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# Studies on Nitrogen use efficiency in irrigated rice as influenced by various sources of Nitrogen

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**Abstract**
Present investigation was carried out during *kharif* season of 2016 at the research farm of the ICAR - Indian Institute of Rice Research (IIRR) (formerly DRR), Hyderabad, Telangana state, entitled " Studies on Nitrogen use efficiency in irrigated rice as influenced by various sources of Nitrogen '. The experiment was laid out in randomized block design with sixteen treatments and three replications. The treatments comprised of $T_1$: Control; $T_2$ :50% RDN from Prilled urea (PU); $T_3$ : 50% RDN from Neem coated urea (NCU); $T_4$ : 50% RDN from Polymer coated urea (PCU); $T_5$ : 50% RDN from Vermi compost (VC); $T_6$ : 50% RDN from Rice straw (RS); $T_7$ : 75% RDN from (PU); $T_8$ : 75% RDN from (NCU); $T_9$ : 75% RDN from (PCU); $T_{10}$ : 75% RDN from (VC); $T_{11}$ : 75% RDN from (RS); $T_{12}$ : 100% RDN from (PU); $T_{13}$ : 100% RDN from (NCU); $T_{14}$ : 100% RDN from (PCU);$T_{15}$ : 100% RDN from (VC); $T_{16}$ : 100% RDN from (RS). The results revealed that the rice plant height was significantly influenced by nutrient management practices and the highest value (97.83 cm) was recorded under $T_{13}$: 100% RDN from (NCU). Similarly, Yield attributing characters of rice were significantly affected by different treatments. The highest value for number of tillers $m^{-2}$ (399), number of panicles $m^{-2}$ (331), number of grains per panicle (128), Panicle length (20. cm) and filled grain percentage (97.45%) were found in treatment $T_{13:}$ 100% RDN from (NCU). Likewise, treatment $T_{13:}$ 100% RDN from (NCU) has also recorded maximum rice grain yield (41.0 q/ha) and straw yield (54.0q/ha) and was followed by $T_{14}$ : 100% RDN from (PCU). Significantly lowest Grain and straw yield of rice were obtained under $T_1$: control.

**Keywords:** Rice, Nitrogen, Neem coated urea, Polymer coated urea, yield

## 1. Introduction

Rice is India pre-eminent crop, and is the staple food of the people of the eastern and southern parts of the country. Rice is one of the chief grains of India. Moreover, this country has the largest area under rice cultivation, as it is one of the principal food crops. It is infact the dominant crop of the country. India is one of the leading producers of this crop. Rice is the basic food crop and being a tropical plant, it flourishes comfortably in hot and humid climate. It is estimated that by 2018 the demand for fertilizer N is predicted to increase by 29.1% in East Asia and by 24.5 % in Southeast Asia (FAO, 2015). However, it is worth mentioning that the nitrogen levels and sources of applied fertilizer N, either expressed as crop N recovery or agronomic efficiency, in rice is very low. Indian rice productivity is still well below the world's average yield of 4.36 t $ha^{-1}$ (FAOSTAT, 2014). It demands temperature of around 25 degree Celsius and above and rainfall of more than100 cm. Rice is also grown through irrigation in those areas that receives comparatively less rainfall. Rice can be cultivated by different methods based on the type of region. But in India, the traditional methods are still in use for harvesting rice. The fields are initially ploughed and then fertiliser is applied which typically consists of cow dung and then the fields is smoothed. The seeds are transplanted by hand and then through proper irrigation, the seeds are cultivated. Rice grows on a variety of soils like silts, loams and gravels. It can also tolerate alkaline as well as acid soils. However, clayey loam is well suited to the raising of this crop. Actually the clayey soil can be easily converted in to mud in which rice seedlings can be transplanted easily. Proper care has to be taken as this crop thrives if the soil remains wet and is under water during its growing years. Rice is considered as the master crop of coastal India and in some regions of the eastern India where during the summer monsoon rainy season both high temperature and heavy rainfall provide ideal conditions for the cultivation of rice.

Almost all parts of India are suitable for raising rice during the summer season provided that the water is available. Thus, rice is also raised even in those parts of western Uttar Pradesh, Punjab and Haryana where low level areas are waterlogged during the summer monsoon rainy season. Rice is the staple food for about 50% of the population that resides in Asia, where 90% of the world's rice is grown and consumed. In Asia, India has the largest area under rice (44.6mha) accounting for 29.4% of the global rice area and record in terms of production (104.3mt) during 2014-15 and at stood next only to china in the world. The yield levels in India are low at 2.1t per ha compared to other major rice producing countries. Rice is produced under both upland and lowland ecosystems with about 76% of the global rice produced from irrigated-lowland rice systems Fageria *et al.*, (2003) [4].

