ISSN Print: 2664-844X
ISSN Online: 2664-8458
NAAS Rating (2026): 4.97
IJAFS 2026; 8(6): 289-292
www.agriculturaljournals.com
Received: 11-03-2026
Accepted: 14-04-2026

Kashish
Research Scholar, Department of Agriculture, G.S.S.D.G.S Khalsa College Patiala, Punjab, India

Harpreet Kaur
Assistant Professor, Department of Agriculture, G.S.S.D.G.S Khalsa College Patiala, Punjab, India

Corresponding Author:
Harpreet Kaur
Assistant Professor, Department of Agriculture, G.S.S.D.G.S Khalsa College Patiala, Punjab, India

Production potential of Knol Khol (*Brassica Oleracea* L. var. *Gongylodes*) as influenced by zinc, boron and RDF levels under Patiala region

Kashish and Harpreet Kaur

DOI: https://www.doi.org/10.33545/2664844X.2026.v8.i6d.1603

Abstract
The study assessed the production potential of knol-khol (*Brassica oleracea* L. var. *gongylodes*) under varying levels of zinc, boron, and the recommended dose of fertilisers (RDF) with respect to growth, yield and economic performance in the Patiala region. A field experiment was conducted during the rabi season of 2024–25 at the Campus for Research and Advanced Studies, Dhablan, G.S.S.D.G.S. Khalsa College, Patiala, using a Randomized Block Design with 13 treatment combinations and three replications. The results demonstrated that the treatment T_{13} (100% RDF + boron 1 kg ha^{-1} + zinc 5 kg ha^{-1}) produced significantly superior values across all parameters. This treatment recorded maximum plant height (41.92 cm), leaf length (29.71 cm), leaf breadth (24.35 cm), number of leaves per plant (18.89), knob diameter (12.84 cm), knob volume (1103.36 cm^3), dry weight (135.54 g), fresh weight (403.29 g), plot yield (10.89 kg plot^{-1}), and estimated yield (172.90 q ha^{-1}). The same treatment also achieved the highest gross return (₹345,806.67 ha^{-1}), net return (₹264,498.66 ha^{-1}), and benefit–cost ratio (3.25), indicating its overall superiority in enhancing productivity and profitability of knol-khol under the agro-climatic conditions of Patiala.

Keywords: RDF, Zinc, Boron and Knol-Khol

Introduction
Knol-khol (*Brassica oleracea* var. *gongylodes*) is a Cole crop valued for its nutritive knobs and wide adaptability. Still, its productivity is strongly limited by nutrient imbalances, particularly zinc and boron deficiencies. As a heavy-feeding Brassica, knol-khol removes large quantities of nutrients from the soil, making balanced fertilisation essential. (Alloway 2008) [1]. Among micronutrients, boron and zinc are the most critical, as they directly influence cell division, knob formation, pollen viability, carbohydrate metabolism, and overall yield quality. Boron plays a central role in meristem activity, membrane integrity, sugar translocation, and reproductive processes. (Shalini *et al.* 2002) [19]. In knol-khol, inadequate boron supply leads to physiological disorders such as knob cracking, brown heart, brittleness and malformed growth, severely reducing marketability. (Tiwari and Tiwari 2015) [20]. Zinc, on the other hand, regulates auxin synthesis, enzyme activation, protein formation, and photosynthesis. Its deficiency—common in nearly half of Indian soils—results in reduced knob diameter, poor vigour, and lower yields. (Biswas 2006) [3]. Because both nutrients interact synergistically with the recommended fertiliser dose (RDF), optimising their levels is essential to achieving maximum growth and quality. Despite the crop's economic and nutritional importance, limited research has examined how different levels of RDF, combined with zinc and boron, influence growth and yield parameters in knol-khol. This gap highlights the need for systematic evaluation of integrated nutrient management strategies to enhance productivity and improve knob quality under field conditions. (Kumari *et al.* 2025) [10].

Methodology
The field experiment entitled *"Production potential of knol khol (Brassica oleracea L. var. gongylodes) as influenced by zinc, boron and RDF levels under Patiala region"* was conducted during the *rabi* season of 2024–25 at the Campus for Research and Advanced Studies, Dhablan, G.S.S.D.G.S. Khalsa College, Patiala, Punjab.

The site lies in the southeastern part of Punjab within the Indo-Gangetic plains and experiences a subtropical, semi-arid climate, characterised by hot and humid summers, a monsoon period, and cold winters. The soil of the experimental field is a well-drained alluvial soil, suitable for vegetable cultivation. This section outlines the experimental site, design, crop establishment, and treatment structure adopted for the study.

