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IMPACT OF NANO UREA AND NANO ZINC ON YIELD AND YIELD ATTRIBUTING CHARACTERS OF CHILLI (*CAPSICUM ANNUUM* L.)

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ABSTRACT

The indiscriminate and imbalanced use of fertilizers in chilli cultivation poses significant environmental risks and threatens sustainable food and nutritional security. Variations in both the method and quantity of nitrogen and zinc fertilizer application considerably influence the yield and yield attributing characters of chilli. To assess this, a field experiment was conducted during the kharif season of 2024 at the Dr. YSRHU-Regional Horticultural Research Station, Lam Farm, Guntur, Andhra Pradesh, using the chilli variety LCA-625. The study comprised of eleven treatments, replicated thrice under in randomized block design, involving foliar sprays of nano urea and nano zinc combined with different recommended doses of nitrogen (100%, 75% and 50%), alongside a farmer's practice (T_1) and an absolute control without the application of fertilizers (T_{11}). The findings of our research study revealed that application of nano urea and nano zinc has significantly improved the yield and yield attributing characters compared to the farmer's practice as well as the absolute control. Among the treatments, T_7 treatment *i.e.*, 75% RDN supplemented with two sprays of nano urea (0.4%) at 30 and 60 days after transplanting (DAT) and two sprays of nano zinc (0.2%) at 60 and 90 DAT produced notably higher fruit length, fruit girth, average fruit weight and dry pod yield per hectare.

Key words : Chilli (LCA-625), Nano urea, Nano zinc, Foliar spray, Fertilizers and Dry pod yield.

Introduction

Chilli (*Capsicum annuum* L.), commonly known as hot pepper belongs to the family Solanaceae. It is one of the most important spice crops in India, contributing nearly 43% to global chilli production. Although widely cultivated across most of the Indian states, Andhra Pradesh ranks highest in chilli productivity, followed by Telangana. Sustainable agriculture aimed at higher productivity is crucial to address global food security challenges posed by climate change, population growth, diminishing fertile land and freshwater scarcity (Achiri *et al.*, 2017). Modern agriculture heavily depends on agrochemicals, particularly synthetic fertilizers, to enhance crop growth and yield. However, these fertilizers often exhibit poor nutrient use efficiency (NUE) due to losses via leaching, volatilization, photolysis and hydrolysis, thus limiting their effectiveness (Alemayehu and Shewarega, 2015). To overcome these limitations, nano fertilizers have emerged as a promising alternative. Due to their small particle size, larger surface area and high solubility, nano fertilizers improve nutrient absorption and enhance NUE, offering economic and environmental benefits. Additionally, they contribute positively to soil health and water conservation (Yu and Ren, 2015). Therefore, the present study focuses on evaluating the impact of nano urea and nano zinc on yield and yield attributing characters of chilli (*Capsicum annuum* L.).

Materials and Methods

The present study was conducted to evaluate the impact of nano urea and nano zinc on the yield and yield

attributing characters of the chilli variety LCA-625, planted with a spacing of 75 × 45 cm^2 (row × plant). The experiment was carried out at Dr. YSRHU - Regional Horticultural Research Station, Lam Farm, Guntur, Andhra Pradesh during the *Kharif* season of 2024. A randomized block design (RBD) with eleven treatments and three replications was used, testing different combinations of nano urea and nano zinc along with the recommended dose of nitrogen. The treatment details are as follows:

Treatment	Details
T_1	FYM 10 t ha^{-1} + 100% RDF (120: 24: 48 kg/ha) through traditional fertilizers + two sprays of micro nutrient mixture at 60 and 90 DAT (Farmer's practice)
T_2	100% RDN + two sprays of nano Zn (0.2%) at 60 and 90DAT
T_3	100% RDN + one spray of nano Urea (0.4%) at 30 DAT+ two sprays of nano Zn (0.2%) at 60 and 90 DAT
T_4	100% RDN + two sprays of nano Urea (0.4%) at 30 and 60 DAT+ two sprays of nano Zn (0.2%) at 60 and 90 DAT
T_5	75% RDN + two sprays of nano Zn (0.2%) at 60 and 90 DAT
T_6	75% RDN + One Spray of nano Urea (0.4 %) at 30 DAT + two sprays of nano Zn (0.2%) at 60 and 90 DAT
T_7	75% RDN + Two Spray of nano Urea (0.4 %) at 30 and 60 DAT + two sprays of nano Zn, (0.2 %) at 60 and 90 DAT
T_8	50% RDN + two sprays of nano Zn (0.2%) at 60 and 90 DAT
T_9	50% RDN + One Spray of nano Urea (0.4%) at 30 DAT + two sprays of nano Zn (0.2 %) at 60 and 90 DAT
T_{10}	50% RDN + Two Sprays of nano Urea (0.4%) at 30 and 60 DAT + two sprays of nano Zn (0.2%) at 60 and 90 DAT
T_{11}	Absolute control (without the application of any fertilizers)

