# *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~~of Agriculture, Technology and Sciences, Prayagraj (U.P) India during *Kharif* season of 2021. The experiment was entitled as "Effect of slow-release nitrogen fertilizer and foliar spray of nano zinc on growth and yield of rice (*Oryza sativa* L.)". The experiment was laid out in randomized block design (RBD) which consisted of nine treatment and replicated thrice viz., $T_1$: Neem Coated Urea 80 kg/ha + Nano Zinc 0.5 g/lt, $T_2$: Neem Coated Urea 80 kg/ha + Nano Zinc 1.0 g/lt, $T_3$: Neem Coated Urea 80 kg/ha + Nano Zinc 1.5 g/lt, $T_4$: Neem Coated Urea 100 kg/ha + Nano Zinc 0.5 g/lt, $T_5$: Neem Coated Urea 100 kg/ha + Nano Zinc 1.0 g/lt, $T_6$: Neem Coated Urea 100 kg/ha + Nano Zinc 1.5 g/lt, $T_7$: Neem Coated Urea 120 kg/ha + Nano Zinc 0.5 g/lt, $T_8$: Neem Coated Urea 120 kg/ha + Nano Zinc 1.0 g/lt and $T_9$: Neem Coated Urea 120 kg/ha + Nano Zinc 1.5 g/lt. The result of 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 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/lt. Significantly highest number of effective tillers/$m^2$ (311.29), number of grains/panicle (97.35), grain yield (5.48 t/ha) and straw yield (11.45 t/ha) were recorded highest in the application of neem coated urea 120 kg/ha + nano zinc 1.5 g/lt.


**Key words**: Basmati rice (Pusa basmati-1), Growth parameters, Nano-zinc (foliar spray), Slow-release nitrogen fertilizer (Neem coated urea) and Yield attributes.

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## INTRODUCTION

Rice (*Oryza sativa* L.) is one amongst 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. Total region under rice India is 42.96 million hectares with annual production of 112.91 million tonnes with productivity 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 their total grain output. China produces about 73 million tonnes per year, followed by the United States. China and India contribute share of 27.63% & 21.89% of worldwide rice production respectively (FAO 2017). Total basmati acreages in 2019 are estimated at 1939 thousand hectares which is 31% on top of the last year acreage of 1480 thousand hectares. The globe under scented rice varieties is increasing day by day with the opening of 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 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 ZnSO4 is just 1 to 4% and most of the applied zinc is rendered unavailable to plants because of many factors like leaching, fixation (Nair et al. 2010). Therefore, the use of recent nano technology applications and nano materials with assistance of nano technology is crucial to reducing nutrient loss during fertilizer application and to increasing crop yield. The nano

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fertilizers or nano encapsulated nutrients may need the properties that are effective to crops, release the nutrients on demand, controlled release of chemical fertilizers that regulate the plant growth and enhanced target activity (DeRosa et al. 2010).

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## 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). Nursery of test variety (Pusa Basmti-1) was sown on 1$^{st}$ week of July and transplanted on 4$^{th}$ 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 nine treatment and replicated thrice viz., $T_1$: Neem Coated Urea 80 kg/ha + Nano Zinc 0.5 g/lt, $T_2$: Neem Coated Urea 80 kg/ha + Nano Zinc 1.0 g/lt, $T_3$: Neem Coated Urea 80 kg/ha + Nano Zinc 1.5 g/lt, $T_4$: Neem Coated Urea 100 kg/ha + Nano Zinc 0.5 g/lt, $T_5$: Neem Coated Urea 100 kg/ha + Nano Zinc 1.0 g/lt, $T_6$: Neem Coated Urea 100 kg/ha + Nano Zinc 1.5 g/lt, $T_7$: Neem Coated Urea 120 kg/ha + Nano Zinc 0.5 g/lt, $T_8$: Neem Coated Urea 120 kg/ha + Nano Zinc 1.0 g/lt and $T_9$: Neem Coated Urea 120 kg/ha + Nano Zinc 1.5 g/lt. 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 $P_2O_5$ and $K_2O$ was applied at the rate of 60 kg/ha at the time of field preparation. Though the source of $P_2O_5$ and $K_2O$ 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/m$^2$, number of grains/panicle, length of panicle, test weight, grain yield, straw yield and harvest index. The data collected on growth and yield attributes were statistically analyzed (Fisher and Yates, 1958).

