

Original Research Article

Effect of slow-release nitrogen fertilizer and foliar spray of nano zinc on growth and yield of rice
(*Oryza sativa* L.)

ABSTRACT

A field experiment took place on Crop Research Farm at Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj (U.P) India during the *Kharif* season of 2021. The Soil of the experimental plot was sandy loam, having a nearly neutral soil reaction (pH 6.9), electrical conductivity 0.29 ds/m, available nitrogen (278.93 kg/ha), available phosphorous (10.8 kg/ha), and available potassium (206.4 kg/ha). The experiment was laid out in randomized block design (RBD) which consisted of nine treatment and replicated thrice viz., T₁: Neem Coated Urea 80 kg/ha + Nano Zinc 0.5 g/l, T₂: Neem Coated Urea 80 kg/ha + Nano Zinc 1.0 g/l, T₃: Neem Coated Urea 80 kg/ha + Nano Zinc 1.5 g/l, T₄: Neem Coated Urea 100 kg/ha + Nano Zinc 0.5 g/l, T₅: Neem Coated Urea 100 kg/ha + Nano Zinc 1.0 g/l, T₆: Neem Coated Urea 100 kg/ha + Nano Zinc 1.5 g/l, T₇: Neem Coated Urea 120 kg/ha + Nano Zinc 0.5 g/l, T₈: Neem Coated Urea 120 kg/ha + Nano Zinc 1.0 g/l and T₉: Neem Coated Urea 120 kg/ha + Nano Zinc 1.5 g/l. The result of the experiment showed that growth parameters viz., plant height (88.41 cm), number of tillers/hill (14.78) and plant dry weight (85.81 g) were significantly increased when the increase in the levels of Neem coated urea + Nano zinc and maximum was obtained with the application of Neem coated urea 120kg/ha + Nano zinc 1.5 g/l (T₉), yield attributes viz., number of effective tillers/m² (311.29), number of grains/panicle (97.35), grain yield (5.48 t/ha) and straw yield (11.45 t/ha) were also recorded.

Key words: Basmati rice, slow-release nitrogen fertilizer, nano-zinc, growth and yield.

INTRODUCTION

Rice (*Oryza sativa* L.) is one of the foremost important staple food crops because it helps to sustain two-thirds of the world's population (Kahani et al. 2015). Among the nutritional staple foods, rice provides instant energy as it is mainly composed of starch (carbohydrate). Rice also provides 27 percent of dietary energy, 20 percent of dietary protein, and dietary fat of three percent. The total region under rice in India is 42.96 million hectares with an annual production

of 112.91 million tonnes with productivity of 2.63 tonnes/ha (DoES, 2018). In terms of rice production and consumption, China and India are the world's largest. It has been estimated that India produces more than 106 million tonnes of rice annually and contributes 40 percent to its total grain output. In India, total basmati acreages in 2019 are estimated at 1939 thousand hectares which is 31% on top of the last year's acreage of 1480 thousand hectares. The globe under scented rice varieties is increasing day by day with the opening of the world market also as domestic consumption (Singh et al. 2008).

Urea is a standard nitrogen source in fertilizer, but when it comes in contact with water it hastily breaks down into ammonia which leads to the problem of leaching. Farmers must apply additional fertilizer to crops to cover that loss, which puts a strain on the economy, especially in developing regions of the globe where food supplies are unstable and populations are increasing. By releasing small accounts of nitrogen when the crop needs it, slow-release nitrogen fertilizers address the current issues of nitrogen loss and increase the ability of nitrogen to maximize the yield. Neem coated urea (NCU) is an indigenous nitrification inhibitor that is reported to enhance rice yield, growth and uptake of nitrogen fertilizer. It is also reported to extend the lifespan and maximize the effectiveness of nitrogen fertilizers on rice. Nitrification inhibiting properties of neem and its role in increasing nutrient use efficiency (NUE) in rice was first reported by (Bains et al. 1971).

Zinc (Zn) is additionally one of several essential micronutrient elements that are involved with auxin production, chlorophyll protein synthesis, and insulin production. The efficiency of applied $ZnSO_4$ is just 1 to 4% and most of the applied zinc is rendered unavailable to plants because of many factors like leaching and fixation (Nair et al. 2010). Therefore, the use of recent nanotechnology applications and nanomaterials with the assistance of nanotechnology is crucial to reducing nutrient loss during fertilizer application and increasing crop yield.

