International Journal of Advanced Biochemistry Research 2025; SP-9(9): 1710-1713

International Journal of Advanced Biochemistry Research

ISSN Print: 2617-4693
ISSN Online: 2617-4707
NAAS Rating (2025): 5.29
IJABR 2025; SP-9(9): 1710-1713
www.biochemjournal.com
Received: 09-06-2025
Accepted: 12-07-2025

Prakhar Kumar Sharma
Department of Horticulture, School of Agriculture, ITM University, Gwalior, Madhya Pradesh, India

Ranjith Reddy
Department of Horticulture, School of Agriculture, ITM University, Gwalior, Madhya Pradesh, India

Divya Pandey
Department of Horticulture, School of Agriculture, ITM University, Gwalior, Madhya Pradesh, India

Shipra Singh Parmar
Department of Horticulture, School of Agriculture, ITM University, Gwalior, Madhya Pradesh, India

Corresponding Author:
Ranjith Reddy
Department of Horticulture, School of Agriculture, ITM University, Gwalior, Madhya Pradesh, India

Effect of foliar feeding of nano zinc on the growth, yield and quality of cabbage

Prakhar Kumar Sharma, Ranjith Reddy, Divya Pandey and Shipra Singh Parmar

DOI: https://www.doi.org/10.33545/26174693.2025.v9.i9Sv.5753

Abstract
The present investigation entitled "Effect of foliar application of nano zinc on yield and quality of cabbage (*Brassica oleracea* var. *capitata* L.)" was conducted at Vegetable Research Farm (CRC-3), Department of Horticulture, ITM University, Gwalior (M.P.) during 2024-25. The experiment was laid out in Randomized Block Design with three replications comprising of nine treatments having nine level of nano zinc T_1: Nano Zinc - 20 ppm, T_2: Nano Zinc - 25 ppm, T_3: Nano Zinc - 30 ppm, T_4: Nano Zinc - 35 ppm, T_5: Nano Zinc - 40 ppm, T_6: Nano Zinc - 45 ppm, T_7: Nano Zinc - 50 ppm, T_8: Nano Zinc - 55 ppm and T_9: Control. The seeds of cabbage cv. Golden Acre were sown in the nursery beds on 12th September, 2024 and the seedlings were transplanted on 30th October, 2024. The plot size was 2 m × 1.5 m and a spacing of 60 cm × 45 cm was followed. The observations were recorded on days to 50% maturity, no. of non-wrappers leaves, plant spread in length (cm), head shape index, gross Weight (g), net Head Weight (g), stalk length (cm), harvest index (%), equatorial diameter of head (cm), polar diameter head (cm), core size (cm), head compactness, yield per plot (kg), yield per hectare (t), TSS (°Brix) and ascorbic acid (mg/100 g). The study clearly demonstrated that foliar application of nano zinc had a significant positive impact on the growth, yield and quality attributes of cabbage. Different concentrations of nano zinc influenced specific parameters with early maturity observed at 20 ppm in T_1, while maximum number of non-wrapper leaves (55 ppm-T_8), plant spread (40 ppm-T_5), head shape index and gross weight (25 ppm-T_2) and head dimensions (30 ppm-T_3) varied across treatments. Notably, treatment with 20 ppm in T_1 nano zinc recorded the highest net head weight, while 50 ppm in T_7 improved head compactness and ascorbic acid content. Yield performance was most pronounced at 35 ppm in T_4, resulting in the highest per plot and per hectare yield along with superior TSS.

