Original Research Article ……….

International Journal of Agricultural Invention

(online available at www.agriinventionjournal.com)

***International Journal of Agricultural Invention* 10(1): 267-271: June, 2025**

ISSN: 2456 – 1797 (P)

Effect of nitrogen and zinc management on nutrient content of Maize (*Zea mays* L.)

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ARTICLE INFO

Original Research Article
Received on May 17, 2025
Revised on May 22, 2025
Accepted on June 15, 2025
Published on June 19, 2025

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PUBLICATION INFO
International Journal of Agricultural Invention (IJAI)
RNI: UPENG/2016/70091
ISSN: 2456-1797 (P)
Vol.: 10, **Issue:** 1, **Pages:** 267-271
Journal Homepage URL
http://agriinventionjournal.com/
DOI: 10.46492/IJAI/2025.10.1.38

ABSTRACT

A field experiment was conducted during Kharif season of 2024 at the Agronomy Instructional Farm, Rajasthan College of Agriculture, Udaipur, Rajasthan to evaluate to the effect of nitrogen and zinc management on nutrient content in maize (*Zea mays* L.). The experiment followed a factorial randomized block design with 12 treatment combinations involving three of nitrogen management levels (100 % RDN through urea, 50% RDN through urea + two foliar spray of nano urea and 33.3% RDN through urea + two foliar spray of nano urea) and four of zinc management levels (Control, soil application at 25 kg ZnSO4 ha-1, foliar spray of 0.5% ZnSO4 and foliar spray of 0.5 % nano zinc). The results revealed that the combined application of 100 % RDN through urea + soil application at 25 kg ZnSO4 ha-1 significantly enhanced nitrogen, phosphorus, potassium and zinc content in grain as well as stover.

KEYWORDS

Maize, Nitrogen, Zinc, RDN, Grain, Stover, Nutrient Content

HOW TO CITE THIS ARTICLE

Sagar, D. S., Chaplot, P. C., Verma, A., Jain, D., Babu, R. (2025) Effect of nitrogen and zinc management on nutrient content of Maize (*Zea mays* L.), *International Journal of Agricultural Invention,* 10(1): 267-271. DOI: 10.46492/IJAI/2025.10.1.38

Maize (*Zea mays* L.) is a crucial staple crop that ranks third after wheat and rice, especially in tropical and subtropical regions. It is referred to as the "Queen of cereals" because it has a higher genetic production potential compared to other cereal crops (Kannan *et al*., 2013). It belongs to the family Poaceae, popularly known as 'Makki' or 'Makka' and it is also a cross-pollinated crop. It is grown all around the world and throughout the year in all seasons. Maize has a high nutritional value with 72 percent starch, 10 per cent protein, 8.5 percent fiber, 4.8 percent oil, 3.0 percent sugar, and 1.7 percent ash content (Ninama *et al*., 2023).

It fulfills about 15 percent of the global protein and 20 percent of the global calories requirement of the human population, indicating its importance in human nutrition. It is also one of the popular dual-purpose crops, grown widely for grain as well as for fodder in India. Maize gives higher fodder productivity even in a shorter period than any other cereal fodder crop. Besides this, being a day-neutral crop, it can be grown in any season. Maize is the most suitable crop among forage crops for fodder as well as silage because of its high-yielding ability and excellent nutritional profile.

Globally, maize is considered an ideal fodder crop due to its rapid growth, succulence, palatability, and high quality. It is free from anti-nutritional factors and can be harvested at any stage of growth. In terms of world acreage, India next stands to U.S.A., Brazil, China and Mexico, while it ranks eleventh in the respect of production. Maize cultivation in India is mostly confined to the states of Karnataka, Madhya Pradesh, Bihar, Tamilnadu, Telangana, Andhra Pradesh, West Bengal, Rajasthan, Uttar Pradesh, Punjab, Haryana, Maharashtra, and Gujarat. Among mineral nutrition plays a pivotal role in crop development (Tisdale *et al*., 1990). It is an important nutrient for plant growth and is the most limiting nutrient in our soils. Nitrogen fertilization influences the dry matter yield by affecting growth and photosynthetic efficiency (Yadav *et al*., 2017). Nitrogen is an also an essential element for both quality and quantity as it is a component of protein and chlorophyll. It is thus essential for photosynthesis, vegetative and reproductive growth, and often determines the yield of forage maize, and it helps in increasing green forage and dry matter yield with higher crude protein and crude fiber content. Zinc is vital in the metabolism of plants, as it affects the function of enzymes such as hydrogenase and carbonic anhydrase, along with stabilizing ribosomal proteins (Tinsdale *et al*., 1984). It activates plant enzymes involved in carbohydrate metabolism, preserves the integrity of cell membranes, facilitates protein synthesis, and regulates auxin production (Marschner, 1995).

