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EFFECT OF DIFFERENT GENERATION OF NITROGENOUS COMPOUNDS ON NUTRIENT UPTAKE AND YIELD OF RICE (Oryza sativa L.) UNDER DIFFERENT TRANSPLANTING TECHNIQUES

Sai Kumar Midde[1], M. Saravana Perumal[1], G. Murugan[1] and R. Sudhagar[2]
[1] Department of Agronomy, Faculty of Agriculture, Annamalai University, Chidambaram
[2] Department of Horticulture, Faculty of Agriculture, Annamalai University, Chidambaram
Corresponding mail: saikumarmidde@gmail.com

ABSTRACT
A field experiment was carried out in a farmer's field in the Chidambaram block during the June – September, 2021 to determine the " Effect of Different Generation of Nitrogenous Compounds on Nutrient Uptake, Yield and Economics of Rice (Oryza sativa L.) under Different Transplanting Techniques." The experiment was carried out in a split-plot design, comprising three methods of crop establishment viz., mechanical transplanting, the system of rice intensification (SRI), and conventional transplanting in the main plot, as well as five nitrogen management methods viz., 100% RDN through urea, 100 % RDN through vermicompost, 50% RDN through urea + 50% RDN through Nano urea, 50% RDN through vermicompost + 50% RDN through Nano urea, and 100% RDN through Nano urea in sub plot. The results of the experiment demonstrated that among the establishment techniques and nitrogen management practices tested, the System of Rice Intensification and application of 50% Inorganic Nitrogen in combination with 50% Nano Nitrogen has shown highest nutrient uptake and grain yield.

Keywords: System of Rice Intensification (SRI), Nano urea, Recommended Dose Nitrogen (RDN), Establishment methods, Rice.

INTRODUCTION
Rice is the major staple food crop in world and it is expected to be 800 million tonnes by the end of 2025 (Rana et al. 2020). As per the 2nd Advance estimates of Agriculture crops 2021-22, rice production accounts for 127.93 million tonnes in India (Anonymous, 2022). The current rice production system particularly from green revolution is input-heavy and only benefits the wealthy farmers. Increasing agricultural input prices prohibit impoverished farmers from adopting modern technologies. In that situation system of rice intensification which is low cost and high yielding system might be sustainable alternative to conventional paddy cultivation (Kumar et al. 2015). SRI techniques include line transplanting, younger seedlings, and wider spacing may be conveniently accessible to mechanical weed control and amendment treatment. SRI advocates argue this technique provides very high yields and improves water productivity (Uphoff et al. 2011).

To grow, develop, and produce grains, rice plants require a lot of essential nutrients, particularly nitrogen. Nitrogen is a vital element in plants because it plays a crucial role in forming chlorophyll, which is required for photosynthesis. Nitrogen is a component of several enzymatic proteins catalysing and regulating plant growth processes (Sinfield et al. 2010). Agriculture nanotechnology applications are increasingly altering the potential of increasing agricultural

output. Nano fertilizers are slow-releasing fertilizers that are a good alternative to conventional fertilizers that supply nutrients in a regulated manner.

This study focuses on the influence of different generations of nitrogenous compounds under different transplanting strategies on increasing productivity while reducing fertilizer usage and increasing rice production sustainability.

