The highest grain yield (4942, 5332 kg $ha^{-1}$) and straw yield (7314, 7725 kg $ha^{-1}$) was noticed with vermicompost (50% N) + urea (50% N) which was on par with poultry manure (50%N) + urea (50%N) but superior to rest of the treatments. Rice yield was more with 100% Urea N compared to 100% RDN as organics alone. The best treatment caused 26.4% increase in grain yield over control, 3.8% over 100% urea N. Integrated use of organics and urea recorded higher concentration of ammonium and nitrate nitrogen compared to their individual addition. The N forms were more under vermicompost amended soil followed by green manure and poultry manure. The mineral N was higher at initial stages and decreased with crop growth. The NUE was higher under integrated use of organics and urea compared to organics and urea alone

**Key words:** N forms, yield, organics, urea, NUE, rice

## INTRODUCTION

Nitrogen is the most limiting nutrient of rice in most soils of India. The balanced nutrition involves systematic exploitation of potential soil resources, chemical fertilizers, biofertilizer and organic manures. When manures are applied in conjunction with urea for efficient growth of crop, decline in organic carbon was arrested and gap between potential and actual yield was bridged to a large extent[12]. Since different organics mineralize at different rates depending up on their nature of organic constituents and prevailing climatic conditions, combined application of organic manures with urea may not lead to availability of significant amount of N forms at some critical stages. To understand the behavior of integrated use of organics and mineral N in this regard, it is essential to monitor the availability of $NH_4$-N and $NO_3$-N in the soil solution and exchange complex. Mineralizable N in the soil plays a dominant role in the nutrition of crops. Incorporation of organic materials along with fertilizer N affects the amount and distribution of N fractions considerably in soil[10].

## MATERIALS AND METHODS

Field experiments were conducted in Kalathur series (Typic Haplusterts) during Kharif 2006, 2007) to study the effect of organic sources and urea on N transformation and yield of rice tested at N equivalence. The experimental soil was clay loam in texture with pH-8.1, EC- 0.36 $dSm^{-1}$, OC- 3.6g $kg^{-1}$, CEC-29.5 cmol ($p^+$) kg $^{-1}$, available N, P and K being 225,14.5 and 310 kg $ha^{-1}$ respectively. The treatment consisted of $T_1$- Absolute control, $T_2$-Composted coir pith (CCP- 100% N),$T_3$-Green manure(GM-100% N),$T_4$- Sugarcane trash compost(STC-100%N), $T_5$-Vermicompost (VC-100% N), $T_6$-Poultry Manure(PM-100%N), $T_7$- Farmyard Manure (FYM-100%N), $T_8$-CCP(50% N) + Urea(50% N), $T_9$- GM(50% N) + Urea (50% N) , $T_{10}$- STC(50% N) + Urea(50% N), $T_{11}$-VC(50% N) + Urea(50% N), $T_{12}$- PM(50% N) + Urea(50%N), $T_{13}$- FYM(50% N) + Urea (50% N), $T_{14}$-RDF(120:60:60 N , $P_2O_5$ , $K_2O$ Kg $ha^{-1}$).The N content in different organics include CCP(1.06%), GM (1.90%), STC(0.45%), VC (1.80%), PM(2.15%) and FYM (0.60%).The treatments $T_2$ to $T_7$ received 120 kg N ha-

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[1] through various organics only and $T_8$ to $T_{13}$ received 60 kg N $ha^{-1}$ through various organics (50% N) and 60 kg N $ha^{-1}$ through urea(50%N). Accordingly quantity of organics added varied depending on N content. Grain and straw yields were recorded at harvest. Wet soil samples were collected at tillering stage, panicle initiation and harvest stages and analyzed for ammonium and nitrate nitrogen following the procedure. Based on grain yield and N uptake following nutrient use efficiency were worked out

1. Factor productivity (kg grain/kg N) = Grain yield/ amount of N applied
2. Response ratio (Kg/kg)

$$= \frac{\text{Grain yield in treated plot- Grain yield in control}}{\text{Amount of N applied}}$$

3. Apparent N recovery(%)

$$= \frac{\text{N uptake in treated plot- N uptake in control}}{\text{Amount of N applied}} \times 100$$

The data was subjected to statistical scrutiny to arrive at meaningful explanation for the effect of treatments on rice crop.