Keywords: Cabbage, foliar, nano-zinc, yield and quality

Introduction
Cabbage (*Brassica oleracea* var. *capitata* L.), a member of the Cole crop group in the family Cruciferae (Brassicaceae), originated from the Mediterranean region and is cultivated worldwide. The wild cabbage (*Brassica oleracea* var. *sylvestris* L.) is considered the ancestral form of modern cabbage. This vegetable, important across many countries has a chromosome number of 2n = 18 and is believed to have originated from the eastern Mediterranean region and Asia Minor (Hazara *et al*., 2011). The edible part known as the "head" is formed by the compact layering of thick, overlapping leaves. In India, cabbage is predominantly grown in Uttar Pradesh, West Bengal, Gujarat, Odisha, Bihar, Assam, Maharashtra and Karnataka.
China, India, and Russia are the world's leading cabbage producers, with Russia also being the largest consumer. India ranks as the second-largest cabbage producer after China. In India, cabbage is cultivated on 442 thousand hectares, production 10,432 MT at an average yield of 23.60 tons per hectare. West Bengal leads in cabbage production within India followed by Odisha, Madhya Pradesh, Gujarat, Assam and Bihar (Anonymous, 2024) [1].
Cabbage is a herbaceous, biennial, dicotyledonous flowering plant with a short stem topped by a dense rosette of leaves. These leaves, typically green but sometimes red or purple in certain varieties, form a compact, globular cluster known as the cabbage head while still young.
Cabbage is consumed fresh as well as in processed form in different countries of the world. Each 100 g of fresh edible portion of cabbage contains moisture 91.9 g, protein 1.8 g, fat 0.1

g, minerals 0.6 g, fiber 1.0 g, others carbohydrates 4.6 g, calories 2.7 g, calcium 39 g, magnesium 10 mg, oxalic acid 3 mg, phosphorus 44.0 mg, Iron 0.8 mg, sodium 14.1 mg, potassium 144.0 mg, copper 0.08 mg, sulphur 67.0 mg, vitamin A, thiamine 0.6 mg, riboflavin 0.03 mg, nicotinic acid 0.4 mg and vitamin C 124 mg. The pleasant scent and sweet flavor of cabbage are linked to the presence of glucosinolates in their makeup. According to various sources, the overall glucosinolate content in white cabbage ranges from 1.05 to 70.56 µ mol/g dry weight.

Cabbage has anti- cancer properties; it protects against bowel cancer due to the presence of indole-3-carbinol. It was utilized in ancient times to treat maladies such as gout, diarrhea, stomach problems and hoarseness. The leaves were used to bandage sores and wounds. It is claimed to improve digestion. It contains a lot of ascorbic acid may also be used to make tasty pickle (sauerkraut), and salads. Cabbage has long been used for therapeutic purposes i.e. Coughs; fevers, gastric ulcers and skin disorders are all typical uses.

Nano fertilizers contain NPs capable of controlling the rate at which fertilizers are released into the soil, allowing farmers to use lesser fertilizer while maintaining the same crop output. Several approaches are considered for designing nano fertilizers that can control the release of nutrients and reduce water loss. On the other hand, use nanoparticles to control the release of nutrients, making them more efficient and cost-effective than traditional fertilizers. Nano fertilizers comprise one or more plant nutrients within nanoparticles where at least 50% of the particles are smaller than 100 nanometers.

Material and Methods

The experiment was laid out in Randomized Block Design with three replications comprising of nine treatments having nine level of nano zinc T_1: Nano Zinc - 20 ppm, T_2: Nano Zinc - 25 ppm, T_3: Nano Zinc - 30 ppm, T_4: Nano Zinc - 35 ppm, T_5: Nano Zinc - 40 ppm, T_6: Nano Zinc - 45 ppm, T_7: Nano Zinc - 50 ppm, T_8: Nano Zinc - 55 ppm and T_9: Control.

The seeds of cabbage cv. Golden Acre were sown in the nursery beds on 12th September, 2024 and the seedlings were transplanted on 30th October, 2024. The plot size was 2 m × 1.5 m and a spacing of 60 cm × 45 cm was followed.

The observations were recorded on days to 50% maturity, no. of non-wrappers leaves, plant spread in length (cm), head shape index, gross Weight (g), net Head Weight (g), stalk length (cm), harvest index (%), equatorial diameter of head (cm), polar diameter head (cm), core size (cm), head compactness, yield per plot (kg), yield per hectare (t), TSS (°Brix) and ascorbic acid (mg/100 g).