MATERIALS AND METHODS

A field experiment was carried out in a farmer's field in the Chidambaram block during the kuruvai season of 2021-22. The soil of the experimental field is clay in texture, low in available nitrogen (218 kg ha-1), medium in phosphorus (19.2 kg ha-1) and low in potassium (242 kg ha-1) with pH and E.C of 7.4 and 0.4 dsm-1. The experiment was laid out in split plot design consisting of three establishment methods i.e., mechanical transplanting, the system of rice intensification (SRI), and conventional transplanting in the main plot and five nitrogen management methods i.e., 100% RDN through urea, 100 % RDN through vermicompost, 50% RDN through urea + 50% RDN through Nano urea, 50% RDN through vermicompost + 50% RDN through Nano urea, and 100% RDN through Nano urea in sub plot and was replicated thrice. ASD 16 variety was used as a test crop and was sown for Mechanical transplanting 18 days old seeding was used with 23.5 cm x 12 cm. While for SRI, 14 days old seedlings used with a spacing of 22.5 cm x 22.5 cm and for Conventional transplanting, 24 days old seedling was used with a spacing of 20 cm x 10 cm was followed. Plant analysis for nutrient content in crops affected by different treatments was performed using conc. H2SO4 digestion and distillation for total nitrogen and Tri-acid digestion method for total P and K as described by Jackson, 1973. The nutrient indices such as apparent nutrient recovery and partial factor productivity by using the formula given below.

Apparent Nitrogen Recovery (ANR)

The percentage of apparent N recovery (ANR) from total N absorption (grain + straw) as specified by Crasswell and Godwin, 1984 was calculated using the following formula:

$$\text{ANR}(\%) = \frac{\text{N uptake (Kg ha}^{-1}\text{)in Fertilized plot} - \text{Grain Yield (Kg ha}^{-1}\text{)in Control}}{\text{N applied (Kg ha}^{-1}\text{)}}\ x\ 100$$

To estimate NUE, independent control plots for various establishment strategies were maintained, and grain yield, straw yield, and total N uptake at harvest were recorded.

Partial factor productivity (PFP):

$$\text{PFP} = \frac{\text{kg grain}}{\text{kg N applied}}$$

The grain yield was recorded at 14% moisture level while the straw was sundried for three days, the weight of grain and straw yield were recorded and expressed in kg ha-1. The data obtained under study was analyzed by the method of analysis of variance as described by Gomez and Gomez, 1984.

RESULTS AND DISCUSSION

Nutrient uptake and indices

Highest nitrogen, phosphorus and potassium uptake was found in the system of rice intensification (Table 1). The 14 days old seedling used in the SRI cultivation showed highest N, P, and K uptake. This should be owing to increased root activity as reflected by longer roots and root volume, which increases nutrient absorption. Similar findings were reported by (Rajendran and Ganesa Raja, 2015).

All the nitrogen management practices showed significant effect on N, P and K uptake (Table 2). Highest N, P and K uptake was recorded in the treatment which is applied with 50% RDN through urea + 50% RDN through Nano urea (130.99, 35.10, 106.91 kg ha-1) respectively. Whereas, the lowest was found in treatment 100 % RDN through vermicompost (58.46, 16.67, 50.10 kg ha-1). This could be attributed to the increased nutrient uptake caused by the application of nano nitrogen through foliar spray, which caused quick absorption of nutrients from leaf tissues, resulting in high N, P, and K uptake. These results are concordance with the findings of Lahari et al. (2021) and Ali et al. (2011). As fig 1 showed nitrogen uptake under various nitrogen management practices followed, significantly influenced on nitrogen harvest index which is directly affect on the yield increase in the rice crop.

Highest apparent nitrogen recovery was obtained in system of rice intensification (64.44) (Table 2). Lowest was found in Conventional transplanting (53.15). This might be due to the higher grain yield and nitrogen uptake.

Highest partial factor productivity was found in system of rice intensification and it was estimated to be 17 % higher with conventional transplanting. Under SRI, 39.95 kg grain was produced with 1 kg application of nitrogen whereas in conventional transplanting it is only 34.14 kg grain for 1 kg nitrogen applied.

Application of 50% RDN through urea + 50% RDN through Nano urea recorded highest apparent nitrogen recovery (84.10). The lowest was recorded in the 100 % RDN through Nano urea (31.00). Highest partial factor productivity was found in the treatment which is applied 50% RDN through urea + 50% RDN through Nano urea and it was estimated to be 57 and 22 % higher than compared to 100 % RDN through vermicompost and 100% RDN through urea, respectively (Table 2).

