Research Article

Evaluation of Nano Urea on Growth and Yield Attributes of Rice (*Oryza Sativa* L.)

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Abstract

A field experiment was conducted at Annamalai Nagar, Annamalai University during 2021 to study the "Effect of Nano Nitrogen on Growth and Yield Attributes of Rice (O*ryza sativa* L.)". The experiment was laid out in Randomized block design with eight treatments and was replicated thrice *viz.*, T_1 Control, T_2 – 100% Nano N, T_3 – 90% RDN + 10% Nano N, T_4 – 80% RDN + 20% Nano N, T_5 – 70% RDN + 30% Nano N, T_6 – 60% RDN + 40% RDN, T_7 – 50% RDN + 50% Nano N, T_8 – 40% RDN + 60% Nano N. The results of the study revealed that the maximum highest plant height (104.7 cm), Number of Tillers (348) and Grain yield (7056 kg ha^{-1}), Straw yield (8342 kg ha^{-1}) found in the treatment 50% RDN + 50% Nano N (T_7).

Keywords: Nano Nitrogen, RDN, Rice

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Introduction

Rice is India's most important food commodity and a widely farmed cereal crop. India is the world's second-largest producer of rice. Tamil Nadu has a rice area of 2.2 million hectares, accounting for 36% of the state's total land area. There is a significant deficiency in nutrients such as nitrogen, phosphorus, and zinc. The state's average productivity is at 2.8 t ha^{-1}.

Manual transplanting is costly and time demanding, resulting in struggle [1]. In many areas, direct seeding is a viable for crop production since it saves labour and time while also ensuring a healthy stand establishment and conserving water [2].

Fertilizer has become increasingly crucial in improving food production and quality, particularly since the advent of high yielding and fertilizer responsive cultivars. Researchers have been working to improve rice production, but only a few cases of nanomaterials have been documented [3, 4]. Nanomaterials are single units ranging in size from 1 to 100 nm in at least one dimension [5]. Nano fertilizers are the next step in nanotechnology's journey to more sustainable agriculture. Over 1mm of urea prill, nano urea contained 55000 nitrogen particles [6]. Nano urea decreases the need for traditional urea by half or more while improving crop production, soil health, and nutritional quality of output without compromising soil productivity. It is less expensive than conventional urea, which lowers farmers' input costs and boosts their profits.

This research focused on using Nano urea in direct seed rice to boost yield, minimise fertiliser consumption and increase farmer revenue. Improvements in nitrogen use efficiency as well as a reduction in leaching losses.

Materials and Methods

The field experiment was conducted in Agricultural experimental farm, Faculty of Agriculture, Annamalai University, Annamalai Nagar, Tamil Nadu. The experimental setup was designed in Randomized Block design (RBD) with three replications. The tested Variety was ASD – 16 (110 days) short duration variety under Kuruvai season June, 2021. The treatments are T_1 - Control, T_2 - 100 % N through Nano urea, T_3 - 90 % RDN through Urea + 10 % N through Nano urea, T_4 - 80 % RDN through Urea + 20% N through Nano urea, T_5 - 70% RDN through Urea + 30% N through Nano urea, T_6 - 60% RDN through Urea +40% N through Nano urea, T_7 - 50% RDN through Urea + 50% N through Nano urea, T_8 - 40% RDN through Urea + 60% N through Nano urea.

Experimental setup

The nitrogen concentration was medium, the phosphorus content was low, and the potassium level was high, according to the soil samples collected and analysed for nutritional content. Before planting, seeds are pre-soaked for around 24 hours and then arranged in a line. IFFCO nano urea was applied to the leaves as a foliar treatment. The size

of the nano urea particle is about 20-50 nm. The spray solution has been created according to the treatment plan (For example, if it is 100 % Nitrogen through Nano urea requires 3000 ml ha^{-1}, i.e., 4 ml $litre^{-1}$, spray fluid is needed). The conventional urea has been given as a basal dose, Nano urea has been sprayed in two split doses (i.e., Tillering and Panicle initiation stage).

Data observations

The data was gathered at various phases of the crop, ranging from 30 DAS to Harvest. Plant Height, Number of Tillers, LAI, Dry Matter Production, and Days to 50% flowering were the growth parameters measured. Grain yield, straw yield, number of panicles, number of grains per panicles, and harvest index were all gathered as yield characteristics.

Results and Discussion

Growth Attributes

The application of 50 % RDN via Urea + 50 % N via Nano urea (T_7), as reported increased plant height (**Table 1**). Furthermore, as the plant matured, dramatically increased plant height compared to the control. 60 % RDN through Urea + 40 % N through Nano urea (T_6) had the best output followed by 50 % RDN via Urea + 50 % N via Nano urea (T_7). It could be due to the fact that nano encapsulated nitrogen effectively releases nutrients, regulating plant development and enhancing target activity. The nano fertilizer is a colloidal farming fertilization additive that aids in nutrient uptake, transportation, and absorption [7].

