Original Research Article

"Influence of zinc and nano urea on growth and yield of maize (*Zea mays L.*)"

ABSTRACT

The field experiment entitled "Influence of zinc and nano urea on growth and yield of maize (*Zea mays L.*)" was conducted during Kharif season, 2022 at Crop Research Farm, Department of Agronomy, Naini Agriculture Institute, Sam Higginbottom University of Agriculture, Technology And Sciences, Prayagraj, Uttar Pradesh. The result showed that growth parameters *viz.* Plant height (195.01 cm), Dry weight (90.62 g), Number of grain per cob (476.79), Cob length (21.2 cm), Grain yield (4.33t/ha), Stover yield (6.65t/ha), were recorded significantly high with the application of Zinc 30 kg/ha + Nano urea 4ml/lt.

Keyword: Maize, zinc, nano urea, growth, yield.

Introduction

Maize is the world's most widely cultivated food crop providing ample food calories and protein for more than one thousand million human beings in the world. Maize is known as "Queen of cereals" because it has the highest genetic yield potential among the cereals. It ranks 3rd among the cereals in India after wheat and rice. The term corn refers as "to sustain life" that provides nutrients for human and animals worldwide. It is cultivated throughout the year in all the seasons and grown around the globe. The nutritional value of maize is high as it contains 72% starch, 10% protein, 8.5% fiber, 4.8% oil, 3.0% sugar and 1.7% ash. Comparatively maize gives more yield than the other cereals such as rice, wheat etc. It is an important staple food and also used as a fodder crop in India. Starch, cooking oil and gluten are also extracted from maize. The starch in maize can be hydrolysed and enzymatically treated to produce syrups, particularly high fructose corn syrup, a sweetener and also as fermented and distilled to produce grain alcohol. **(Rathore *et al*.2022).**

Globally, total area of maize amounts to 197 million hectares and production of 1210 million thousand tonnes in 2021. In India, maize is the third most important food crops after rice and wheat. According to advance estimate it is cultivated in an area of about 9.86 million hectares with production of 31.51 million tones and an average productivity of 3195 kg/ha which is the fifth largest producer in the world contributing three percent of the total global

production. Uttar Pradesh contributes an area of about 0.77 million hectares with 7.98% to all over India and production 1.80 million tones. (**GOI, 2021)**

In Indian soil zinc shortage issue. Zinc activates various enzymes, aids in the production of auxin, and boosts meristematic activity. The majority of research on this crop's nutrition has focused on major components, whereas micronutrients' importance is still largely disregarded. For the research community, nanoscience and nanotechnology constitute a new horizon. Utilizing the tiniest possible particles, nano fertilizer raises hopes for increasing agricultural yield by solving issues that cannot be resolved normally. When fertilizers are applied directly to the soil, nutrients are lost through a variety of processes, including photolysis, hydrolysis, leaching, and degradation. As a result, it's possible that the applied fertilizer won't be able to reach the intended locations in the plant's system and so won't be able to promote crops' best development and production. Thus, an effort was made to spray foliar fertilizer onto the crop in order to boost the effectiveness of applied fertilizer in the form of nano fertilizer **(Kumar *et al.* 2021)**.

Zinc plays a very important role in plant metabolism by influencing the activities of hydrogenase and carbonic anhydrase and stabilization of ribosomal proteins. Amongst crops, maize shows the high sensitivity to Zn deficiency for its physiological requirements. Zn activates the plant enzymes by carbohydrate metabolism, maintaining the integrity of cellular membranes, protein synthesis and regulation of auxin synthesis. It is essential for the synthesis of auxin because Zinc helps in tryptophan production, which is a precursor of Indole-3-acetic acid (IAA). Zn has apronounced effect on the important processes of plants like photosynthesis, protection against reactive oxygen species. Nitrogen metabolism, carbonic anhydrase activity, chlorophyll synthesis and resistance to biotic and abiotic stresses. Maize is one of the crops most sensitive to Zn deficiency. Zinc is a micronutrient which enhances the grain productivity in the maize production. The supply of Zn in the crops can be done directly on the soil, as fertilizers, via foliar fertilization or seed treatments The overall objective of the study was to assess the effect of zing as soil and foliar application on the growth and yield of maize. (**Kumar *et al.* 2019**).