Results and Discussion

Different parameters related to yield and quality of cabbage reflected a significant variation under different treatments presented in Table 1 & Table 2 respectively.

Foliar feeding of nano zinc showed significant for days to 50 per cent maturity. Regarding the effect of foliar feeding of nano zinc, results showed that minimum days to 50 per cent maturity (69.51 Days) were recorded for the treatment T_1: Nano Zinc - 20 ppm which was followed by T_4 (Nano Zinc - 35 ppm) taking 73.54 days, whereas, the maximum days to 50 per cent maturity (77.04 Days) were recorded for the treatment T_9: Control. Similar results were reported Naher *et al*. (2014) [10].

Foliar feeding of nano zinc showed significant for number of non-wrappers leaves. Regarding the effect of foliar feeding of nano zinc, results showed that maximum number of non-wrappers leaves (14.21) were recorded for the treatment T_8: Nano Zinc - 55 ppm which was followed by T_9 (Control) taking 14.14, whereas, the minimum number of non-wrappers leaves (10.56) were recorded for the treatment T_1: Nano Zinc - 20 ppm. Similar results were reported Kumar *et al*. (2017) [8].

Foliar feeding of nano zinc showed significant for plant spread in length (cm). Regarding the effect of foliar feeding of nano zinc, results showed that highest plant spread in length (39.53 cm) were recorded for the treatment T_5: Nano Zinc - 40 ppm which was followed by T_4 (Nano Zinc - 35 ppm) taking 39.12 cm, whereas, the lowest plant spread in length (36.28 cm) were recorded for the treatment T_2: Nano Zinc - 25 ppm. The results are consistent with previous research conducted by Rajawat (2011) [12] on cabbage.

Foliar feeding of nano zinc showed significant for head shape index. Regarding the effect of foliar feeding of nano zinc, results showed that maximum head shape index (1.61) were recorded for the treatment T_2: Nano Zinc - 25 ppm which was followed by T_8 (Nano Zinc - 55 ppm) taking 1.21, whereas, the minimum head shape index (0.90) were recorded for the treatment T_1: Nano Zinc - 20 ppm. Similar results were reported Kanujia *et al*. (2006) [6].

Foliar feeding of nano zinc showed significant for gross weight (g). Regarding the effect of foliar feeding of nano zinc, results showed that maximum gross weight (1418.20 g) were recorded for the treatment T_2: Nano Zinc - 25 ppm which was followed by T_4 (Nano Zinc - 35 ppm) taking 1303.93 g, whereas, the minimum gross weight (1103.60 g) were recorded for the treatment T_9: Control. This finding is consistent with Chaudhari *et al*. (2017) [2] in cabbage.

Foliar feeding of nano zinc showed significant for net head weight (g). Regarding the effect of foliar feeding of nano zinc, results showed that maximum net head weight (849.77 g) were recorded for the treatment T_1: Nano Zinc - 20 ppm which was followed by T_5 (Nano Zinc - 40 ppm) taking 823.82 g, whereas, the minimum net head weight (621.75 g) were recorded for the treatment T_9: Control. Similar results were reported Chaudhari *et al*. (2017) [2] in cabbage.

Foliar feeding of nano zinc showed significant for stalk length (cm). Regarding the effect of foliar feeding of nano zinc, results showed that maximum stalk length (6.51 cm) were recorded for the treatment T_5: Nano Zinc - 40 ppm which was followed by T_6 (Nano Zinc - 45 ppm) taking 6.31 cm, whereas, the minimum stalk length (4.84 cm) were recorded for the treatment T_9: Control. The results are in accordance with the findings of Kumar *et al*. (2017) [8] in cabbage.

Foliar feeding of nano zinc showed significant for harvest index (%). Regarding the effect of foliar feeding of nano zinc, results showed that maximum harvest index recorded (77.03%) were recorded for the treatment T_8: Nano Zinc - 55 ppm which was followed by T_5 (Nano Zinc - 40 ppm) taking 73.93%, whereas, the minimum harvest index (61.70%) were recorded for the treatment T_9: Control. The findings are consistent with those of Dhakal *et al*. (2009) [4] regarding cauliflower.

