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Effect of Nano Urea and Zinc on Growth and Yield of Kharif Maize

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

A field experiment was conducted with the objective to evaluate the Effect of Nano Urea and zinc on growth and yield of Kharif maize during kharif (Monsoon) season of 2023 at Crop Research Farm Department of Agronomy. The treatments consisted of 3 levels of Nano urea (3,4,5 ml/l) and 3 level Zinc (0.3 %,0.5 %,0.7 %) along with recommended doses of nitrogen and potash and a control (120-60-40kg N-P-K/ha). The experiment was laid out in a Randomized Block Design with 10 treatments and replication thrice. Application of Nano urea at 4ml/l at 0.5% Zinc (Treatment 5) recorded highest plant height (226.71cm), no. of leaves (14.18), dry weight (104.67 g) and crop growth rate (5.926 g/m2/day), yield attributes and yield viz ., No. of cobs/plant (1.33), No. of grains / row (23.56), No. of rows / cob (13.900),seed index (23.10 g), grain yield (6.05 t/ha) and stover yield (8.99 t/ha) compared to control.

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Keywords: Maize; nano urea; zinc; yield attributes.

1. INTRODUCTION

Maize is one of the most important cereal crop after rice and wheat and occupies a prominent place in global agriculture. It ranks third after rice and wheat in India. Maize (*Zea mays* L.) also called as corn, is one of the most crucial and strategic crops in the world.Its origin is in Mexico (Central America) . It is called as queen of cereal due to it great importance in human, animal diet and high yielding ability. It efficiently utilizes solar energy and has immense potential for higher yield, so called as "Miracle Crop". The nutritional composition of maize (per 100 g) is as follows protein 4 g. 30 g carbohydrate, 3.5 g dietary fiber , 1.5 g fat , 3.6 g sugar , 4 mg calcium , 0.72 mg zinc etc. [1]. Every part of the maize plant has economic value (the grain, leaves, stalk, tassel, and cob) and all are used to produce a large variety of food and non-food products also there is concept on which focus of government of india goes behind i.e corn to, ethanol Presently, USA is the major exporter of maize and shifted 30% of its maize grains towards bio - fuel production to meet society's prospective hidden requirements. Corn is the most economical source of starch, comprising about 68-72% of kernel weight, which is easily converted into glucose and fermented into ethanol (ICAR).

nano urea has high nitrogen use efficiency and also it is environment friendly. This fertilizer is popularly known as "smart fertilizer" because it reduces the emission of nitrous oxide which is primarily responsible for contaminating soil, air and water bodies and also helps in reduction of global warming. Liquid nano fertilizer which is currently the best alternative to urea fertilizer. One bottle of nano urea (500 ml) is equivalent to a bag of urea fertilizer (45 kg), 10% lower than a bag of conventional urea. It can bring down the import of urea fertilizer. One nano urea liquid particle is 30 nano meters in diameter, with 10,000 times higher surface area to volume size than normal granular urea. Foliar application of nano urea liquid at critical crop growth stages of a plant effectively fulfills its nitrogen requirement and leads to higher crop productivity and quality in comparison to conventional urea [2].

zinc (Zn) is an essential micronutrient for plant growth, Zn input has received much less attention than nitrogen (N), phosphorus (P), or irrigation during the Green Revolution (Tilman et al.,2002; Mueller et al., 2012). Maize attainable yield reduction resulting from the lack of Zn application was assessed by these authors at the level of 10%. As well documented by plant physiologists, zinc exerts a great influence on basic plant life processes, such as (i) nitrogen metabolism – uptake of nitrogen and protein quality; (ii) photosynthesis chlorophyll synthesis, carbon anhydrase activity; (iii) resistance to abiotic and biotic stresses – protection against ox- idative damage [3,4]. Most research on soil and foliar application of zinc focused on alleviating its deficiencies, particularly on wheat and rice cultivated in semi- arid or arid regions of the world [3,4]. Maize was recognized by farmers for a long time as a crop of high response to zinc supply.

