IMPACT Impact OF DIFFERENT NITROGEN ENRICHED N2 SOURCES ON NITROGEN USE EFFICIENCY INDCIES IN HYBRID RICE

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ABSTRACT

A research trail was executed carried out during *kharif* -2018 at the research farm, ICAR-Indian Institute of Rice Research (IIRR), Hyderabad, Telangana state to know the effect of different enriched nitrogen enriched treatments sources at different levels on nitrogen use efficiency indices in transplanted rice. The results showed that highest Agronomic Efficiency (AE_N) (29.8), Physiological Efficiency (PE_N) (103.8) and Apparent Recovery Efficiency (ARE_N) (59%) was recorded with application of 100% RDN through neem coated urea (T_7). Highest Partial Nutrient Balance (PNB_N) (1.08), Partial Factor Productivity (PFP_N) (60.99) and Agro Physiological Efficiency (APE_N) (50.30) werewas achieved with application of 100% RDN through neem coated urea (T_7)

Keywords: Transplanted rice; enriched nitrogen sources; nitrogen use efficiency indices

1. INTRODUCTION

Rice is one of the world's most widely consumed foods, with about half of the world's population consuming it. Asia produces and consumes nearly all of the world's rice. In India, rice is the most widely grown crop with 43.6 M ha of area producing 118.87 million tons with an average productivity of 27.22 q ha^{-1}[1]. One of the most important macroelements for plant growth and development is nitrogen. In most agricultural cropping systems, soil nitrogen availability limits crop yields. World consumption of N fertilizers has averaged 83-85 million metric tonnes in recent years, with nearly 60% of that amount applied to cereal crops. A considerable part of applied nitrogen is lost in flooded rice fields, contributing to low nitrogen use efficiency relative to other crops. According to [2] typical N recovery efficiency ranges from 20 to 30 percent under rainfed conditions and 30-40 percent under irrigated conditions. Volatilization, nitrification, denitrification, and leaching [3] are the major driving processes responsible for these large losses from rice fields. Nitrogen Use Efficiency (NUE) is a term used to indicate the ratio between the amount of fertilizer N removed from the field by the crop and the amount of fertilizer N applied. The N application is sensitive and must be relateding to the crop's need [4]. Slow release fertilisers are an excellent way to increase N use efficiency because they give N on a time schedule that strives to be better synced with crop needs, reducing N losses in the environment [5]. Keeping in this in

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view ~~an~~ research experiment was conducted to study the effect of different nitrogen enriched ~~nitrogen~~ sources on nitrogen use efficiency ~~indices~~ in transplanted rice.

2. MATERIALS AND METHOD

The field experiment was carried out during *kharif* -2018 at the research farm of the ~~ICAR~~ Indian Institute of Rice Research (IIRR), Hyderabad, Telangana state. The soil of the experimental field was clay loam in texture. Varadhan, a mid early duration variety was used. The experiment was laid out in randomized block design with eleven treatments and each one replicated thrice. The treatments ~~comprised~~ were T_1 Control (0:60:40 kg N:P:K ha^{-1}), T_2 (75% RDN through neem coated urea), T_3 (75% RDN through enriched rice straw compost with *trichoderma*), T_4 (75% RDN through vermicompost), T_5 (75% RDN through neem coated urea + nitrification inhibitor), T_6 (75% RDN (50% RDN through vermicompost + 25% RDN through neem coated urea + nitrification inhibitor), T_7 (100% RDN through neem coated urea), T_8 (100% RDN through enriched rice straw compost with *trichoderma*), T_9 (100% RDN through vermicompost), T_{10} (100% RDN through neem coated urea + nitrification inhibitor) and T_{11} (100% RDN (50% RDN through vermicompost + 50% RDN through neem coated urea + nitrification inhibitor**).** The results of the study were analysed by using the analysis of variance (ANOVA) method, as outlined by [6]. The "F" test's level of significance was set at 5%. The critical difference (CD) values in the table are at a significance level of 5%.

Table 1. Initial Physico-chemical properties of the experimental soil.

Particulars	**Value**	**Method employed**
Soil pH	8.2	Glass electrode pH meter[7]
EC (dS m^{-1})	0.59	Solubridge (Jackson, 1973)[8]
Organic carbon (%)	0.62	Wet digestion method (Walkey and Black, 1934)[9]
Available nitrogen (kg ha^{-1})	239	Alkaline permanganate method (Subbaiah and Asija, 1956)[10]
Available phosphorus(P_2O_5) (kg ha^{-1})	36	Olsen method (Olsen *et al.*, 1954)[11]
Available potassium (K_2O) (kg ha^{-1})	407	Flame photometer method (Jackson, 1973)[8]

