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EFFECT OF FOLIAR SPRAY OF MICRO-NUTRIENT ON GROWTH AND YIELD OF KNOL-KHOL (*BRASSICA OLERACEAE* L. *VAR* GONGLYODIES)

Neelam Kumari[1*], Anoop Yadav[1], Pradumn Kumar Mourya[2] and Saurabh Singh[1]
[1]Department of Horticulture, Institute of Agriculture and Natural Sciences,
DDU Gorakhpur University, Gorakhpur, U.P., India
[2]Department of Entomology, Institute of Agriculture and Natural Sciences,
DDU Gorakhpur University, Gorakhpur, U.P., India
*Corresponding author E-mail: neelamk1086@gmail.com
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ABSTRACT

The Present investigation entitled "Effect of foliar spray of micronutrients on growth, yield and quality parameters of Knol khol (*Brassica oleraceae* L. *var* gonglyodies)" was carried out during *Rabi* season 2022-2023 at the Vegetable Research Farm, Department of Horticulture, Institute of Agricultural & Natural Sciences, Deen Dayal Upadhyaya Gorakhpur University, Gorakhpur. The Experimental materials of present investigation were comprised of one genotype of knol khol (var. White Vienna) with three micronutrients with their combinations and control, the three micro-nutrients taken namely Boric acid (H_3BO_3) 0.25%, 0.50%, Copper sulphate ($CuSO_4$) 0.25%, 0.50% and zinc sulphate ($ZnSO_4$) 0.25%, 0.50%, each of the micro-nutrients was sprayed at three different concentrations. Experiment was carried out with a completely randomised block design with 7 treatments and three replications. The following observations were recorded Growth parameters of knol khol viz., plant height (cm), number of leaves per plant, leaf width (cm), were recorded at 30 days and at harvest stage. All the treatments exhibited superior growth and yield of knol khol. Treatment T_4 (boric acid @ 0.25%) was found highly effective for growth and yield parameters as it showed the highest average weight of the knob (214.35 g). The Treatment T_3 (zinc Sulphate @ 0.50%) was found effective for yield attributing as it showed the highest knob length (7.65 cm), knob diameter (6.74 cm), leaves width at 30 days (10.66 cm) and at harvest (28.24 cm) and leaf length at 30 days (10.35 cm) and at harvest (28.50 cm). Treatment T_5 (boric acid @ 0.50 %) was found highly effective for growth and yield parameters as it showed greatest plant height (33.37 cm) at 30 days and (47.59 cm) at harvest days, number of leaves (12.10) at 30 days and at harvest (25.28).

Keywords **:** Zinc Sulphate, Boric acid, Copper Sulphate, Growth and Yield Attributes.

Introduction

Knol-khol (*Brassica oleraceae var. gongylodes* L.) 2n = 18 is popularly known as kohlrabi or mini cabbage in India and belongs to the family Brassicaceae. It is a winter-season crop that originated in the coastal countries of the Mediterranean Region and Northern Europe. These regions are considered to be the probable origins of this crop (Silatar *et al.*, 2018). In India knol-khol is widely grown in Kashmir, West Bengal, and some parts of Uttar Pradesh (Thamburaj and Singh, 2010). When knol khol grown for vegetables, both in 1 plains and hills, it is an herbaceous annual, but when seeds are produced, it becomes a biannual.

