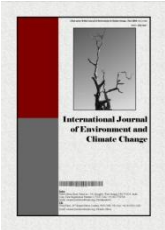

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Impact of Different Enriched Nitrogen Sources on Nitrogen Use Efficiency in Transplanted Rice

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

A research trail was executed during *kharif* -2018 to know the effect of different nitrogen enriched sources on nitrogen use efficiency in transplanted rice. The results showed that highest Agronomic Efficiency (AE_N) (29.8), Physiological Efficiency (PE_N) (103.8), Apparent Recovery Efficiency (ARE_N) (59%) and Agro Physiological Efficiency (APE_N) (50.30) was recorded with application of 100% RDN through neem coated urea (T_7). Highest Partial Nutrient Balance (PNB_N) (1.08) and Partial Factor Productivity (PFP_N) (60.99) were achieved with application of 75% RDN through neem coated urea.

Keywords: Transplanted rice; neem coated urea; trichoderma; vermicompost; nitrogen use efficiency.

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

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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 Rakshit *et al*., 2015 [2] N recovery efficiency ranges from 20 to 30 percent under rainfed conditions and 30-40 percent under irrigated conditions. Volatilization, 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 relate 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 this in view research experiment was conducted to study the effect of different nitrogen enriched sources on nitrogen use efficiency in transplanted rice.

2. MATERIALS AND METHODS

The field experiment was carried out during *kharif* -2018 at the research farm of the Indian Institute of Rice Research (IIRR), Hyderabad, Telangana state. The soil of the experimental field was clay loam in texture, low in available nitrogen, medium in phosphorus and high in potassium content. 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 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 recommended dose of nitrogen for 100% RDN was 120 kg N ha^{-1} and for 75% RDN it is 90 kg N ha^{-1}. The crop was transplanted on 04-08-2018 and was harvested on 20-11-2018.The nitrogen content in vermicompost is 1.1 % and in rice straw compost it is 1.2 %. The quantity of vermicompost applied was 11000 kg ha^{-1} and rice straw compost applied was 10000 kg ha^{-1}.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 [8]
Organic carbon (%)	0.62	Wet digestion method [9]
Available nitrogen (kg ha^{-1})	239	Alkaline permanganate method [10]
Available phosphorus(P_2O_5) (kg ha^{-1})	36	Olsen method [11]
Available potassium (K_2O) (kg ha^{-1})	407	Flame photometer method [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]

2.1 Nitrogen use Efficiency Indices calculation

Different nutrient use efficiencies were calculated using following formulae given by [13-16].

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

AE_N = (Grain Yield in fertilized plot (kg ha^{-1}) – Grain Yield in control plot (kg ha^{-1})) / Quantitiy of fertilizer N applied (kg ha^{-1})

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

PE_N = (Biological yield of fertilized plot (kg ha^{-1}) – Biological yield in control plot (kg ha^{-1})) / (Total nutrient uptake of fertilized plot – Total nutrient uptake in control plot (kg ha^{-1}))

c) Apparent Recovery efficiency- (%)

ARE_N = ([Total N uptake in "N" fertilized plot] - [total N uptake control plot] x 100) / Quantity of N fertilizer applied in N-fertilized plot

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

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

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

PFP_N = Grain Yield (kg) / N fertilizer applied (kg)

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

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

3. RESULTS AND DISCUSSION

3.1 Effect on Agronomic Efficiency

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% RDN through neem coated urea (T_7) which was on par with 75% RDN through 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% RDN through vermicompost (T_4) (5.9). Similar findings were reported by [17] and [18].

3.2 Effect on Physiological Efficiency

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% RDN through 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].

3.3 Effect on Apparent Recovery Efficiency

Apparent recovery efficiency recorded significant 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 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].

3.4 Effect on Partial Nutrient Balance, Partial Factor Productivity and Agro Physiological efficiency

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) was achieved with application of 75% RDN through neem coated urea (T_2). Lowest partial nutrient balance 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 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

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 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. CONCLUSION

From the above study it can be proved that nitrogen use efficiency is significantly influenced by different enriched nitrogen sources. 100% RDN through Neem coated urea and 75% RDN through Neem coated increased nitrogen use efficiency as they decreased the losses like leaching, volatilization and denitrification. Application of 100% RDN through neem coated urea increased Agronomic efficiency, Physiological efficiency,Apparent recovery efficiency and Agro physiological efficiency. Partial nutrient balance and Partial factor productivity was highest with 75% RDN through neem coated urea.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Indiastat; 2020. Available:https://www.indiastat.com/agriculture-data/2/agricultural production/225/stats.aspx...
2. Rakshit A, Singh HB, Sen A. Nutrient use efficiency: From basics to advances. Springer. 2015;417.
3. Aulakh MS, Singh B. Nitrogen losses and fertilizer N use effciency in irrigated porous soils. Nutrient Cycling in Agroecosystems. 1996;47(3):197-212.
4. Slafer GA, Savin R. Can N management affect the magnitude of yield loss due to heat waves in wheat and maize? Curr Opin Plant Biol. 2018;45:276–283.
5. Shaviv A, Mikkelsen RL. Controlled-release fertilizers to increase efficiency of nutrient use and minimize environmental degradation-A review. Fertility Research. 1993;35:1–12.

6. Gomez AK, Gomez AA. Statistical Procedures for Agriculture Research. Awiley-Inter Sci. Publication. Johan Wiley and Sons, New York; 1984.
7. Piper CS. Soil and Plant Anaslysis. Academic Press, New York. 1967;368.
8. Jackson ML. Soil Chemical Analysis.Prentice Hall of Inco. New York, USA. 1973;498.
9. Walkley A, Black CA. Estimation of organic carbon by the chromic acid titration method. Soil Science. 1934;47:29-38.
10. Subbaiah, Asija GL. Rapid procedure for estimation of available nitrogen in soils. Current Science. 1956;25:259-260.
11. Olsen SR, Cole CV, Watanabe FS, Dean LA. Estimation of available phosphorus in soil by extraction with sodium bicarbonate. USDA, Circ. 1954;939.
12. Piper CS. Soil and Plant Science. Hans Publishers, New York. 1960;59.
13. Cassman KG, Peng S, Olk DC, Ladha JK, Reichardt W, Dobermann A, Singh U. Opportunities for increased nitrogen-use efficiency from improved resource management in irrigated rice systems. Field Crops Research. 1998;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. Genetic basis of inorganic plant nutrition. In: Lauchli A and Bieleski RL. (eds.), Inorganic Plant Nutrition. Encyclopedia and Plant Physiology New Series, Volume 15B. Springer Verlag, New York, NY. 1983;453–480.
16. Fageria NK. Maximizing Crop Yields. Marcel Dekker, New York, NY; 1992.
17. Singh S, Shivay YS. Coating of prilled urea with ecofriendly neem (*Azadirachta indica*) formulations for efficient nitrogen use in hybrid rice. ActaAgronomica Hungarica. 2003;51(1):53-59.
18. Khatun A, Hasina Sultana, Sultan Uddin Bhuiya MD, Abu Saleque MD. Nitrogen use efficiency of low land rice as affected by organic and chemical sources. Open Access Library Journal. 2015;2: 1327.
19. Thind HS, Bijay Singh RPS, Pannu RPS, Yadvinder Singh, Varinderpal Singh, Gupta RK, Monika Vashistha, Jagmohan Singh, Ajay Kumar. 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. 2010;87:1-8.
20. Kumara DC, Devakumar B, Kumar, RB, Dasa A, Panneerselvama P, Shivaya YS. 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. 2010;33:1939–1959.

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