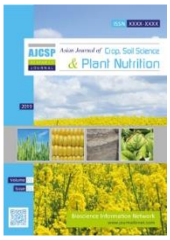
Published with Open Access at Journal BiNET
Vol. 10, Issue 01: 377-386

Asian Journal of Crop, Soil Science and Plant Nutrition

Journal Home: https://www.journalbinet.com/ajcsp-journal.html



Enhancement of growth and yield of broccoli (*Brassica oleracea L. var. italica*) through different doses of potassium and zinc

Madhuri Rani Roy[1], Md. Rezaul Karim[2], Md. Rashed Khan Milon[1], Md. Harun Ar. Rashid[2] and Tamanna Haque[2]

[1]Bangladesh Jute Research Institute, Manik Mia Avenue, Dhaka, Bangladesh
[2]Department of Horticulture, Bangladesh Agricultural University, Mymensingh, Bangladesh

✉ Article correspondence: roy.madhury857@gmail.com (Roy, MR)
Article received: 12.12.2023; Revised: 28.04.2024; First published online: 15 May, 2024.

ABSTRACT

To assess the effect of potassium and zinc on growth and yield of broccoli an experiment was conducted at the Horticulture Farm, Bangladesh Agricultural University, during the period from November 2017 to February 2018. The experiment consisted of four doses of potassium (K), Viz. K_0: 0 (Control), K_1: 50 kg, K_2: 70 kg and K_3: 100 kg per hectare and four doses of Zinc (Zn), Viz, Zn_0: 0 (Control), Zn_1: 1 Kg, Zn_2: 2 Kg and Zn_3: 3 Kg per hectare, respectively. The two-factor experiment was laid out in Randomized Complete Block Design with three replications. The results of the experiment revealed that plant height, primary curd diameter, primary curd weight, secondary curd weight, stem diameter, yield per hectare were significantly increased by different levels of Potassium (100 kg/ha), gave the best result on plant height (47.48 cm), primary curd diameter (13.76 cm), primary curd weight (228.86 gm), weight of secondary curd (36.37 gm) stem diameter (3.49 cm), yield per plant (265.23 gm), yield per plot 3.18 kg and yield per hectare (13.26 ton). The highest level of zinc (3 kg/ha) produced the best result on plant height (45.13 cm), plant spread (39.99 cm), primary curd diameter (214.39 g), secondary curd weight (32.55 g), stem diameter (3.21 cm), yield per plant (246.94 g), yield per plot (2.96 kg) and yield per hectare (12.35 t). The combined treatment of 100 kg potassium and 3 kg zinc per hectare produced the highest weight of primary curd (276.04 gm), yield per plot (3.78 kg) and yield per hectare (15.75 t). The lowest weight of primary curd (141.98 g), yield per plot (1.70 kg) and yield per hectare (7.08t) were obtained from no application of potassium and zinc at harvest. Considering the above findings, applications of 100 kg potassium with 3 kg zinc per hectare appeared to be suitable for growth and yield of broccoli.

Key Words: *Enhancement, Potassium; Zinc; broccoli; Curd; Growth and Yield.*

Cite Article: Roy, M. R., Karim, M. R., Milon, M. R. K., Rashid, M. H. A. and Haque, T. (2024). Enhancement of growth and yield of broccoli (*Brassica oleracea L. var. italica*) through different doses of potassium and zinc. Asian Journal of Crop, Soil Science and Plant Nutrition, 10(01), 377-386. **Crossref:** https://doi.org/10.18801/ajcsp.100124.46

I. Introduction

Broccoli (*Brassica oleracea* L. var. *italica*) is a nutritious green vegetable belonging to the Brassicaceae family. It has a large head called a curd and is commonly consumed as a vegetable. Broccoli is healthier than cauliflower, which belongs to the same genus. While it originally comes from temperate regions, it is now grown in both sub-tropical and tropical areas. In Bangladesh, broccoli was introduced several years ago and can also be found in the Mediterranean region (Decoteau, 2000). Broccoli is rich in nutrients, including 3.3% protein and vitamins C, A, niacin, thiamine, riboflavin, calcium, and iron. It also contains a high amount of carotenoids, which are pigments found in many fruits and vegetables. Carotenoids have a positive effect on ocular diseases, cardiovascular health, and cancer prevention (Kirsh et al., 2007). Broccoli is often referred to as a "jewel vegetable" due to its high content of vitamins and minerals (Vasanthi et al., 2009).

The cultivation of broccoli dates to the sixth century BC and is the result of research on breeding cultivated Brassica vegetables in the northern Mediterranean region (Maggioni et al., 2010). It is considered a storehouse of vitamins, minerals, fiber and antioxidants. Broccoli is a high-profile vegetable crop with significant commercial value (Yoldas et al., 2008) [12]. It is a healthy and nutritious food, providing dietary fiber and a wide range of vitamins and minerals, such as vitamins A, C, K, E (Alpha Tocopherol), B6, folate, niacin, pantothenic acid, calcium, iron, magnesium, phosphorus, potassium and zinc. Broccoli also contains 3.3% protein, thiamine, and riboflavin. It can be found in various colors, including green, white, and purple, with the green variety being the most nutritious and popular. Green broccoli contains phytochemicals like sulforaphane, which has anti-cancer properties, and antioxidants that offer medicinal value and health benefits.