The fleshy, turnip-like stem grows entirely above the ground, and it is harvested for use as a raw or cooked vegetable, while immature leaves are also consumed in some regions (Babychand *et al.,* 2017). Knol-khol tastes and feels like broccoli stems or cabbage, but it's gentler and sweeter. The knobs have a crunchy texture and a rich flavour (Bose, 2001). Knol-khol is a richest source of minerals like calcium, magnesium, potassium, phosphorus, sodium and sulphur. Nutritional value of one hundred gram of edible portion of knol-khol contains 92.7 g moisture, 1.1 g protein, 0.2 g fat, 0.7 g minerals, 1.5 g fibre, 3.8 g carbohydrates, 25 cal. energy, 20 mg calcium, 18 mg magnesium, 10 mg oxalic acid, 35 mg phosphorus, 0.4 mg iron, 0.12 mg sodium, 37 mg potassium, 0.09 mg copper, 143 mg sulphur, 36 I.U. vitamin A, 0.12 mg riboflavin, 0.5 mg nicotinic acid, 0.05 mg thiamine, and 85 mg vitamin C (Singh & Nath, 2012). Heavy feeders like Knol-khol react favorably to fertilizer treatments. Growing and yield are mostly influenced by genetics and cultural or managerial variables. Growth, output, and quality are greatly influenced by two main factors: diversity and micronutrients. utilizing novel application techniques, such as the right mix of micronutrients, such as boron in the form of boric acid, $ZnSO_4$, $CuSO_4$, and others. Enhanced khol development and output need the maintenance of an ideal plant population per unit area (Rai *et al*., 2003).

Thapa *et al.* (2017) state that different cultivars have unique growth and yield characteristics that vary depending on the growing conditions. Variety is essential to the growth and development of a crop. A few cultivars of knol khol, such as White Vienna, Early White Vienna, and Palam Tender Knob, were developed specifically for the hard winters of North India. Micronutrients including boron, chlorine, copper, iron, manganese, molybdenum, nickel, and zinc are required in lesser amounts than other essential nutrients. They are essential for healthy plant growth and successful crop production. For the majority of the Crucifers, especially Knol-khol, zinc is absolutely necessary. Zinc has a significant impact on the activities of hydrogenase and carbonic anhydrase, the stabilisation of ribosomal fractions, and the synthesis of cytochrome in plants. Zn-activated plant enzymes have a role in protein synthesis, glucose metabolism, cellular membrane integrity maintenance, auxin production regulation, and pollen formation. Reduced leaves, chlorosis, stunted development, and spikelet sterility are all symptoms of zinc deficiency. A lack of zinc can also have a negative impact on the quality of harvested goods, the susceptibility of plants to damage from excessive light or temperature intensity, and the susceptibility of plants to fungi (Marschner, 1995; Cakmak, 2000).

The inadequacy or sufficiency of various nutrients, including boron, in the soil, however, depends primarily on its annual withdrawal under intensive cropping systems and its replenishment through fertilisers, manures, crop residues, and irrigation water (Dwivedi and Dwivedi, 2007). According to recent estimations, one-third of the more than 40000 soil samples studied were found to be deficient in boron (Shukla *et al.,* 2012). Boron affects the synthesis of RNA, the construction of cell walls, and the transfer of glucose (Narayanamma *et al.,* 2007). The flow of sugar or energy into various growing regions of plants is made easier by the presence of the boron, which also gives biological membranes structural stability and functional integrity. Additionally, it facilitates seed germination and pollination (Hakala *et al*., 2006). Brassica plants suffering from a lack of boron exhibit severe symptoms such as head browning, cubical or transverse cracking, and discoloration.

Same as Copper is a necessary non-mobile metal for plant growth and the activation of numerous enzymes involved in the metabolism of carbohydrates, nitrogen, and lignin. A lack of copper can cause leaf yellowing, stem and twig die-back, and poor plant development. The effectiveness of micronutrients in vegetables and the reproductive growth parameter of Knol Khol, however, are less well known. Supplementation with micronutrients is crucial for increased production potential. Application of micronutrients is therefore crucial for preserving vegetable quality as well as soil health and crop output. There are multiple methods of applying micronutrients with varying concentrations to knol khol crops at various growth stages.

