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Effects of Conventional and Nano Fertilizers on Growth and Yield of Maize (*Zea mays* L.)

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ABSTRACT

Background: In the current global landscape, agriculture is heavily reliant on synthetic fertilisers, which places stress on the soil and plant environment. The greatest alternative is nano fertilisers. As a result, the following research was completed.

Methods: In 2021, a pot experiment was conducted at Annamalai Nagar, Faculty of Agriculture, Annamalai University, to investigate the effects of conventional and nano fertilizer on maize growth and yield (*Zea mays* L.). To analyse maize crop development and yield qualities, the experiment was set up in a Completely randomized block design (CRBD) with two factors and ten treatments: Factor A nano zinc and zinc EDTA and Factor B combined application of nano nitrogen with conventional fertilizers.

Result: In our investigation results was concluded that combined application 50% N through urea + 50% N through nano urea combined with nano Zn substantially increases plant height 195.80 cm, LAI 1.95, dry matter production 15013 kg ha^{-1}, number of grains cob^{-1} 496, garin yield 8926 kgs ha^{-1}, stover yield 12094 kgs ha^{-1} and harvest index 42.46.

Key words: Nano nitrogen, Nano zinc, RDN, Zinc EDTA.

INTRODUCTION

Maize is one of India's most important rainfed crops and it is used for both feed and food. It has the largest production potential, which is affected by various biotic and abiotic variables such as nutrients, weeds, pests and diseases. Small and marginal farmers cultivate most of the crops, accounting for 80% of total farmers. Zinc is a requisite element for both plants and animals and it is involved in a variety of metabolic processes in plants. It activates enzymes and lipids and protein, carbohydrate and nucleic acid metabolism (Tahmasebi *et al.,* 2002). There is a zinc deficiency concern in practically all of India's soils. Zinc is involved in manufacturing growth factors like auxins, which help plants create more cells and dry matter (Ram Prosad Nandi *et al.,* 2020). In crop production, nitrogen is the most dominant yield-limiting nutrient. Chemical nitrogen fertilizer is one of the most used methods for increasing production. However, colossal nitrogen fertilizer applications in the 1990s contributed to a severe deterioration of air, soil and water quality and there is a substantial risk of nitrogen losses through numerous channels (Ju *et al.,* 2009). The objective of agricultural researchers is to achieve sustainable agriculture with higher yields while maintaining society's health. As a result, experts seek better alternatives to chemical fertilizers, which have long been vilified due to their adverse effects on the environment and the quality of agricultural products. Nanotechnology is a branch of science that focuses on the specific features of materials that emerge from nano matrices, intending to improve food sector engineering and energy conservation. Agriculture nanotechnology applications are increasingly altering the potential for increasing agricultural output. Nanomaterials are materials with a single unit size of one to 100 nanometers in at least one dimension (Liu and Lal 2015). Nano fertilizers are slow-release fertilizers that are good alternatives to traditional fertilizers for supplying nutrients to the soil gradually and in a regulated manner. The essential stages of crop establishment must be managed to design effective nitrogen control procedures. To eliminate losses due to volatilization, leaching and runoff, timely foliar application of nano fertilizers boosts crop output while lowering environmental risk (Rathanayaka *et al.,* 2018). Therefore, this research aims to evaluate the nano nitrogen and nano zinc on the growth and yield of maize.

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MATERIALS AND METHODS

The pot experiment was conducted at the Department of Agronomy, Faculty of Agriculture, Annamalai University, Chidambaram during the Kuruvai 2021 crop season (June - September). Ankur Adithya Maize Hybrid was the variety

chosen for the experiment. Clay loam soil was obtained from the farm and used to fill the pots. For each pot, two seeds were sowed at a depth of 4cm. The experiment included 30 pots and three replications. The experiment was laid out in completely randomized block design (CRBD) with two factors and ten treatments *viz*. Factor A, A_1 - Nano Zn, A_2 - Zn EDTA Factor B B_1 - 100% N through urea, B_2 - 100% N through Nano urea, B_3 - 25% N through urea + 75% N through Nano urea, B_4 - 50% N through urea + 50 % N through Nano urea and B_5 - 75% N through urea + 25% N through Nano urea.

Methodology

The zinc EDTA was applied to the pots @ 25 kgs ha^{-1} and the Nano Zinc was applied 2 ml lit^{-1} at two split doses *viz* first spray at Knee Height stage second spray at tasseling stage and it was applied as foliar spray The basal dosage of conventional urea was administered according to the treatment schedule. The IFFCO nano urea was used as foliar spray and the size of nano urea particle size is 20-50 nm. The spray solution was prepared for the top dressing was applied using @ 2 ml lit^{-1} was applied in two split doses, the first at the knee height stage and the second at the tasseling stage.

