Studies on the Effect of Nano-urea on Growth, Yield and Nutrient Use Efficiency in Transplanted Rice

ABSTRACT

Rice is a staple crop that feeds a large section of the world's population, and conventional urea fertilisers have played an important role in increasing rice yields. However, nano urea, a game-changing invention in modern agriculture, represents a big step forward in terms of sustainable and efficient crop production.The experiment was carried out at wetlands farm of Tamil Nadu Agricultural University, Coimbatore, during*Navarai* season, 2022 in a Randomized block design with eight treatments and three replications. The main objective is to enhancing the growth and yield of rice through foliar application of nano urea. The rice variety CO 55 was taken up for the study with the RDF of 150:50:50 NPK kg ha^{-1}. The experimental details viz;T_1-100% recommended dose of nitrogen (RDN) (150 kg N) through urea (25% each at basal, AT, PI and heading stage), T_2 - 100% RDN (150 kg N) through urea (50% as basal+ two top dressing 25% each at AT& PI), T_3 - 50% RDN (75 kg N) through urea (basal only) , T_4 - 50% RDN (75 kg N) through urea (basal only) + two foliar sprays of nano urea at $20^{th}$and 40^{th} DAT, T_5 -50% RDN (75 kg N) through urea (basal only) + three foliar sprays of nano urea at 20^{th}, $40^{th}$and 60^{th} DAT, T_6-25% RDN (37.5 kg N) through urea (basal only) + three foliar sprays of nano urea at 20^{th}, 40^{th} and 60^{th} DAT, T_7 -Foliar sprays of nano urea at 20^{th} $40^{th}$and 60^{th} DAT (no basal application), T_8 -Control (0% N). Based on the experimental results show that, among the treatmentsthe higher plant height, leaf area index and yieldshould be obtained in the T_5 treatmentie; reduced basal nitrogen applicationas 50%, with nano urea foliar spray.

Keywords: Transplanted rice; Nano urea; Nutrient use efficiency; Yield

1. INTRODUCTION

Rice is one of the most important staple daily diet consumed by a large portion of the world's population. Rice has been cultivated for thousands of years and plays a significant role in the diets and cultures of many countries, particularly in Asia, where it is a dietary staple. India is one of the major rice producing and consuming country. It is the world's second-largest producer of rice.Nano-urea has the potential to improve nutrient use efficiency in rice crops. Studies have showed that Nano-sized urea particles can be more easily absorbed by plant roots, leading to increased nitrogen uptake (Iqbal *et. al.,* 2019) [1]. This enhanced nutrient uptake can result in improved plant growth, higher grain yield and increased nitrogen use efficiency, which is particularly crucial in rice cultivation (Shah *et al.,* 2019)[3]. Liquid nano fertilizer which is currently the best alternative to urea fertilizer. One bottle of nano urea (500 ml) is equivalent to a bag of urea fertilizer (45 kg). One nano urea liquid particle is 30 nano

meters in diameter, with 10,000 times higher surface area to volume size than normal granular urea (Lakshman, K., et al 2022) [2]. Foliar application of nano urea liquid at critical crop growth stages of a plant effectively fulfils its nitrogen requirement and leads to higher crop productivity and quality in comparison to conventional urea. Sharmila and Rahale (2011) [4] has monitored the nutrient release pattern of nano-fertiliser formulations carrying nitrogen. The data have shown the nano-clay based fertilizer formulations (zeolite and montmorillonite with a dimension of 30-40 nm) are capable of releasing the nitrogen for a longer period of time (> 1000 hrs) than conventional fertilizers (< 500 hrs). Nano urea refers to urea that has been formulated with nanoparticles to improve its efficiency and effectiveness as a nitrogen fertilizer. The nitrogen holding capacity of nano urea refers to the amount of nitrogen that can be held in the particles and released slowly over time, providing a sustained source of nutrients for plant growth (Baboo et al., 2021) [5].According to studies, spraying rice with nano urea boosts yield-contributing traits such the highest number of panicles (m^{-2}), the total number of grains (g), the number of filled grains (g), test weight (g), grain yield, and straw yield (Sahu *et al.,* 2022) [6]. Nano urea will also have a huge positive impact on the quality of underground water, a very significant reduction in global warming with an impact on climate change and sustainable development (Kantwa*et al.,* 2022) [7].