Material and Methods

This experiment was carried out during *Rabi* season 2022-2023 at the Vegetable Research Farm Department of Horticulture, Institute of Agricultural & Natural Sciences, Deen Dayal Upadhyaya Gorakhpur University, Gorakhpur. There were 7 Number of Treatments using Randomized Block Design (RBD) with 3 replications and each plot size was 3×3m it spacing was 45 × 60 cm, the number of plants was counting 25 plants per plots. The gap between plots and replications was 0.5m × 1.0 m. The total seven treatments were including one control treatment were selected for investigation in which there three micronutrients used in Boric acid (H_3BO_3) 0.25%, 0.50%; Copper sulphate ($CuSO_4$) 0.25%, 0.50%, and

zinc sulphate ($ZnSO_4$) 0.25%, 0.50%. Each of the micronutrients was sprayed at three different concentrations. Well decomposed farm yard manure 1.5 Kg/plots was applied in the experimental field. Fertilizer in the form of urea, DAP and MOP were used as the source of nitrogen, phosphorous and potassium (N: P: K) was applied, and nitrogen (391.30 Kg/ha.) in the form of urea, P_2O_5 (260.86 Kg/ha) in the form of SSP and K_2O (166.66 Kg/ha) in the form of MoP respectively. The data were taken from randomly five plants from each plots of different characters *viz.* Plant growth (cm), number of leave per plant, leaf width (cm), knob diameter (cm), knob length (cm), knob diameter (cm), yield of knob (kg/plot), total yield (q/ha).

Result and Discussion

Plant height (cm)

The effects of foliar spray of micro nutrients were recorded at 30 days after transplanting and at harvest stage this data is presented in Table no. 1. The significant difference was founded at 30 days in plant height by the application of various treatments. The highest plant height (33.37 cm) was observed in T_5 (Boric acid @ 0.50%) However, the lowest plant height was recorded in (25.85 cm) under T_7 (Copper sulphate @ 0.50%) followed by T_1 (Control) with (29.23 cm). At harvest days, the highly significant plant height was recorded in T_5 (Boric acid @ 0.50%) with (47.59 cm) while, the lowest height of plant was seen in T_7 (Copper Sulphate @ 0.50%) which is (39.49 cm) followed by T_1 control with (41.48 cm).

Number of leave per plant

The number of leaves was counted at 30 days and at harvesting time in per plant of knol khol. The data is presented in Table no. 1. The number of leaves per plant was founded significant difference among the treatments at 30 days and at harvest. At 30 days after transplanting, the maximum number of leaves per plant (12.10) were recorded with foliar spray of T_5 (Boric acid @ 0.50%) followed by T_2 (Zinc Sulphate @ 0.25%) with (10.96) However, the minimum number of leaves per plant counted was (8.50) with T_6 (Copper Sulphate @ 0.25%) followed by T_1 (control). At harvesting stage, the data was found non-significant.

Leaf width (cm)

Leaf width of knol khol represented on Table no. 1. The foliar spray of micro-nutrients which is significant variance to the respect of leaf width recorded at 30 days and at harvesting stage. At 30 days the highest leaf width was observed (10.66 cm) by the application of T_3 (Zinc sulphate @ 0.50 %), while the lowest leaf width was recorded (8.65 cm) under the treatment of T_7 (Copper Sulphate @ 0.25%) followed by T_1 (Control). At harvest, the maximum leaf width was observed (28.24 cm) under the treatment of T_3 (Zinc Sulphate @ 0.50%), however, the lowest leaf width was recorded under the treatment T_7 (Copper Sulphate @ 0.50%) with (18.71 cm) followed by T_1 (Control).

Leaf length (cm)

This is apparent from the data in table no.1 At 30 days, the highest leaf length per plant was seen (10.35 cm) under the foliar application of T_3 (Zinc Sulphate @ 0.50%) followed by T_4 (Boric acid @ 0.25%) with (10.00 cm) and T_2 (Zinc Sulphate @ 0.25%) with (9.95 cm) and the lower leaf length was recorded under the treatment of T_6 (Copper Sulphate @ 0.25%) with (8.03 cm) followed by T_1 (Control). At harvest, maximum leaf length was noticed (28.50 cm) under the treatment T3 (Zinc Sulphate @ 0.50%) followed by T_2 (Zinc Sulphate @ 0.25%) with (27.40 cm) followed by T_1 (Control) and the lower leaf length was recorded T_7 (Copper Sulphate @ 0.50%) with (18.53 cm) followed by T_6 (Copper Sulphate @ 0.25%) with leaf length was recorded is (19.49 cm) followed by T_1 (Control).

