



International Journal of Research in Agronomy

E-ISSN: 2618-0618
P-ISSN: 2618-060X
© Agronomy
NAAS Rating (2026): 5.20
www.agronomyjournals.com
2026; 9(9): 360-364
Received: 19-07-2026
Accepted: 23-08-2026

Naveen Kumar BT
Assistant Professor of Agronomy,
Livestock Research and
Information Centre
(Amrithmahal), Tiptur,
Karnataka, India

Shivkumar R
Associate Professor of Veterinary
Microbiology, College of
Veterinary, Hassan, Karnataka,
India

Anil
Assistant Professor of Animal
Nutrition, Livestock Research and
Information Centre
(Amrithmahal), Tiptur,
Karnataka, India

Corresponding Author:
Naveen Kumar BT
Assistant Professor of Agronomy,
Livestock Research and
Information Centre
(Amrithmahal), Tiptur,
Karnataka, India

Influences of nano-fertilizers on growth and yield of maize (*Zea mays* L.) in dryland situation of Karnataka

Naveen Kumar BT, Shivkumar R and Anil

DOI: <https://www.doi.org/10.33545/2618060X.2026.v9.i9e.6527>

Abstract

A field investigation was performed at the Livestock Research and Information Centre located in Konehalli, Tiptur during the Kharif growing season of 2024-25. The study employed a Randomized Complete Block Design framework with three replications across eight different treatment combinations. Results demonstrated that incorporating 50% of the standard recommended fertilizer dose combined with foliar treatments of nano urea at 4 ml/l and nano zinc at 2 ml/l applied at 30 days post-sowing, along with nano DAP at 4 ml/l and nano zinc at 2 ml/l at 45 days post-sowing (T₈), produced the most favorable outcomes. This optimal treatment achieved a plant stature of 180.83 cm, a leaf count of 16.33, accumulated dry mass of 346.63 g per plant, leaf area coefficient of 3.80, and a leaf-to-stem proportion of 0.64. Regarding output characteristics, this treatment yielded the highest values for grain quantity per ear (518.50), grain mass per ear (246.13 g), ear segment measurement (21.77 cm), and grain mass per unit weight (260.67 g), along with the most substantial grain production (59.03 q/ha), stem and leaf production (77.70 q/ha), and cumulative biomass generation (136.73 q/ha) when contrasted with the untreated comparison group. Performance metrics showed that this combination was statistically equivalent to treatment T₇. The investigation confirms that by utilizing nano-scale nutrient products in spray applications, producers can substantially curtail the quantity of synthetic nitrogen-based chemical fertilizer needed while concurrently preserving soil quality and reducing ecological harm. Under water-stressed agricultural settings, nano-nutrient applications proved instrumental in regulating physiological equilibrium and managing cellular oxidative damage while supporting mechanisms that enhance tolerance to inadequate water supply.

Keywords: Maize, nano urea, nano DAP, nano zinc, foliar application, yield

Introduction

Maize stands as one of the most adaptable and economically significant cereal crops cultivated across diverse geographical and climatic zones internationally. Its exceptional capacity to generate substantial quantities per unit area compared to other grain crops has earned it the designation 'Queen of Cereals' on the global stage. This crop serves multiple purposes for populations around the world, including nutritional consumption, animal feed supplementation, raw ingredients for industrial applications, and forage production. Worldwide production statistics indicate approximately 1.24 billion metric tonnes of this grain is harvested from roughly 205 million hectares, averaging around 6.01 tonnes per hectare across 170 nations (IIMR, 2025) ^[3]. This single crop accounts for more than one-third of the world's total grain production capacity.