## Methods & Materials

A field experiment was carried out during the *Kharif* season (June–October) of 2016 at the research farm of the ICAR - Indian Institute of Rice Research (IIRR) (formerly DRR), Hyderabad, Telangana state, entitled " Studies on Nitrogen use efficiency in irrigated rice as influenced by various sources of Nitrogen '. The experiment was laid out in randomized block design with sixteen treatments and three replications. The treatments comprised of $T_1$: Control; $T_2$ :50% RDN from Prilled urea (PU); $T_3$ : 50% RDN from Neem coated urea (NCU); $T_4$ : 50% RDN from Polymer coated urea (PCU); $T_5$ : 50% RDN from Vermi compost (VC); $T_6$ : 50% RDN from Rice straw (RS); $T_7$ : 75% RDN from (PU); $T_8$ : 75% RDN from (NCU); $T_9$ : 75% RDN from (PCU); $T_{10}$ : 75% RDN from (VC); $T_{11}$ : 75% RDN from (RS); $T_{12}$ : 100% RDN from (PU); $T_{13}$ : 100% RDN from (NCU); $T_{14}$ : 100% RDN from (PCU);$T_{15}$ : 100% RDN from (VC); $T_{16}$ : 100% RDN from (RS). The soil (black soil) was clay loam in texture with alkaline pH (8.24). It was non-saline (EC 0.74 dS $m^{-1}$) and high in organic carbon content (0.68%). The soil was low in available nitrogen (242 kg $ha^{-1}$) (Subbiah and Asija 1956), high in available phosphorus (15.4 kg $P_2O_5$ $ha^{-1}$) (Olsen *et al.* 1954) and high in available potassium (376 kg $K_2O$ $ha^{-1}$). Available zinc content (1.0 mg $kg^{-1}$) was above the critical level (0.6 mg $kg^{-1}$). The experiment was laid out in a Randomized block design with three replications and eight treatments namely i.e. 100 % PU (3 splits), 75 % NCU (3 splits), 100 % NCU (3 splits), 125 % NCU (3 splits), 100 %NCU (full basal), 100 % NCU (2 splits 50%+50%), 100 % NCU (2 splits 75%+25%) and Control ($N_o$ $P_{60}$ $K_{40}$). The treatment means were compared using least significant differences at 5% level of significance (Gomez and Gomez 1984) [6].

**Table 1:** Initial soil properties

| S. No | Soil properties | Value |
|---|---|---|
| 1 | Soil type | Black soil |
| 2 | Sand (%) | 43 |
| 3 | Silt (%) | 25 |
| 4 | Clay (%) | 32 |
| 5 | Soil textural class | Clay loam |
| 6 | Bulk density (Mg $m^{-3}$) | 1.45 |
| 7 | pH (1:2.5) | 8.24 |
| 8 | EC (1:2.5) (dS $m^{-1}$) | 0.74 |
| 9 | Organic carbon (g $kg^{-1}$) | 0.68 |
| 10 | Available N (kg $ha^{-1}$) | 242 |
| 11 | Available $P_2O_5$ (kg $ha^{-1}$) | 15.4 |
| 12 | Available $K_2O$ (kg $ha^{-1}$) | 376 |
| 13 | Available Zn (mg $kg^{-1}$) | 1.0 |

## Results and discussion

### SPAD chlorophyll meter reading (SCMR)

The data presented in table 2 on SPAD reading reveal significant differences among the treatments both at tillering and panicle initiation and the maximum SPAD readings were recorded at 100% RDN from NCU (40) at panicle initiation stage and the lowest SPAD reading was recorded under Control (T1) at tillering stage (Table 2). In general higher SCMR means greater Nitrogen and Chlorophyll. The results observed in the present study are in conformity with the results of Xu *et al.* (2000) [22], Sudhakar *et al.* (2006) [19] and Talwar *et al.* (2011).

### Plant height (cm)

Data pertaining to plant height (cm) at tillering, panicle initiation and harvesting stages of rice ranged from 47.21 to 62.88 cm, 70.05 to 82.89 and 82.89 to 97.83 cm (Table 2). At tillering, the different nitrogen levels and sources had significant influence on the plant height with maximum 100% RDN of Neem coated urea (T13). This may be ascribed to the increase in availability of nitrogen from Neem coated urea along with RDN that was responsible for increased vegetative growth. In case of panicle initiation, the maximum plant height was observed in 100% RDN of Neem coated urea (T13). At harvesting, maximum plant height was observed in 100 % RDN of Neem coated urea (T13). This may also be attributed to the increased availability of nitrogen in these treatments. This corroborates the findings of Tarikul (2007) [20].