Table 1. Effect of different establishment methods and nitrogen management practices on nutrient uptake of rice

Treatments	N uptake	P uptake	K uptake
Establishment methods			
Mechanical Transplanting	96.50	26.38	78.20
System of Rice Intensification (SRI)	103.92	28.43	86.24
Conventional Transplanting	89.22	24.30	72.17
S. Ed	0.86	0.22	0.60

C.D (*P=0.05*)	2.39	0.60	1.65
Nitrogen Management practices			
100% RDN through urea	101.38	27.08	82.02
100 % RDN through vermicompost	58.46	16.67	50.10
50% RDN through urea + 50% RDN through Nano urea	130.99	35.10	106.91
50% RDN through vermicompost + 50% RDN through Nano urea	76.99	22.45	62.07
100% RDN through Nano urea	114.92	30.54	93.25
S. Ed	2.65	0.76	2.25
C.D (*P=0.05*)	5.47	1.56	4.64

Table 2. Effect of different establishment methods and nitrogen management practices on nutrient indices of rice

Treatments	Apparent Nitrogen Recovery (ANR)	Partial Factor Productivity (PFP)	Nitrogen Harvest index
Establishment methods			
Mechanical Transplanting	59.11	37.03	57.25
System of Rice Intensification (SRI)	64.44	39.95	58.42
Conventional Transplanting	53.15	34.14	56.34
Nitrogen Management Practices			
100% RDN through urea	60.98	38.71	57.91
100 % RDN through vermicompost	31.00	21.14	53.15
50% RDN through urea + 50% RDN through Nano urea	84.10	49.77	60.88
50% RDN through vermicompost + 50% RDN through Nano urea	46.62	31.92	55.42
100% RDN through Nano urea	71.80	43.67	59.33