Recent statistical data from India reveals remarkable expansion in maize production, with the 2025-26 season producing approximately 55.09 million metric tonnes. This represents an exceptional growth of about 11.68 million metric tonnes compared to the preceding year's output of 43.41 million metric tonnes, marking the most significant single-year increase observed in contemporary agricultural records. The nation's grain productivity per hectare has progressed substantially beyond the 3.19 tonne benchmark established in previous years, though it maintains distance from the international baseline of 5.5–5.6 tonnes per hectare. When assessed on a per-unit-area daily production calculation, Indian agricultural output compares favorably with output levels in technologically advanced nations. India maintains several strategic advantages including year-round production capability, competitive transportation expenses, well-developed infrastructure for seed propagation and commercial networks, and convenient accessibility to maritime shipping routes. Nonetheless, the domestic consumption requirements remain

substantial, resulting in limited grain exports relative to production volumes (IIMR, 2025) [3].

Traditionally, this crop was primarily cultivated during the monsoon months in the northern regions of the country. However, since the mid-1980s, the geographical distribution of cultivation has shifted markedly, with substantial acreage transfers occurring to the southern peninsula, which currently encompasses more than 40% of the national cultivation area and generates roughly half of the nation's total production. Concurrent with this transition, cultivation during the dry season has expanded into previously non-traditional regions including coastal Telangana, eastern provinces, and Bengal territories. Upland cultivation practices have also gained traction in the northwestern agricultural zones. Among Indian states, Madhya Pradesh now leads in both cultivated area (1.9 million hectares) and total production volumes, followed closely by Karnataka (1.56 million hectares), Maharashtra (1.08 million hectares), and other significant producing regions. Dry season grain cultivation is experiencing particularly rapid expansion in eastern provinces.

Contemporary utilization patterns demonstrate that approximately 47% of domestically produced grain finds application within animal feed formulations, with an additional 13% channeled for direct livestock consumption. Processing facilities for starch extraction account for roughly 14% of grain utilization. Traditional direct human consumption has diminished significantly to approximately 13%, though processed grain products have gained prominence, now comprising about 7% of national consumption. Specialty cultivars including sweet varieties, immature cob harvest, and popped kernels represent an emerging agricultural sector where production increasingly integrates with farmer-led business initiatives and value-added agricultural enterprises. Silage production and conservation methods are expanding rapidly. These specialized grain categories can effectively complement dairy production systems through integrated agricultural approaches. This cereal represents an optimal option for accomplishing governmental initiatives directed at enhancing farmer economic returns.

Within the state of Karnataka, approximately 1.47 million hectares are devoted to cultivation, generating approximately 53.6 lakh metric tonnes with an average production capacity of 3000 kg per hectare. Over the previous decade, cultivation expansion has outpaced that of competing crops and has progressively substituted traditional rain-dependent agricultural commodities including root vegetables, leaf crops, cotton, legume crops, and grain sorghum.

Most Indian cultivated lands experience inadequate nitrogen concentrations, particularly in granular-structured soil formations. Nitrogen qualifies as an indispensable nutrient essential for polypeptide construction, genetic material fabrication, plant hormone synthesis, and micronutrient production. This element constitutes the central component of chlorophyll pigmentation. Contemporary nanotechnology-derived fertilizers encompass substances generated through chemical transformation, physical separation, mechanical disintegration, and biological conversion methodologies employing either subdivision or assembly construction approaches. Nano-sized urea serves as a fundamental nitrogen delivery system supporting plant biomass development and ultimate productivity improvement. Strategically timed applications of nano-scale urea solutions efficiently fulfill crop nutritional demands. This formulation can function as an alternative to traditional chemical nitrogen fertilizers, providing advantages to environmental sustainability, economic farm viability, and terrestrial soil conservation. This product delivers

4% elemental mass in ultra-small particle configuration. The designation 'nano' derives from classical language signifying 'extremely diminished.' The quantitative description spans from one millionth of a millimeter to ten raised to the negative ninth power. Particles categorized as ultra-microscopic maintain proportions where at least one measurement falls below 100 nanometers. These minute substances demonstrate distinctive physicochemical characteristics including substantial area-to-volume proportions and behaviors at ultra-microscopic dimensions, facilitating broad-scale implementation (Kumar *et al.*, 2021) [6].

