Agric Res J **61** (1): 140-144, *February* 2024
DOI: 10.5958/2395-146X.2024.00020.5

ASSESSMENT OF VARYING LEVELS OF NITROGEN AND ZINC SULPHATE ON GROWTH AND YIELD OF WINTER BABY CORN (*Zea mays* L.)

Keerthi Vysyaraju, S P Singh, Sant Prasad and Ved Prakash*

Department of Agronomy, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi-221 005, India

Baby corn (*Zea mays* L.) is a recently introduced high-value crop in India, gaining popularity due to its rapid growth, short duration, and ability for year-round cultivation across diverse agro-climatic conditions. It refers to the de-husked, unfertilized young maize ear harvested with 2-3 cm long silk (Singh *et al.*, 2019a). The distinction between baby cob and baby corn lies in the presence or absence of husk and silk; baby cob includes the husk, silk, and corn, whereas baby corn refers to the corn without husk and silk (Hrudaya *et al.*, 2024). Notably, baby corn is highly nutritious and free from agrochemical residues, making it a safer choice compared to other popular vegetables. Additionally, its by-products, including tassels, cob husks, silks, and green stalks, are valuable as cattle feed (Yadav *et al.*, 2020).

Nitrogen, a crucial element, plays a pivotal role in various physiological functions such as cell division, amino acid and protein synthesis, nucleic acid formation, vitamin and hormone production, enzyme activity, and chlorophyll synthesis. Given its exhaustive nature, baby corn demands higher nitrogen levels during its peak growth period, making it a key determinant in achieving optimal plant growth and quality produce (Jakhar *et al.*, 2022; Neupane *et al.*, 2011; Singh *et al.*, 2019b). Increased nitrogen availability promotes protein synthesis and photosynthesis, facilitating rapid cell division and overall plant growth (Prakash, 2019).

Zinc, an essential micronutrient, acts as a cofactor for various enzymes involved in metabolic processes. It plays a vital role in oxidation processes within plant cells, carbohydrate and sugar transformation, cell division and elongation, photosynthesis, and nitrogen metabolism, thereby enhancing maize growth. Zinc deficiency poses a serious health concern in humans, which can potentially be addressed by increasing zinc content in edible parts like baby corn (Kumar *et al.*, 2017). To address these considerations, the present study aimed to evaluate the impact of nitrogen and zinc sulfate levels on the growth and yield of winter baby corn and explore potential interactions between these factors.

*Corresponding author: ved.prakash13@bhu.ac.in
Date of receipt: 20.09.2021, Date of acceptance: 18.01.2024

The investigation was conducted during the late winter season of 2021 at Rajiv Gandhi South Campus Research Farm, Mirzapur of Banaras Hindu University, Varanasi. The experimental site is situated in the Vindhyan region at 25.146 degrees north latitude and 82.569 degrees south longitude, with an altitude of 128.93 meters above mean sea level. The soil at the experimental site was sandy loam in texture, near-neutral in pH (6.74), with an electrical conductivity of 0.24 dSm^{-1} at 25°C. The available nutrient levels in the soil were measured as 163.12 kg ha^{-1} of nitrogen, 20.31 kg ha^{-1} of phosphorus, and 229.96 kg ha^{-1} of potassium.

A factorial experiment was designed using a randomized complete block design (RCBD), with two factors: nitrogen and zinc sulfate levels. Four levels of nitrogen (N0 – 0, N1 – 50, N2 – 100, and N3 – 150 kg ha^{-1}) and three levels of zinc sulfate (Z0 – 0, Z1 – 15, and Z2 – 25 kg ha^{-1}) were applied to assess their impact on the growth and productivity of winter baby corn. The experiment was replicated thrice. In the pot experiment, two water-soaked seeds (soaked for 72 hours) of the hybrid maize variety (Hira BSHM-21) were sown per pot. After germination, only one healthy plant per pot was retained. Fertilizer rates in the pots were adjusted to match field-based rates for either uniform or variable application as per treatment. Nitrogen doses were applied in three splits: half as a basal application and the remaining half equally divided and applied at knee-height and tasseling stage. Zinc sulfate levels were applied basally according to the treatments. Fertilizer sources included urea, single superphosphate, muriate of potash, and zinc sulfate. Irrigation was uniformly applied to each pot at appropriate intervals, and detasseling was performed uniformly across all treatments. The crop period experienced a rainfall of 1.9 mm. Standard agronomic practices were followed for the cultivation of the test crop.