Table 2. Nutrient content in the compost and quantity added

Organic manures	**N content (%)**	**Quantity added**	**Method employed**
Vermicompost	1.1	11,000 kg ha^{-1}	Modified micro kjeldhal method, Piper, 1960[12]

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Rice straw compost	1.2	10,000 kg ha^{-1}	Modified micro kjeldhal method, Piper, 1960[12]

Nitrogen Use Efficiency Indices calculation:

Different nutrient use efficiencies were calculated using following formulae given by [13], [14], [15] and [16]

a) Agronomic efficiency- (kg increase in grain yield kg^{-1} N applied)

$$AE_N = \frac{\text{Grain Yield in fertilized plot (kg ha}^{-1}\text{)} - \text{Grain Yield in control plot (kg ha}^{-1}\text{)}}{\text{Quantitiy of fertilizer N applied (kg ha}^{-1}\text{)}}$$

b) Physiological Efficiency- (kg biological yield kg^{-1} N uptake)

$$PE_N = \frac{\text{Biological yield of fertilized plot (kg ha}^{-1}\text{)} - \text{Biological yield in control plot (kg ha}^{-1}\text{)}}{\text{Total nutrient uptake of fertilized plot} - \text{Total nutrient uptake in control plot (kg ha}^{-1}\text{)}}$$

c) Apparent Recovery efficiency- (%)

$$ARE_N = \frac{\text{(Total N uptake in N fertilized plot)} - \text{(total N uptake in zero N plot)}}{\text{Quantity of N fertilizer applied in N-fertilized plot}} \times 100$$

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d) Partial nutrient balance - (kg nutrient uptake per kg nutrient applied)

$$PNB_N = \frac{\text{Total nutrient uptake (grain+ straw) (kg ha}^{-1}\text{)}}{\text{Total amount of nutrient applied (kg ha}^{-1}\text{)}}$$

e) Partial factor productivity- (Kg grain kg^{-1} N applied)

$$PFP_N = \frac{\text{Grain Yield (kg)}}{\text{N fertilizer applied (kg)}}$$

f) Agro Physiological Efficiency- (kg grain yield increase per kg increase in N uptake)

$$APE_N = \frac{\text{Grain yield in treated plot- Grain yield in control plot (kg ha}^{-1}\text{)}}{\text{Total nutrient uptake in treated plot- total nutrient uptake in control plot (kg ha}^{-1}\text{)}}$$

3. RESULTS AND DISCUSSION

The ability of a plant to enhance yield in response to nitrogen applied is referred to as agronomic efficiency. Agronomic efficiency represents the ability of the plant to increase economic yield in response to nitrogen applied. Agronomic efficiency was significantly affected by different enriched nitrogen sources (Table 3). Highest agronomic efficiency (29.8) was recorded with the application of 100% neem coated urea (T_7) which was on par with 75% neem coated urea (T_2) (26.3). This might be due to improved nitrogen use efficiency as the neem coated urea is available in top soil for more duration of time which resulted in more uptake of nitrogen and also attributed to reduced leaching losses. Lowest agronomic efficiency was recorded with the application of 75% of vermicompost (T_4) (5.9). Similar findings were reported by [17] and [18]

The ability of a plant to convert nutrients absorbed from fertilizer into yield is referred to as physiological efficiency. Physiological efficiency represents the ability of a plant to transform nutrients that are absorbed from fertilizer into economic yield. Physiological efficiency was significantly affected by different enriched nitrogen sources (Table 3). Highest physiological efficiency (103.8) was recorded with the application of 100% RDN through neem coated urea (T_7) which was on par with 75% neem coated urea (T_2), 75% RDN through neem coated urea + nitrification inhibitor (T_5), 100% RDN through enriched rice straw compost with *Trichoderma* (T_8), 100% RDN through neem coated urea + nitrification inhibitor (T_{10}), 100% RDN [50% RDN through vermicompost + 50% RDN through neem coated urea + nitrification inhibitor]) (T_{11}) (92.1, 94.0, 90.3, 103.5 and 102.1). Lowest physiological efficiency was recorded with the application of 75% RDN through enriched rice straw compost with Trichoderma (T_3) (57.6). This could be owing to nitrate leaching being reduced as a result of nitrification retardation. Similar findings were reported by [19].

Apparent recovery efficiency recorded significantly ?with different enriched nitrogen sources (Table 3). Highest apparent recovery efficiency (59) was recorded with application 100% RDN through neem coated urea (T_7) which was on par with 75% RDN through neem coated urea (T_2) and 100% RDN through neem coated urea + nitrification inhibitor (T_{10}) (57 and 51%, respectively). This might be due to application of neem coated urea which resulted in slow release of nitrogen and increased uptake by the crop which reduced the losses synchronizing the nutrient demand with supply at critical stages. Lowest apparent recovery efficiency (20%) was recorded (20) with the application of 75% RDN through vermicompost (T_4) and with 100% RDN through vermicompost (T_9) (20). Similar findings were reported by [20].