Micronutrient scarcity has emerged as a significant agricultural obstacle in contemporary times attributable to intensive land usage practices. Zinc ranks as the fourth-most significant constituent limiting productivity internationally, following nitrogen, phosphorous, and potassium. Scientific projections suggest that approximately 36.5% of Indian soil formations experience zinc depletion (Khardia *et al.*, 2022) [5]. Zinc functions in multiple essential physiological processes and molecular systems, playing crucial roles in hereditary material organization and metabolic enzyme functions. This nutrient participates in light-energy conversion mechanisms, protein assembly, cellular proliferation, cellular barrier preservation, microorganism protection, and reproductive activities through its influence on male reproductive cells, pollen characteristics, and female reproductive tissues (Jalal *et al.*, 2024) [4]. Taking these factors into account, the current research program was undertaken to examine the impact of nanoscale nutrient applications on biomass development and commodity generation of this staple grain crop under dry land production circumstances in a southern Indian state.

Materials and Methods

The experimental work was performed during Kharif 2024 at Livestock Research and Information Centre (Amrithmahal), Konehalli, Tiptur, Karnataka. This investigation focused on assessing the impact of nano-scale nutrient formulations on biomass generation and commodity yield of a grain crop. A complete randomized block experimental framework was employed, incorporating eight separate treatment regimens and three replicate blocks. Treatment protocols included: T₁ – No fertilizer input; T₂ - Full nutrient recommendation (100% RDF), T₃ - Fifty percent nutrient recommendation plus nano urea spray at 2 ml/liter applied at 30 days following planting and nano DAP spray at 2 ml/liter at 45 days following planting; T₄ - Fifty percent nutrient recommendation plus nano urea at 3 ml/liter and nano DAP at 3 ml/liter applied at the aforementioned intervals; T₅ - Fifty percent nutrient recommendation plus nano urea at 4 ml/liter and nano DAP at 4 ml/liter; T₆ - Fifty percent nutrient recommendation plus combined nano urea and nano zinc sprays (2 ml/liter each) at 30 days, and combined nano DAP and nano zinc (2 ml/liter each) at 45 days; T₇ - Fifty percent nutrient recommendation plus nano urea and nano zinc (3 ml/liter each) at 30 days and nano DAP with nano zinc (3 ml/liter each) at 45 days; T₈ - Fifty percent nutrient recommendation plus nano urea and nano zinc (4 ml/liter each) at 30 days and nano DAP with nano zinc (4 ml/liter each) at 45 days.

Baseline nutrient quantities consisted of 65 kg nitrogen, 40 kg phosphate, and 40 kg potassium per hectare. Phosphorus and potassium components were applied entirely at the planting stage. Nitrogen application was divided into two portions, with initial application at sowing and supplementary application at 30 days post-emergence. Nano-formulation sprays were administered according to individual treatment specifications. Grain variety

MAH-15-84 was planted on 25 July 2024 at a seeding rate of 50 kg per hectare using 60 cm row spacing and 30 cm inter-row spacing. Experimental measurements and observations underwent statistical processing using a split-plot structure with significance threshold established at 5%. Statistical evaluation methodology followed established agricultural research protocols (Panse and Sukhatme, 1985) ^[10].

