



Determining the Effect of Nitrogen and Zinc on Growth and Yield of Maize (*Zea mays* L.)

Patil Rajvardhan Mahadev ^{a++*}, Vikram Singh ^{a#}
and Shruti Grace George ^{at}

^a Department of Agronomy, Naini Agricultural Institute, SHUATS, Prayagraj, Uttar Pradesh, India.

Authors' contributions

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

Article Information

DOI: <https://doi.org/10.9734/jeai/2024/v46i82687>

Open Peer Review History:

This journal follows the Advanced Open Peer Review policy. Identity of the Reviewers, Editor(s) and additional Reviewers, peer review comments, different versions of the manuscript, comments of the editors, etc are available here: <https://www.sdiarticle5.com/review-history/118272>

Original Research Article

Received: 02/05/2024

Accepted: 04/07/2024

Published: 17/07/2024

ABSTRACT

A field experiment was conducted during Kharif (rainy) season of 2023 at Crop Research Farm Department of Agronomy. The treatments consisted of 3 Nitrogen (100kg/ha + 120kg/ha + 140kg/ha) and Zinc Sulphate (ZnSO₄) (15kg/ha + 20kg/ha + 25kg/ha) along with recommended doses of Nitrogen, phosphorus and potash and a control (120-60-40 kg N-P-K/ha). The experiment was laid out in a Randomized Block Design with 10 treatments and replication thrice. Apply of a Nitrogen and zinc sulphate in treatment recorded highest plant height (182.4 cm), maximum plant dry weight (98.81 gm), Number of cobs per plant (3.3), Number of seed per cob (466.45), Seed index (27.20), seed yield (5.05), stover yield (23.2).

⁺⁺ M.Sc. Scholar;

[#] Associate Professor;

[†] Ph. D. Scholar;

*Corresponding author: E-mail: rajvardhanpatil1612@gmail.com;

Cite as: Mahadev, Patil Rajvardhan, Vikram Singh, and Shruti Grace George. 2024. "Determining the Effect of Nitrogen and Zinc on Growth and Yield of Maize (*Zea Mays* L.)". *Journal of Experimental Agriculture International* 46 (8):143-47. <https://doi.org/10.9734/jeai/2024/v46i82687>.

Keywords: Nitrogen; zinc; growth; yield; maize.

1. 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. [1].

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” [2]. “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 [3].

“Nitrogen is vital for crops because it is a major constituent of chlorophyll, the compound by which plants use sunlight energy to produce sugars from water and carbon dioxide that is photosynthesis. It is correspondingly a major factor of amino acids, the building blocks of proteins. Lacking proteins, plants wither and die. The main nutrients are required for plant growth are nitrogen (N), phosphorus (P), and potassium (K) and the use of nitrogen fertilizer outcomes in improved crop production costs and atmospheric pollution. Numerous plant particles such as amino acids, chlorophyll, nucleic acids, ATP and phytohormones, that contains nitrogen as a basic

part, are required to complete the biological processes, involving carbon and nitrogen metabolisms, photosynthesis and protein production. Nitrogen application is more important than the other major important fertilizers/nutrients for successful crop production” [4].

Maize is nitro positive and needs ample quantity of nitrogen for its better production. It is, therefore, imperative to use an optimum amount of N through a suitable and efficient source. Nitrogen plays a very significant role in crop development because it is not only an integral part of structural and functional proteins, chlorophyll and nucleic acids (RNA and DNA) but also it is very essential for the proper utilization of carbohydrates. Nitrogenous fertilizer is the major source of nitrogen supply the crop. “The beneficial effects of nitrogen on crop production are well documented however, nitrogen mining by crops for optimum productivity widely vary on account of different agro-climates, soils, cultivars, management practices and other factors” [5]. The response of nitrogen application depends on moisture supply and the quantity of the nitrogen applied in the soil. Maize has maximum nitrogen use efficiency of about 50 per cent, but under poor management, its efficiency varies between 30 to 40 per cent [6].

“In the plant system, zinc is important for several enzymatic and physiological processes. Additionally, many enzymatic reactions are activated by zinc, which is a key nutrient in the construction of several enzymes like alcohol dehydrogenase, carbonic anhydrase, and superoxide dismutase. Zinc is also necessary for the synthesis of enzymes in plants. Plants enzymes activated by Zn are involved in carbohydrate metabolism, and regulation of auxin synthesis and pollen formation. Zn seems to affect the capacity for water uptake and transport in plants and also reduce the adverse effects of short periods of heat and salt stress. As Zn is required for the synthesis of tryptophan which is a precursor of IAA, it also has an active role in the production of an essential growth hormone auxin” (Alloway, 2008).