## RESULTS AND DISCUSSION

**N Transformation:** Ammonium–N and nitrate-N concentration in soil at various stages of crop growth due to treatments is shown in Table 1a, 1b. The trend of $NH_4$-N content of soil showed that under flooded condition, it remained in sufficiently higher in all the treatments over control. The concentration of $NH_4$-N was higher at tillering stage and progressively declined with advancement of crop growth. The ammonium-N concentration was higher under integrated use of organics and urea compared to individual addition and it was consistently highest with vermicompost(60 kg N $ha^{-1}$)and urea(60 kg N $ha^{-1}$ ) followed by green manure (60 kg N $ha^{-1}$) and urea (60 kg N $ha^{-1}$ ) and poultry manure (60 kg N $ha^{-1}$) and urea (60 kg N $ha^{-1}$). Ammonium-N concentration was relatively higher with urea compared to organics. On an average, integrated use of organics and urea caused 96.6 to 113.6% increase in $NH_4$-N over control. Increase in $NH_4$-N and $NO_3$-N at early stages is due to rapid hydrolysis of urea and accelerated mineralization of organic nitrogen sources in the presence of urea because of the stimulating effect of chemical nitrogen on microbes responsible for carry out the process[12]. Higher amounts of mineral N accumulation in those soils treated with organic sources in combination with inorganic than those treated with organics alone is attributed to a priming effect[1]. The priming effect is mainly the result of the decrease in the C: N ratio and increase in the rate of decomposition of organic residues in the presence of inorganic N. As the submergence prolonged, the rice crop picked up growth and started to absorb more of $NH_4$-N which explains the reduction in $NH_4$-N in soil at later stages[4]. Beneficial effect of integrated use of organics with urea N on wet soil $NH_4$-N was reported earlier by[5].

The $NO_3$-N concentration in the soil decreased with stages of rice crop. Higher values of $NO_3$-N in soil was observed in plots which received both organics and urea compared to their individual application. However nitrate N in the surface soil at different stages showed lower values in spite of the fact that ammonium N content in soil was relatively high. This might be due to quick loss of nitrate N through denitrification[9]. Further addition of organics might have increased the immobilization of fertilizer N in soils during early stages of crop growth due to increased supply of carbon source to the soil microbes.

**Grain and Straw Yield:** Grain and straw yields of rice in both years was significantly increased due to addition of various organics alone or urea at 100% RDN or combined addition at equal rate of N over control. (Table 2). The treatment receiving vermicompost (60 kg N $ha^{-1}$) and urea (60 kg N $ha^{-1}$) recorded the highest grain yield (4943, 5332 kg $ha^{-1}$) and straw yield (7314, 7725 kg $ha^{-1}$) during 2006, 2007 respectively followed by poultry manure (60 kg N $ha^{-1}$) and urea (60 kg N $ha^{-1}$ ) and green manure (60 kg N $ha^{-1}$) and urea (60 kg N $ha^{-1}$). The best treatment caused 26.9% increase in grain yield over control, 3.8% over 100% RDN urea and 7.3% over 100% N through vermicompost. Grain yield response was higher when recommended dose of N was applied through urea compared to the same rate applied through organics. On an average addition of various organics addition caused 13.4% increase over control whereas the recommended dose of N through urea caused 22.2% increase over control.. On integration of organics and urea the grain yield increase ranged from 16.9 to 26.9% over control. Crop yields depend mainly on the availability of $NH_4$-N in submerged conditions. Azam[1] observed higher rice yields due to organics was mainly attributed to overall improvement in soil fertility including N supply. Grain yields obtained in this experiment are explained by significant variation in wet soil ammonium N at different stages of crop growth. In general use of organics alone or in combination with urea N maintained wet soil $NH_4$-N at higher levels throughout rice growth period than urea which is observed in the present study (Table 1). Organics alone or with urea N supply $NH_4$-N to the plant through continuous mineralization of organic N and in turn increase NUE, ultimately giving higher yield[4]. Application of urea N produced higher yield than

**Table 1a:** Effect of organics and urea on $NH_4$-N( mg $kg^{-1}$) concentration in rice soil

| Treatments | Kharif 2006 | | | Kharif 2007 | | |
|---|---|---|---|---|---|---|
| | Tillering stage | Panicle Initiation | Harvest stage | Tillering stage | Panicle Initiation | Harvest stage |
| $T_1$ | 18.6 | 9.4 | 7.5 | 17.9 | 10.2 | 8.2 |
| $T_2$ | 28.4 | 22.6 | 18.5 | 26.8 | 22.9 | 16.5 |
| $T_3$ | 35.9 | 25.7 | 20.5 | 30.3 | 24.8 | 18.6 |
| $T_4$ | 34.6 | 23.7 | 19.4 | 27.6 | 23.2 | 17.1 |
| $T_5$ | 37.9 | 26.9 | 21.8 | 31.9 | 25.8 | 19.2 |
| $T_6$ | 36.5 | 24.8 | 19.7 | 30.6 | 23.9 | 18.4 |
| $T_7$ | 35.6 | 24.6 | 19.5 | 30.9 | 23.6 | 18.0 |
| $T_8$ | 39.1 | 31.1 | 22.9 | 32.8 | 26.2 | 21.3 |
| $T_9$ | 47.6 | 38.5 | 24.2 | 35.6 | 29.2 | 22.9 |
| $T_{10}$ | 40.1 | 32.1 | 23.4 | 33.6 | 26.7 | 21.7 |
| $T_{11}$ | 50.1 | 39.2 | 24.6 | 36.9 | 29.6 | 21.9 |
| $T_{12}$ | 47.4 | 37.2 | 22.6 | 35.4 | 28.5 | 19.9 |
| $T_{13}$ | 43.1 | 34.4 | 22.5 | 31.9 | 22.9 | 20.9 |
| $T_{14}$ | 44.2 | 36.4 | 23.9 | 32.6 | 25.1 | 22.6 |
| CDat 5% | 0.42 | 0.31 | 0.32 | 0..57 | 0.41 | 0.36 |