Materials and Methods

A field experiment was conducted during *Kharif* season of 2024 at the Agronomy Instructional Farm, Rajasthan College of Agriculture, MPUAT, Udaipur, Rajasthan which, is situated at 24°35' North latitude, 74°42′ East longitude and at an altitude of 581.13 metres above mean sea level. It falls under agro climatic zone IVa "Sub-Humid Southern Plain and Aravalli Hills" of Rajasthan. The soil of the site was clay loam, alkaline (pH 7.8) with medium organic carbon (0.53 %), low available nitrogen (302.53 kg ha^{-1}), medium phosphorus (23.18 kg ha^{-1}) and high potassium (372.25 kg ha^{-1}). The experiment was laid out in a factorial randomized block design (FRBD) with 3 replications, comprising 12 treatment combinations.

These treatments for experiment comprised combination of the three nitrogen management and zinc management. These treatments included three nitrogen management levels: A_1 (100 % recommended dose of nitrogen through urea), A_2 (50% RDN through urea + two foliar spray of nano urea), A_3 (33.3% RDN through urea + two foliar spray of nano urea) and four levels of zinc management: B_1 (Control), B_2 (Soil application at 25 kg $ZnSO_4$ ha^{-1}), B_3 (Foliar spray of 0.5% $ZnSO_4$) and B_4 (Foliar spray of 0.5 % nano zinc). The recommended fertilizer dose applied was 100: 40: 30 kg N: P_2O_5: K_2O per hectare. The maize variety used was PHM–3, which is medium maturing variety (84-88 days) and is well-suited for cultivation in drought-prone and rainfed areas of Rajasthan. The following methods were followed for determination of nutrient content of maize.

Nutrient Content

For estimation of nitrogen, phosphorus, potassium and zinc contents, representative the seed and stover. Samples were collected at harvest from each experimental unit. These samples were oven dried at $70^{O}C$ to a constant weight and grounded in laboratory mill for estimating nutrient content in grain and stover of maize. Nutrient content in grain and stover was estimated as per the method adopted for determination of nutrients content (table 1).

Table 1. Methods of analysis for nutrient content and quality parameters

S.N.	Nutrient	Method of Analysis
1.	Nitrogen	Nessler's reagent colorimeter method (Snell and Snell, 1949)
2.	Phosphorus	Ammonium vanadomalayaite yellow color method (Richards, 1968)
3.	Potassium	Flame photometer method (Jackson, 1973)
4.	Zinc	Atomic absorption spectrophotometer method (Lindsay and Norvell, 1978)

Results and Discussion

The application of nitrogen and zinc management significantly influenced nitrogen (N), phosphorus (P), potassium (K) and zinc (Zn) content in grain as well as stover of maize.

Nutrient Content

Among the nitrogen management levels (table 2 and 3), the application of 100% RDN through urea recorded the highest nutrient content – N (1.378 % grain, 0.483 % stover), P (0.478 % grain, 0.168 % stover), K (0.593 % grain, 1.713 % stover) and Zn (24.749 ppm grain, 22.027 ppm stover), which was significantly superior over application of 33.3% RDN though urea + two foliar spray of nano urea. The improvement can be attributed to the synergistic effects of 100 % RDN ensures sufficient nitrogen supply throughout critical growth stages, improving N use efficiency and promotes better kernel filling and grain content.