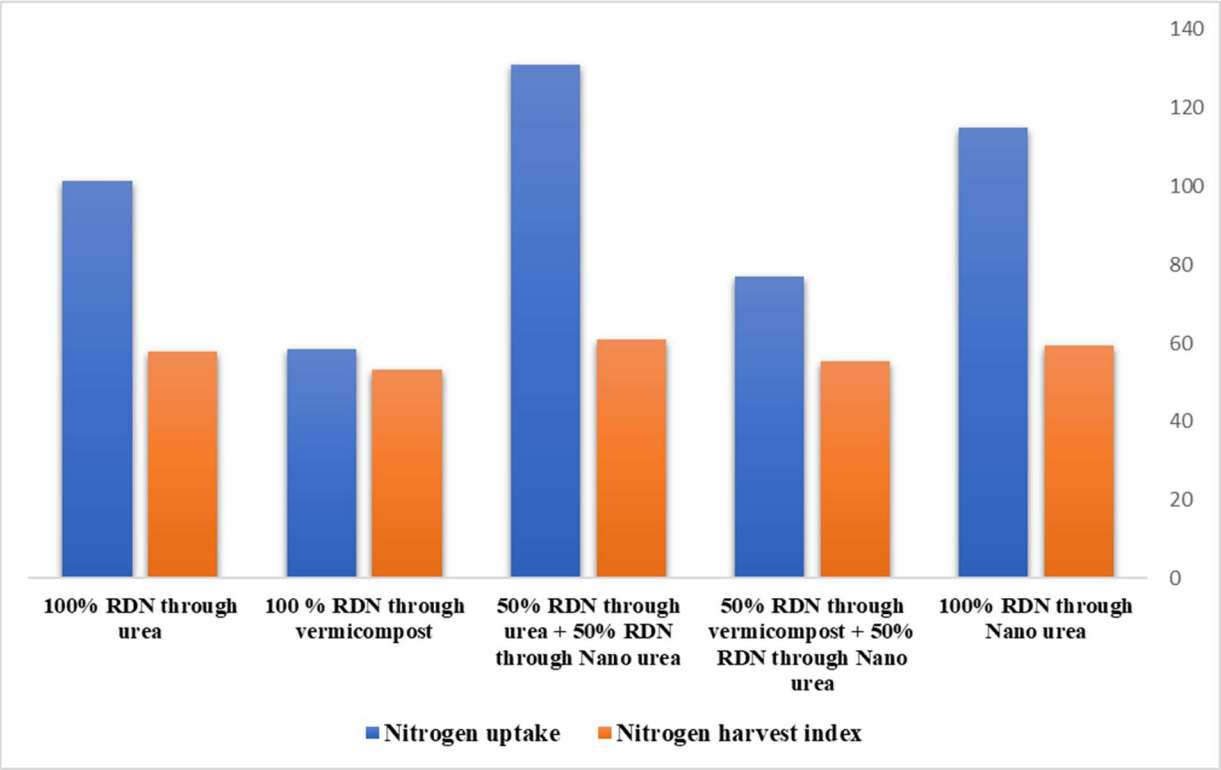

Fig 1: Effect of Nitrogen Management Practices on Nitrogen uptake and Nitrogen harvest index

Yield

The system of rice intensification produced the highest grain and straw yields 4794 and 7216 kg ha-1, respectively it is clearly evident from Fig 2. Higher yields under SRI may be due to the use of younger seedlings, wider spacing, aerobic conditions, minimising transplanting stress, and transplanting seedlings before the third phyllochron. Similar findings were observed by Rakesh Kumar et al. (2015).

Higher grain and straw yields were observed in 50 % RDN urea + 50 % RDN Nano urea 5972 and 8692 kg ha-1, respectively which is clearly evident in Table 3. The increased grain yield might be due to favourable influence of nitrogen in increasing the appropriate source to sink relationship (Samui et al. 2013). These findings are consistent with the outcome of Midde et al. (2022).

Fig 4. Showed the trend of increasing the Grain yield as influenced by establishment methods and nitrogen management practices.

Linear relationship between nitrogen uptake and grain yield as influenced by nitrogen management practices

Fig 2. represents the highest grain yield was obtained due to higher nitrogen uptake. This was confirmed with positive correlation was found between grain yield and nitrogen uptake (r= 0.9843). The uptake of nutrients was found to be increased with foliar application of nano nitrogen which might be due to rapid transport of nutrients into the plant this resulted in higher rate of photosynthesis which in turn increased the vegetative and reproductive growth. These are concordance with the results Lahari et al., (2021) and Kumar et al., (2014).

Table 3. Effect of different establishment methods and nitrogen management practices on yield of rice

Treatments	Grain Yield (Kg ha^{-1})	Straw yield (Kg ha^{-1})
Establishment methods		
Mechanical Transplanting	4444	6751
System of Rice Intensification (SRI)	4794	7216
Conventional Transplanting	4097	6310
S. Ed	95.47	142.19
C.D (*P=0.05*)	265.41	395.30
Nitrogen Management Practices		
100% RDN through urea	4645	6970
100 % RDN through vermicompost	2537	4493
50% RDN through urea + 50% RDN through Nano urea	5972	8692
50% RDN through vermicompost + 50% RDN through Nano urea	3830	5899
100% RDN through Nano urea	5240	7741
S. Ed	165.18	239.87
C.D (*P=0.05*)	340.27	494.13