Data on yield and yield attributing characters including fruit length (cm), fruit girth (cm), average fruit weight (g) and dry pod yield per hectare (q), the fruit length was measured from the pedicel region to the tip of the fruit. Collected five fruits from each plant and the average value for fruit length was worked out and expressed in centimetres (cm). The fruit girth was recorded individually for five fruits collected from each plant in each treatment and in each replication with the help paper scale, which was measured at the circumference or distance around the fruit and the average value was worked out and expressed in centimeters (cm). The average fruit weight was recorded for ten fruits from each tagged plant in each treatment and in each replication. Average fruit weight was measured using an electronic balance. The average fruit weight was calculated and expressed in grams (g) and The dry pod yield per hectare was assumed from the pod yield per plot. The average fruit yield per hectare was expressed in quintals (q). were collected from five randomly selected representative plants within each plot. The average values of these parameters for the five plants were calculated and used for statistical analysis. The data were analyzed using the methods described by Panse and Sukhatme (1985).

Results and Discussion

Fruit length (cm)

The data related to fruit length (cm) has shown a significant difference among the treatments (Table 1 and Fig. 1). The highest fruit length (10.30 cm) was recorded in treatment T_7 (75% RDN + two sprays of nano urea (0.4%) at 30 and 60 DAT + two sprays of nano Zn (0.2%) at 60 and 90 DAT), which was statistically on par with treatment T_4 (9.40 cm). The lowest fruit length was found in treatment T_{11} (absolute control) at 8.07 cm, followed closely by treatment T_8 (8.10 cm). The superior fruit length observed in T_7 treatment may be attributed to the foliar application of nano urea and nano zinc, which enhances nutrient absorption and uptake critical for fruit

Plate 1 : General view of experimental plot on chilli crop.

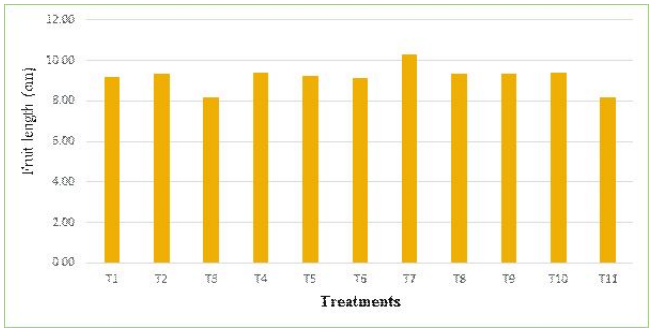

Fig. 1 : Impact of nano urea and nano zinc on fruit length (cm) in chilli (*Capsicum annuum* L.).

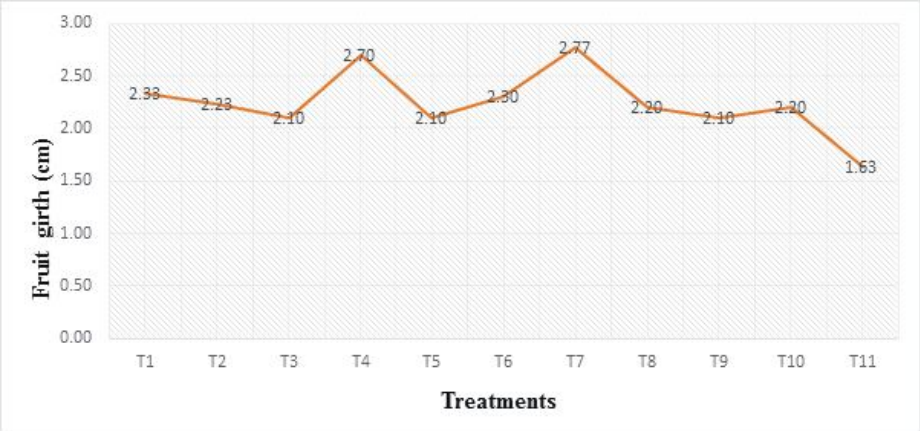

Fig. 2 : Impact of nano urea and nano zinc on fruit girth (cm) in chilli (*Capsicum annuum* L.).