2. MATERIALS AND METHODS

A field experiment was conducted during *Kharif-2023* at Crop Research Farm, Department of Agronomy, SHUATS, Prayagraj (U.P). The soil of

the experimental plot was sandy loam in texture, nearly neutral in soil reaction (pH 7.1), organic carbon (0.36%), available N (171.48 kg/ha), available P (15.2 kg/ha) and available K (232.5 kg/ha). The treatments consisting of three levels of Nitrogen viz. 100,120,140 kg/ha and zinc viz. 15,20,25 kg/ha. The experiment was laid out in Randomized Block Design with ten treatments each replicated thrice. The treatment combinations treatment 1 - Nitrogen 100 kg/ha + Zinc 15 kg/ha 2 Nitrogen 100 kg/ha + Zinc 20 kg/ha, treatment 3- Nitrogen 100 kg/ha + Zinc 25 kg/ha, treatment 4 - Nitrogen 120 kg/ha + Zinc 15 kg/ha, treatment 5 - Nitrogen 120 kg/ha + Zinc 20 kg/ha, treatment 6 - Nitrogen 120 kg/ha + Zinc 25 kg/ha, treatment 7 - Nitrogen 140 kg/ha + Zinc 15 kg/ha, treatment 8 - Nitrogen 140 kg/ha + Zinc 20 kg/ha, treatment 9 - Nitrogen 140 kg/ha + Zinc 25 kg/ha, treatment 10 - Control (RDF-120,60,40 kg/ha). The growth parameters and yield, production was recorded at harvest from randomly selected plants in each plot. The data was computed and analysed by following statistical method of Gomez and Gomez (1984).

3. RESULTS AND DISCUSSION

3.1 Growth Parameters

3.1.1 Plant height (cm)

The data revealed that, significantly higher plant height (182 cm) was recorded with the application of 140 kg/ha Nitrogen + 25 kg/ha Zinc, Significant and higher Further, significantly higher plant height was observed with application of nitrogen on plant growth, which results in a progressive increase in internode length and a steady increase in plant height, may be the cause of the height increase observed after applying nitrogen fertilizer. According to Bbukvic et al. (2003), similar results were obtained.

The application of zinc fertilizer levels increase of total nitrogen uptake induced by zinc application. Similar finding were reported by Alloway, 2004.

Zinc is involved in the protein synthesis and bio synthesis of indole 3- acetic acid, involved cell division and cell elongation increased in plant height. Similar finding were reported by Patel, 1997.

3.1.2 Plant dry weight (g)

The data observed that, significantly the maximum dry matter accumulation (98.81 g) was

recorded with treatment 140 kg/ha Nitrogen + 25 kg/ha zinc, Significant and higher plant dry weight was observed with application of Zinc (25 kg/ha) may be due Significant and higher plant dry weight was observed with application of both nitrogen and zinc fertilizers increased the photosynthesis, which ultimately enhanced the dry matter production of plant. The similar findings were reported by Raju et al., 1997 and Cakmak et al., 1998. Zinc (25 kg/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. [7].

3.2 Yield & Yield Attributes

1. Number of cob/plants: The data revealed that, maximum head diameter (3.3) was recorded with the treatment of application of Nitrogen 140 kg/ha + ZnSO₄ 25 kg/ha) Though there was significant difference among the treatments [8,9].

2. Number of grain/cobs: The data revealed that, Significantly Maximum no. of grain/cob (29.60) was recorded with the treatment of application of 140 kg/ha Nitrogen + 25 kg/ha zinc. Significant and higher number of grains/cob was obtained with the application of zinc (30kg/ha) might be due to the Significant and higher number of grains/cob was obtained with the application of zinc (30kg/ha) might be due to the improved physiological processes in crop plants that result in higher growth and increased photosynthates to silk may be the cause of the increased fertilizer application. The similar findings were reported by Kumar et al. (2007). Significant and higher length of cob was observed with the application of Zinc(30kg/ha) might be due to increased levels of chlorophyll and photosynthetic activity, metabolite production, and control the oxidation and metabolism of growth chemicals. These similar findings were reported by Meena et al. [5].

3. Seed Index (g): At harvest, highest seed index (27.20) was observed in treatment 140 kg/ha Nitrogen + 25 kg/ha Zinc though there was no significant difference among the treatments [10].

Table 1. Effect of different levels of nitrogen and zinc on yield attributes of maize