Results and Discussion

Effect of foliar application on growth parameters

Data pertaining to plant architectural characteristics including stem length, foliage count, dry mass accumulation at crop maturity, light absorption efficiency index, and foliage-to-stalk proportion measured at 70 and 80 days post-establishment, respectively, were assessed in relation to nano-nutrient spray applications as documented in Table 1. The most advantageous treatment incorporating fifty percent standard nutrient dose with nano urea spray at 4 ml/liter and nano zinc at 2 ml/liter on day 30, followed by nano DAP at 4 ml/liter and nano zinc at 2 ml/liter on day 45, generated substantially superior stem dimensions (180.83 cm), enhanced foliage quantity (16.33), heightened dry mass compilation (346.63 g per plant), elevated light absorption coefficient (3.80), and increased foliage-to-stalk measurements (0.64) relative to untreated plants (146.83 cm, 11.67 leaves, 271.56 g per plant, 2.79, and 0.49, correspondingly). Statistical analysis demonstrated that this treatment performed equivalently to treatment T₇. The enhanced developmental characteristics may be attributable to nano-nutrient formulations facilitating protein assembly, nutrient activation processes, chemical conversion reactions, and carbohydrate metabolic pathways. Grain commodity generation and output efficiency of this crop increase through utilization of fertilizer combinations containing nitrogen and phosphorous constituents reported by Neogi and Das (2022) ^[9]. When mineral nutrient deficiencies occur, photosynthetic capacity diminishes significantly, culminating in compromised developmental indicators and diminished commodity generation. Augmented pigmentation density might have amplified solar energy interception, absorption efficiency, and utilization capacity, thereby strengthening photosynthetic efficiency which manifested in increased light absorption coefficients. Multiple research publications have documented that concurrent application of standard fertilizer recommendations alongside nano-scale nitrogen and nano-scale zinc spray applications demonstrated optimal results for augmenting development and productivity. Additional investigations by Manikanta *et al.* (2023) ^[7] established that developmental progression, commodity yield, and productivity-determining variables showed marked responsiveness to diversified nano-nutrient spray regimens. Additional findings suggest this enhancement may stem from nano-nutrient characteristics enabling rapid plant assimilation, potentially triggering increased photosynthetic rates and dry matter capital accumulation (Navya *et al.*, 2022) ^[8]. Corresponding conclusions were also demonstrated through additional independent investigations by Samui *et al.* (2022) ^[12], Sannathimmappa *et al.* (2022) ^[13], Singh *et al.* (2022) ^[14] and Reddy *et al.* (2022) ^[11].

Effect of foliar application on yield and yield parameters

Nano-nutrient spray applications generated substantial improvements across virtually all productivity-determining

characteristics of the grain crop (Table 2). Ear quantity per plant (1.62), grain frequency per ear (518.50), grain mass per ear (246.13), ear length measurement (21.77 cm), and individual seed mass (260.67g) demonstrated statistically significant elevation through application of the fifty percent standard nutrient regime combined with nano urea at 4 ml/liter and nano zinc at 2 ml/liter on day 30, plus nano DAP at 4 ml/liter and nano zinc at 2 ml/liter on day 45, compared to untreated comparison plants (1.00 ears per plant, 376.90 grains per ear, 171.55 g per ear, 15.90 cm ear length, and 124.67g individual seed mass, correspondingly). These enhancements in productivity-determining characteristics translated into statistically significant increases in commodity yield (59.03 q/ha) and stalk yield (77.70 q/ha) relative to untreated plants (35.33 q/ha and 50.75 q/ha, respectively), as documented in Table 3. These values were statistically indistinguishable from the treatment incorporating fifty percent standard nutrients with nano urea and nano zinc at 3 ml/liter on day 30 and nano DAP with nano zinc at 3 ml/liter on day 45 (1.62 ears per plant, 506.83 grains per ear, 244.54 g grain mass per ear, 21.20 cm ear extent, 252.33g seed mass, 56.17 q/ha commodity yield, and 73.07 q/ha stalk yield, correspondingly). The productivity and cumulative biomass augmentation resulted from enhanced nutrient supply accessibility and superior nutrient capital collection through nano-nutrient formula combinations. Nano-nutrient applications produced marked consequences for commodity generation. Investigation findings demonstrated that treatment combinations of fifty percent standard NPK supplemented with nano-scale urea and nano-scale zinc generated the most substantial productivity-determining variables and commodity yields. Comparable results were documented in alternative research. Further investigation by Al-Juthery *et al.* (2020). Dhawne *et al.* (2024) ^[2] documented that combined application of 50:50:50 kg NPK per hectare as baseline nutrition with nano urea spray at 3 ml/liter on days 20 and 40 post-emergence facilitated cellular elongation processes, stimulated meristematic tissue functions, promoted enzymatic activities, and augmented grain generation, thereby increasing ear segment measurements and aggregate grain quantities. Regarding cumulative biomass generation, nano-scale urea and nano-scale DAP spray applications demonstrated substantial effects on total biological productivity and harvest effectiveness (Table 3). Maximum cumulative biomass yield (136.73 q/ha) and productivity ratio (0.43) were documented with the treatment incorporating fifty percent standard fertilizer plus nano urea at 4 ml/liter and nano zinc at 2 ml/liter on day 30, plus nano DAP at 4 ml/liter and nano zinc at 2 ml/liter on day 45, surpassing untreated comparison plants (86.08 q/ha cumulative yield and 0.41 productivity ratio, correspondingly). The combined application of standard nutrients, nano urea, nano DAP, and nano zinc formulations possibly enhanced biochemical processes and metabolic transformations. This mechanism in progression stimulated cellular multiplication and elongation mechanisms, thereby improving the preponderance of vegetative developmental indicators. The availability of these components possibly simultaneously decreased stomatal impedance while enhancing stomatal accessibility, supplying the vegetation with sufficient carbon dioxide and moisture for sustaining photosynthetic mechanisms and extracting soil-based elements, ultimately increasing commodity yield (Al-Juthery *et al.*, 2020) ^[1].