2.MATERIALS AND METHOD

2.1 Site Description

The experimental study was carried out during in 2022 at the wetland, TNAU, Coimbatore, Tamil Nadu Which was 11^0 N latitude and 77^0 E longitude with 426.7 altitude (MSL). The soil type of the experimental field is clay loam, which was pH 8.1, EC of 0.42 dsm^{-1} with organic carbon of 0.63%. The availability of the primary nutrients viz., nitrogen (alkaline permanganate method), phosphorus (Olsen method) and potassium (neutral normal ammonium acetate method) in the soil are 260 kg ha^{-1}, 19.5 kg ha^{-1} and 440 kg ha^{-1} respectively. The soil sample were collected from 0-15 cm depth, later dried and grounded in 2 mm sieve and used for further analysis.

2.2 Experimental Description

The experimental study was carried out under conventional method of rice cultivation with CO 55 as test variety during *Navarai* season (2023). The research experiment was conducted in (RBD) Randomized Block Design involving 8 treatments and 3 replications with plot size 7.0 m x 3.6 m respectively. The varied dose of basal nitrogen, phosphorus and potassium, foliar spray of nano urea is applied. The eight treatments were T_1-100% recommended dose of nitrogen (RDN) (150 kg N) through urea (25% each at basal, AT, PI and heading stage), T_2 - 100% RDN (150 kg N) through urea (50% as basal+ two top dressing 25% each at AT& PI), T_3- 50% RDN (75 kg N) through urea (basal only), T_4 - 50% RDN (75 kg N) through urea (basal only) + two foliar sprays of nano urea at $20^{th}$and 40^{th} DAT, T_5- 50% RDN (75 kg N) through urea (basal only) + three foliar sprays of nano urea at 20^{th},

$40^{th}$and 60^{th} DAT, T_6- 25% RDN (37.5 kg N) through urea (basal only) + three foliar sprays of nano urea at 20^{th}, $40^{th}$and 60^{th} DAT, T_7- Foliar sprays of nano urea at 20^{th}, $40^{th}$and 60^{th} DAT (no basal application), T_8- Control (0% N). Recommended dose of fertilizer for short duration rice 150:50:50 NPK $kgha^{-1}$ were applied to the research land. It was transplanted at 21 DAS with 20 x 15 cm spacing. The nitrogen was sprayed in three stages at 20^{th}, 40^{th} and 60^{th} DAT. Phosphorus was applied as basal. Potassium was given in four splits as per the recommendation. The experimental data were statistically analyzed with the critical differences worked out at 5% (0.05).

3. RESULTS AND DISCUSSION

3.1 Effect of nano urea on Plant height

Adoption of varied dose of basal nitrogen, phosphorus and severalconcentrations of conventional urea and nano urea as foliar spray significantly influenced the growth attributes viz., plant height, leaf area index of the paddy crop.

The plant height showed significant difference among the treatments 30, 60, 90 DAT and maturity. Among the treatments, 50% RDN as urea (basal only) + three foliarspray of nano urea at 30, 60 and 90 DAT (T_5) recorded higher plant height of 39.3, 72.6, 89.8, 99.2 cm at active tillering, panicle initiation, flowering and at maturity stages, respectively.It was on par with application of 100% recommended dose of nitrogen through urea (25% each at basal, AT, PI and heading stage), T_1 recorded plant height of 39.1, 70.8, 87.3, 99.0 cm at active tillering, panicle initiation, flowering and maturity stages, respectively. The lower plant height was recorded at control (T_8) with 28.4, 40.2, 62.1, 72.6 cm at active tillering, panicle initiation, flowering and maturity stages, respectively.

Plant height was more enhanced when nano fertilizer was mixed with the conventional ones, even at a lower application rate (Benzon *et al.,* 2015)[8].Midde *et al.,* (2021) [9] findings show that, 50% of RDN as conventional urea and remaining 50% nitrogen as nano-urea foliar spray, when both applied together the height of the rice plant increased.

The study by Rostaman*et al.,* (2021) [10] found that the sole application of nano-urea and conventional urea to rice crop resulted lesser plant height than the use of nano inorganic fertilizer application with 400 times dilution on 75% (NPK + urea) was given better plant height.