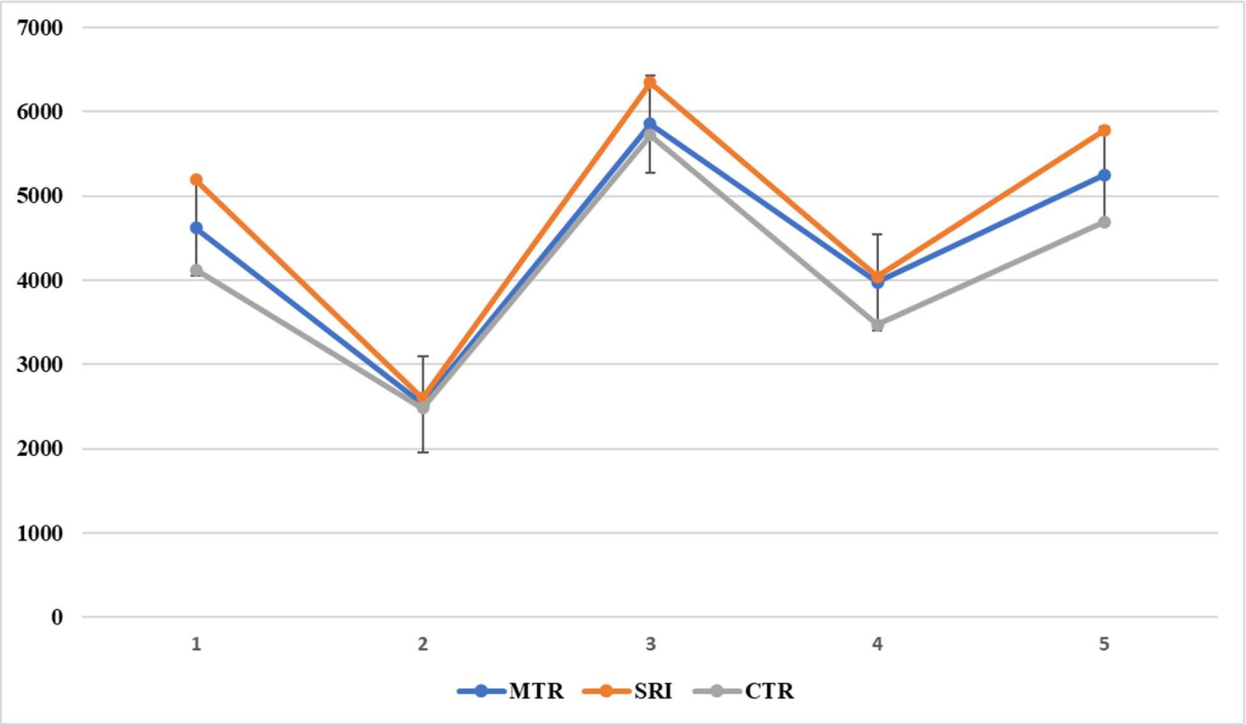

Fig 2. Effect of Nitrogen Management Practices on grain yield under Mechanical Transplanted Rice, System of Rice Intensification and Conventional Transplanted Rice Transplanting Techniques