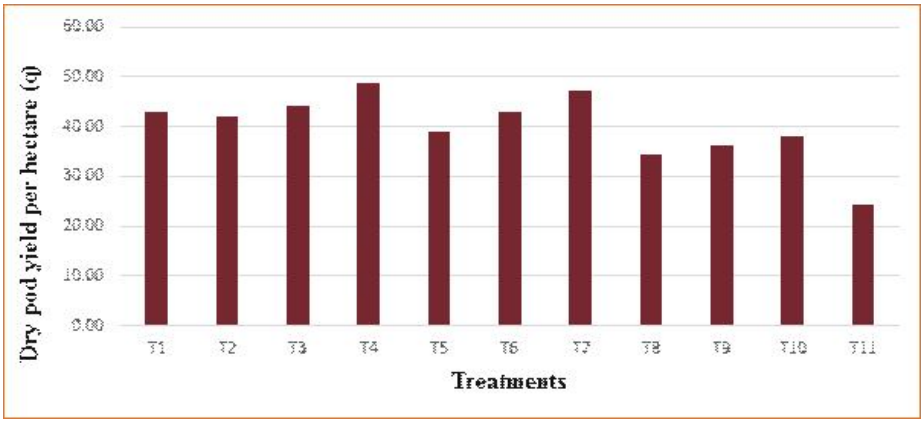

Fig. 3 : Impact of nano urea and nano zinc on dry pod yield per hectare (q) in chilli (*Capsicum annuum* L.).

Table 1 : Response of nano urea and nano zinc on yield and yield attributing characters of chilli (*Capsicum annuum* L.).

Treatments	Fruit length (cm)	Fruit girth (cm)	Average fruit weight (g)	Dry pod yield per hectare (q)
T_1	9.17	2.33	0.86	43.06
T_2	9.33	2.23	0.95	42.01
T_3	9.20	2.10	0.98	44.33
T_4	9.40	2.70	1.05	47.23
T_5	9.23	2.10	0.93	39.13
T_6	9.13	2.30	0.97	42.83
T_7	10.30	2.77	1.13	48.90
T_8	8.10	2.10	0.90	35.63
T_9	8.27	2.20	0.93	36.30
T_{10}	8.43	2.20	0.94	38.16
T_{11}	8.07	1.63	0.63	24.20
Mean	8.96	2.24	0.93	40.16
SEm (±)	0.329	0.171	0.050	1.88
CD at 5%	0.96	0.505	0.146	5.56
CV%	6.34	13.22	9.24	8.163

development. Nano fertilizers, due to their small particle size, facilitate efficient nutrient absorption. Moreover, micronutrients such as zinc play a crucial role in physiological processes influencing fruit growth and elongation. These findings align with previous studies by Parani and Nanthini (2021), Rather *et al*. (2022) and Chauhan *et al*. (2023) in chilli.

Fruit girth (cm)

The data on fruit girth (cm) presented in Table 1 and Fig. 2 indicated a significant difference among the treatments imposed. Significantly highest average fruit girth (2.77 cm) was recorded in treatment T_7 (75% RDN + two sprays of nano urea (0.4%) at 30 and 60 DAT + two sprays of nano zinc (0.2%) at 60 and 90 DAT), which was statistically on par with treatments T_4 (2.70 cm), T_1 (2.33 cm) and T_6 (2.30 cm). The lowest fruit girth (1.63 cm) was observed in treatment T_{11} (absolute control). The enhanced fruit girth under T_7 treatment can be attributed to the application of nano urea and nano zinc, which improved nutrient uptake, promoted better cell division and facilitated better fruit tissue expansion. Similar findings were reported by Chauhan *et al*. (2023) and Sunil *et al*. (2024) in chilli.

Average fruit weight (g)

The data on average fruit weight (g), is presented in Table 1 has shown a significant difference among the treatments. The highest average fruit weight (1.13 g) was observed in treatment T_7 (75% RDN + two sprays of nano urea (0.4%) at 30 and 60 DAT + two sprays of nano zinc (0.2%) at 60 and 90 DAT), which was statistically on par with treatment T_4 (1.05 g). The lowest average fruit weight (0.63 g) was recorded in treatment T_{11} (absolute control). The increased fruit weight in T_7 may be attributed to the application of nano fertilizers, where nano urea supports vigorous vegetative growth and fruit set and nano zinc contributes to enzymatic activation and hormonal regulation. These processes facilitate cell enlargement and efficient nutrient translocation within the fruit, thereby increasing fruit girth and weight as suggested by Gusain *et al*. (2015) in chilli