The result of growth parameters was investigated significantly affected the various stages. Application of H_3BO_3 @ 0.50% increased plant height (47.58 cm) and number of leaf (25.28 cm) was recorded rest of the treatments, while spraying of $ZnSO_4$ @ 0.50% recorded significantly highest leaf length (28.50 cm) and leaf width (28.24 cm) over the control. These findings data mentioned in table no 1 addressed that the foliar application of micro-nutrients played important roles to increasing growth attributes in knol-khol. It may possible reasons for foliar application of minerals boron, copper and zinc for plant growth and enhance metabolic activity which is very effective way to noticed such deficit's in knol-khol, micro-nutrients applied *via* foliage have a distinct benefits ever those applied in soil as well as plant because of nutrients are delivered quickly absorbed by the intended organs. They are very an essential part to play enzymatic activities and are crucial for synthesis of proteins, production of chlorophyll and function of oxidation–reduction in biological systems (Kaya and Higgs, 2002). Plant height and number of leaf was increased by application of boric acid at all the growth stage, Significant difference was observed in the highest plant height was observed with the application of boric acid @ 50% at 30 as well as harvesting days. The Similar results were reported by Saha *et al.* (2010) in knol khol var. early White Vienna, swain *et al.* (2015) in cauliflower, Thapa *et al.* (2016) in broccoli,

Chowdhury & Sikder (2017) in broccoli. Metwaly *et al.* (2016) in broccoli, Patel *et al.* (2017), Sen *et al.* (2017). While, the result was in conformity increment in leaf width and leaf length due to the application of zinc sulphate@ 0.50% at 30 days and at harvesting time founded in Shweta *et al.* (2016) in knol khol, Quratul *et al.* (2016) in broccoli, Vineet *et al*. (2016) in Brassica juncea, Kotecha *et al*. (2016) in cabbage, Bairwa *et al.* (2020) in cauliflower, Tudu *et al.* (2020) in broccoli, Ain *et al.* (2021) in broccoli and Kumar *et al*. (2012) in broccoli, Swain *et al.* (2015) in cauliflower.

Table 1 : Effect of micro-nutrient on plant height (cm), Number of leaves, Leaf width (cm) and Leaf length at different growth stage of Knol-khol.

S.No.	Treatment	Plant height		Number of leaves		Leaf width		Leaf length	
		30 days	at harvest	30 days	at harvest	30 days	at harvest	30 days	at harvest
1	T_1 Control	29.23	41.48	11.10	21.06	8.75	21.98	9.29	21.56
2	T_2 $ZnSo_4$ @0.25%	32.17	46.88	10.96	25.25	9.76	25.34	9.95	27.40
3	T_3 $ZnSo_4$ @0.50%	28.60	45.97	10.43	24.38	10.66	28.24	10.35	28.50
4	T_4 B_3Ho_3 @0.25%	30.25	45.80	8.56	21.23	9.58	27.15	10.00	21.47
5	T_5 B_3Ho @0.50%	33.37	47.80	12.10	25.28	10.41	24.12	8.88	20.26
6	T_6 $CuSo_4$ @0.25%	32.21	42.26	8.50	20.68	9.79	23.34	8.03	19.49
7	T_7 $CuSo_4$ @0.50%	25.85	39.48	9.53	21.90	8.65	18.71	8.48	18.53
	C.V	7.43	2.84	13.09	14.41	6.87	8.16	8.44	9.50
	CD (5%)	3.99	2.23	2.36	-	1.18	3.50	1.39	3.80

Yield Parameter

Days to 50% knob maturity (days)

The data represented on Table no.2 that the effect of foliar application of micro nutrients recorded significantly was days to 50% knob maturity. The minimum period of 50% knob maturity was observed under the Treatment T_2 ($ZnSO_4$ @ 0.25%) with (38.53 days) followed by T_4 (Boric acid @ 0.25%) with (40.04 days) and (43.63 days) with application of T_5 (Boric acid @ 0.50%) while the maximum days to 50% knob maturity (45.89 days) was observed under treatment of T_1 (control).