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Table 3. Agronomic Efficiency, Physiological Efficiency and Apparent Recovery Efficiency of Nitrogen as influenced by different enriched nitrogen sources in transplanted rice.

Treatment	AE_N (kg increase in grain yield kg^{-1} N applied)	PE_N (kg biological yield kg^{-1} N uptake)	ARE_N (%)
T_1- Control (0:60:40 kg N:P:K ha^{-1})	-	-	-
T_2- 75% RDN through neem coated urea	26.3	92.1	57
T_3- 75% RDN through enriched rice straw compost with *Trichoderma*	9.0	57.6	25
T_4- 75% RDN through vermicompost	5.9	63.3	20
T_5- 75% RDN through neem coated urea + nitrification inhibitor	22.4	94.0	50
T_6- 75% RDN (50% RDN through vermicompost +25% RDN through neem coated urea +nitrification inhibitor)	14.7	87.4	36
T_7-100% RDN through neem coated urea	29.8	103.8	59
T_8-100% RDN through enriched rice straw compost with *Trichoderma*	10.2	90.3	24
T_9-100% RDN through vermicompost	8.3	89.5	20
T_{10}-100% RDN through neem coated urea + nitrification inhibitor	25.7	103.5	51
T_{11}-(100% RDN [50% RDN through vermicompost + 50% RDN through neem coated urea +nitrification inhibitor])	20.8	102.1	42
SE(m) ±	1.3	4.7	2.9
CD (p=0.05)	3.8	14.0	8.7

The simplest type of nutrient recovery efficiency is partial nutrient balance, which is commonly stated as nutrient uptake per unit of nutrient applied. Highest partial nutrient balance (1.08) and partial factor productivity ~~was~~ were achieved with application of 75% RDN through neem coated urea (T_2). Lowest partial nutrient balance and partial factor productivity was recorded with 100% RDN through vermicompost (T_9) (0.60). The crop yield per unit of fertilizer applied is explained by using partial factor productivity. Highest partial factor productivity was achieved with application of 75% RDN through neem coated urea (T_2) (60.99). It might be due to improved compatability between crop nitrogen demand and the applied fertilizer. Lowest partial factor productivity was recorded with 100% RDN through vermicompost (T_9) (34.31). The economic yield obtained per unit of nutrient taken has been termed as agrophysiological efficiency. Agro physiological efficiency was not influenced by different nitrogen sources. However highest agro physiological efficiency was achieved with application of 100% RDN through neem coated urea (T_7)(50.30) and lowest agro physiological efficiency was achieved with application of 75% RDN through vermicompost (T_4) (26.80) (Table 4)

Table -4. Partial nutrient balance, Partial factor productivity and Agro physiological efficiency of Nitrogen as influenced by different enriched nitrogen sources in transplanted rice.

Treatment	**PNB_N** (kg nutrient uptake per kg nutrient applied)	**PFP_N** (Kg grain kg^{-1} N applied)	**APE_N** (kg grain yield increase per kg increase in N uptake)
T_1- Control (0:60:40 kg N:P:K ha^{-1})	-	-	-
T_2- 75% RDN through neem coated urea	1.08	60.99	46.80
T_3- 75% RDN through enriched rice straw compost with *Trichoderma*	0.76	43.70	32.90
T_4- 75% RDN through vermicompost	0.71	40.57	26.80
T_5- 75% RDN through neem coated urea + nitrification inhibitor	1.00	57.10	45.40
T_6- 75% RDN (50% RDN through vermicompost +25% RDN through neem coated urea +nitrification	0.87	49.32	39.00

inhibitor)			
T7-100% RDN through neem coated urea	0.98	55.78	50.30
T8-100% RDN through enriched rice straw compost with *Trichoderma*	0.62	36.21	42.20
T9-100% RDN through vermicompost	0.60	34.31	39.00
T10-100% RDN through neem coated urea + nitrification inhibitor	0.90	51.70	49.70
T11-(100% RDN [50% RDN through vermicompost + 50% RDN through neem coated urea +nitrification inhibitor])	0.81	46.82	48.80
SE(m) ±	0.03	1.90	5.40
CD (p=0.05)	0.09	5.90	NS

4. CONCLUSIONS

From the above study it can be concluded that nitrogen use efficiency indices are significantly influenced by different enriched nitrogen sources. Agronomic efficiency, Physiological efficiency and Apparent recovery efficiency was highest with 100% RDN through neem coated urea. Partial nutrient balance and Partial factor productivity was highest with 75% RDN through neem coated urea. Agro physiological efficiency was highest with application of 100% RDN through neem coated urea

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