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Evaluation of INM practices and nano urea on the performance of drum seeded rice

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Abstract
A field experiment was conducted on "Evaluation of INM practices and nano urea on the performance of drum seeded rice" at Experiment Farm, Department of Agronomy, Faculty of Agriculture, Annamalai Nagar, Tamil Nadu, India during Late Navarai season (February-May, 2023) in randomized block design with four replications making six treatment combinations. Among different treatments experimented, the treatment T_5 - 100% RDF + 25% RDN as goat manure + 0.2% Nano urea spray showed that the maximum highest plant height (98.40 cm), number of tillers m^{-2} (468.6), leaf area index (5.44), dry matter production (14,216 kg ha^{-1}), grain yield (6,234 kg ha^{-1}) and straw yield (9,261 kg ha^{-1}). Hence, treatment, T_5 - 100% RDF + 25% RDN as goat manure + 0.2% Nano urea spray remarkably enhanced the growth and yield of drum seeded rice.

Keywords: Rice, nano urea, goat manure, growth attributes, yield

Introduction
Rice is one of the most important food crops and a primary food source for more than one third of the world's population (Prasad *et al.,* 2010) [13]. India is the second largest producer and consumer of rice in the world. India is also the fourth largest exporter of rice in the world. Rice is cultivated worldwide in an area of 177.25 million ha with the production of 518.14 million tonnes, having a productivity of 2.92 t ha^{-1} (USDA, 2022-23) [20]. In India, rice is cultivated in an area of 46.38 million hectares having annual production of 130.29 million tonnes with a productivity of 2.8 t ha^{-1} (MAFW, 2022) [9]. In Tamil Nadu, rice is cultivating in the area of 2.2 million hectares with a production of 8.65 million tonnes and average productivity of about 3.93 t ha^{-1} (ICAR, 2023) [6]. Rice plants require a lot of mineral nutrients, especially nitrogen, to grow, develop, and produce grains. Nitrogen is one of the important elements in plant owing to its major part in chlorophyll production, which is essential for the photosynthesis process. Nitrogen is part of different enzymatic proteins that catalyze and regulate plant development processes (Sinfield *et al.,* 2010) [18]. Nano urea is liquid formulations manufactured by Nano Biotechnology Research Center in association with Indian Farmers Fertilizers Cooperative Limited. The 500 ml of nano urea is equivalent to a 45 kg urea fertilizer. It contains nano scale nitrogen particles (55,000 nano particles) with high surface area (10,000 times over 1mm Urea prilled). On foliar application, these small particles are delivered directly to the plant cell, thereby releasing nitrogen inside the cells as per the requirement in a phased manner which ensure low and target efficient release for providing the nutrients to the crop and thus increase nutrient use efficiency.

Thus, foliar application of nano urea enhances availability of nitrogen through stomata of leaves via gaseous uptake and activate many enzymes involved in biochemical pathways for maintenance of biological membranes. Integrated nutrient management has been shown to considerably improve rice yields by minimizing nutrient losses to the environment and managing the nutrient supply, and thereby results in high nutrient use efficiency (Parkinson *et al.,* 2013) [12]. Integration of organic manure along with inorganic fertilizers could be the best option for sustaining rice yield and restoring soil fertility and facilitating the continuous supply of nutrients throughout the crop season. Therefore, the present investigation was under taken to study the effect of INM practices and nano urea on the growth and yield component for

enhancing the production of rice.

Materials and Methods

The Field experiment was conducted in the Experimental Farm, Department of Agronomy, Faculty of Agriculture, Annamalai University, Annamalai Nagar during *Late Navarai* season (February-May, 2023). The experiment was laid out in Randomized Block Design (RBD) using ADT-43 as the test crop with six treatments and four replications, *viz.*, T_1 - 100% RDF, T_2 - 100% RDF + 25% RDN as goat manure, T_3 - 100% RDF + 25% RDN as green leaf manure, T_4 - 100% RDF + 0.2% Nano urea spray, T_5 - 100% RDF + 25% RDN as goat manure + 0.2% Nano urea spray, T_6 - 100% RDF + 25% RDN as green leaf manure + 0.2% Nano urea spray. The soil of the experiment field was clay in texture. The data were statistically analyzed as suggested by (Gomez and Gomez, 1984) [5].

Results and Discussion

Growth attributes

Among the treatments, the highest plant height (98.40 cm), number of tillers m^{-2} (468.6), leaf area index (5.44) and dry matter production (14,216 kg ha^{-1}) were recorded under treatment T_5- 100% RDF + 25% RDN as Goat manure + 0.2 % Nano urea spray which was followed by treatment T_4- 100% RDF + 0.2 % as Nano urea spray (Table 1). Increase in plant height by application of goat manure might be due to high amount of phosphorus and potash content in goat manure, which is easily available to plants. This result is similar to the finding of Shalini and Brijbhooshan (2017) [16] and Bhattarai *et al.* (2020) [3] and also Foliar spray of nano urea might due to nitrogen that has been nano-encapsulated efficiently release nutrients, controlling plant growth and boosting target activity. The nano fertilizer is a colloidal farming fertilization additive that aids in nutrient uptake, transportation, and absorption. These result findings were in close agreement with the findings of (Bahmaniar and Sooaee-Mashaee (2010) [1]; Benzon *et al.*, 2015) [2] to positively influence plant height.