2. MATERIALS AND METHODS

The experiment was conducted during Kharif season of 2023 at Crop Research Farm, Department of Agronomy, SHUATS, Prayagraj (U.P). The soil of the experimental field was sandy loam in texture, nearly neutral in soil reaction (pH - 6.9), organic carbon (0.870%), available N (270.81 kg/ha), available P (11.5 kg/ha) and available K (215.9 kg/ha). The treatment consists of T1: Nano Urea 3 ml/l + Zinc 0.3 %, T2: Nano Urea 3 ml/l + Zinc 0.5 %, T3: Nano Urea 3 ml/l + Zinc 0.7 %, T4: Nano Urea 4 ml/l + Zinc 0.3%, T5: Nano Urea 4 ml/l + Zinc 0.5 %, T6: Nano Urea 4 ml/l + Zinc 0.7 %, T7: Nano Urea 5 ml/l + Zinc 0.3 %, T8: Nano Urea 5 ml/l + Zinc 0.5 %, T9: Nano Urea 5 ml/l + Zinc 0.7 %, T10: Control (RDF- N-P-K- 120-60-40 kg/ha).

The experiment was laid out in Randomized Block Design, with 10 treatments replicated thrice. One of the primary benefits of RBD in agriculture is its ability to increase the precision of treatment effect estimates. By accounting for variability among blocks that might otherwise confound the results, RBD allows researchers to isolate the effect of the treatment more effectively. The observations were recorded for plant height, plant dry weight, No. of cobs perplant, Number of rows/cob, Number of grains/row, Seed index(g), Grain yield (t/ha), Stover Yield (t/ha), Harvest Index (%).

The collected datawas subjected to statistical analysis by analysis of variance method. Kharif maize, were selected for sowing. Seeds are sowed of spacing (60 x 25 cm).

3. RESULTS AND DISSCUSSION

3.1 Growth Parameters

Plant height (cm): The data revealed that significantly higher plant height (226.71 cm) was recorded with application of Nano Urea 4 ml/l + Zinc 0.5 %. However, treatment 2 and 8 (211.83cm, 214.40cm respectively) were statistically at par with application of Nano Urea 4 ml/l + Zinc 0.5 %.

Foliar spray of Nano Urea at knee stage and tasselling stage could be an ideal technological alternative to achieve sustainability in irrigated maize [5] and significantly increased the plant height. Foliar nitrogen application through Nano - N resulted in notably greater plant heights in Oats [6]. Zinc help in synthesis of tryptophan which is a precursor of IAA, it also has an active role in the production of auxin, an essential growth hormone. Hence the plant height is maximum with optimum application of micronutrient and Nano urea. Similar result reported by Shahzad et al., (2012), Tahir et al., (2012), Samui et al. [5], Rajesh et al. [6].

Plant dry weight (g/plant): Significantly highest plant dry weight (104.67 g) was observed with application of Nano Urea 4 ml/l + Zinc 0.5 %, whereas treatment 8 (97.33 g) which was found to be statistically at par with Nano Urea 4 ml/l + Zinc 0.5 %.

Nitrogen and phosphorus application through RDF and foliar spray of urea and nano urea treatments increase plant height, stem girth, leaf: stem ratio which ultimately increase fodder yield of maize. The results are in corroborate with the finding of Tariq et al., Singh et al. and Meena et al. The highest forage yield obtained with nano urea foliar spray rates were in conformity with the findings of Abdel. Tariq et al., (2014) where there is foliar applied Zn increases the photosynthesis and chlorophyll production that ultimately increases the dry weight.

Crop growth rate (g/m2/day): The Significantly maximum CGR (5.926 g/m2/day) was recorded with application of Nano urea 4ml/l + Zinc 0.5% which was found to be statistically at par to all treatments

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The application of *Nano urea 4ml/l + Zinc 0.5%* resulted in higher crop growth rate, this might be due to increased chlorophyll production and photosynthesis which leads to higher biomass production. Hence ultimately increasing in crop growth rate. Similar finding was also reported by kumar et al*.,* (2019)

Relative growth rate (g/g/day): The maximum relative growth rate (0.0115 g/g/day) was recorded with application of *Nano Urea 4 ml/l + Zinc 0.5 %* which was found to be statistically at par to all treatments.

3.2 Yield Parameter

Number of cobs/plant: Application of (Nano Urea 4 ml/l + Zinc 0.5%) was recorded significantly higher number of cobs per plant (1.33) However, treatment no. 2, 3, 4, 5, 6, 7, 8, 9 (1.27, 1.20, 1.13, 1.33, 1.27, 1.27, 1.27, 1.20) was found to be statistically at par with the highest.