Growth attributes: The data presented in Table 1 illustrates a significant enhancement in growth attributes, including plant height, number of leaves per plant, dry matter per plant (in grams), leaf area per plant (in square centimeters), and chlorophyll a and b content, with each increment in nitrogen levels from the control to 150 kg ha^{-1}. The provision of balanced and adequate nitrogen supply is associated with rapid cell division and elongation, which likely contributed to the favorable influence on the growth of baby corn (Neupane *et al.*, 2017a). Furthermore, the application of zinc sulfate up to 25 kg ha^{-1} resulted in a noticeable effect on growth attributes. Zinc plays a crucial role in auxin metabolism, leading to increased hormonal activity and growth at various crop stages (Kumar and Bohra, 2014).

Notably, the interaction between nitrogen and zinc levels had a significant impact on plant height at the harvest stage and leaf area per plant at 50 and 75 days after sowing (DAS). This suggests that the combined application of nitrogen and zinc influenced these growth attributes synergistically, potentially enhancing the overall growth and development of the baby corn plants.

The treatment combination of N_3Z_2 (150 kg N + 25 kg $ZnSO_4$ ha^{-1}) exhibited the highest plant height, distinctly superior to all other treatment combinations (Fig. 1a). Plant height was notably reduced in treatment combinations with lower levels of nitrogen and zinc sulfate, with the lowest values recorded in the control group (N_0Z_0). The combined application of nitrogen and zinc sulfate is known to enhance photosynthetic activity, physiological processes, plant metabolism, and ultimately, plant growth, by maintaining higher auxin levels (Tharaka *et al.*, 2021). Zinc is crucial for auxin formation, which regulates growth and stem elongation (Kumar *et al.*, 2018). Treatment combinations also showed distinct variations in leaf area per plant, with values nearly doubling at 75 days after sowing (DAS) compared to the previous stage at 50 DAS (Fig. 1b). Leaf area increased with higher doses of nitrogen and zinc in the respective treatment combinations, with the greatest response observed in N_3Z_2 (the highest levels). This phenomenon can be attributed to increased protein synthesis resulting from higher nitrogen rates, which induces vegetative growth and leads to an expansion of the photosynthetic surface, stimulating leaf length, width, and blade size (Jeet *et al.*, 2012).

The enhanced leaf area per plant is indicative of significant leaf expansion, higher cell division, and enlargement, contributing to improved vegetative growth due to zinc fertilization. Similar findings were reported by Tharaka *et al.* (2021) and Kumar *et al.* (2018).

Yield attributes and yield: The data presented in Table 2 indicates that all yield attributes and yields, including days taken to harvest the first baby cob, total harvest period, length, girth, weight, and yield of baby corn (in grams per plant), number of baby cobs per plant, cob weight and yield (in grams per plant), and fodder yield (in grams per plant), were significantly influenced by progressive increments in nitrogen application levels up to the highest rate (150 kg ha^{-1}). However, an increase in nitrogen levels up to the maximum caused a significant reduction in the number of days taken to harvest the first baby cob, resulting in an earlier harvest and a decreased total harvest period. The rapid growth stimulated by higher nitrogen fertilization likely played a significant role in enhancing photosynthate production and the uptake of other nutrients, leading to optimal growth and superior yield attributes. In most cereals, a greater assimilating surface during reproductive development results in an improvement in green cob formation due to the adequate production of metabolites

Table 1. Effect of varying levels of nitrogen and zinc sulphate on growth attributes of winter baby corn at harvest