Data observations

Experimental readings were taken at 20, 40, 60 and 80 days after sowing (DAS) growth factors like plant height, LAI, dry matter production. At the harvesting time, the grain yield and stover yield were recorded.

RESULTS AND DISCUSSION

Growth Attributes

Among all the treatments, the treatment supplemented with 50% N through urea+50% N through Nano urea coupled with Nano Zn (Table 1) showed a significant effect on plant height (Fig 1). This may be due to Nano fertilizers can release the nutrients in the controlled form to enhance the nutrient use efficiency while preventing the nutrient ions from either getting fixed or lost to the environment (Subramanian *et al.,* 2008).

The treatment of 50% N through urea + 50% N through Nano urea combined with Nano Zn enhanced the Leaf Area Index (Table 1). Applying Nano urea directly to the plant lowers volatilization. It allows the nutrient to be absorbed quickly by the plant tissues. The residual nutrient is stored in the plant parts and maybe utilized slowly when needed. Nano Zn application can reduce plant stress and the gradual release of nutrients can result in mineral sequestration, leading to an increase in LAI (Broos *et al.,* 2007).

Application of 50% N through urea and 50% N through Nano urea in combination with Nano Zn increased maize dry matter yield. The treatment with Nano Urea and Nano Zn yielded the maximum dry matter yield. This is due to the use of Nano fertilisers as foliar sprays, which boosts the absorption rate and aids in forming high dry matter.

Table 1: Interaction effects of nano urea and nano Zn on growth attributes.

Treatments	Plant height (cm)	LAI	Dry matter production (kg ha^{-1})
$A_1 B_1$	181.78^{d}	1.67^{d}	13300^{d}
$A_1 B_2$	189.56^{b}	1.85^{b}	13895^{b}
$A_1 B_3$	185.67^{c}	1.76^{c}	13589^{c}
$A_1 B_4$	195.80^{a}	1.95^{a}	15013^{a}
$A_1 B_5$	191.91^{b}	1.86^{b}	14286^{b}
$A_2 B_1$	164.14^{h}	1.30^{h}	12104^{h}
$A_2 B_2$	171.22^{f}	1.48^{f}	12658^{f}
$A_2 B_3$	168.03^{g}	1.39^{g}	12385^{g}
$A_2 B_4$	178.29^{e}	1.58^{e}	12987^{e}
$A_2 B_5$	175.11^{f}	1.50^{f}	12714^{f}
LSD	2.89	0.08	263

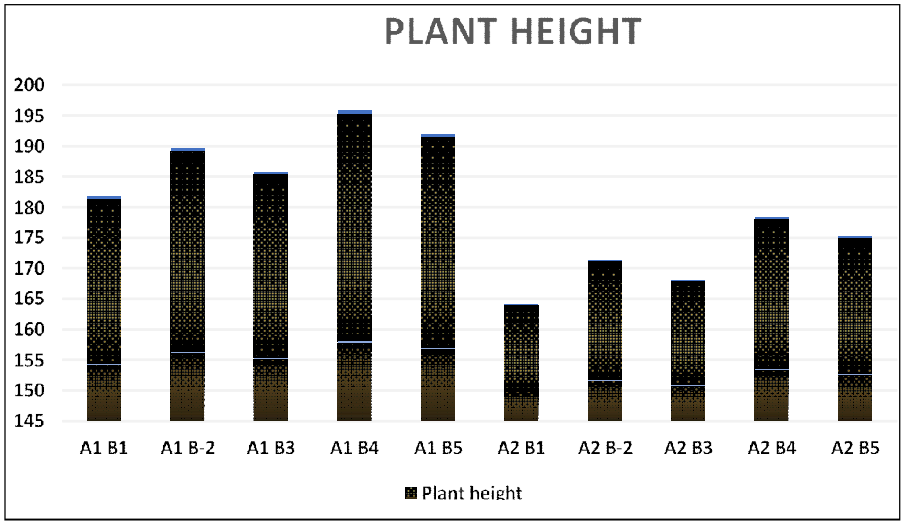

Fig 1: Effect of plant height as influenced by nano urea and nano Zn.

Similar findings were observed Liu and Liao (2008), Zunejo *et al.,* (2012).

Yield and Yield attributes

The application of 50% N through urea+50% N through Nano urea combined with Nano Zn substantially impacted the number of grains per cob (Table 2). Compared to conventional urea and Zinc EDTA, it has a wide surface area and the capacity to synchronise nitrogen release, increasing the number of grains in the cob. Similar findings were reported by Manikandan and Subramanian (2016), Dvivedi *et al.,* (2016).

Maize grain yields differed considerably when 50% N was provided by urea and 50% N was provided by Nano urea in combination with Nano Zn (Table 2). Nano fertilizers in conjunction with traditional fertilizers improve nutrient absorption efficiency. It boosts photosynthesis and nutrient translocation, increasing productivity and grain output.