Foliar feeding of nano zinc showed significant for equatorial diameter of head (cm). Regarding the effect of foliar feeding of nano zinc, results showed that maximum equatorial diameter of head (14.21 cm) were recorded for the treatment T_3: Nano Zinc - 30 ppm which was followed by T_4 (Nano Zinc - 35 ppm) taking 14.14 cm, whereas, the minimum equatorial diameter of head (11.54 cm) were recorded for the treatment T_9: Control. The findings are consistent with Naher *et al*. (2014) [10] and Chaudhari *et al*. (2017) [2] in cabbage.

Foliar feeding of nano zinc showed significant for polar diameter head (cm). Regarding the effect of foliar feeding of nano zinc, results showed that maximum polar diameter head (14.41 cm) were recorded for the treatment T_3: Nano Zinc - 30 ppm which was followed by T_4 and T_8 (Nano Zinc - 35 ppm) and (Nano Zinc - 55 ppm) respectively taking 12.24 cm, whereas, the minimum polar diameter head (10.56 cm) were recorded for the treatment T_9: Control. The findings are consistent with Lashkari *et al*. (2008) [9] regarding cauliflower and Naher *et al*. (2014) [10] regarding cabbage.

Foliar feeding of nano zinc showed significant for core size (cm). Regarding the effect of foliar feeding of nano zinc, results showed that maximum core size (5.92 cm) were recorded for the treatment T_2: Nano Zinc - 25 ppm which was followed by T_5 (Nano Zinc - 40 ppm) taking 5.55 cm, whereas, the minimum core size (4.95 cm) were recorded for the treatment T_9: Control. Similar results were reported Kanujia *et al*. (2006) [6].

Foliar feeding of nano zinc showed significant for head compactness. Regarding the effect of foliar feeding of nano zinc, results showed that maximum head compactness (57.34) were recorded for the treatment T_7: Nano Zinc - 50 ppm which was followed by T_6 (Nano Zinc - 45 ppm) taking 54.84, whereas, the minimum head compactness (40.48) were recorded for the treatment T_9: Control. Similar results were observed in the cabbage study conducted by Kotnala (2008) [7].

Foliar feeding of nano zinc showed significant for yield per plot (kg). Regarding the effect of foliar feeding of nano zinc, results showed that highest yield per plot (9.42 kg) were recorded for the treatment T_4: Nano Zinc - 35 ppm which was followed by T_7 (Nano Zinc - 50 ppm) taking 9.36 kg, whereas, the lowest yield per plot (8.30 kg) were recorded for the treatment T_9: Control. In addition, the results confirmed the findings of Ningawale *et al*. (2016) [11] regarding cauliflower.

Foliar feeding of nano zinc showed significant for yield per hectare (t). Regarding the effect of foliar feeding of nano zinc, results showed that highest yield per hectare (31.39 t) were recorded for the treatment T_4: Nano Zinc - 35 ppm which was followed by T_7 (Nano Zinc - 50 ppm) taking 31.28 t, whereas, the lowest yield per hectare (27.67 t) were recorded for the treatment T_9: Control. Naher *et al*. (2014) [10] in cabbage, Ningawale *et al*. (2016) [11] in cauliflower and Chaudhari *et al*. (2017) [2] in cabbage also reported similar results.

Foliar feeding of nano zinc showed significant for TSS (°Brix). Regarding the effect of foliar feeding of nano zinc, results showed that highest TSS (8.06 °Brix) were recorded for the treatment T_4: Nano Zinc - 35 ppm which was followed by T_7 (Nano Zinc - 50 ppm) taking 7.99 °Brix, whereas, the lowest TSS (7.31 °Brix) were recorded for the treatment T_9: Control. These findings are in agreement with Chatterjee *et al*. (2012) [2] in cabbage.