Among the zinc management levels (table 2 and 3) the application of Soil application of $ZnSO_4$ 25 kg ha^{-1} also significantly improved nutrient content. It recorded N (1.380 % grain, 0.487 % stover), P (0.480 % grain, 0.168 % stover), K (0.593 grain, 1.713 stover) and Zn (25.423 % grain, 22.626 % stover), which was significantly recorded superior as compared over control. Through the use of Soil application of $ZnSO_4$ 25 kg ha^{-1} provided readily soluble zinc, which improves zinc concentrations in roots, shoots and grains. Zinc is a cofactor in many enzymes responsible for protein synthesis and growth hormones and also enhanced nitrogen metabolism.

Table 2. Effect of nitrogen and zinc management on N, P, K and Zn content in grains of maize

Treatments	Nutrient Content (%)			
	Nitrogen	Phosphorus	Potassium	Zinc
Nitrogen Management				
100% RDN through Urea	1.378	0.478	0.593	24.749
50% RDN through Urea + two foliar spray of nano urea	1.362	0.467	0.583	24.593
33.3% RDN through Urea + two foliar spray of nano urea	1.349	0.465	0.568	24.292
SEm±	0.006	0.002	0.003	0.115
C.D.(P=0.05)	0.018	0.006	0.010	0.337
Zinc Management				
Control	1.347	0.456	0.574	23.806
Soil application of $ZnSO_4$ 25 kg ha^{-1}	1.380	0.480	0.593	25.423
Foliar spray of 0.5% $ZnSO_4$	1.370	0.475	0.580	24.655
Foliar spray of 0.5% Nano Zinc	1.355	0.469	0.579	24.295
SEm±	0.007	0.002	0.004	0.133
C.D. (P=0.05)	0.020	0.007	0.011	0.389

Table 3. Effect of nitrogen and zinc management on N, P, K and Zn content in stover of maize

Treatments	Nutrient Content (%)			
	Nitrogen	Phosphorus	Potassium	Zinc
Nitrogen Management				
100% RDN through Urea	0.483	0.168	1.713	22.027
50% RDN through Urea + two foliar spray of nano urea	0.478	0.164	1.684	21.887
33.3% RDN through Urea + two foliar spray of nano urea	0.473	0.163	1.641	21.620
SEm±	0.002	0.001	0.010	0.102
C.D. (P=0.05)	0.006	0.002	0.028	0.300
Zinc Management				
Control	0.468	0.160	1.657	21.187
Soil application of $ZnSO_4$ 25 kg ha^{-1}	0.487	0.168	1.713	22.626
Foliar spray of 0.5% $ZnSO_4$	0.480	0.167	1.676	21.943
Foliar spray of 0.5% Nano Zinc	0.478	0.164	1.672	21.623
SEm±	0.002	0.001	0.011	0.118
C.D.(P=0.05)	0.007	0.003	0.033	0.346

Similar findings were reported earlier by (Faujdar *et al*., 2014; Paramesh *et al*., 2014; Gohil *et al*., 2015; Almaz *et al*., 2017; Banotra *et al*., 2017; Chaudhary *et al*., 2017; Ranpariya *et al*., 2017; Kumar *et al*., 2018; Kamlakannan *et al*., 2019; Ahmed *et al*., 2020; Ahirwar *et al*., 2025; Dalal and Mahmoud, 2025).

Conclusion

The study revealed that nitrogen and zinc management significantly improved nitrogen, phosphorus, potassium and zinc content in maize. The combined application of 100 % RDN through urea + soil application at 25 kg $ZnSO_4$ ha^{-1} recorded the highest nutrient content in both grain and stover. These results highlights the synergistic effects between nitrogen and zinc improved enzyme activities and nutrient translocation, resulting in a higher accumulation of N, P, K and Zn content in grains as well as stover of maize. That indicated a more efficient nutrition use and ultimately supports higher yields and better grain nutritional quality. Therefore, effect of nitrogen and zinc management offer an effective and sustainable approach to improve N, P, K and Zn content in maize, thereby contributing to enhanced productivity, soil fertility and nutritional security.

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