Urea contributes about 82 per cent of the total fertilizer consumption in India and about 55 per cent of the total fertilizer nitrogen consumed in the world. Around 30-40 per cent of nitrogen from urea is utilized by plants and the rest gets wasted due to quick chemical

transformation as a result of leaching, volatilization, denitrification and run off, thereby low use efficiency.

Whereas, 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. **(Sahu *et al.* 2022)**. These properties make it a promising alternative over conventional urea, Micro-organism plays a vital role in fixing, solubilizing, mobilizing, recycling of macro and micro nutrients in an agricultural eco-system. Although, they are occurring naturally in soil but their population is generally insufficient to bring about the desired level of nutrient mobilization. **(Kanoj *et al*. 2022).** Keeping the above aspects in view, the present investigation entitled "Effect of different levels of zinc and nano urea application on growth and yield of Maize (*Zea mays L.*).

MATERIAL AND METHODS

The experiment was conducted during the *Kharif* season 2022, at the Crop Research Farm (CRF), Department of Agronomy, Naini Agricultural Institute, Sam Higginbottom University of Agriculture, Technology And Sciences, Prayagraj (U.P.) which is located at 25° 39' 42"N latitude, 81° 67 56" E longitude, and 98 m altitude above the mean sea level (MSL). The experiment was laid out in Randomised Block Design with ten treatments which are replicated thrice with three levels of application of Zinc 20, 25, 30 kg/ha and three levels of foliar application of Nano Urea 2, 3, 4ml/l and control. Treatment combinations are T1: Zinc (20kg/ha) + Nano Urea (2ml/l), T2: Zinc (20kg/ha) + Nano Urea (3ml/l), T3: Zinc (20kg/ha) + Nano Urea (4ml/l), T4: Zinc (25kg/ha) + Nano Urea (2ml/l), T5: Zinc (25kg/ha) + Nano Urea (3ml/l), T6: Zinc (25kg/ha) + Nano Urea (4ml/l), T7: Zinc (30kg/ha) + Nano Urea

(2ml/l), T8: Zinc (30kg/ha) + Nano Urea (3ml/l), T9: Zinc (30kg/ha) + Nano Urea (4ml/l), T10: Control (RDF 120-60-40 Kg/ha NPK) are used. The soil in the experimental area was sandy loam with pH (8.0), organic carbon (0.42%), available N (180.58 kg/ha), available P (15.54 kg/ha), and available K (198.67 kg/ha). Seeds are sown at a spacing of 60*25 cm to a seed rate of 25 kg/ha. The recommended dose of nitrogen (20 kg/ha), phosphorus (30 kg/ha) and potassium (60 kg/ha) were applied as basal dose just before sowing and Zinc and Nano urea (Foliar spray at 35 and 55 DAS) were applied as per the treatments. Data recorded on different aspects of crop, viz., growth, yield attributes were subjected to statistically analysed by analysis of variance method (Gomez and Gomez, 1976).

RESULT AND DISCUSSION

GROWTH ATTRIBUTES

Plant height(cm) The data revealed that significant and higher plant height (195.01cm) was observed in treatment 9 (Zinc 30 kg/ha + 4ml/l Nano Urea). However, treatment 8(30 kg/ha Zinc + 3ml/l Nano Urea), was found to be statistically at par with treatment 9 (30 kg/ha Zinc + 4ml/l Nano Urea) in (table 1). Significant and higher plant height was observed with application of Nano urea (4 ml/l) might be due to increasing dose of nano urea increase cell division, cell metabolism and growth of cells. Similar results was reported by **Singh *et al.* (2019)**. Further, significantly higher plant height was observed with application of Zinc (30kg/ha) it may be due to zinc is an activator of plant nutrients and plays an important role in growth and metabolism of microorganisms, where Zinc element is present in the enzyme system as co-factor and mental activator of many enzymes, and this improvement in plant height. Similar findings was also reported by **Vankatakrishnan *et al.* (2003).**