Number of rows/cob: Treatment-5 (Nano Urea 4 ml/l + Zinc 0.5%) was recorded significantly maximum Number of rows/cob (13.900). However, treatment no. 1 , 2, 8 (12.800, 13.700, 13.233) was found to be statisticallyat par with highest.

Number of grains/row: Treatment-5 (Nano Urea 4 ml/l + Zinc 0.5%) was recorded significantly maximum Number of grains/row ((23.56) which was superior over all other treatments. However, treatment no. 1 , 2, 8 (12.800, 13.700, 13.233) was found to be statistically at par with highest.

Seed index (g): Treatment-5 (Nano Urea 4 ml/l + Zinc 0.5%) was recorded significantlymaximum seed index (23.10 g) which was superior over all other treatments. However, treatments treatment 2, 3, 4, 5, 6, 7, 8, 9 (22.90g, 22.64g, 22.89g, 22.53g, 21.74g, 23.04g, 22.61g) was found to be statistically at par with Treatment-5(Nano Urea 4 ml/l + Zinc 0.5%).

Sharma et al.: investigated the effect of nitrogen levels on maize growth and yield in India. Found that increasing nitrogen application significantly increased grain yield and biomass production of maize. While the study did not specifically focus on seed index, the positive impact of nitrogen on overall yield suggests the potential for an indirect effect on seed characteristics. Nano urea has the potential to improve pollination and fertilization processes in maize. It can enhance pollen viability, germination, and pollen tube growth, leading to efficient fertilization and potentially resulting in improved seed set and seed index.

Table 1. Effect of Nano urea and Zinc on growth attributes of Kharif maize

Sl No.	Treatments	80 DAS		60-80 DAS	
		Plant height (cm)	Dry Weight (cm)	C.G.R(g/m2/day)	RGR(g/g/day)
1	Nano Urea 3 ml/l + Zinc 0.3 %	209.23	68.23	1.232	0.0033
2	Nano Urea 3 ml/l + Zinc 0.5 %	211.83	90.51	5.194	0.0115
3	Nano Urea 3 ml/l + Zinc 0.7 %	199.00	86.73	5.203	0.0107
4	Nano Urea 4 ml/l + Zinc 0.3 %	208.60	86.77	4.657	0.0107
5	Nano Urea 4 ml/l + Zinc 0.5 %	226.71	104.67	5.926	0.0115
6	Nano Urea 4 ml/l + Zinc 0.7 %	204.03	87.59	4.553	0.0103
7	Nano Urea 4 ml/l + Zinc 0.7 %	203.83	88.71	5.232	0.0117
8	Nano Urea 5 ml/l + Zinc 0.5 %	214.40	97.33	4.352	0.0088
9	Nano Urea 5 ml/l + Zinc 0.7 %	204.50	90.08	4.468	0.0099
10	Control- 120-60-40 kg NPK/ha (Farmer's Practice)	195.67	79.76	4.667	0.0080
	S.Em(±)	5.28	2.55	0.73	0.001
	CD (P= 0.05)	15.71	7.58	2.19	-

Table 2. Effect of Nano urea and Zinc on yield attribute of maize

S. No.	Treatments	No. of cobs/plant	No. of grains/cob	No. of rows/cob	Seed index (g)	Grain yield (t/ha)	Yield Stover (t/ha)	Harvest index (%)
1	Nano Urea 3 ml/l + Zinc 0.3 %	1.00	20.40	12.800	20.95	3.96	8.03	33.12
2	Nano Urea 3 ml/l + Zinc 0.5 %	1.27	22.67	13.700	22.90	5.92	8.89	39.92
3	Nano Urea 3 ml/l + Zinc 0.7 %	1.20	21.91	12.433	22.64	4.87	8.40	36.73
4	Nano Urea 4 ml/l + Zinc 0.3 %	1.13	22.13	12.467	22.89	4.74	8.44	35.83
5	Nano Urea 4 ml/l + Zinc 0.5 %	1.33	23.56	13.900	23.10	6.05	8.99	40.11
6	Nano Urea 4 ml/l + Zinc 0.7 %	1.27	23.54	12.700	22.53	5.62	8.86	38.89
7	Nano Urea 5 ml/l + Zinc 0.3 %	1.27	23.47	12.200	21.74	5.21	7.95	39.44
8	Nano Urea 5 ml/l + Zinc 0.5 %	1.27	23.51	13.233	23.04	5.73	8.63	39.87
9	Nano Urea 5 ml/l + Zinc 0.7 %	1.20	21.90	12.733	22.61	4.91	8.65	36.34
10	Control- 120-60-40 kg NPK/ha (Farmer's Practice)	1.00	20.34	12.200	19.91	3.28	7.07	31.60
S.Em(+)		0.06	0.82	0.37	0.64	0.33	0.35	1.83
CD (P= 0.05)		0.20	2.45	1.10	1.91	1.00	1.06	5.46