### Number of tillers $m^{-2}$

Data pertaining to number of tillers $m^{-2}$ at tillering, panicle initiation and harvesting stages of rice were given in Table 2. Tiller numbers $m^{-2}$ ranged from 325 to 397, 350 to 399 and 350 to 399 respectively (Table 2). At different stages, the different nitrogen levels and sources had significant influenced the number of tillers $m^{-2}$with maximum in 100 % RDN from NCU over control. This may be due to maximum easy in availability of nitrogen responsible for vegetative growth. This corroborates the findings of Bhalla and Prasad (2008) [2].

### Panicle length (cm) and filled grains percentage

Data pertaining to panicle length (cm) and filled grains percentage at harvesting of rice ranged from 19.45 to 20.86 cm and 68.16 to 97.45 percent, respectively (Table 3). Treatment 100% RDN from NCU (T13) registered significantly higher panicle length over control, which was at par with rest of nitrogen use efficiency management practices except in control (T1). In case of number of filled grains percentage, treatment 100% RDN from (T13) recorded significantly higher value as compared to rest of the treatments. Similar trend was reported by Shivay *et al.* (2000) [15].

### Test weight (g)

The size and boldness of rice seed measured as 1000-grain weight as influenced by different nitrogen levels and sources have been presented in (Table 3.). The test weight of rice varied from 27 to 30 g. All the treatments failed to give significant impact on test weight of rice. The maximum value of test weight was recorded with 100% RDN from NCU (T13).

**Number of grains panicle$^{-1}$ and number of panicle m$^{-2}$**

Data pertaining to number of grain per panicle and number of panicles per m-2 at harvesting of rice ranged from 80 to 127.75 and 303 to 331 Respectively (Table 3). All the treatments failed to give significant impact on number of panicle per per m-2 of rice. Among the different nitrogen levels and sources, the highest number of panicles m-2 was recorded in treatment 100% RDN from NCU (T13). These findings were corroborated with the findings of Ottis and Talbert (2005) [12] and Bhalla and Prasad (2008) [2].

**Grain and Straw yield (q ha$^{-1}$)**

The average grain and straw yield of rice was significantly affected by different nitrogen levels and sources. The yields of grain and straw of rice varied from 21(q ha$^{-1}$) to 41and 32(q ha$^{-1}$) to 54(q ha$^{-1}$) respectively, in various treatments (Table 4). The different nitrogen levels and sources influenced the grain yield significantly with maximum grain yield was recorded in treatment 100% RDN from NCU (T13) and minimum grain yield was observed in control (T1). It may be due to increase in the availability of nitrogen. The maximum total yield was recorded in 100% RDN from NCU (T13) treatment. Control (T1) treatment recorded significantly lower straw yield as compared to other treatments. NCU deactivate the ammonia mono oxygenize enzyme responsible for the oxidation of ammonical nitrogen to nitrite form. NCU help to retain soil N in the ammonical form for a longer time and therefore provide more opportunities and time for its uptake by crop plants. Low yield was observed in the treatments having organic inputs (VC) and (RS) because they cannot release sufficient N immediately for the current crop when they are applied first time and after repeated application, the nutrients will be accumulated and they will be provided in sufficient quantities to the succeeding crops. It may be due to increase in the availability of nitrogen, these results are in conformity with the findings of Bains *et al. (*1971) [1], Ketkar (1974) [8], Reddy and Prasad (1977) [14], Chakravorti (1979) [3], Thomas and Prasad (1983) [21], Surve and Daftardar (1985) [18], Geethadevi *et al.* (1991) [5], Jena *et al*. (1993) [7], Kumar and Thakur (1993) [9], Prasad *et al.* (1999) [13], Shivay *et al.* (2000) [15], Shivay *et al.* (2001) [16] and Mohapatra, *et al*. (2015) [10].