Table 1: Influence of Nano fertilizers on growth parameters of maize at harvest

Treatment	Plant Height (cm)	No. of leaves	Dry matter accumulation (g plant ⁻¹)	LAI at 70 DAS	Leaf stem ratio at 80 DAS
T ₁	146.83	11.67	271.56	2.79	0.49
T ₂	149.91	12.00	287.20	3.15	0.53
T ₃	161.04	13.33	299.52	3.32	0.56
T ₄	161.95	13.67	334.83	3.39	0.57
T ₅	165.70	14.33	338.30	3.47	0.58
T ₆	174.97	14.67	342.47	3.60	0.61
T ₇	177.40	15.33	344.54	3.69	0.62
T ₈	180.83	16.33	346.63	3.80	0.64
S.Em.	1.43	0.38	5.15	0.04	0.012
CD @ 5%	4.32	1.54	15.68	0.14	0.036

Table 2: Influence of Nano fertilizers on yield parameters of maize at harvest

Treatment	Number of cob plant ⁻¹	No. of grain cob ⁻¹	Grain weight cob ⁻¹	Cob length (cm)	Test weight (g)
T ₁	1.00	376.90	171.55	15.90	124.67
T ₂	1.32	406.40	187.13	18.23	160.67
T ₃	1.34	452.63	199.51	19.00	166.33
T ₄	1.39	462.13	233.17	19.47	171.33
T ₅	1.50	461.83	238.30	19.80	192.67
T ₆	1.56	475.63	242.33	19.83	195.00
T ₇	1.60	506.83	244.54	21.20	252.33
T ₈	1.62	518.50	246.13	21.77	260.67
S.Em.	0.05	3.42	5.07	0.21	4.01
CD @ 5%	0.14	10.38	15.38	0.64	12.16

Table 3: Influence of Nano fertilizers on yield of maize at harvest

Treatment	Grain yield (q ha ⁻¹)	Stover yield (q ha ⁻¹)	Biological yield (q ha ⁻¹)	Harvest index (%)
T ₁	35.33	50.75	86.08	0.41
T ₂	41.70	57.47	99.17	0.42
T ₃	44.07	60.57	104.63	0.42
T ₄	46.60	63.10	109.70	0.42
T ₅	51.67	68.17	119.83	0.43
T ₆	52.50	69.00	121.50	0.43
T ₇	56.17	73.07	129.23	0.43
T ₈	59.03	77.70	136.73	0.43
S.Em.	1.15	1.13	1.20	0.005
CD @ 5%	3.48	3.42	6.06	0.015