Experimental and treatment details

The study was conducted using a Randomised Block Design (RBD) comprising 13 treatments and replicated three times, resulting in 39 experimental plots. Plot dimensions and crop geometry were maintained uniformly across the field, where the gross plot size was 3.15 m × 2.00 m, the net plot size: 2.70 m × 1.75 m, spacing: 45 cm × 25 cm and a seed rate of 1 kg ha^{-1}, of the Early White Vienna variety was taken and transplanted on 22 November 2024. During the experiment, the recommended dose of Fertilisers (RDF) for knol-khol was 80:50:30 kg N: P_2O_5: K_2O ha^{-1}. While the treatments consisted of different RDF levels combined with zinc and boron, are as follows:

T_1: Control
T_2: 50% RDF
T_3: 75% RDF
T_4: 100% RDF
T_5: 50% RDF + 5 kg Zn ha^{-1}
T_6: 50% RDF + 1 kg B ha^{-1}
T_7: 50% RDF + 5 kg Zn ha^{-1} + 1 kg B ha^{-1}
T_8: 75% RDF + 5 kg Zn ha^{-1}
T_9: 75% RDF + 1 kg B ha^{-1}
T_{10}: 75% RDF + 5 kg Zn ha^{-1} + 1 kg B ha^{-1}
T_{11}: 100% RDF + 5 kg Zn ha^{-1}
T_{12}: 100% RDF + 1 kg B ha^{-1}
T_{13}: 100% RDF + 5 kg Zn ha^{-1} + 1 kg B ha^{-1}

Results and discussion

Growth parameters

Plant height, leaf length, leaf breadth, and number of leaves per plant at the time of harvesting showed clear and significant improvement under the combined application of zinc, boron, and RDF. At harvest, T_{13} (100% RDF + 5 kg Zn ha^{-1} + 1 kg B ha^{-1}) recorded the highest plant height (41.92 cm), leaf length (29.71 cm), leaf breadth (24.35 cm) and number of leaves per plant (18.89) followed by T_{11}, T_{12} and T_4 while the control (T_1) showed the lowest value of (36.78 cm), (23.63), (17.85) and (12.67).

Table 1: Effect of zinc, boron and RDF levels on the growth parameter of knol khol

Treatments detail		Plant height (cm)	Leaf length (cm)	Leaf breadth (cm)	Number of leaves per plant
T_1	Control	36.78	23.63	17.85	12.67
T_2	50% RDF	38.13	25.31	19.53	14.14
T_3	75% RDF	39.80	26.32	21.27	16.11
T_4	100% RDF	41.22	29.10	23.73	18.36
T_5	50% RDF + Z	38.81	25.85	20.72	15.28
T_6	50% RDF + B	38.65	25.73	20.32	14.93
T_7	50% RDF + Z + B	39.27	25.97	21.01	15.61
T_8	75% RDF + Z	39.99	27.11	21.85	16.70
T_9	75% RDF + B	39.83	26.73	21.48	16.39
T_{10}	75% RDF + Z + B	40.19	27.76	22.89	16.83
T_{11}	100% RDF + Z	41.74	29.40	24.07	18.52
T_{12}	100% RDF + B	41.68	29.19	23.76	18.38
T_{13}	100% RDF + Z + B	41.92	29.71	24.35	18.89
SEm (±)		0.35	0.36	0.30	0.33
CD at 5%		0.80	0.83	0.70	0.75

This superior performance is attributed to zinc-induced enzymatic activity and chlorophyll synthesis, as well as boron-mediated cell wall formation and sugar translocation. Similar enhancements in vegetative growth under Zn and B have been reported by Choudhry *et al.* (2018) [4] in knol-khol, Dhakad *et al.* (2024**)** [6] in cauliflower, Khatri *et al.* (2022) [8] in tomato, Kumar *et al.* (2020) [9] in brinjal, Pavithra and Subbarayappa (2023) [16] in knol-khol, Ningawale *et al.* (2019) [14] in cauliflower, Sen *et al*. (2025) [17] in cabbage and Meena *et al*. (2019) [12] in cauliflower.

Yield Parameters

Knob diameter and volume were significantly enhanced by the combined application of Zn and B. Treatment T_{13} recorded the maximum knob diameter (12.84 cm) and volume (1103.36 cm^3), while the control recorded the lowest values. Zinc improves photosynthesis and carbohydrate metabolism, while boron enhances nutrient absorption and meristematic activity. Similar synergistic effects were reported by Ashraf *et al.* (2024) [2] in bitter gourd. Fresh and dry weight of knobs were also highest in T_{13} (403.29 g fresh; 153.54 g dry). This improvement may be due to increased biomass accumulation and better nutrient storage in knobs. Comparable results were documented by Faris *et al.* (2023) [7] and Dandhich S. (2013) [5] in knol-khol. Knob yield hectare per plot showed a marked increase under T_{13} (172.90 q ha^{-1}), whereas the lowest yield was recorded in the control. The enhanced yield is attributed to balanced macro and micronutrient supply, which improves enzyme activation, protein synthesis and knob development. These results corroborate the findings of Kumari *et al.* (2025) [10], Naik *et al.* (2025) [13] and Manhar *et al.* (2023) [11] in knol-khol.