**Table 1b:** Effect of organics and urea on $NO_3$-N ((mg $kg^{-1}$) concentration in rice soil

| Treatments | Kharif 2006 | | | Kharif 2007 | | |
|---|---|---|---|---|---|---|
| | Tillering stage | Panicle Initiation | Harvest stage | Tillering stage | Panicle Initiation | Harvest stage |
| $T_1$ | 4.5 | 3.9 | 2.6 | 5.6 | 4.0 | 3.2 |
| $T_2$ | 12.6 | 10.4 | 8.2 | 12.9 | 8.9 | 7.6 |
| $T_3$ | 15.2 | 11.6 | 11.6 | 15.9 | 13.2 | 10.6 |
| $T_4$ | 13.9 | 10.9 | 12.5 | 14.1 | 10.5 | 11.2 |
| $T_5$ | 15.9 | 11.2 | 13.6 | 14.6 | 9.8 | 12.3 |
| $T_6$ | 13.9 | 9.8 | 8.3 | 12.8 | 8.4 | 9.5 |
| $T_7$ | 14.1 | 12.7 | 10.9 | 13.5 | 11.6 | 10.2 |
| $T_8$ | 15.7 | 13.2 | 11.3 | 14.1 | 12.0 | 11.0 |
| $T_9$ | 14.5 | 12.9 | 11.5 | 13.8 | 11.2 | 12.1 |
| $T_{10}$ | 13.4 | 10.2 | 8.9 | 12.9 | 8.9 | 8.1 |
| $T_{11}$ | 14.7 | 10..9 | 10.8 | 13.8 | 9.2 | 9.6 |
| $T_{12}$ | 12.9 | 10.3 | 8.9 | 11.5 | 8.6 | 8.6 |
| $T_{13}$ | 11.2 | 11.9 | 9.5 | 10.9 | 10.6 | 9.0 |
| $T_{14}$ | 12.1 | 9.65 | 7.6 | 11.6 | 8.6 | 6.9 |
| CDat 5% | 0.55 | 0.60 | 0.35 | 0.46 | 0.50 | 0.36 |

**Table 2:** Effect of organics and fertilizer nitrogen on rice yield (kg $ha^{-1}$)

| Treatments | Kharif 2006 | | | Kharif 2007 | | |
|---|---|---|---|---|---|---|
| | Grain yield | Percent increase over control | Straw yield | Grain yield | Percent increase over control | Straw yield |
| $T_1$ | 3896 | - | 5846 | 4300 | - | 6235 |
| $T_2$ | 4271 | 9.6 | 6276 | 4752 | 10.5 | 6728 |
| $T_3$ | 4527 | 16.2 | 6716 | 4962 | 15.4 | 7108 |
| $T_4$ | 4296 | 10.2 | 6315 | 4777 | 11.1 | 6746 |
| $T_5$ | 4603 | 18.1 | 6782 | 5078 | 18.1 | 6746 |
| $T_6$ | 4451 | 14.2 | 6620 | 4881 | 13.5 | 7239 |
| $T_7$ | 4363 | 11.9 | 6366 | 4825 | 12.2 | 7040 |
| $T_8$ | 4674 | 19.9 | 6698 | 5070 | 17.9 | 6765 |
| $T_9$ | 4857 | 24.7 | 7177 | 5088 | 18.3 | 7108 |
| $T_{10}$ | 4634 | 18.9 | 6786 | 5113 | 18.9 | 7201 |
| $T_{11}$ | 4943 | 26.9 | 7314 | 5332 | 22.9 | 7725 |
| $T_{12}$ | 4841 | 24.2 | 7151 | 5285 | 24.0 | 7607 |
| $T_{13}$ | 4654 | 19.5 | 6962 | 5135 | 19.4 | 7600 |
| $T_{14}$ | 4762 | 22.2 | 7092 | 5210 | 21.2 | 7575 |
| CDat 5% | 76.2 | - | 89.7 | 91.5 | - | 104.5 |

organics alone which might be due to inability of organic N sources to release nutrients at peak requirement of the crop. Combined application of inorganic and organic sources produced higher yields than inorganic alone was reported earlier[11]. The highest rice yield on addition of vermicompost with urea was reported earlier[6].