**Comment [SC8]:** Direct sowing?

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## RESULTS AND DISCUSSION

### Effect of slow-release nitrogen fertilizer and foliar spray of nano zinc on growth character of rice

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#### Plant height

Growth parameters are important when assessing plant growth because a plant's height is a measure of it 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/lt ($T_9$) was found significantly superior (Table 1). At harvest maximum plant height (88.41 cm) was recorded in application ($T_9$) Neem coated urea 120 kg/ha + Nano zinc 1.5 g/lt. followed by treatment ($T_6$) Neem coated urea 100 kg/ha + Nano zinc 1.5 g/lt (86.22 cm) and ($T_8$) Neem coated urea 120 kg/ha + Nano zinc 1.0 g/lt (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 same dose and split schedule. (Shivay *et al.* 2001).

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#### Number of tillers/hill

Significantly higher number of tillers/hill (15.46) was noted (Table 1) in treatment ($T_9$) neem coated urea 120 kg/ha + nano zinc 1.5 g/lt followed by treatment ($T_5$) Neem coated urea 100 kg/ha + Nano zinc 1.0 g/lt (13.92), ($T_6$) Neem coated urea 100 kg/ha + Nano zinc 1.5 g/lt (14.21) and ($T_8$) Neem coated urea 120 kg/ha + Nano zinc 1.0 g/lt (14.78). (Table 1). This increased number of tillers/m might have been caused by nitrogen fertilization, a vital step in cell division. (Mamata Meena *et al.* 2013).

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#### Plant dry weight

Maximum plant dry weight (85.81 g/hill) was significantly recorded (Table 1) in the treatment ($T_9$) neem coated urea 120 kg/ha + nano zinc 1.5 g/lt followed by treatment ($T_5$) Neem coated urea 100 kg/ha + Nano zinc 1.0 g/lt (80.39 g/hill), ($T_6$) Neem coated urea 100 kg/ha + Nano zinc 1.5 g/lt (82.48 g/hill) and ($T_8$) Neem coated urea 120 kg/ha + Nano zinc 1.0 g/lt (83.57 g/hill). (Table 1). An increase in dry matter might result from increased nitrogen levels increasing plant height and tiller production/$m^2$ and thereby increasing dry matter production. (Wani *et al.* 2016).

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**Effect of slow-release nitrogen fertilizer and foliar spray of nano zinc on yield attributes and yield of rice**

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~~Observation regarding yield attributes is given in Table 2.~~

**Number of effective tillers/m$^2$**

The number of effective tillers/m$^2$ was significantly maximum (Table 2) in treatment ($T_9$) Neem coated urea 120 kg/ha + Nano zinc 1.5 g/lt (311.29) except treatment ($T_5$) Neem coated urea 100 kg/ha + Nano zinc 1.0 g/lt (285.73), ($T_6$) Neem coated urea 100 kg/ha + Nano zinc 1.5 g/lt (299.19) and ($T_8$) Neem coated urea 120 kg/ha + Nano zinc 1.0 g/lt (305.96) which were statistically at par with treatment ($T_9$). While, minimum number of effective tillers/m$^2$ (231.77) was noted in treatment ($T_1$) Neem coated urea 80 kg/ha + Nano zinc 0.5 g/lt.

**Number of grains/panicle**

Number of grains/panicle (97.35) was noted significantly maximum in treatment ($T_9$) (Table 2) Neem coated urea 120 kg/ha + Nano zinc 1.5 g/lt except ($T_5$) Neem coated urea 100 kg/ha + Nano zinc 1.0 g/lt (91.73), ($T_6$) Neem coated urea 100 kg/ha + Nano zinc 1.5 g/lt (93.45) and ($T_8$) Neem coated urea 120 kg/ha + Nano zinc 1.0 g/lt (94.26) which were statistically at par with ($T_9$) Neem coated urea 120 kg/ha + Nano zinc 1.5 g/lt. According to khandey *et al*. (2017) similar results were found