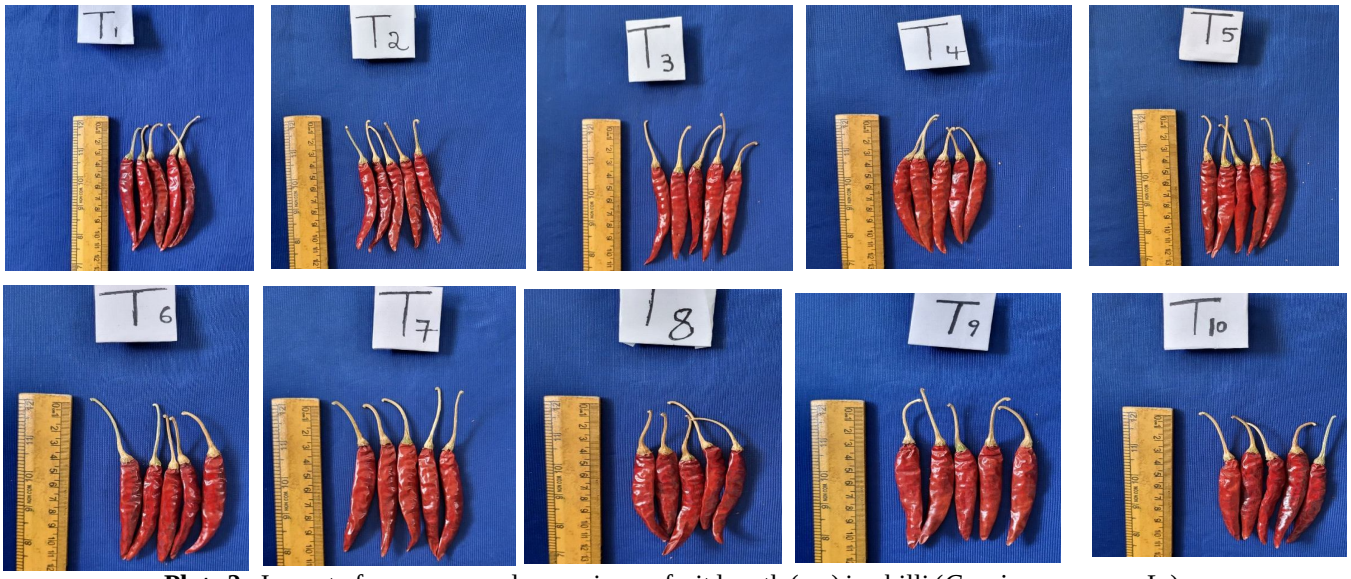

Plate 2 : Impact of nano urea and nano zinc on fruit length (cm) in chilli (*Capsicum annuum* L.).

and Vimal *et al*. (2018) in tomato.

Dry pod yield per hectare (q)

The data on dry pod yield per hectare (q) has shown a significant difference among the treatments (Table 1 and Fig. 3.). The highest dry pod yield per hectare (48.84 q) was recorded in T_7 (75% RDN + two sprays of nano urea (0.4%) at 30 and 60 DAT + two sprays of nano zinc (0.2%) at 60 and 90 DAT) treatment, which was statistically on par with treatments T_4 (47.23 q) and T_3 (44.33 q). The lowest dry pod yield per hectare (24.20 q) was observed in the absolute control (T_{11}). The superior yield in T_7 could be attributed to the enhanced nutrient use efficiency, uptake and sustained availability provided by the combined application of nano urea and nano zinc fertilizers as foliar sprays. These nano-fertilizers stimulate photosynthesis, enzyme activity and hormonal regulation, promoting flowering, fruit set and pod growth, while reducing nutrient losses and increasing overall productivity. These findings are consistent with previous reports of Yogaraju *et al*. (2019), Malik *et al*. (2020), Mishra *et al*. (2020), Thennakoon *et al*. (2020), Ahmed *et al*. (2021), Parani and Nanthini (2021) and Rather *et al*. (2022) in chilli.

Conclusion

The study revealed that foliar application of nano urea (0.4%) and nano zinc (0.2%) in combination with 75% of the recommended dose of nitrogen (RDN) significantly enhanced the yield and yield attributing characters of chilli as compared to the farmer's practice (T_1) and absolute control (T_{11}). Treatment with 100% RDN supplemented with nano fertilizers performed nearly equivalently, indicating the potential to reduce traditional nitrogen fertilizer usage by 25% without compromising the productivity. Thus, nano fertilizers, when applied as foliar sprays, present a sustainable alternative to conventional fertilization methods, reducing the reliance on traditional fertilizers while ensuring increased productivity, profitability and environmental safety in chilli cultivation.

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