Plant Dry weight (g) The data revealed that significantly higher plant dry weight (90.62 g) was observed in treatment 9(Zinc 30kg/ha + Nano Urea 4ml/l). However, treatment 8(Zinc 30kg/ha + Nano Urea 3ml/l) was found to be statistically at par with treatment 9(Zinc 30kg/ha + Nano Urea 4ml/l) in (table 1). Significant and higher plant dry weight was observed with application of Zinc (30kg/ha) may be due to micronutrient helps to activate the synthesis of tryptophan and precursor of IAA which is responsible to stimulation of plant growth and accumulation of biomass and micronutrient being a component of ferredoxin and electron transport are also associated with chloroplast which acceleration in photosynthesis is

evident for the better vegetative growth, resulted in higher plant dry weight. Similarly, findings were also reported by **Singh *et al.* (2017)**

YIELD ATTRIBUTES

Number of grains/cobs: The data revealed that in treatment 9 (Zinc 30 kg/ha + Nano Urea 4 ml/l) recorded significant highest number of grain/cob (476.79). However, treatment 8(Zinc 30 kg/ha + Nano Urea 3 ml/l), treatment 6 (Zinc 25 kg/ha + Nano Urea 4 ml/l) was found to be statistically at par with treatment 9(Zinc 30kg/ha + Nano Urea 4ml/l) in (table 2). Significant and higher number of grains/cob was obtained with the application of zinc (30kg/ha) might be due to the increased fertilizers application could be attributed to the increased physiological processes in crop plant leading to higher growth and increased photosynthates to silk. The similar findings were reported by **Kumar *et al.* (2007).**

Length of cob (cm): The data revealed that in treatment 9 (Zinc 30 kg/ha + Nano Urea 4 ml/l) recorded significant highest length of cob (21.1 cm). However, treatment 8(Zinc 30 kg/ha + Nano Urea 3 ml/l), treatment 6 (Zinc 25 kg/ha + Nano Urea 4 ml/l) was found to be statistically at par with treatment 9(Zinc 30kg/ha + Nano Urea 4ml/l) in (table 2). Significant and higher length of cob was observed with the application of Zinc(30kg/ha) might be due to higher chlorophyll contents and photosynthetic activity, synthesis of metabolites and regulate growth substances oxidation and metabolic activities. These similar findings were reported **by Meena *et al*. (2013).**

Grain yield (t/ha): The data revealed that in treatment 9 (Zinc 30 kg/ha + Nano Urea 4 ml/l) recorded significant highest number of grain yield (4.33 t/ha). However, treatment 8(Zinc 30 kg/ha + Nano Urea 3 ml/l), treatment 6 (Zinc 25 kg/ha + Nano Urea 4 ml/l) was found to be statistically at par with treatment 9(Zinc 30kg/ha + Nano Urea 4ml/l) in (table 2). Significant and higher grain yield was with nano urea (4ml/l) which might be due to because

of increasing growth of plant parts and metabolic process such as photosynthesis leads to higher photosynthates accumulation and translocation to the economic parts of the plant. The similar findings were reported by **Kumar *et al.* (2020)** in rice crop. Further application of Zinc (30kg/ha) may be due to the improved physiology of plant with the add Zn consequently correction the efficiency of different enzymes, chlorophyll content, IAA hormone and improvement in nitrate conversion to ammonia in plant leading to higher yield. The similar findings were reported by **Firdous *et al*. (2018).**