Based on the study of Kothari *et al.,* (2023)[11], the results were shown that comparatively taller plants are observed in plots with nano nitrogen as foliar spray than control plot without foliar spray of nano nitrogen.The plant height of ‘Bg 250’ rice cultivar treated with nitrogen showed taller plants when compared to the plants without fertilizer treatment. But comparatively significantly taller plants observed in nano-urea treated plots than conventional urea treated plot (Rathnayaka *et al.,* 2018)[12].

3.2 Effect of nano urea on leaf area index

The leaf area index at 30, 60 and 90 DAS was found maximum under T_5 (50% RDN (75 kg N) through urea (basal only) + three foliar sprays of nano urea at 20^{th}, $40^{th}$and 60^{th} DAT) and significant

over other treatments .It was on par with T_1 (100% RDN (150 kg N) through urea (25% each at basal, AT, PI and heading stage).The leaf area index at maturity stage was found maximum under T_5 (50% RDN (75 kg N) through urea (basal only) + three foliar sprays of nano urea at 20th, 40th and 60th DAT) and superiorly significant over other treatments. The lowest leaf area index was recorded in the control plot T_8 (0% N).

Application of nano-urea spray has demonstrated a significant influence on rice leaf area index (LAI). Research by Sharma *et al.,* (2022) [13] highlights that nano-urea spray leads to increased LAI due to enhanced nutrient uptake and utilization. The nanoscale formulation ensures better nutrient penetration and absorption through leaves, promoting leaf expansion and overall canopy development.

This aligns with earlier findings on the positive correlation between nano urea and enhanced LAI. The study underscores the potential of this innovative approach to booster crop growth and productivity sustainably.Nano urea has shown a positive influence on physiological traits of rice.

Table 1. Effect of treatments on plant height (cm) of transplanted rice at 30, 60, 90 DAT and maturity stages

Treatments		Plant height (cm)			
		Active Tillering	**Panicle Initiation**	**Flowering**	**Maturity**
T_1	100% recommended dose of nitrogen (RDN) (150 kg N) through urea (25% each at basal, AT, PI and heading stage)	39.1	70.8	87.3	99.0
T_2	100% RDN (150 kg N) through urea (50% as basal+ two top dressing 25% each at AT& PI)	37.8	65.1	85.2	97.5
T_3	50% RDN (75 kg N) through urea (basal only)	34.5	52.1	77.5	83.7
T_4	50% RDN (75 kg N) through urea (basal only) + two foliar sprays of nano urea at 20th & 40th DAT	35.4	64.3	79.8	94.2
T_5	50% RDN (75 kg N) through urea (basal only) + three foliar sprays of nano urea at 20th, 40th& 60th DAT	39.3	72.6	89.8	99.2
T_6	25% RDN (37.5 kg N) through urea (basal only) + three foliar sprays of nano urea at 20th, 40th & 60th DAT	35.2	58.3	78.1	92.1
T_7	Three foliar sprays of nano urea at 20th, 40th& 60th DAT (no basal application)	31.6	46.4	69.4	78.6
T_8	Control (0% N)	28.4	40.2	62.1	72.6
	SEd	**1.2**	**2.7**	**3.5**	**2.2**
	CD (5%)	**2.6**	**5.6**	**7.3**	**4.6**

Table 2. Effect of treatments on leaf area index of transplanted rice

Treatments		Leaf area index			
		Active tillering stage	**Panicle initiation stage**	**Flowering stage**	**Maturity stage**
T_1	100% recommended dose of nitrogen (RDN) (150 kg N) through urea (25% each at basal, AT, PI and heading stage)	1.2	3.2	3.9	2.8
T_2	100% RDN (150 kg N) through urea (50% as basal+ two top dressing 25% each at AT& PI)	1.1	3.1	3.8	2.7
T_3	50% RDN (75 kg N) through urea (basal only)	0.9	2.7	3.0	2.4
T_4	50% RDN (75 kg N) through urea (basal only) + two foliar sprays of nano urea at 20th & 40th DAT	1.1	3.0	3.6	2.6
T_5	50% RDN (75 kg N) through urea (basal only) + three foliar sprays of nano urea at 20^{th}, 40^{th}& 60^{th} DAT	1.2	3.3	4.0	3.0
T_6	25% RDN (37.5 kg N) through urea (basal only) + three foliar sprays of nano urea at 20th, 40th & 60th DAT	1.0	2.9	3.3	2.5
T_7	Three foliar sprays of nano urea at 20^{th}, 40^{th}& 60^{th} DAT (no basal application)	0.9	2.5	2.7	2.2
T_8	Control (0% N)	0.8	2.2	2.2	2.1
SEd		**0.05**	**0.15**	**0.18**	**0.14**
CD (5%)		**0.16**	**0.4**	**0.5**	**0.39**