Days to knob harvesting (days)

Applying of micro nutrients to observed significant difference with the respect of days to knob harvesting the data is given below the Table no.2. The significantly minimum days to knob harvesting was recorded (60.32 days) under the treatment of T_2 (Zinc Sulphate @ 0.25%) followed by (60.70 days) to knob harvesting period was recorded under the treatment of T_3 (Zinc Sulphate @ 0.50%) and (60.94 days) was recorded under treatment of T_4 (Boric acid @ 0.25%) whereas, the maximum days to knob harvesting (68.15 days) was recorded in T_1 (control).

Average weight of knob (g)

The average weight of knob was observed at harvesting stage. The data given in Table no.2. The highest average weight of knob was observed (214.35 g) under the treatment of T_4 (Boric acid @ 0.25%) followed by (210.34 g) under the application of T_2 (Zinc Sulphate @ 0.25%) and (209.87 g) under treatment of T_3 (Zinc Sulphate @ 0.50%), while the lowest weight of knob was recorded (179.14 g) under treatment in T_7 (Copper Sulphate @ 0.50%).

Volume of knob (cc)

The data was given in Table no.2. The highest significant volume of knob was recorded (127.26 cc) under the treatment of T_6 (Copper Sulphate @ 0.25%) followed by T_4 (Boric acid @ 0.25%) with (126.83 cc) and T_2 (Zinc Sulphate @ 0.25%) with (126.13 cc) and the lowest volume of knob was observed (116.04 cc) under the treatment of T_1 (control).

Knob length (cm)

Table no.2 revealed that knob length was significant with the effect of foliar spray of micronutrients on knol khol. The highest knob length was founded (7.65 cm) under the treatment T_3 (Zinc Sulphate @ 0.50%) followed by (7.65 cm) treatment T_3 (Zinc Sulphate @ 0.50%) and (6.55 cm) with T_2 (Zinc Sulphate @ 0.25%) however the minimum knob length was recorded (5.32 cm) under the treatment of T_5 (Boric acid @ 0.50%) followed by T_1 under the treatment (control).

Knob diameter (cm)

The knob diameter was influenced by different treatments are mentioned in Table no.2. Significant difference was observed among the treatments for knob diameter. The maximum knob diameter was recorded (6.74 cm) under treatment T_3 (Zinc Sulphate @ 0.50%) followed by (6.61 cm) under the treatment was T_1 (Control) and (6.59 cm) with T_2 (Zinc Sulphate @ 0.25%) while the lowest value for knob diameter was observed 5.02 under the treatment of T_7 ($CuSO_4$) 0.50%.

Yield of knob Kg/plot

The significant differences are founded among the treatments for yield of knob in per plots. The maximum yield of knob was recorded (15.22 Kg/plot) under the application of T_2 (Zinc Sulphate @ 0.25%) followed by T_3 (Zinc Sulphate @ 0.50%) with (14.72 Kg/plot) and T_4 (Boric acid @ 0.25%) with (14.39 Kg/plot) while, the minimum yield of knob was obtained (12.89 Kg/plot) under the treatment of T_7 (Copper Sulphate @ 0.50%) followed by (13.56 Kg/plot) yield of knob was observed in under the treatment of T_1 (Control) 0%.

Total yield q/ha.

The data represented of Total yield q/ha as influenced by sources and different levels of treatments of micro-nutrients are given the Table no.2.The maximum total yield was recorded (159.32 q/ha) under the treatment T_2 (Zinc Sulphate @ 0.25%) followed by T_4 (Boric acid @ 0.25%) with (156.32 q/ha) followed by T_3 (Zinc Sulphate @ 0.50%) with (154.93 q/ha) whereas, the minimum yield was recorded (142.29 q/ha) under the application of T_6 (Copper Sulphate @) 0.25%) followed by T_1 (Control) with (146.22 q/ha).