MATERIAL AND METHODS

During kharif season of 2021, a field experiment was conducted out at the Crop Research Farm of the Department of Agronomy, Naini Agricultural Institute, SHUATS, Prayagraj (Allahabad) U.P. in alluvial soil. Soil of experimental plot was sandy loam, having nearly neutral soil reaction (pH 6.9), electrical conductivity 0.29 ds/m, available nitrogen (278.93 kg/ha), available phosphorous (10.8 kg/ha) and available potassium (206.4 kg/ha). Test variety (Pusa Basmti-1)

was transplanted on 4th week of July 2021 with a spacing of 20×10 cm. The experiment was laid out in randomized complete block design (RCBD) which consisted of 9 treatment and replicated thrice viz., T₁: Neem Coated Urea 80 kg/ha + Nano Zinc 0.5 g/l, T₂: Neem Coated Urea 80 kg/ha + Nano Zinc 1.0 g/l, T₃: Neem Coated Urea 80 kg/ha + Nano Zinc 1.5 g/l, T₄: Neem Coated Urea 100 kg/ha + Nano Zinc 0.5 g/l, T₅: Neem Coated Urea 100 kg/ha + Nano Zinc 1.0 g/l, T₆: Neem Coated Urea 100 kg/ha + Nano Zinc 1.5 g/l, T₇: Neem Coated Urea 120 kg/ha + Nano Zinc 0.5 g/l, T₈: Neem Coated Urea 120 kg/ha + Nano Zinc 1.0 g/l and T₉: Neem Coated Urea 120 kg/ha + Nano Zinc 1.5 g/l. Neem coated urea is applied in split dosage as half dose at the time of field preparation or basal dose and the remaining N was top dressed at tillering and panicle initiation stages. The whole dose of P₂O₅ and K₂O was applied at the rate of 60 kg/ha at the time of field preparation. Though the source of P₂O₅ and K₂O was single super phosphate (SSP) and muriate of potash (MOP), respectively. Nano Zinc was used as a foliar application and was done twice viz; tillering and panicle initiation stages. The data collected were plant height, number of tillers/hill, plant dry weight, effective number of tillers/m², number of grains/panicle, length of panicle, test weight, grain yield, straw yield and harvest index.

RESULTS AND DISCUSSION

Plant height

Growth parameters are important when assessing plant growth because a plant's height is a measure of its vegetative growth which directly relates to biological yield (grain+straw). Among all the treatments, the treatment neem coated urea 120 kg/ha + nano zinc 1.5 g/l (T₉) was found significantly superior (Table 1). At harvest maximum plant height (88.41 cm) was recorded in application (T₉) Neem coated urea 120 kg/ha + Nano zinc 1.5 g/l. followed by treatment (T₆) Neem coated urea 100 kg/ha + Nano zinc 1.5 g/l (86.22 cm) and (T₈) Neem coated urea 120 kg/ha + Nano zinc 1.0 g/l (86.67 cm). This may be because NCU releases nitrogen gradually and maintains a higher level of nitrogen in the soil throughout the crop growth period than PU with the same dose and split schedule (Shivay *et al.* 2001).

Number of tillers/hill

Significantly higher number of tillers/hill (15.46) was noted (Table 1) in treatment (T₉) neem coated urea 120 kg/ha + nano zinc 1.5 g/l followed by treatment (T₅) Neem coated urea 100

kg/ha + Nano zinc 1.0 g/l (13.92), (T₆) Neem coated urea 100 kg/ha + Nano zinc 1.5 g/l (14.21) and (T₈) Neem coated urea 120 kg/ha + Nano zinc 1.0 g/l (14.78). This increased number of tillers/m might have been caused by nitrogen fertilization, a vital step in cell division (Mamata Meena *et al.* 2013).

Plant dry weight

Maximum plant dry weight (85.81 g/hill) was significantly recorded (Table 1) in the treatment (T₉) neem coated urea 120 kg/ha + nano zinc 1.5 g/l followed by treatment (T₅) Neem coated urea 100 kg/ha + Nano zinc 1.0 g/l (80.39 g/hill), (T₆) Neem coated urea 100 kg/ha + Nano zinc 1.5 g/l (82.48 g/hill) and (T₈) Neem coated urea 120 kg/ha + Nano zinc 1.0 g/l (83.57 g/hill). An increase in the dry matter might result from increased nitrogen levels increasing plant height and tiller production/m² and thereby increasing dry matter production (Wani *et al.* 2016).

Number of effective tillers/m²

The number of effective tillers/m² was significantly maximum (Table 2) in treatment (T₉) Neem coated urea 120 kg/ha + Nano zinc 1.5 g/l (311.29) except treatment (T₅) Neem coated urea 100 kg/ha + Nano zinc 1.0 g/l (285.73), (T₆) Neem coated urea 100 kg/ha + Nano zinc 1.5 g/l (299.19) and (T₈) Neem coated urea 120 kg/ha + Nano zinc 1.0 g/l (305.96) which were statistically at par with treatment (T₉).

Number of grains/panicle

Number of grains/panicle (97.35) was noted significantly maximum (Table 2) in treatment (T₉) Neem coated urea 120 kg/ha + Nano zinc 1.5 g/l except (T₅) Neem coated urea 100 kg/ha + Nano zinc 1.0 g/l (91.73), (T₆) Neem coated urea 100 kg/ha + Nano zinc 1.5 g/l (93.45) and (T₈) Neem coated urea 120 kg/ha + Nano zinc 1.0 g/l (94.26) which were statistically at par with (T₉) Neem coated urea 120 kg/ha + Nano zinc 1.5 g/l. Khandey *et al.* (2017) also found similar results.