**Table 2:** Effect of different nitrogen levels and sources on growth parameters

| Treatment | SPAD values | | Plant height (cm) | | | Number of Tillers m$^2$ | | |
|---|---|---|---|---|---|---|---|---|
| | A.T | P.I | A.T | P.I | Harvesting | A.T | P.I | Harvesting |
| Control | 34 | 37 | 47.21 | 70.05 | 75.16 | 325 | 350 | 350 |
| 50% RDN from prilled urea(PU) | 37 | 35 | 48.44 | 75.36 | 82.81 | 366 | 370 | 370 |
| 50% RDN from Neem coated urea(NCU) | 37 | 37 | 54.1 | 77.41 | 85.22 | 375 | 376 | 376 |
| 50% RDN from Polymer coated urea(PCU) | 37 | 36 | 48.88 | 76.9 | 84.51 | 373 | 374 | 374 |
| 50% RDN from Vermi compost | 39 | 35 | 48.71 | 73.35 | 80.06 | 365 | 366 | 366 |
| 50% RDN from Rice Straw(RS) | 36 | 36 | 49.21 | 72.41 | 79.52 | 361 | 363 | 363 |
| 75% RDN from PU | 37 | 39 | 50.9 | 78.57 | 89.88 | 385 | 386 | 386 |
| 75% RDN from NCU | 37 | 37 | 51.74 | 81.36 | 95.68 | 388 | 389 | 389 |
| 75% RDN from PCU | 38 | 37 | 56.77 | 85.26 | 95.1 | 386 | 386 | 386 |
| 75% RDN from VC | 39 | 36 | 50.1 | 76.62 | 83.4 | 369 | 373 | 373 |
| 75% RDN from RS | 35 | 36 | 47.1 | 76.6 | 82.93 | 370 | 373 | 373 |
| 100% RDN from PU | 32 | 36 | 54.32 | 84.48 | 96.32 | 395 | 396 | 396 |
| 100%RDN from NCU | 35 | 40 | 62.88 | 82.89 | 97.83 | 397 | 399 | 399 |
| 100% RDN from PCU | 31 | 37 | 54.6 | 83.34 | 96.62 | 395 | 397 | 397 |
| 100% RDN from VC | 36 | 36 | 50.65 | 80.34 | 88.76 | 377 | 379 | 379 |
| 100% RDN from RS | 34 | 37 | 53.2 | 77.4 | 85.41 | 376 | 378 | 378 |
| SEm± | 0.57 | 0.33 | 1.02 | 1.1 | 1.76 | 3.35 | 4.41 | 4.41 |
| CD (P= 0.05) | 1.73 | 1.01 | 3.09 | 3.32 | 5.32 | 10.1 | 13.29 | 13.29 |

**Table 3:** Effect of different nitrogen levels and sources on plant yield attributes of irrigated rice

| Treatment | Number of grains Panicle$^{-1}$ | Panicle length (cm) | Filled grain percentage | Test weight (g) | Number of panicle m$^{-2}$ |
|---|---|---|---|---|---|
| Control | 80.00 | 19.45 | 68.16 | 27 | 303 |
| 50% RDN from prilled urea(PU) | 92.00 | 20.26 | 81.5 | 27 | 310 |
| 50% RDN from Neem coated urea(NCU) | 104.25 | 20.31 | 85 | 27.5 | 320 |
| 50% RDN from Polymer coated urea(PCU) | 100.00 | 20.3 | 84.21 | 27.5 | 314 |
| 50% RDN from Vermi compost | 90.00 | 20.26 | 80.56 | 27 | 295 |
| 50% RDN from Rice Straw(RS) | 85.45 | 20.25 | 80.5 | 27 | 290 |
| 75% RDN from PU | 112.00 | 20.4 | 88.43 | 27.5 | 310 |
| 75% RDN from NCU | 114.50 | 20.56 | 92.58 | 27.8 | 318 |
| 75% RDN from PCU | 114.00 | 20.45 | 92.5 | 27.7 | 316 |
| 75% RDN from VC | 95.00 | 20.26 | 82.3 | 27.2 | 303 |
| 75% RDN from RS | 93.50 | 20.25 | 81.5 | 27 | 302 |
| 100% RDN from PU | 120 | 20.65 | 92.83 | 28 | 324 |
| 100%RDN from NCU | 127.75 | 20.86 | 97.45 | 30 | 331 |
| 100% RDN from PCU | 120.45 | 20.76 | 93.21 | 29.8 | 341 |
| 100% RDN from VC | 108.75 | 20.36 | 87.39 | 27 | 321 |
| 100% RDN from RS | 108 | 20.33 | 85.5 | 27 | 316 |
| SEm± | 3.45 | 0.07 | 1.77 | 0.23 | 3.27 |
| CD (P= 0.05) | 10.42 | 0.23 | 5.36 | NS | 9.87 |

**Table 4:** Influence of different nitrogen levels and sources on grain and straw yield

| Treatment | Grain Yield (q $ha^{-1}$) | Straw Yield (q $ha^{-1}$) |
|---|---|---|
| Control | 21.0 | 32 |
| 50% RDN from prilled urea(PU) | 28.0 | 41 |
| 50% RDN from Neem coated urea(NCU) | 32.0 | 45 |
| 50% RDN from Polymer coated urea(PCU) | 34.0 | 47 |
| 50% RDN from Vermi compost | 24.0 | 35 |
| 50% RDN from Rice Straw(RS) | 23 | 36 |
| 75% RDN from PU | 31 | 44 |
| 75% RDN from NCU | 36 | 47 |
| 75% RDN from PCU | 36 | 47 |
| 75% RDN from VC | 26 | 37 |
| 75% RDN from RS | 27 | 38 |
| 100% RDN from PU | 34 | 47 |
| 100%RDN from NCU | 41 | 54 |
| 100% RDN from PCU | 41 | 54 |
| 100% RDN from VC | 30 | 41 |
| 100% RDN from RS | 29 | 40 |
| SEm± CD (P= 0.05) | 1.49 | 1.61 |
| | 4.5 | 4.58 |

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