S.No.	Treatment combination	Plant Height(cm)	Plant Dry Weight(g)	No. of Cob/Plant	No. of grain /cob	Seed Index (g)	Grain Yield (t/ha)
1.	Nitrogen 100 kg/ha + ZnSO415 kg/ha	168.3	87.55	2.2	20.93	23.72	3.70
2.	Nitrogen 100 kg/ha + ZnSO420 kg/ha	164.8	87.48	2.2	22.00	22.87	3.37
3.	Nitrogen 100 kg/ha + ZnSO425 kg/ha	165.3	90.47	2.3	22.43	22.00	3.40
4.	Nitrogen 120 kg/ha + ZnSO4 15 kg/ha	171.7	91.46	2.5	23.40	23.76	3.70
5.	Nitrogen 120 kg/ha + ZnSO4 20 kg/ha	177.7	94.80	3.0	24.20	24.78	4.53
6.	Nitrogen 120 kg/ha + ZnSO4 25 kg/ha	178.0	96.45	3.1	26.20	26.70	4.78
7.	Nitrogen 140 kg/ha + ZnSO415 kg/ha	175.4	93.94	2.7	27.60	24.40	4.37
8.	Nitrogen 140 kg/ha + ZnSO4 20 kg/ha	173.7	91.79	2.7	29.00	24.32	4.13
9.	Nitrogen 140 kg/ha + ZnSO4 25 kg/ha	182.4	98.81	3.3	29.60	27.20	5.05
10.	CONTROL NPK, 120:60:40 kg/ha	153.1	78.92	2.1	23.00	20.79	3.16
	F test	S	S	S	S	NS	S
	SEm (±)	1.17	3.77	0.23	1.02	1.81	0.29
	CD (p=0.05)	15.05	7.93	0.28	2.14	-	0.62

4. Grain yield (t/ha): Significant and higher grain yield was obtained with application of Zinc (30kg/ha) may be due to the obtained with application of nitrogen, may be due which supplied more rapidly and synthesized carbohydrates it ultimately increase in grain productivity. The similar findings were reported by Ashoub et al., 1996.

4. CONCLUSION

It can be concluded that in Maize with the application of Nitrogen 140 kg/ha along with the application of Zinc 25 kg/ha. (Treatment 9) was observed highest grain yield and benefit costratio.

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.

ACKNOWLEDGEMENT

I express my gratitude to my advisor Dr. Vikram Singh and all the faculty members of the Department of Agronomy, Naini Agricultural

Institute, Prayagraj, Sam Higginbottom University of Agriculture Technology and sciences, (U.P) India for providing necessary facilities to undertaken the studies.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

- Rathore R, Hasan A, David AA, Thomas T, Reddy IS, David A, Reddy S. Effect of different levels of nano urea and conventional fertilizer on soil health of maize (*Zea mays* L.) Var, P3544 in an Inceptisols of Prayagraj, (UP) India. *Pharma Innov.* 2022;11(8):560-563.
- Debbarma V. Influence of potassium and zinc on growth, yield and economics of cluster bean (*Cyamopsis tetragonoloba* L.). *International Journal of Plant & Soil Science.* 2023;13(35):9.
- GOI. Agricultural Statistics at al. Glance, Agricultural Statistics Division, Directorate of Economics and

- Statistics, Department of Agriculture and Cooperation, Ministry of Agriculture, Government of India, New Delhi; 2021.
4. Singh A, Meena NL. Effect of nitrogen and sulphur on growth, yield attributes and seed yield of mustard (*Brassica juncea*) in eastern plains of Rajasthan. Indian journal of Agronomy. 2004;49(3): 186-188
 5. Meena SK, Mundra SL, Singh P. Response of maize (*Zea mays*) to nitrogen and zinc fertilization. Indian Journal of Agronomy. 2013;58(1):127-128.
 6. Faujdar RS, Sharma M. Effect of FYM, bio fertilizers and zinc on nitrogen uptake by maize crop. An Asian Journal of Soil Science. 2015;10(1):125-129.
 7. Singh G, Kumar R, Kumar S. Effect of tillage and nitrogen levels on growth and yield of maize (*Zea mays* L.). Annals of Agricultural Research. 2006;27(2):198-199.
 8. Sabhajeet S, Kumar JP, Rakesh P, Rakesh K, Kumar P, Anupma Kumari & Prakash P. Effect of nitrogen and sulphur levels on yield, economics and quality of QPM hybrids under dry land condition of Eastern Uttar Pradesh, India. Journal of Agricultural Science. 2012;4(9):31-38.
 9. Jain D, Kumar A, Dwarka, Singh O, Jain SK, Patel R. Response of Fertility Levels and Biofertilizers on Growth and Yield Attributes Quality of Chickpea (*Cicer arietinum* L.) Crop. Asian Journal of Soil Science and Plant Nutrition. 2024;10(2): 358–365. Available:<https://doi.org/10.9734/ajsspn/2024/v10i2293>
 10. Asif M, Tunc CE, Yazici MA, Tutus Y, Rehman R, Rehman A, Ozturk L. Effect of predicted climate change on growth and yield performance of wheat under varied nitrogen and zinc supply. Plant and soil. 2019;434:231-44.

Disclaimer/Publisher's Note: The statements, opinions and data contained in all publications are solely those of the individual author(s) and contributor(s) and not of the publisher and/or the editor(s). This publisher and/or the editor(s) disclaim responsibility for any injury to people or property resulting from any ideas, methods, instructions or products referred to in the content.

© Copyright (2024): Author(s). The licensee is the journal publisher. This is an Open Access article distributed under the terms of the Creative Commons Attribution License (<http://creativecommons.org/licenses/by/4.0>), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

Peer-review history:

The peer review history for this paper can be accessed here:

<https://www.sdiarticle5.com/review-history/118272>