**Nitrogen Use Efficiency:** Nitrogen use efficiency in terms of factor productivity, response ratio and apparent N recovery clearly showed that integrated use of organics with urea provided higher NUE compared to their individual additions. (Table 3). Factor productivity, response ratio and apparent N recovery was relatively higher with 100% RDN through urea compared to 100% RDN through organics. The highest factor productivity (41.2, 44.4 kg grain kg $N^{-1}$), response ratio (8.73,8.60 kg $kg^{-1}$) and apparent N recovery(47.4,44.3%) was noticed with addition of VC(60 kg N $ha^{-1}$)+ urea(60 kg N $ha^{-1}$ ) followed by GM (60 kg N $ha^{-1}$)+ urea(60 kg N $ha^{-1}$ ) and PM(60 kg N $ha^{-1}$)+ urea(60 kg N $ha^{-1}$ ) in 2006 and 2007 respectively. Factor productivity of applied N was increased by1.5 and 1.0 kg grain/kg N during 2006 and 2007 with VC (60 kg N $ha^{-1}$) + urea (60 kg N $ha^{-1}$) compared with 100%RDN through urea. Higher recovery efficiency of N in integrated use of organics with urea might be due to lower N losses and synchronization of N supply with crop needs[2]. The results were in conformity with findings of [7] who reported that blended inorganic fertilizers increased use efficiency of nutrients.

Relative efficiency of organic materials was calculated as the index of organic material N efficiency in the following formula proposed by[8]

Relative efficiency (%) = $NUE_{Or}$ / $NUE_{CF}$ x 100 where Or- organics, CF-chemical fertilizer.

Accordingly the relative efficiency of different organic materials were CCP(35.1,17.4%), GM(49.7,40.4%), STC (26.9,24.4%), VC(63.4,50%), PM(43.7,40.7%) and FYM(34.6,32.3%) during 2006 and 2007 respectively. It is evidently observed that vermicompost followed by green manure and poultry manure provided higher N to the rice crop which has been reflected in obtaining higher rice yield in both years in the present study.

**Conclusion:** Thus study showed that organics and fertilizer N are not only complimentary but also synergistic since organic inputs have beneficial effects beyond their nutritional components and enhance the effect of applied mineral fertilizers.

**Table 3:** Effect of organics and fertilizer N on nitrogen use efficiency of rice

| Treatments | Kharif 2006 | | | | Kharif 2007 | | | |
|---|---|---|---|---|---|---|---|---|
| | Factor productivity (kg grain/ kg N) | Response ratio ( kg $kg^{-1}$) | Apparent N recovery (%) | Realtive efficiency (%) | Factor productivity (kg grain/ kg N) | Response ratio ( kg $kg^{-1}$) | Apparent N recovery (%) | Realtive efficiency (%) |
| $T_1$ | 32.5 | - | - | - | 35.8 | - | - | - |
| $T_2$ | 35.6 | 3.13 | 12.3 | 35.1 | 39.6 | 3.77 | 6.2 | 17.4 |
| $T_3$ | 37.7 | 5.26 | 17.4 | 49.7 | 41.4 | 5.52 | 14.4 | 40.4 |
| $T_4$ | 35.8 | 3.33 | 9.4 | 26.9 | 39.8 | 3.98 | 8.7 | 24.4 |
| $T_5$ | 38.4 | 5.89 | 22.2 | 63.4 | 42.3 | 6.48 | 17.8 | 50.0 |
| $T_6$ | 37.1 | 4.63 | 15.3 | 43.7 | 40.7 | 4.84 | 14.5 | 40.7 |
| $T_7$ | 36.4 | 3.89 | 12.1 | 34.6 | 40.2 | 4.38 | 11.5 | 32.3 |
| $T_8$ | 38.9 | 6.48 | 23.3 | - | 42.3 | 6.42 | 20.8 | - |
| $T_9$ | 40.5 | 8.01 | 42.8 | - | 42.4 | 6.57 | 37.3 | - |
| $T_{10}$ | 38.6 | 6.15 | 26.5 | - | 42.6 | 6.78 | 26.3 | - |
| $T_{11}$ | 41.2 | 8.73 | 47.4 | - | 44.4 | 8.60 | 44.3 | - |
| $T_{12}$ | 40.3 | 7.88 | 38.5 | - | 44.0 | 8.21 | 40.8 | - |
| $T_{13}$ | 38.8 | 6.32 | 30.9 | - | 42.8 | 6.96 | 32.6 | - |
| $T_{14}$ | 39.7 | 7.22 | 35.0 | 100 | 43.4 | 7.58 | 35.6 | 100 |

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