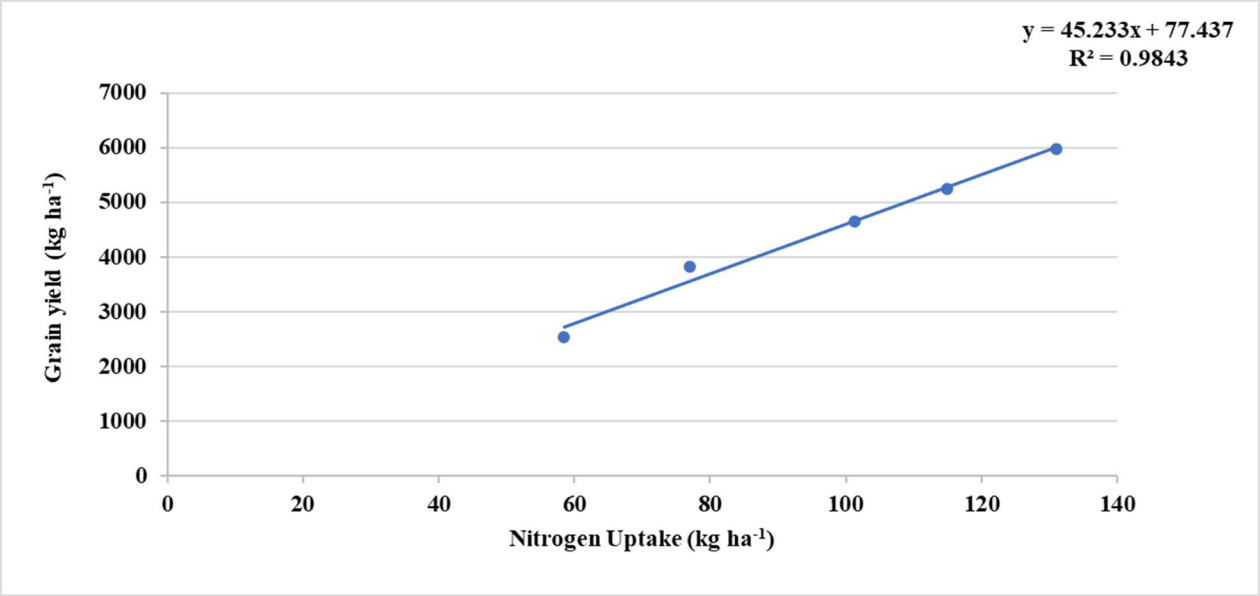

Fig 3. Linear relationship between Nitrogen Uptake and Grain Yield of Rice

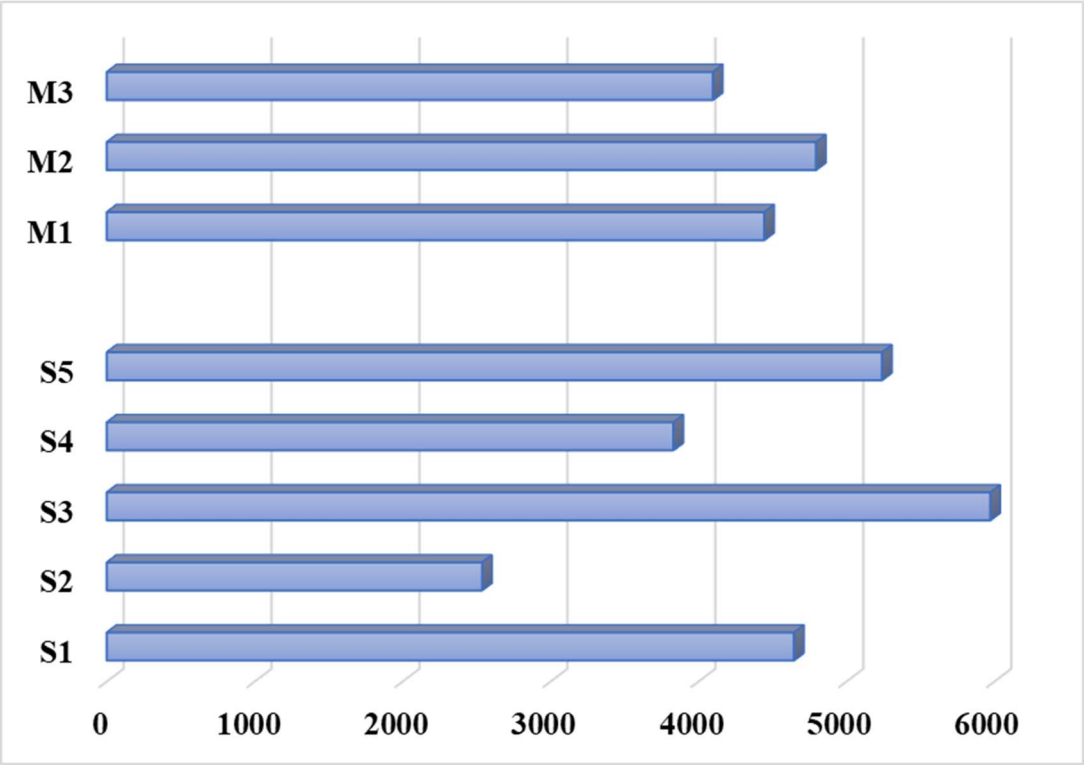

Fig 4. Grain yield as influenced by establishment methods and nitrogen management practices

CONCLUSION

The results of this study indicated that SRI method of establishment increased the grain yield significantly at the same time application of nitrogen through nano form along with conventional fertilizer resulted in higher nutrient uptake and grain yield.

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