Treatment	Plant height (cm)	Number of leaves plan^{t-1}	Dry matter plant^{-1} (g)	Leaf area plant^{-1} (cm^2)		Chlorophyll *a*		Chlorophyll b	
Nitrogen levels (kg ha^{-1})				**50 DAS**	**75 DAS**	**50 DAS**	**75 DAS**	**50 DAS**	**75 DAS**
N_0 -0	110.60	7.81	70.38	329.50	623.70	1.42	2.69	0.86	1.92
N_1 -50	121.30	8.13	76.84	341.60	640.40	1.56	2.74	0.94	1.97
N_2 -100	128.80	9.66	84.99	352.10	667.60	1.70	2.81	1.04	2.06
N_3 -150	139.40	10.87	92.58	365.80	692.60	1.83	2.87	1.15	2.16
SEm±	0.18	0.26	0.59	0.20	0.23	0.02	0.01	0.01	0.01
CD (P≤0.05)	0.53	0.77	1.73	0.59	0.67	0.06	0.02	0.02	0.03
Zinc sulphate levels (kg ha^{-1})									
Z_0 -0	122.20	8.92	78.91	344.10	648.5	1.57	2.76	0.97	2.01
Z_1 -15	124.80	9.01	81.20	347.00	655.9	1.63	2.77	0.99	2.02
Z_2 -25	128.00	9.43	83.48	350.60	663.8	1.67	2.80	1.03	2.06
SEm±	0.16	0.23	0.51	0.17	0.20	0.02	0.01	0.01	0.01
CD (P≤0.05)	0.46	0.66	1.49	0.52	0.58	0.05	0.02	0.02	0.03
Interaction	0.92	NS	NS	1.03	1.17	NS	NS	NS	NS

Table 2. Effect of varying levels of nitrogen and zinc sulphate on yield attributes and yields of winter baby corn

Treatment	First baby cob harvest (days)	Total harvest period (days)	Baby cobs plant^{-1}	Baby corn length (cm)	Baby corn girth (cm)	Baby cob weight (g)	Baby corn weight (g)	Baby cob yield (g plant^{-1})	Baby corn yield (g plant^{-1})	Baby cob: baby corn
Nitrogen levels (kg ha^{-1})										
N_0 -0	74.80	12.88	1.27	7.86	1.25	30.64	6.34	33.79	7.43	4.60
N_1 -50	73.59	10.78	1.38	8.68	1.51	33.09	6.77	44.19	10.01	4.81
N_2 -100	71.03	9.24	1.61	9.97	1.53	35.19	7.18	57.10	11.93	4.86
N_3 -150	67.36	7.92	2.16	10.47	1.69	38.44	7.83	82.72	17.05	4.87
SEm±	0.36	0.19	0.09	0.03	0.02	0.16	0.04	0.64	0.22	0.03
CD (P≤0.05)	1.05	0.55	0.27	0.07	0.05	0.46	0.11	1.87	0.64	NS
Zinc sulphate levels (kg ha^{-1})										
Z_0 -0	72.80	10.73	1.55	9.09	1.46	33.09	6.77	47.56	10.52	4.68
Z_1 -15	71.39	10.23	1.59	9.27	1.47	34.56	7.08	55.82	11.37	4.83
Z_2 -25	70.89	9.65	1.67	9.38	1.55	35.37	7.23	59.97	12.92	4.84
SEm±	0.31	0.16	0.08	0.02	0.02	0.14	0.03	0.55	0.18	0.02
CD (P≤0.05)	0.91	0.48	NS	0.06	0.04	0.40	0.09	1.63	0.55	NS
Interaction	NS	NS	NS	0.13	0.09	0.80	0.18	3.25	NS	NS

and their translocation towards the cob. Similar results were observed by Neupane *et al.* (2017b) and Kumar *et al.* (2015). Although baby cob to baby corn ratio remained statistically at par, the values improved with the use of nitrogen up to the highest level of 150 kg ha^{-1}. This suggests that nitrogen application contributed to a more favorable ratio of baby cob to baby corn, potentially enhancing overall yield and quality attributes.