Table 2: Effect of zinc, boron and RDF levels on the yield parameter of knol khol

Treatments detail		Diameter (cm)	Volume (cm^3)	Fresh weight (g)	Dry weight (g)	Yield of knob (q ha^{-1})
T_1	Control	6.87	169.03	294.29	104.48	67.12
T_2	50% RDF	7.41	211.54	338.45	124.63	122.16
T_3	75% RDF	9.79	490.39	380.90	129.88	143.22
T_4	100% RDF	12.68	893.07	392.59	133.96	159.14
T_5	50% RDF + Z	8.84	359.82	350.93	128.70	131.48
T_6	50% RDF + B	7.69	237.12	342.15	128.45	125.28
T_7	50% RDF + Z + B	8.95	374.66	369.59	128.89	130.10
T_8	75% RDF + Z	10.83	662.45	386.97	130.43	146.50
T_9	75% RDF + B	9.91	509.60	385.01	130.29	144.65
T_{10}	75% RDF + Z + B	10.92	682.27	388.55	133.47	147.08
T_{11}	100% RDF + Z	12.73	821.42	394.27	133.97	159.83
T_{12}	100% RDF + B	12.70	1003.35	392.66	133.71	159.62
T_{13}	100% RDF + Z + B	12.84	1103.36	403.29	135.54	172.90
SEm (±)		0.07	142.60	4.82	2.20	9.55
CD at 5%		0.16	322.28	10.90	4.99	21.59

Economic Parameters

Economic analysis revealed that T_{13} produced the highest gross return (₹345,807 ha^{-1}), net return (₹264,499 ha^{-1}) and B: C ratio (3.25). The lowest economic performance was recorded in the control. The profitability of T_{13} is attributed to higher yield and improved quality, which enhance market value. These results agree with Panda *et al.* (2019) [15], Faris *et al.* (2023) [7] and Shah *et al.* (2010) [18] in knol-khol. The combined application of zinc, boron, and the full recommended dose of fertilisers produced the most favourable outcomes, with T_{13} (100% RDF + 5 kg Zn ha^{-1} + 1 kg B ha^{-1}) consistently outperforming all other treatments.

Table 3: Effect of zinc, boron and RDF levels on the economic parameter of knol khol

Treatments detail		Gross return (Rs. ha^{-1})	Net return (Rs. ha^{-1})	B: C
T_1	Control	134253.33	59933.33	0.81
T_2	50% RDF	244327.67	167013.67	2.61
T_3	75% RDF	286447.67	207636.67	2.63
T_4	100% RDF	318293.23	237985.23	2.96
T_5	50% RDF + Z	262973.33	185109.33	2.38
T_6	50% RDF + B	250573.33	172759.33	2.22
T_7	50% RDF + Z + B	260207.67	181843.67	2.32
T_8	75% RDF + Z	293007.67	213646.67	2.69
T_9	75% RDF + B	289307.67	209996.67	2.65
T_{10}	75% RDF + Z + B	294167.67	214306.67	2.68
T_{11}	100% RDF + Z	319673.00	238815.00	2.95
T_{12}	100% RDF + B	319253.00	238445.00	2.95
T_{13}	100% RDF + Z + B	345807.67	264499.67	3.25
SEm (±)		19102.7	20063.4	0.25
CD at 5%		8.41	45343.3	0.57

Conclusion

From the present study, it can be concluded that the combined application of zinc, boron and RDF levels of fertilisers produced the most favourable outcomes, found in treatment T_{13} (100% RDF + 5 kg Zn ha^{-1} + 1 kg B ha^{-1}), which is outperforming significantly as compared to all other treatments. An integrated nutrient approach enhances growth, yield, quality, and economic returns by improving both nutrient availability and physiological efficiency in knol-khol. Their synergistic interaction promoted superior knob development and improved marketable quality.