The results of the interaction were found significant and therefore, are being discussed about yield attributes here. It was revealed that the yield components *viz.* days to 50% knob maturity (days), days to knob harvest (days), yield of knob (kg/plot), total yield of knob (q/ha), were observed significantly increased in the treatment of $ZnSO_4$ @ 0.25% as liken control. The significant influence effect of foliar application of $ZnSO^4$ to the positively affect found which is taken minimum period (38.53) days to 50% knob maturity. This agreement is similar as, Kotecha *et al.* (2016) in cabbage, Chowdhury and sikder (2019) in broccoli, Swain *et al.* (2015) in cauliflower, Hange *et al.* (2020) in knol khol. The shortest taken time for days to knob harvest (60.32 days), highest produced of yield of knob per plot (15.22 kg/plot) and increased total yield of per hectare (159.32 q/plot) was significantly found under the application of $ZnSO_4$ among the all treatments, It may be accelerated micro-nutrient because Zn is very fruitful micronutrients to enhanced maximum yield. According to Tisdole *et.al* (1984) Zinc is the most effective nutrients for generating carbonic anhydrase and hydrogenase activity, this is a stabilizer for fractions of ribosomal action as well as the synthesis of chromosomes in plants therefore, it's beneficial for enhancing of yield attributes. Similar results were recorded by Ain *et al.* (2021) in broccoli, Ratan & Kavita (2017) in broccoli, Kumar *et al*. (2023) in cauliflower, Swain *et al.* (2015) in cauliflower. Effective result was obtained by application of B_3HO_3 enhanced the average weight of knob in knol khol maximum significant result was observed 214.35 g under the application of boric acid 0.25%. Boric acid applied as a foliar spray to enhance plant health and resilience. It stimulates plant growth, increase nutrient uptake and improves stress tolerance in adverse environmental conditions. The findings are in line with Thapa *et al.* (2016) in broccoli. The highly significant volume of the knob was recorded 127.26 and 126.83 under the spraying of ($CuSO_4$ and H_3BO_3). As similar as Matwaly *et al.* (2016) in broccoli, Metwaly *et al.* (2020) in cauliflower, Ratan & Kavita (2017) in broccoli, Hange *et al.* (2020) in knol khol.

Table 2 : Effect of micronutrients on Days to 50 % knob maturity (days), Days to knob harvesting (days), Average weight of knob (g), Volume of knob (cc), knob length (cm), knob diameter (cm), yield of knob Kg/plot, total yield q/ha.

S. No	Treatment	Days to 50% knob maturity (days)	Days to knob harvesting (days)	Average weight of knob(g)	Volume of knob (cc)	Knob length (cm)	Knob Diameter (cm)	Yield of knob Kg/plot	Total yield q/ha
1	T_1 (Control)	45.89	68.15	203.21	116.04	5.79	6.61	13.56	146.22
2	T_2 $ZnSo_4$@0.25%	38.53	60.32	210.34	126.13	6.55	6.59	15.22	159.32
3	T_3ZnSo_4@0.50%	44.53	60.72	209.87	119.40	7.65	6.74	14.72	154.93
4	$T_4B_3Ho_3$@0.25%	40.04	60.94	214.35	126.83	7.55	6.49	14.39	156.61
5	T_5 B_3Ho_3@0.50%	43.63	62.03	201.73	124.58	5.32	5.22	13.31	151.83
6	T_6CuSo_4@0.25%	44.24	61.55	192.18	127.26	5.37	5.50	12.68	142.29
7	T_7CuSo_4@0.50%	43.89	61.55	179.14	124.32	5.64	5.02	12.89	143.26
	C.V	5.32	3.75	5.36	2.84	12.54	12.21	6.39	3.52
	CD (5%)	4.07	4.16	19.22	6.25	1.40	1.31	1.57	9.43

Conclusion

The present investigation was carried out the year 2022-23 for a single season therefore, it is not possible to find a definitive conclusion based on one season data. However, on the basis of result founded the application of different micro-nutrients (Cu, B and Zn) show effective response in growth, yield and quality parameters in Knol-khol. The experimental results

were revealed that T_2-Zinc sulphate @ 0.25%, T_3-zinc sulphate @ 0.50%, T_4-boric acid @ 0.25% T_5-boric acid 0.50% was found better for growth and yield parameters.

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