Upon examining the data presented in Table 2, it becomes evident that increasing levels of zinc sulfate exerted a similar effect on the yield attributes and yields of baby corn as observed with nitrogen application. There was a reduction in the number of days required to harvest the first cob, accompanied by a considerable decrease in the total harvest period. Furthermore, all other yield attributes and yields were enhanced with the rise in zinc sulfate levels from 0 to 25 kg ha^{-1}. However, the application of 15 kg ha^{-1} (Z_1) and 25 kg ha^{-1} (Z_2) of zinc sulfate resulted in statistically similar outcomes. Yield, as an end product, is influenced by numerous yield attributes and physiological and morphological processes occurring in plants during growth and development. Zinc fertilization is known to have a beneficial effect on physiological processes, plant metabolism, and growth, ultimately leading to higher yields. The increase in baby cob and corn yield with the application of zinc has been previously reported by Kumar and Bohra (2014). Notably, the baby cob to baby corn ratio was not significantly influenced by zinc levels, suggesting that while zinc sulfate application enhanced overall yield attributes and yields, it did not significantly alter the ratio of baby cob to baby corn.

Nitrogen and zinc sulfate exhibited significant interaction regarding baby corn length, baby corn girth, baby cob and corn weight, and baby cob yield (Figure 2a, b, c, d, & e). The highest values for these yield attributes and yield were observed with the application of the treatment combination N_3Z_2 (150 kg N + 25 kg Zn ha^{-1}), while the lowest values were noticed with N0Z0 (no nitrogen and zinc sulfate). It is plausible that higher application rates of these nutrients enhanced the translocation of photosynthates, leading to improved growth and yield of baby corn. These findings are consistent with the results reported by various researchers studying baby corn, such as Mahdi *et al.* (2012), Kumar and Bohra (2014), and Singh *et al.* (2019b). This interaction between nitrogen and zinc sulfate highlights the importance of considering both nutrients in optimizing baby corn production, as their combined application can lead to synergistic effects on yield attributes and overall crop performance.

The study suggests that for achieving higher yields of late-sown winter baby corn, specifically the Hira BSHM-21 variety, along with its fodder, it is recommended to apply 150 kg of nitrogen per hectare along with 25 kg of zinc sulfate per hectare. This application should be supplemented with the recommended doses of phosphorus and potassium in the Vindhyan region, specifically in Mirzapur, Uttar Pradesh. By following these recommended nutrient application rates, farmers in the region can potentially optimize the growth,

Table 3. Interaction effect of nitrogen and zinc sulphate levels on plant height and leaf area

Treatments	Plant height (cm)			Leaf area plant^{-1} (cm^2) at 50 DAS					
	Harvest			50 DAS			75 DAS		
	Z_0 - 0	Z_1 - 15	Z_2 - 25	Z_0 - 0	Z_1 - 15	Z_2 - 25	Z_0 - 0	Z_1 - 15	Z_2 - 25
N_0 - 0	107.72	110.22	113.74	328.45	329.22	330.69	619.41	623.58	628.22
N_1 -50	118.31	122.1	123.57	338.11	341.97	344.75	631.4	638.47	651.22
N_2 -100	125.88	127.52	133.01	348.46	352.51	355.22	662.28	667.43	673.14
N_3 -150	136.72	139.84	141.844	361.22	364.39	350.62	681.03	694.17	702.55
SEm±		0.32			0.35			0.39	
CD (p≤0.05)		0.93			1.03			1.17	

N_0= No nitrogen, N_1= 50, N_2= 100, N_3= 150 and Z_0= No zinc, Z_1= 15, Z_2= 25 kg ha^{-1}

Table 4. Interaction effect of nitrogen and zinc sulphate levels on baby corn length, baby corn girth, baby cob weight, baby corn weight and baby cob yield

Treatments	Baby corn length (cm)			Baby corn girth (cm)			Baby cob weight (g)			Baby corn weight (g)			Baby cob yield (g plant^{-1})		
	Z_0-0	Z_1-15	Z_2-25	Z_0-0	Z_2-15	Z_2-25	Z_0-0	Z_1-15	Z_2-25	Z_0-0	Z_1-15	Z_2-25	Z_0-0	Z_1-15	Z_2-25
N_0 -0	7.66	7.88	8.03	1.17	1.22	1.36	28.43	31.47	32.02	5.89	6.54	6.58	31.32	32.65	37.39
N_1 -50	8.33	8.74	8.89	1.58	1.46	1.48	32.69	32.99	33.57	6.76	6.78	6.77	36.96	43.29	52.33
N_2 -100	9.94	9.96	10	1.49	1.53	1.57	33.95	35.31	36.32	6.83	7.14	7.56	47.32	61.21	62.78
N_3 -150	10.42	10.48	10.51	1.59	1.68	1.78	37.28	38.46	39.57	7.59	7.89	8.02	74.56	86.13	87.37
SEm±		0.04			0.03			0.27			0.06			1.11	
CD (p≤0.05)		0.12			0.09			0.81			0.18			3.25	