Grain yield

Based up the result of this experiment, it can be noted that the maximum grain yield (5.48 t/ha) was noticed (Table 2) in the treatment (T₉) Neem coated urea 120 kg/ha + Nano zinc 1.5 g/l. However, treatment (T₆) Neem coated urea 100 kg/ha + Nano zinc 1.5 g/l (5.14 t/ha) and (T₈) Neem coated urea 120 kg/ha + Nano zinc 1.0 g/l (5.21 t/ha) was found to be at par with (T₉)

Neem coated urea 120 kg/ha + Nano zinc 1.5 g/l. Nitrogen releases from neem coated urea are more likely to match crop growth and nitrogen requirement; as result, these fertilizers are likely to boost yields and efficiency in nitrogen utilization (Heitor *et al.* 2018).

Straw Yield

Significant higher straw yield (11.45 t/ha) was obtained (Table 2) in the application (T₉) Neem coated urea 120 kg/ha + Nano zinc 1.5 g/l followed by (T₈) Neem coated urea 100 kg/ha + Nano zinc 1.0 g/l (11.23 t/ha), (T₆) Neem coated urea 100 kg/ha + Nano zinc 1.5 g/l (10.57 t/ha) and (T₅) Neem coated urea 120 kg/ha + Nano zinc 1.0 g/l (10.39 t/ha). Singh and Shivay (2003) also found significantly higher grain and straw yield as compared to prilled urea.

Table 1. Influence of slow-release nitrogen fertilizer and foliar spray of nano zinc on growth parameters of rice

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Treatments		Plant height (cm)	Number of tillers/hill (No.)	Plant dry weight (g/hill)
1.	Neem coated urea 80 kg/ha + Nano-zinc 0.5 g/l	82.79	11.57	69.56
2.	Neem coated urea 80 kg/ha + Nano-zinc 1.0 g/l	83.58	12.11	73.37
3.	Neem coated urea 80 kg/ha + Nano-zinc 1.5 g/l	83.92	12.45	76.57
4.	Neem coated urea 100 kg/ha + Nano-zinc 0.5 g/l	84.49	12.62	77.42
5.	Neem coated urea 100 kg/ha + Nano-zinc 1.0 g/l	85.19	13.92	80.39
6.	Neem coated urea 100 kg/ha + Nano-zinc 1.5 g/l	86.22	14.21	82.48
7.	Neem coated urea 120 kg/ha + Nano-zinc 0.5 g/l	84.85	13.24	79.30
8.	Neem coated urea 120 kg/ha + Nano-zinc 1.0 g/l	86.67	14.78	83.57
9.	Neem coated urea 120 kg/ha + Nano-zinc 1.5 g/l	88.41	15.46	85.81
SEm ±		1.04	0.55	1.93
CD (5%)		3.10	1.63	5.79

Table 2. Influence of slow-release nitrogen fertilizer and foliar spray of nano zinc on yield attributes and yield of rice

Treatments		Effective tillers/m ²	Grains/panicle	Grain Yield (t/ha)	Straw Yield (t/ha)
1.	Neem coated urea 80 kg/ha + Nano-zinc 0.5 g/l	231.77	83.46	3.86	8.95
2.	Neem coated urea 80 kg/ha + Nano-zinc 1.0 g/l	241.06	85.24	3.98	9.33
3.	Neem coated urea 80 kg/ha + Nano-zinc 1.5 g/l	256.23	88.89	4.22	9.41
4.	Neem coated urea 100 kg/ha + Nano-zinc 0.5 g/l	264.79	89.15	4.41	9.72
5.	Neem coated urea 100 kg/ha + Nano-zinc 1.0 g/l	285.73	91.73	4.97	10.39
6.	Neem coated urea 100 kg/ha + Nano-zinc 1.5 g/l	299.19	93.45	5.14	10.57
7.	Neem coated urea 120 kg/ha + Nano-zinc 0.5 g/l	272.82	90.49	4.67	10.07
8.	Neem coated urea 120 kg/ha + Nano-zinc 1.0 g/l	305.96	94.26	5.21	11.23
9.	Neem coated urea 120 kg/ha + Nano-zinc 1.5 g/l	311.29	97.35	5.48	11.45
SEm (±)		11.12	2.21	0.17	0.45
CD (5%)		33.35	6.35	0.50	1.34

CONCLUSION

Using the results obtained from the present findings, it is found that an increase in the amount of urea containing Neem combined with Nano zinc provided significant benefits in enhancing rice growth characteristics, yield attributes and yield. Experimental findings indicate that application (T₉) Neem Coated urea 120 kg/ha + Nano zinc 1.5 g/l was found to be significantly the best treatment, that recorded highest plant height, tillers/hill, plant dry weight, effective tillers/m², grains/panicle, grain yield and straw yield.

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