The number of tillers (m^{-2}) was found to be increased with foliar spray of nano urea might be due higher division, cell elongation and meristematic activity in plants. Similar findings reported by Ranjan *et al.* (2023) [15]. This was because reducing particle size increased a fertilizer's specific surface area and the quantity of particles per unit area. This increased the fertilizer's opportunities for penetration led to higher synthesis and mobilization of carbohydrates, proteins resulted in cell division, thus increased the number of tillers (m^{-2}). Similar finding reported by Chandana *et al.* (2021) [4]; Mahmoodi *et al.* (2020) [10].

Leaf area index increase was caused due to nano urea boosted the production of chlorophyll, which in turn raised the rate of photosynthesis, cell division and caused leaf growth. Higher plant height accommodating a greater number of leaves (Midde *et al.*, 2022) [11]. Application of nano-urea spray has demonstrated a significant influence on rice leaf area index (LAI). Research by Sharma *et al.* (2022) [17] 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. Foliar spray of nano urea fertilizer significantly improved the dry matter accumulation. area, particle size less than the leaves can easily penetrate into the plant and improve nutrient use efficiency leads to high dry matter production (Qureshi *et al.*, 2018) [14]. Nano-urea exhibit a beneficial impact on the activity of enzymes that produce antioxidants, chloroplasts, and nitrogen-reductase are methods for enhancing plant development which allows for better translocation of assimilates and photosynthates to different plant parts resulting in higher dry matter accumulation. These results are in agreement with the findings of Mahmoodi *et al.* (2020) [10] and Midde *et al.* (2022) [11].

Grain yield and straw yield

Among the treatments, the highest grain yield (6,234 kg ha^{-1}) and straw yield (9,261 kg ha^{-1}) was observed under treatment T_5- 100% RDF + 25% RDN as Goat manure + 0.2 % Nano urea spray which was followed by treatment T_4- 100% RDF + 0.2 % as Nano urea spray (Table 1).

Grain yield increased with application of goat manure might be due to the improved parameters like plant growth and filled grains per panicle. Goat manure's high levels of organic matter and nutrients promote better plant growth by enhancing soil microbial activity and facilitating the quick release of macro- and micronutrients, which in turn boost rice's physiological and reproductive activities and result in a high yield. Similar finding is also documented by others authors, Surekha *et al.* (2010) [19], Uwah and Eyo (2014) [21] and Shalini and Brijbhooshan (2017) [16]

And, also the main way that nano fertilizers boost rice grain output is through the growth of plant parts and metabolic processes like photosynthesis, which increase the accumulation and transfer of photosynthates to the sections of the plant that are useful to the plant. These result findings were in close agreement with the findings of Kumar *et al.* (2020) [8]. A foliar spray of nano urea fertilizer enhanced the amount of straw produced. This could be because the nano fertilizer was quickly absorbed by the plant and was easy to translocate, which improved photosynthetic rates and raised the amount of dry matter buildup. Nearly similar results were found by Khalil *et al.* (2019) [7].

Table 1: Effect of Effect of INM practices and nano urea on growth attributes and yield of rice

Treatment	Plant height (cm)	No. of tillers m^{-2}	LAI	DMP (kg ha^{-1})	Grain yield (kg ha^{-1})	Straw yield (kg ha^{-1})
T_1 - 100% RDF	70.23	333.8	3.52	9673	4106	6631
T_2 - 100% RDF + 25% RDN as GM (Goat manure)	83.76	387.0	4.35	12177	5367	8272
T_3 - 100% RDF + 25% RDN as Green Leaf manure	76.78	362.1	3.83	10957	4696	7357
T_4 - 100% RDF + 0.2% Nano Urea spray	94.86	440.4	5.10	12762	5887	8790
T_5 - 100% RDF + 25% RDN as GM (Goat manure) + 0.2% Nano Urea spray	98.40	468.6	5.44	14216	6234	9261
T_6 - 100% RDF + 25% RDN as Green Leaf manure + 0.2% Nano Urea spray	90.01	420.9	4.75	12421	5616	8544
SEm±	1.13	5.26	0.08	131.55	72.00	80.00
CD (P=0.05)	3.41	15.89	0.23	397.29	217.45	241.61

Conclusion

Based on the results of the experiment it can be concluded that the treatment, T_5 - 100% recommended dose of fertilizer + 25% recommended dose of nitrogen as goat manure + 0.2% Nano urea spray was highly impressive and showed the maximum growth attributes and yield of rice. Hence, this treatment is recommended to the farmers to attain highest growth and yield of rice.

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