**Grain yield**

Based upon the result of this experiment, it can be noted that the maximum grain yield (5.48 t/ha) was noticed in the treatment ($T_9$) (Table 2) Neem coated urea 120 kg/ha + Nano zinc 1.5 g/lt. ~~(Table 3).~~ However, treatment ($T_6$) Neem coated urea 100 kg/ha + Nano zinc 1.5 g/lt (5.14 t/ha) and ($T_8$) Neem coated urea 120 kg/ha + Nano zinc 1.0 g/lt (5.21 t/ha) was found to be at par with ($T_9$) Neem coated urea 120 kg/ha + Nano zinc 1.5 g/lt. Nitrogen releases from neem coated urea are more likely to match crop growth and nitrogen requirement; as s result, these fertilizers are likely to boost yields and efficiency in nitrogen utilization. (Heitor *et al.* 2018).

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**Straw Yield**

Significant higher straw yield (11.45 t/ha) was obtained in the application ($T_9$) Neem coated urea 120 kg/ha + Nano zinc 1.5 g/lt followed by ($T_5$) Neem coated urea 100 kg/ha + Nano zinc 1.0

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g/lt (10.39 t/ha), ($T_6$) Neem coated urea 100 kg/ha + Nano zinc 1.5 g/lt (10.57 t/ha) and ($T_8$) Neem coated urea 120 kg/ha + Nano zinc 1.0 g/lt (11.23 t/ha).

| 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/lt | 82.79 | 11.57 | 69.56 |
| 2. | Neem coated urea 80 kg/ha + Nano-zinc 1.0 g/lt | 83.58 | 12.11 | 73.37 |
| 3. | Neem coated urea 80 kg/ha + Nano-zinc 1.5 g/lt | 83.92 | 12.45 | 76.57 |
| 4. | Neem coated urea 100 kg/ha + Nano-zinc 0.5 g/lt | 84.49 | 12.62 | 77.42 |
| 5. | Neem coated urea 100 kg/ha + Nano-zinc 1.0 g/lt | 85.19 | 13.92 | 80.39 |
| 6. | Neem coated urea 100 kg/ha + Nano-zinc 1.5 g/lt | 86.22 | 14.21 | 82.48 |
| 7. | Neem coated urea 120 kg/ha + Nano-zinc 0.5 g/lt | 84.85 | 13.24 | 79.30 |
| 8. | Neem coated urea 120 kg/ha + Nano-zinc 1.0 g/lt | 86.67 | 14.78 | 83.57 |
| 9. | Neem coated urea 120 kg/ha + Nano-zinc 1.5 g/lt | 88.41 | 15.46 | 85.81 |
| SEm ± | | 1.04 | 0.55 | 1.93 |
| CD (5%) | | 3.10 | 1.63 | 5.79 |

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

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/lt | 231.77 | 83.46 | 3.86 | 8.95 |
| 2. | Neem coated urea 80 kg/ha + Nano-zinc 1.0 g/lt | 241.06 | 85.24 | 3.98 | 9.33 |
| 3. | Neem coated urea 80 kg/ha + Nano-zinc 1.5 g/lt | 256.23 | 88.89 | 4.22 | 9.41 |
| 4. | Neem coated urea 100 kg/ha + Nano-zinc 0.5 g/lt | 264.79 | 89.15 | 4.41 | 9.72 |
| 5. | Neem coated urea 100 kg/ha + Nano-zinc 1.0 g/lt | 285.73 | 91.73 | 4.97 | 10.39 |
| 6. | Neem coated urea 100 kg/ha + Nano-zinc 1.5 g/lt | 299.19 | 93.45 | 5.14 | 10.57 |
| 7. | Neem coated urea 120 kg/ha + Nano-zinc 0.5 g/lt | 272.82 | 90.49 | 4.67 | 10.07 |
| 8. | Neem coated urea 120 kg/ha + Nano-zinc 1.0 g/lt | 305.96 | 94.26 | 5.21 | 11.23 |
| 9. | Neem coated urea 120 kg/ha + Nano-zinc 1.5 g/lt | 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 ($T_9$) Neem Coated urea 120 kg/ha + Nano zinc 1.5 g/lt was found to be significantly the best treatment, that recorded highest plant height, tillers/hill, plant dry weight, effective tillers/$m^2$, grains/panicle, grain yield and straw yield.

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