3.3 Effect of nano urea on GrainYield of transplanted rice

Grain yield of rice was significantly influenced by the different dose of nitrogen application and the results are presented in the graph (a).

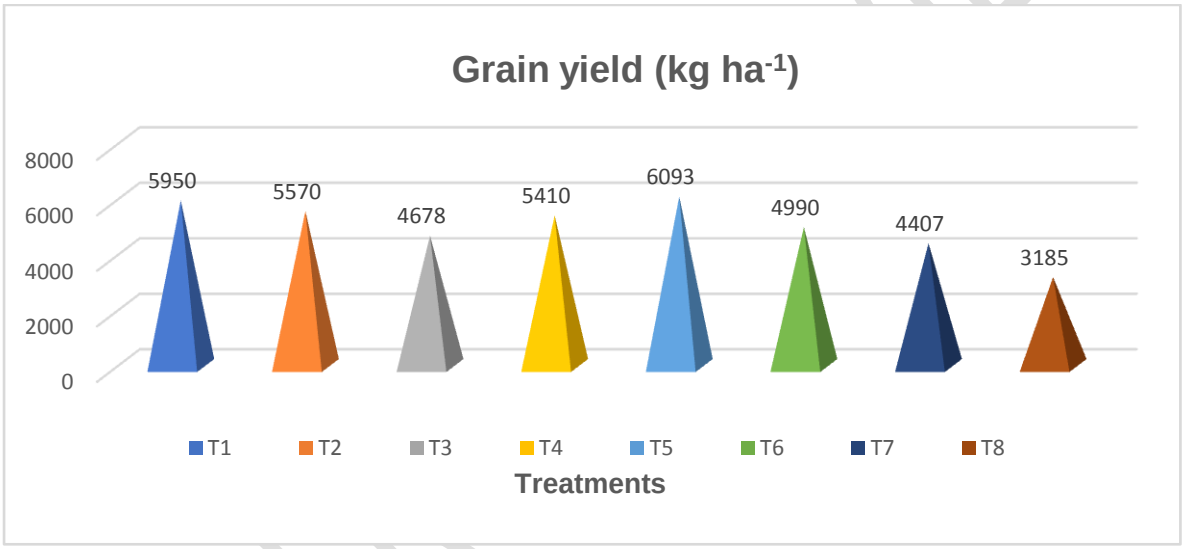
Among the treatments, 50% recommended dose of nitrogen (75 kg N) through urea (basal only) + three foliar spray of nano urea at 20^{th}, 40^{th} and 60^{th} DAT gave significantly higher grain yield of 6093 kg ha^{-1} (T_5) and it was on par with 100% recommended dose of nitrogen (150 kg N) through urea @ 25% each at basal active tillering, panicle initiation and heading stage with the grain yield of 5950 kg ha^{-1}(T_1). This was followed by 100% recommended dose of nitrogen (150 kg N) through urea @ 50% as basal + two top dressing 25% each at active tillering & panicle initiation with the grain yield of 5570 kg ha^{-1} (T_2) and it was on par with 50% dose of nitrogen (75 kg N) through urea (basal only) + two foliar spray of nano urea at 20^{th}, 40^{th} DAT with the yield of 5410 kg ha^{-1} (T_4). The lowest grain yield of 2785 kg ha^{-1} was accounted with control (T_8) in transplanted rice.

Similar findings such that the application of nano-urea as foliar spray along with the conventional urea resulted the better grain yield and straw yield by Kothari *et al.,* (2023) [11],Upadhyay *et al.,* (2023) [14], Attri*et al.,* (2022) [15], Yadav *et al.,* (2021) [16], Algym *et al.,* (2020) [17]and Gewaily*et al.,* (2019) [18].