Conclusion

The experimental findings substantiate that consistent application of nano-nutrient sprays comprising nano-scale urea, phosphate, and zinc components applied at 30 and 45 days post-establishment exerted substantial effects on plant development characteristics, productivity-determining variables, and commodity generation in grain cultivation. The treatment incorporating fifty percent standard nutrient allocation supplemented with nano urea spray at 3 ml/liter and nano zinc at 2 ml/liter on day 30, followed by nano DAP at 3 ml/liter and nano zinc at 2 ml/liter on day 45, generated commodity increases equivalent to forty percent elevation over untreated plants and stalk production increases corresponding to thirty-four percent improvement relative to control treatment conditions.

References

- Al-Juthery WA, Al-Maamouri EHO. Effect of urea and nano-nitrogen fertigation and foliar application of nano-boron and molybdenum on some growth and yield parameters of potato. QJAS Al-Qadisiyah Journal of Agricultural Sciences. 2020;1(1):253-263.
- Dhawne MN, Shamkuwar GR, Kalpande P, Madavi VP, Khan SF, Madavi SR. Influence of foliar application of nano urea on chemical, biochemical, yield and yield parameters in rice (*Oryza sativa* L.). Soils and Crops. 2024;34(1):141-145.
- Indian Institute of Maize Research. Annual report 2025. Indian Institute of Maize Research; 2025. p. 51-52.
- Jalal A, Júnior EF, Teixeira Filho MCM. Interaction of zinc mineral nutrition and plant growth-promoting bacteria in tropical agricultural systems: a review. Plants. 2024;13(5):571.
- Khardia N, Meena RH, Jat J, Sharma S, Kumawat H, Dhayal S. Soil properties influenced by the foliar application of nano fertilizer in maize (*Zea mays* L.) crop. International Journal of Plant and Soil Science. 2022;34(14):99-111.
- Kumar R, Singh RK, Panda A, Singh SK. Nano urea: an efficient tool for precision agriculture and sustainability. Vigyan Varta. 2021;2(9):72-74.
- Manikanta B, Channakeshava B, Mamatha B. Effect of nitrogen, copper and zinc liquid nano fertilizers on soil properties, nutrient concentration, uptake and nutrient use efficiency of crops. Mysore Journal of Agricultural Sciences. 2023;57(1):127-138.
- Navya K, Sai Kumar R, Krishna Chaitanya A, Sampath O. Effect of nano nitrogen in conjunction with urea on growth and yield of mustard (*Brassica juncea* L.) in Northern Telangana Zone. Biological Forum-An International Journal. 2022;14(3):95-99.
- Neogi S, Das SK. Effect of nitrogen and zinc in nano forms on growth and productivity of potato (*Solanum tuberosum* L.) in inceptisols. Journal of Crop and Weed. 2022;18(1):32-38.
- Panse VG, Sukhatme PV. Statistical methods for agricultural workers. New Delhi: Indian Council of Agricultural Research; 1985.
- Reddy BM, Elankavi S, Kumar MS, Sai MD, Vani BD. Effect of conventional and nano fertilizers on growth and yield of maize (*Zea mays* L.). Bhartiya Krishi Anusandhan Patrika. 2022. doi:10.18805/BKAP500.
- Samui S, Sagar L, Sankar T, Manohar A, Adhikari R. Growth and productivity of rabi maize as influenced by foliar application of urea and nano-urea. Crop Research. 2022;53(3):136-140.

13. Sannathimmappa HG, Patil M, Channagouda FR, Patil C. Effect of nano nitrogen and nano zinc nutrition on growth and yield of irrigated maize in southern transition zone of Karnataka. The Pharma Innovation Journal. 2022;12(1):1706-1709.
14. Singh BV, Singh S, Verma SK, Mishra T, Mohapatra S, Gupta SP. Effect of nano-nutrient on growth attributes, yield, Zn content and uptake in wheat (*Triticum aestivum* L.). International Journal of Environment and Climate Change. 2022;12(11):2028-2036.