Table 3. Effect of Nano urea and zinc on economics of maize

S. No.	Treatments	Cost of cultivation (₹/ha)	Gross returns(₹/ha)	Net returns(₹/ha)	Benefit Cost Ratio(B:C)
1	Nano Urea 3 ml/l + Zinc 0.3 %	45189	103290	58101	1.29
2	Nano Urea 3 ml/l + Zinc 0.5 %	45265	136180	90915	2.01
3	Nano Urea 3 ml/l + Zinc 0.7 %	45341	114200	68859	1.52
4	Nano Urea 4 ml/l + Zinc 0.3 %	45414	111680	66266	1.46
5	Nano Urea 4 ml/l + Zinc 0.5 %	45490	138980	93490	2.06
6	Nano Urea 4 ml/l + Zinc 0.7 %	45566	130120	84554	1.86
7	Nano Urea 5 ml/l + Zinc 0.3 %	45639	120100	74461	1.63
8	Nano Urea 5 ml/l + Zinc 0.5 %	45715	131860	86145	1.88
9	Nano Urea 5 ml/l + Zinc 0.7 %	45791	115500	69709	1.52
10	Control- 120-60-40 kg NPK/ha (Farmer's Practice)	44400	90994	46594	1.05

Grain yield (t/ha): Treatment-5 (Nano Urea 4 ml/l + Zinc 0.5%) was recorded significantly maximum grain yield (6.05 t/ha) which was superior over all other treatments. However, treatments 2 , 6, 7, 8 (5.92 , 5.62 , 5.21 , 5.73t/ha respectively) was found to be statistically at par with Treatment-5(Nano Urea 4 ml/l + Zinc 0.5%).

Zinc availability may have increased meristematic cell activity and cell elongation, which in turn improved vegetative growth and eventually helped produce more dry matter . This improved dry matter production was further reflected in yield-attributing characteristics, and as a result, the yield of the crop under the current treatment was significantly higher. Similar result was reported by Imsong et al. [7].

Stover yield (t/ha): Treatment-5 (Nano Urea 4 ml/l + Zinc 0.5%) was recorded significantly maximum stover yield (8.99 t/ha) which was superior over all other treatments. However, all treatments was found to be statistically at par with Treatment-5(Nano Urea 4 ml/l + Zinc 0.5%).

The experiment was done on kharif maize the treatment combination of Zinc (15 kg/ha) along with nitrogen (150 kg/ha) recorded significantly higher stover yield (11.20 t/ha) [8].

Harvest index (%): Highest harvest index (40.11 %) was recorded with the application of Treatment No.- 5 (Nano Urea 4 ml/l + Zinc 0.5 %) whereas treatment 2, 3, 4, 5, 6, 7, 8 and 9 (39.92 % ,36.73 % , 35.83 % , 40.11 % , 38.89 %, 39.44 %, 39.87 %, 36.34 %) found to be statistically at par to all treatment [9].

3.3 Economics

The data on the economics of different treatments presented showed that the maximum gross return (₹ 138980 / ha) and net return (₹ 93490 / ha) wa s recorded with application of Nano Urea 4 ml/l + Zinc 0.5 % (treatment 5). However, maximum benefit-cost ratio was obtained in treatment 5 (2.06) due to low cost of cultivation. minimum was observed in control (₹ 90994 / ha) and net return (₹ 46594 / ha) was observed with application of Nano Urea 3 ml / l + Zinc 0.3 % (treatment 1) and lowest benefit-cost ratio (1.29) was recorded in treatment 1 (Nano Urea 3 ml/l + Zinc 0.3 %) [10,11].

4. CONCLUSION

Maize was recognized by farmers for a long time as a crop of high response to zinc supply. On the basis of one season experimentation, we can conclude that the cultivation of maize with Foliar spray of Nano Urea 4 ml/l + Zinc 0.5 % 30 DAS and 45 DAS was more desirable in terms of growth, yield and economics.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of manuscripts.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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