N_0= No nitrogen, N_1= 50, N_2= 100, N_3= 150 kg ha^{-1} and Z_0= No zinc, Z_1= 15 kg ha^{-1}, Z_2= 25 kg ha^{-1}

development, and yield of late-sown winter baby corn, thereby enhancing overall productivity and profitability of cultivation.

LITERATURE CITED

Hrudaya K, Singh S P, Prasad S and Prakash V 2024. Growth and yield of late sown winter baby corn (*Zea mays*) as influenced by NKP levels. *Indian J Agron* **60**(1): 50-53.

Jakhar B, Singh S P and Prakash V 2022. Response of integrated nitrogen management on winter baby corn's (*Zea mays* L.) growth, yield and economics. *J Appl Hortic* **24**(3): 345-48.

Jeet S, Singh J P, Kumar R, Prasad R K, Kumar P, Kumari A and Prakash P 2012. Effect of nitrogen and sulphur levels on yield, economics and quality of QPM hybrids under dryland condition of eastern Uttar Pradesh, India. *J Agric Sci* **4**(9): 31-38.

Kumar R and Bohra J S 2014. Effect of NPKS and Zn application on growth, yield, economics and quality of baby corn. *Arch Agron Soil Sci* **60**(9): 1193-1206.

Kumar R, Bohra J S, Kumawat N and Singh A K 2015. Fodder yield, nutrient uptake and quality of baby corn as influenced by NPKS and Zn fertilization. *Res Crops* **16**(2): 243-49.

Kumar R, Bohra J S, Kumawat N, Upadhyay P K and Singh A K 2018. Effect of balanced fertilization on production, quality, energy use efficiency of baby corn (*Zea mays*) and soil health. *Indian J Agric Sci* **88**(1): 28-34.

Kumar R, Kumawat N, Kumar S, Singh A K and Bohra J S 2017. Effect of NPKS and Zn fertilization on growth, yield and quality of baby corn-A Review. *Int J Curr Microbiol Appl Sci* **6**(3): 1392-1428.

Mahdi S S, Hasan B and Singh L 2012. Influence of seed rate, nitrogen and zinc on fodder maize (*Zea mays*) in temperate conditions of western Himalayas. *Indian J Agron* **57**(1): 85-88.

Neupane M P, Singh R K, Kumar R and Kumari A 2011. Response of baby corn (*Zea mays* L.) to nitrogen sources and row spacing. *Environ Ecol* **29**(3): 1176-79.

Neupane M P, Singh S P and Uppu S S 2017a. Response of baby corn genotypes to soil and foliar nitrogen application schedule. *Arch Agron Soil Sci* **63**(13): 1912-26.

Neupane M P, Singh S P, Sravan U S and Singh A 2017b. Effect of soil and foliar nitrogen application on growth, yield and quality of baby corn cultivars. *J Exp Agric Int* **16**(3): 1-11.

Prakash V 2019. Nitrogen use efficiency in baby corn - A Review. *Indian J Pure Appl Biosci* **7**(5): 547-56.

Singh M K, Singh S P and Singh B 2019a. Agro-techniques for baby corn production. **In**: M Hasanuzzaman (ed) Agronomic crops, Springer, Singapore. pp. 261-72.

Singh S P, Neupane M P, Sravan U S, Kumar S, Yadav T K and Choudhary S K 2019b. Nitrogen management in baby corn: A review. *Curr J Appl Sci Technol* **34**(5): 1-11.

Tharaka M, Ravi C K and Singh V 2021. Influence of nitrogen and zinc on growth and yield of baby corn (*Zea mays* L.). *Int J Plant Soil Sci* **33**(23): 64-70.

Yadav G S, Babu S and Das A 2020. Baby Corn–A New Venture of income to the farmers of Tripura. *Biotic Res Today* **2**(11): 1154-56.