Foliar feeding of nano zinc showed significant for ascorbic acid (mg/100 g). Regarding the effect of foliar feeding of nano zinc, results showed that highest ascorbic acid (13.88 mg/100 g) were recorded for the treatment T_7: Nano Zinc - 50 ppm which was followed by T_2 (Nano Zinc - 25 ppm) taking 13.52 mg/100 g, whereas, the lowest ascorbic acid (12.98 mg/100 g) were recorded for the treatment T_9: Control. These findings are also in agreement with Chatterjee *et al*. (2012) [2] in cabbage.

Table 1: Effect of foliar application of nano zinc on Days to 50% maturity, No. of non-wrappers leaves, Plant spread in length (cm), Head shape index, Gross Weight (g), Net Head Weight (g), Stalk length (cm) and Harvest index of cabbage

S. No.	Treatments	Days to 50% maturity	No. of non-wrappers leaves	Plant spread in length (cm)	Head shape index	Gross Weight (g)	Net Head Weight (g)	Stalk length (cm)	Harvest index
T_1	Nano Zinc - 20 ppm	69.51	10.56	38.63	0.90	1,108.87	849.77	5.94	64.78
T_2	Nano Zinc - 25 ppm	73.75	12.01	36.28	1.61	1,418.20	652.90	5.79	64.91
T_3	Nano Zinc - 30 ppm	73.81	12.24	36.87	1.16	1,122.60	775.41	5.45	70.26
T_4	Nano Zinc - 35 ppm	73.54	11.96	39.12	0.91	1,303.93	687.77	5.77	63.69
T_5	Nano Zinc - 40 ppm	74.00	12.01	39.53	0.98	1,143.60	823.82	6.51	73.93
T_6	Nano Zinc - 45 ppm	76.65	12.36	38.43	1.19	1,110.27	744.11	6.31	66.65
T_7	Nano Zinc - 50 ppm	74.11	12.70	37.16	1.15	1,232.60	731.10	5.77	71.49
T_8	Nano Zinc - 55 ppm	75.34	14.21	38.41	1.21	1,250.60	735.29	5.34	77.03
T_9	Control	77.04	14.14	37.32	1.09	1,103.60	621.75	4.84	61.70
SEm (±)		0.35	0.48	0.70	0.06	55.43	9.00	0.22	0.31
CD 5%		1.06	1.14	2.11	0.17	166.19	26.98	0.67	0.92

Table 2: Effect of foliar application of nano zinc on Equatorial diameter of head (cm), Polar diameter head (cm), Core size (cm), Head compactness, Yield per plot (kg), TSS (°Brix) and Ascorbic acid (mg/100 g) of cabbage

S. No.	Treatments	Equatorial diameter of head (cm)	Polar diameter head (cm)	Core size (cm)	Head compactness	Yield per plot (kg)	Yield per hectare (t)	TSS (°Brix)	Ascorbic acid (mg/100 g)
T_1	Nano Zinc - 20 ppm	12.36	12.14	5.46	43.62	9.11	30.38	7.89	13.19
T_2	Nano Zinc - 25 ppm	12.70	11.96	5.92	44.81	8.48	28.25	7.73	13.52
T_3	Nano Zinc - 30 ppm	14.21	14.41	5.38	41.85	9.24	31.18	7.69	13.46
T_4	Nano Zinc - 35 ppm	14.14	12.24	5.00	47.03	9.42	31.39	8.06	13.45
T_5	Nano Zinc - 40 ppm	12.57	11.87	5.55	51.11	8.89	29.64	7.59	13.33
T_6	Nano Zinc - 45 ppm	11.92	11.96	5.32	54.84	8.98	29.94	7.95	13.26
T_7	Nano Zinc - 50 ppm	13.08	12.01	5.41	57.34	9.36	31.28	7.99	13.88
T_8	Nano Zinc - 55 ppm	13.27	12.24	5.08	49.18	9.15	30.51	7.70	13.05
T_9	Control	11.54	10.56	4.95	40.48	8.30	27.67	7.31	12.98
SEm (±)		1.90	0.54	0.29	1.38	0.51	1.69	0.22	0.27
CD 5%		5.80	1.15	0.88	4.12	1.52	5.07	0.67	0.81