The application of % N through urea+% N through Nano urea combined with Nano Zn resulted in maize yields (Table 2). Nanoparticles less than 5 nm in the cuticles of leaves can enter through stomatal pores and move through vascular systems, affecting the efficacy of nanoparticles by affecting chemical composition and shape, which can lead to biological yield. Similar findings were reported by Varshney *et al.,* (2018), Talan *et al.,* (2018).

The Harvest Index of maize was distinguished by applying % N *via* urea + % N via Nano urea in combination with Nano Zn (Table 2). This is due to the safekeeping of non-required nutrient materials at a given time instant and releasing them in a need-based manner through gradient diffusion and hormonal controls, which reduce the stress load on the plant and soil, resulting in a higher biological and economic yield, resulting in the highest Harvest Index. Fig 2. depicts that the sequential application of nano urea and nano zinc as foliar applications as increased yield while also maintaining harvest index due to increased nutrient use efficiency.

Table 2: Interaction effects of nano urea and nano Zn on yield attributes.

Treatments	Number of grains cob^{-1}	Grain yield (kg ha^{-1})	Stover yield (kg ha^{-1})	Harvest index (%)
$A_1 B_1$	418^{d}	7789^{d}	10808^{d}	41.88^{d}
$A_1 B\text{-}_2$	461^{b}	8496^{b}	11588^{b}	42.30^{b}
$A_1 B_3$	440^{c}	8098^{c}	11198^{c}	41.97^{c}
$A_1 B_4$	496^{a}	8926^{a}	12094^{a}	42.46^{a}
$A_1 B_5$	475^{b}	8528^{b}	11614^{b}	42.34^{b}
$A_2 B_1$	321^{h}	6350^{h}	8942^{h}	41.52^{h}
$A_2 B\text{-}_2$	365^{f}	7025^{f}	9848^{f}	41.63^{f}
$A_2 B_3$	343^{g}	6698^{g}	9416^{g}	41.57^{g}
$A_2 B_4$	397^{e}	7468^{e}	10389^{e}	41.82^{e}
$A_2 B_5$	378^{f}	7114^{f}	9956^{f}	41.68^{f}
LSD	16.32	276.08	377.24	-

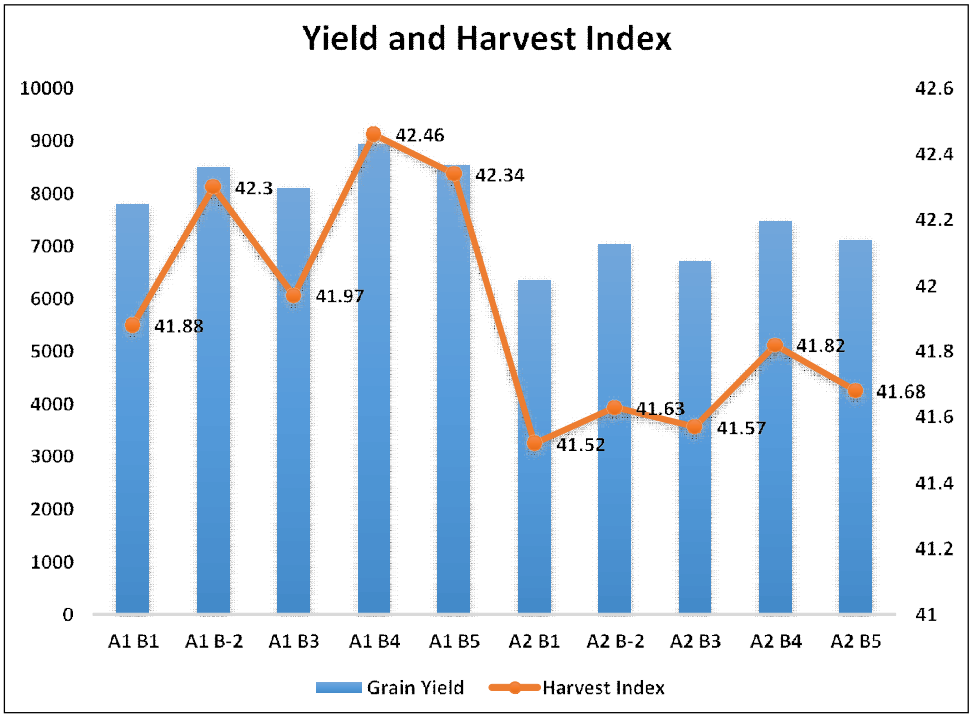

Fig 2: Interaction effect of yield and harvest index as influenced by nano urea and nano Zn.

CONCLUSION

Because of the increased availability of macro and micronutrients to the plants, conventional urea with Nano Urea and Nano Zn significantly improved plant growth and yield factors in maize crops. As a result, current agricultural research is focusing heavily on Nano fertilizers as an alternative to chemical fertilizers, allowing for a more environmentally friendly approach in agriculture.

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