Impact OF DIFFERENT ENRICHED N_2 SOURCES ON NITROGEN USE EFFICIENCY INDCIES IN HYBRID RICE

ABSTRACT

A research trail was 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 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) was 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 relating 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 view an research was conducted to study the effect of different 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]

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- (%)

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

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 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). 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. Lowest apparent recovery efficiency 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].

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 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	PFP_N	APE_N
	(kg nutrient uptake per kg nutrient applied)	(Kg grain kg^{-1} N applied)	(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 inhibitor)	0.87	49.32	39.00

T_7-100% RDN through neem coated urea	0.98	55.78	50.30
T_8-100% RDN through enriched rice straw compost with *Trichoderma*	0.62	36.21	42.20
T_9-100% RDN through vermicompost	0.60	34.31	39.00
T_{10}-100% RDN through neem coated urea + nitrification inhibitor	0.90	51.70	49.70
T_{11}-(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

REFERENCES :

1. Indiastat. 2020. https://www.indiastat.com/agriculture-data/2/ agricultural production/225/ stats.aspx...

2. Rakshit A, Singh HB, Sen A. 2015. Nutrient use efficiency: From basics to advances. Springer, 417

3.Aulakh MS, Singh B. 1996. Nitrogen losses and fertilizer N use effciency in irrigated porous soils. Nutrient Cycling in Agroecosystems, 47(3): 197-212

4.Slafer GA, Savin R. 2018. Can N management affect the magnitude of yield loss due to heat waves in wheat and maize? Curr Opin Plant Biol 45:276–283

5.Shaviv A, Mikkelsen RL. 1993 Controlled-release fertilizers to increase efficiency of nutrient use and minimize environmental degradation-A review. *Fertility Research 35*, 1–12.

6. Gomez AK, Gomez AA. 1984. Statistical Procedures for Agriculture Research. Awiley-Inter Sci. *Publication. Johan Wiley and Sons, New York*.

7.Piper CS. 1967. Soil and Plant Anaslysis. *Academic Press, New York*. 368.

8.Jackson ML. 1973. Soil Chemical Analysis.*Prentice Hall of Inco. New York, USA*. 498

9.Walkley A, Black CA. 1934.Estimation of organic carbon by the chromic acid titration method. *Soil Science*. 47 : 29-38.

10.Subbaiah, Asija GL. 1956. Rapid procedure for estimation of available nitrogen in soils. *Current Science*. 25: 259-260.

11.Olsen SR, Cole CV, Watanabe FS, Dean LA. 1954. Estimation of available phosphorus in soil by extraction with sodium bicarbonate. *USDA, Circ*. 939.

12.Piper CS. 1960. Soil and Plant Science. *Hans Publishers, New York* pp. 59.

13.Cassman KG, Peng S, Olk DC, Ladha JK, Reichardt W, Dobermann A, Singh U. 1998. Opportunities for increased nitrogen-use efficiency from improved resource management in irrigated rice systems. *Field Crops Research.* 56: 7-39

14.Fageria NK, Baligar VC. Lowland rice response to nitrogen fertilization. *Communications in Soil Science and Plant Analysis*. 2001; *32*(9-10): 1405-1429.

15.Gerloff GC, Gabelman WH. 1983. Genetic basis of inorganic plant nutrition. pp 453–480. In: A Lauchli and R L Bieleski. (eds.), Inorganic Plant Nutrition. Encyclopedia and Plant Physiology New Series, Volume 15B. Springer Verlag, New York, NY.

16.Fageria NK. 1992. Maximizing Crop Yields. Marcel Dekker, New York, NY.

17.Singh S, Shivay YS. 2003. Coating of prilled urea with ecofriendly neem (*Azadirachtaindica*) formulations for efficient nitrogen use in hybrid rice. *ActaAgronomica Hungarica.* 51(1): 53-59.

18 .Khatun A, Hasina Sultana, Sultan Uddin Bhuiya MD, Abu Saleque MD. 2015 Nitrogen use efficiency of low land rice as affected by organic and chemical sources. *Open Access Library Journal.* 2: 1327.

19.Thind HS, Bijay Singh RPS, Pannu RPS, Yadvinder Singh, Varinderpal Singh, Gupta RK, Monika Vashistha, Jagmohan Singh, Ajay Kumar. 2010. Relative performance of neem (*Azadirachta indica*) coated urea vis-a-vis ordinary urea applied to rice on the basis of soil test or following need based nitrogen management using leaf colour chart. *Nutrient Cycling in Agroecosystem*. 87:1-8.

20. Kumara DC, Devakumar B, Kumar, RB, Dasa A, Panneerselvama P, Shivaya YS.2010. Effect of neem-oil coated prilled urea with varying thickness of neem-oil coating and nitrogen rates on productivity and nitrogen-use efficiency of lowland irrigated rice under indo-gangetic plains, *Journal of Plant Nutrition*. 33:1939–1959.