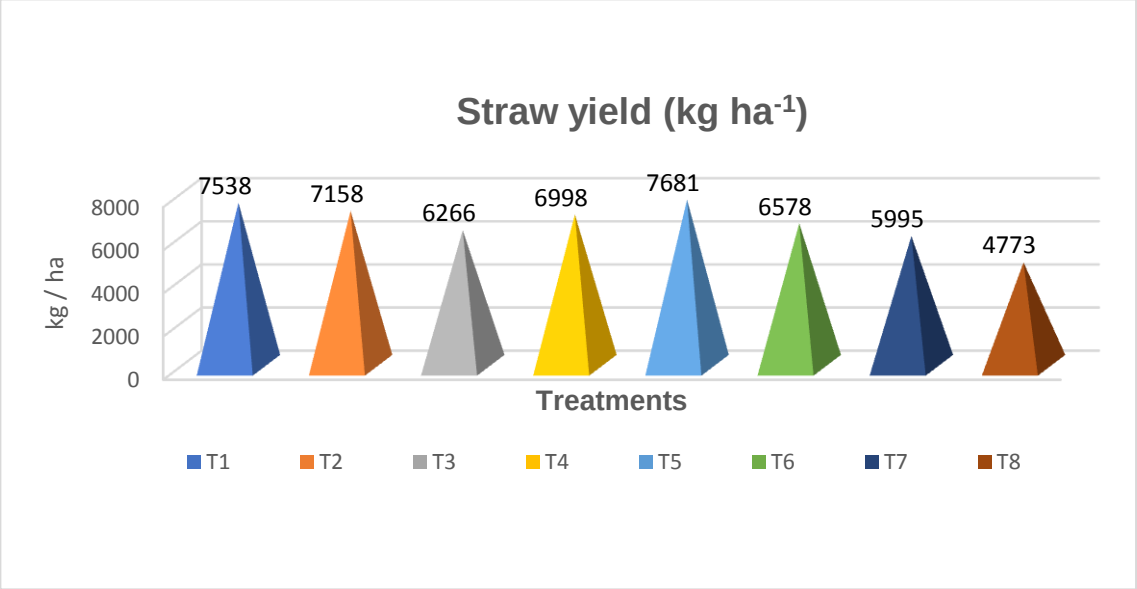
3.4 Effect of nano urea on Straw Yield of transplanted rice

The impact of different dose of nitrogen application in transplanted rice is presented in the graph (b).

Among the treatments, 50% recommended dose of nitrogen (75kgN) through urea (basal only) + three foliar spray of nano urea at 20th, 40th, 60th DAT had a profound influence on straw yield of transplanted rice (7681 kg ha^{-1}) which was on par with 100% recommended dose of nitrogen (150kgN) through urea @ 25% each at basal, active tillering, panicle initiation and heading stage with the straw yield of 7538 kg ha^{-1} (T_1). This was followed by 100% recommended dose of nitrogen (150 kg N) through urea @ 50% as basal + two top dressing 25% each at active tillering & panicle initiation with the straw yield of 7158 kg ha^{-1} (T_2) and it was on par with 50% recommended dose of nitrogen (75kgN) through urea (basal only) + two foliar spray of nano urea at 20th, 40th DAT with the yield of 6998 kg ha^{-1} (T_4). Subsequently, the lowest straw yield of 4373 kg ha^{-1} was recorded with control (T_8), control 0% N.



Graph (a): Effect of nano urea on grain yield of transplanted rice



Graph (b) Effect of nano urea on straw yield of transplanted rice

4. CONCLUSION

From the experiment, it was concluded that, 50% RDN (75 kg N) through urea (basal only) + foliar sprays of nano urea at 20th, 40thand 60th DAT recorded the higher plant height,leaf area index and yield and it was on par with the treatment 100% recommended dose of nitrogen (RDN) (150 kg N) through urea (25% each at basal, AT, PI and heading stage).

Since both treatment combinations generated higher growth characteristics that were comparable to one another, the adoption of a reduced dose of basal nitrogen; 50% N along with foliar spray of nano-urea at 20th,40th& 60th DAT is an economically viable choice for boosting growth when applying a foliar application of nano-urea.

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