References

1. Alloway BJ. *Zinc in soil and crop nutrition*. 2nd ed. Brussels (Belgium): International Zinc Association (IZA); Paris (France): International Fertilizer Industry Association (IFA); 2008.
2. Ashraf MT, Liaqat B, Shahzadi K, Kiran S, Anam L, Hussain N, et al. Effect of zinc, iron and boron on growth, yield and quality of bitter gourd (*Momordica charantia* L.) in Punjab. Int J Appl Sci Res Rev. 2024;11(3):1-5.
3. Biswas A. Integrated use of organic manures with nitrogenous fertilizer on growth and yield of kohlrabi [MSc thesis]. Mymensingh (Bangladesh): Bangladesh Agricultural University; 2006.
4. Choudhary R, Bairwa, Ola AL, Jitarwal P. Effect of zinc on growth, yield and quality of knol khol (*Brassica caulorapa* L.). Int J Chem Stud. 2018;6(3):1217-9.
5. Dandhich S. Effect of levels of nitrogen and zinc on growth, yield and quality of knol-khol (*Brassica oleracea* var. *caulorapa*) in loamy sand soil of Jobner [thesis]. Jobner (India): SKN College of Agriculture; 2013.
6. Dhakad A, Maji S, Razauddin, Chouhan T, Meena N, Meena SK. Effect of boron and zinc on growth and yield of cauliflower (*Brassica oleracea* var. *botrytis* L.) cv. Pusa Snowball K-1. Int J Plant Soil Sci. 2024;36(12):254-61.
7. Faris MP, Basavalingaiah, Girijesh GK, Thippeshappa GN, Srinivasa V, Shivapra D. Effect of nutrient levels

and planting geometry on yield, quality and economics of knol-khol (*Brassica oleracea* var. *gongylodes*) under protected cultivation. Pharma Innov J. 2023;12(2):2541-6.
8. Khatri D, Bhattarai K, Thapa P, Wagle N, Yadav PK. Effect of foliar spray of zinc and boron on performance of tomato (*Solanum lycopersicum*) cv. Manisha under net house condition. Russ J Agric Soc Econ Sci. 2022;5(125):252-61.
9. Kumar A, Kumar P, Singh T, Sulekh, Kashyap L. Influence of zinc and boron on growth, uptake and yield of brinjal (*Solanum melongena* L.). J Plant Dev Sci. 2020;12(9):549-53.
10. Kumari N, Yadav A, Mourya PK, Singh S. Effect of foliar spray of micronutrient on growth and yield of knol-khol (*Brassica oleracea* L. var. *gongylodes*). Plant Arch. 2025;25(1):2140-6.
11. Manhar I, Singh A, Singh BV. Response of different organic manures and fertilizers on growth and yield of knol khol (*Brassica oleracea* var. *gongylodes* L.). Pharma Innov J. 2023;12(11):1599-602.
12. Meena SL, Aravindakshan K, Arya CK, Meena KK, Meena MK. Effect of bioregulators and boron on growth attributes of cabbage (*Brassica oleracea* var. *capitata* L.) cv. Golden Acre. Int J Chem Stud. 2019;7(3):1540-3.
13. Naik RV, Bai MS, Bairwa LN, Sekhar V, Komali G. Effect of zinc on growth, yield and quality of knol khol (*Brassica oleracea* var. *gongylodes*). Int J Res Agron. 2024;8(1):145-8.
14. Ningawale DK, Singh R, Bose US, Gurjar PS, Sharma, 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. 2015;86(6):125-9.
15. Panda RS, Sahoo D, Jena B, Sahlu GS, Tripathy P, Nayak RK, et al. Residual effect of boron on growth parameters of knol khol (*Brassica oleracea* var. *gongylodes* L.) in coastal regions of Odisha. Int J Chem Stud. 2019;7(3):4598-601.
16. Pavithra R, Subbararayappa CT. Effect of soil and foliar application of zinc on nutritional composition and uptake by knol khol (*Brassica caulorapa* var. *gongylodes*). Mysore J Sci. 2023;7(4):203-9.
17. Sen O, Regar P, Bairwa R, Mishra D, Singh P. Effect of zinc, boron and vermicompost on growth of cabbage (*Brassica oleracea* var. *capitata*). Int J Adv Biochem Res. 2025;9(7):713-7.
18. Shah DA, Narayan R, Ahmad N, Narayan S, Wani KP. Influence of boron and zinc on growth, yield and quality of knol khol cv. Early White Vienna. Indian J Hortic. 2010;67:323-8.
19. Shalini SB, Channal HT, Hebsur NS, Dharmatti PR, Sarangamath PA. Effect of integrated nitrogen management on nutrient uptake in knol-khol, yield and nutrient availability of soil. Karnataka J Agric Sci. 2002;15(1):43-6.
20. Tiwari KN, Tiwari. Managing boron deficiency in vegetable crops. Indian Hortic. 2015;60(1):16-19.