Stover yield (t/ha): The data revealed that in treatment 9 (Zinc 30 kg/ha + Nano Urea 4 ml/l) recorded significant highest stover yield (6.65 t/ha). However, treatment 8(Zinc 30 kg/ha + Nano Urea 3 ml/l), treatment 6 (Zinc 25 kg/ha + Nano Urea 4 ml/l) was found to be statistically at par with treatment 9(Zinc 30kg/ha + Nano Urea 4ml/l) in (table 2). Significant and higher seed yield was obtained with the application of Zinc (30kg/ha) might be due to zinc plays an important role in biosynthesis of the IAA and initiation of primordial for reproductive parts and a result of favourable effect on the metabolic reactions within the plants. Similar result was reported by ***Malve et al.* (2014)** in sorghum crop. Further, higher stover yield was obtained with application of Nano Urea (4ml/l) might be due to nano fertilizer quick absorption by the plant and easiness of translocation, which aided in better rates of photosynthesis. Similar result was reported by ***Khalil et al.* (2019)** in rice crop**.**

CONCLUSION

It can be concluded that in Maize with the application of Zinc 30 kg/ha along with the application of Nano urea 4ml/l. (Treatment 9) was observed highest grain yield and benefit cost ratio.

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Table 1 Effect of Different Levels of Zinc and Foliar Application of Nano urea on Dry Weight (g) of Maize.

S.no.	Treatment combinations	Plant height (cm)	Plant dry weight (g)
1.	Zinc 20kg/ha + Nano urea 2ml/l	177.88	79.67
2.	Zinc 20kg/ha + Nano urea 3ml/l	181.65	84.03
3.	Zinc 20kg/ha + Nano urea 4ml/l	177.98	81.59
4.	Zinc 25kg/ha + Nano urea 2ml/l	186.61	84.88
5.	Zinc 25kg/ha + Nano urea 3ml/l	189.63	87.25
6.	Zinc 25kg/ha + Nano urea 4ml/l	178.07	82.40
7.	Zinc 30kg/ha + Nano urea 2ml/l	186.93	85.66
8.	Zinc 30kg/ha + Nano urea 3ml/l	193.96	88.65
9.	Zinc 30kg/ha + Nano urea 4ml/l	195.01	90.62
10.	Control (120:60:40 NPK kg/ha)	163.08	77.47
	F test	S	S
	SEm(±)	7.64	2.46
	CD (p=0.05)	16.05	7.33

Table 2. Effect of different levels of zinc and foliar application of nano urea on yield attributes of maize.

S.No.	Treatment combination	No. of cob/ plant	No. of grains /cob	Length of Cob (cm)	Seed Index (g)	Grain Yield (t/ha)	Stover yield (t/ha)	Harvest Index (%)
1.	Zinc 20kg/ha + Nano urea 2ml/l	1.7	348.82	16.2	21.50	3.18	6.13	34.13
2.	Zinc 20kg/ha + Nano urea 3ml/l	1.7	367.94	16.4	21.61	3.19	6.18	33.60
3.	Zinc 20kg/ha + Nano urea 4ml/l	1.8	377.49	17.5	21.75	3.20	6.20	34.01
4.	Zinc 25kg/ha + Nano urea 2ml/l	1.8	409.76	17.6	22.28	3.24	6.21	34.24
5.	Zinc 25kg/ha + Nano urea 3ml/l	1.9	423.23	18.0	22.65	3.39	6.46	34.17
6.	Zinc 25kg/ha + Nano urea 4ml/l	2.0	443.25	19.0	23.16	3.54	6.49	35.20
7.	Zinc 30kg/ha + Nano urea 2ml/l	1.8	422.40	17.9	22.29	3.27	6.35	34.00
8.	Zinc 30kg/ha + Nano urea 3ml/l	2.2	443.95	20.6	23.89	4.18	6.51	39.00
9.	Zinc 30kg/ha + Nano urea 4ml/l	1.9	476.79	21.2	25.03	4.33	6.65	39.41
10.	Control (RDF 120:60:40 NPK kg/ha)	1.7	338.66	14.3	19.78	3.16	5.96	34.69
	F test	NS	S	S	NS	S	S	NS
	SEm (±)	0.11	11.67	0.49	1.006	0.26	0.12	1.94
	CD (p=0.05)	-	34.69	1.45	-	0.78	0.38	-