The no. of tillers m^{-2} has been significantly affected in 50% RDN through Urea + 50% N through Nano urea (T_7), whereas the other treatments revealed a severe reduction in tiller development. This was because reducing particle size improved the specific surface area and number of particles per unit area of a fertilizer, which provided more opportunities for fertilizer interaction, resulting in more penetration and nutrient uptake, thus resulting in a more significant number of tillers [8], as stated in Table 1.

The LAI was enhanced in 50% RDN through Urea + 50% N through Nano urea (T_7), followed by 60% RDN through Urea +40% N through Nano urea (T_6) and 70% RDN through Urea + 30% N through Nano urea (T_5). It was caused due to Nano urea has increased the chlorophyll formation, rate of photosynthesis results in overall growth in plant which may results in formation of a greater number of leaves. Similar findings were reported by [9] and [10].

The treatment with 50 % RDN through Urea + 50 % N through Nano urea resulted in the maximum Dry Matter Production. This effect was due to the larger surface area, particle size less than the leaves can easily penetrate into the plant and improve nutrient use efficiency leads to high dry matter production [11].

The days to flowering 50% RDN through Urea + 50% N through Nano urea (T_7) followed by 60% RDN through Urea + 40% N through Nano urea (T_6) demonstrated a superior performance and the period needed for 50% blooming is shortened. The results of this study revealed that rice treated with 50% RDN via Urea + 50% N via Nano urea has a substantial effect. It may caused due to the spraying of Nano urea during the panicle initiation time gives more strength to plants which leads to early flowering.

Table 1 Effect of Nano nitrogen on Growth Attributes

Treatments	Plant height (cm)	No. of Tillers	LAI	DMP (Kg ha^{-1})	Days to 50% flowering
T_1	81.9	185	4.02	10397	79
T_2	99.5	305	5.10	15423	73
T_3	95.7	279	4.73	14540	75
T_4	96.8	283	4.80	14738	75
T_5	100.2	311	5.15	15614	73
T_6	102.6	331	5.44	16295	72
T_7	104.7	348	5.73	16950	70
T_8	93.3	253	4.42	13851	77
S. Ed	0.87	6.89	0.11	292.17	0.61
C.D	1.87	14.78	0.23	626.7	1.30

Yield and Yield attributes

In comparison to the control plot, the treatment with 50 % RDN via Urea + 50 % N through Nano urea produced more panicles m^{-2} and had the highest number of filled grains $panicle^{-1}$. It might be attributed due to the enhancement

in enzymatic activity that may leads to formation and transportation photosynthates that may results trigger the number of grains per panicle.

The use of Nano urea has a considerable impact on grain and straw yields (**Table 2**). The application of 50 % RDN via Urea + 50 % N through Nano urea, followed by application of 60 % RDN through Urea + 40 % N through Nano urea activated grain yield. It may be caused due to combined application of conventional fertilizer as basal dose and split dosage application of Nano urea has been sprayed on plant surface leads to storage of remaining nitrogen in plant cells that may release slowly that can prevent the plant biotic and abiotic stress produces the high grain yield.

Compared to the control plot, the treatment with 50 % RDN through Urea + 50 % N through Nano urea produced the maximum straw yield (Table 2). The ideal blend of traditional and Nano fertilizer resulted in maximum straw production. It may probably due to fact that it releases the nutrients on demand and controlled released of nutrients that regulates the plant growth and enhanced the target activity which leads to biological production of crop. Similar findings reported by [12] and [13].

The plot treated with 50 % RDN via Urea + 50 % N via Nano urea had the greatest harvest index because both economic and biological yields increased significantly in the plot treated with 50 % RDN via Urea + 50 % N through Nano urea. It could be due to the maturation of leaves is accompanied by large number of functional and anatomic changes resulting in reversal of transport direction from importing to exporting this may have triggers the transportation capabilities in terms of penetration movements with in the plant system resulted higher biological yield gets a highest harvest index.

Table 2 Effect of Nano Nitrogen on Yield attributes

Treatments	No. of panicles m^{-2}	No. of filled grains $Panicle^{-1}$	Grain yield ($kg.\ ha^{-1}$)	Straw yield ($kg.\ ha^{-1}$)
T_1	183	99.85	4236	5462
T_2	291	144.6	6589	7437
T_3	268	132.5	6299	7043
T_4	272	135.8	6371	7186
T_5	299	148.3	6645	7513
T_6	321	157.4	6814	7956
T_7	335	165.9	7056	8342
T_8	249	123.7	6053	6809
S. Ed	6.53	2.85	101.40	146.73
C.D	12.15	6.12	217.25	314.71

Conclusion

The experimental study conducted “Effect of Nano Nitrogen on Growth and Yield Attributes of Rice” revealed that reduced usage of Urea with half recommended rate of Nano Urea resulted in highest plant height (104.7 cm), Number of Tillers (348), LAI (5.73) and Yield attributes Filled grains per Panicle (165.9) and Grain yield (7056 kg ha^{-1}), Straw yield (8342 kg ha^{-1}). According to the existing scenario, chemical fertilizers promote soil depletion, and the soil may no longer be appropriate for agricultural production in the future. So, to reiterate, nano fertilisers are a viable alternative to chemical fertilisers.

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Publication History
Received 08.02.2022
Revised 11.05.2022
Accepted 12.05.2022
Online 31.05.2022