Conclusion

The study clearly demonstrated that foliar application of nano zinc had a significant positive impact on yield and quality attributes of cabbage. Different concentrations of nano zinc influenced specific parameters with early maturity observed at 20 ppm in T_1, while maximum number of non-wrapper leaves (55 ppm-T_8), plant spread (40 ppm-T_5), head shape index and gross weight (25 ppm-T_2) and head dimensions (30 ppm-T_3) varied across treatments. Notably, treatment with 20 ppm in T_1 nano zinc recorded the highest net head weight, while 50 ppm in T_7 improved head compactness and ascorbic acid content.

Yield performance was most pronounced at 35 ppm in T_4, resulting in the highest per plot and per hectare yield along with superior TSS. Overall, nano zinc application significantly enhanced yield and quality parameters compared to control, indicating its vital role in improving cabbage productivity.

The results suggest that an optimal concentration between 30–40 ppm may be most effective for achieving balanced yield and quality in cabbage production.

References

1. Anonymous. Department of Agriculture & Farmers Welfare (MoA & FW), Government of India. 2024.
2. Chatterjee R, Rana JC, Paul PK. Enhancement of head yield and quality of cabbage (*Brassica oleracea* var. capitata L.) by combining different sources of nutrients. Indian J Agric Sci. 2012;82:324-328.
3. Chaudhari VL, Patel NK, Patel GD, Chaudhary VJ, Nayak SR. Impact of micronutrients on growth and yield of cabbage (*Brassica oleracea* var. capitata L.). Int J Chem Stud. 2017;5:2113-5.
4. Dhakal D, Shah SC, Gautam DM, Yadav RN. Response of cauliflower (*Brassica oleracea* var. botrytis) to the application of boron and phosphorus in the soils of Rupandehi district. Nepal Agric Res J. 2009;9:56-66.
5. Hazra P, Chattopadhyay A, Karmakar K, Dutta S. Modern Technology in Vegetable Production. New Delhi: New India Publishing Agency; 2011. p. 155-167.
6. Kanujia SP, Ahmed N, Chattoo MA, Jabeen N, Naryan S. Effect of micronutrients on growth and yield of cabbage (*Brassica oleracea* var. capitata L.). Appl Biol Res. 2006;8:15-8.
7. Kotnala K. Effect of macro and micro nutrients along with FYM and Azotobacter on cabbage [PhD thesis]. Nauni, Solan (HP): Dr Y S Parmar University of Horticulture and Forestry; 2008. 108 p.
8. Kumar D, Kumar S, Meena RK, Verma S. Effect of organic and inorganic fertilizers on growth, yield and quality of cabbage (*Brassica oleracea* var. capitata L.). Int J Pure Appl Sci. 2017;5:1590-15903.
9. Lashkari CO, Parekh HB, Sharma SJ, Karetha KM, Kakade DK. Beneficial effect of foliar spray of zinc and iron on economics of cauliflower (*Brassica oleracea* var. botrytis L.) cv. Snowball-16. Asian J Hortic. 2008;3:422-4.
10. Naher MNA, Alam MN, Jahan N. Effect of nutrient management on the growth and yield of cabbage (*Brassica oleracea* var. capitata L.) in calcareous soils of Bangladesh. Agriculturists. 2014;12:24-33.
11. Ningawale DK, Singh R, Bose US, Gurjar PS, Sharma A, Gautam US. Effect of boron and molybdenum on growth, yield and quality of cauliflower (*Brassica oleracea* var. botrytis) cv. Snowball 16. Indian J Agric Sci. 2016;86:825-9.
12. Rajawat BS. Effect on different levels of sulphur and zinc on growth and yield of cabbage (*Brassica oleracea* var. capitata L.) [PhD thesis]. Gwalior (MP): Rajmata Vijayaraje Scindia Krishi Vishwa Vidyalaya; 2011. 110 p.