A garden-fresh broccoli consists of 89.1% water, 2500 IU of vitamin A and 113 mg of vitamin C per 100 g (Dhaliwal, 2012). It also contains anti-cancer elements and high levels of active phytochemicals called glucosinolates (Zhao et al., 2007). However, broccoli yields in Bangladesh are lower compared to other countries. Several factors contribute to this, including the unavailability of quality seeds of high-yielding varieties, limited knowledge of fertilizer management, pest and disease infestations, and inadequate irrigation facilities. To improve broccoli production, the use of different nutrient doses or balanced nutrient management can play a key role (Ambrosini et al., 2015).

Zinc (Zn) is crucial for many essential physiological functions and has a positive impact on growth and physiological parameters. For every crop production, a balanced dose of potassium and zinc is required without causing adverse effects on the environment. The ideal amount of applied nutrients for broccoli may vary depending on soil conditions, climate, plant density, and cultivation methods. The required fertilizer doses, which vary based on biotic and abiotic conditions, should be determined through exact field trials specific to the soil and climate. Therefore, the goal of this experiment was to assess the positive effects of different doses of potassium and zinc fertilizers on the growth and yield of broccoli.

II. Materials and Methods

The present experiment was conducted at Horticulture Farm, Bangladesh Agricultural University, Mymensingh, from October 2017 to February 2018. The soil of the experimental area was sandy loan type and the Old Brahmaputra Flood Plain Alluvial Tract (UNDP, 1988). The selected plot was a high land fertile, well drained and having pH of 6.8. The variety of broccoli used in the experiment was the "Green Sprout". Its seeds were collected from M/S Moushumi Biz Bitan, 58, Rambabu Road, Mymensingh. The two-factor experiment included four does of potassium and four doses of zinc:

Factor A : Different does of potassium	Factor B : Different doses of zinc
K_0 = 0 Kg ha^{-1} of K (control)	Zn_0 = 0 Kg ha^{-1} of Zn (control)
K_1 = 50 Kg ha^{-1} of K	Zn_1 = 1 Kg ha^{-1} of Zn
K_2 = 75 Kg ha^{-1} of K	Zn_2 = 2 Kg ha^{-1} of Zn
K_3 = 100 Kg ha^{-1} of K	Zn_3 = 3 Kg ha^{-1} of Zn

The experiment was laid out in randomized complete block design (RCBD) with three replications. Each block consists of 16 plots. Thus, the total number of plots was 48. In each block, combinations of different levels of potassium and zinc were assigned randomly. The size of a unit was 1.6 m × 1.5 m. Distance of 0.3 m between the plots and 5 m between the blocks were maintained. Thus, the total area of the experiment was 221.65 m^2.

EISSN 2706-5510

During land preparation, well-decomposed cow dung was applied to the plots at the rate of 10 t/ha and incorporated into the soil. Triple super phosphate (TSP) was applied at the rate of 150 kg/ha as a basal dose to provide 72 kg P_2O_5/ha (FRG, 2012). The experimental land was fallow during land preparation. The land was prepared for cultivation of broccoli on the 11th October, 2017 with a power tiller and was concomitantly ploughed several times to obtain a good tilth ready for transplanting the seedlings. Weeding was done during land preparation and stubble was removed from the field and the land was uniformly leveled by ladder. Cow dung was applied on 7 November, 2017 and Triple super phosphate (TSP) on 3 November, 2017. The insecticide Bisteran was applied to the soil to kill soil insects. Ring method was used for application of total amount of urea and MoP fertilizer. At first, one-third of urea and MoP were applied after 15 days of transplanting. The rest of the urea and MoP were applied in two installments at 30 and 45 days after transplanting. During land preparation, a basal dose of half of the nitrogen @ 120 kg ha^{-1}, full dose of phosphorous @ 100 kg ha^{-1} was applied and potassium @ 150 kg ha^{-1} was applied in three uniform installments at 15, 30 and 45 days after transplanting. At the time of transplanting, nitrogen was applied in two splits and rest half after 45 days after transplanting.

Different plant growth parameters, i.e. plant height, stem length, stem diameter, primary curd weight, primary curd diameter was recorded and analyzed. Weight of secondary curd, primary and secondary curd yield per plot and primary and secondary curd yield per hectare were also recorded.

The data collected from the experimental plants to various characters were statistically analyzed to find out the differences among the treatments. The analysis of variance for most of the characters under consideration was performed by F-test. Mean comparison of the treatments was evaluated by the least significant difference (LSD) test.

III. Results and Discussion

Plant height

Potassium has a significant effect on plant height of broccoli. The plant height was increased gradually with the advancement of time and continued up to 60 DAT. At 20, 40 and 60 DAT the maximum plant height (15.03 cm), (32.73 cm) and (50.56 cm) were obtained from K_3. The lowest (12.02 cm), (28.80 cm) and (43.19 cm) were recorded at control (Figure 01). Plant height showed a general trend to increase with the increasing levels of potassium. Similar results were reported by Khatun (1999) and Islam (2001).

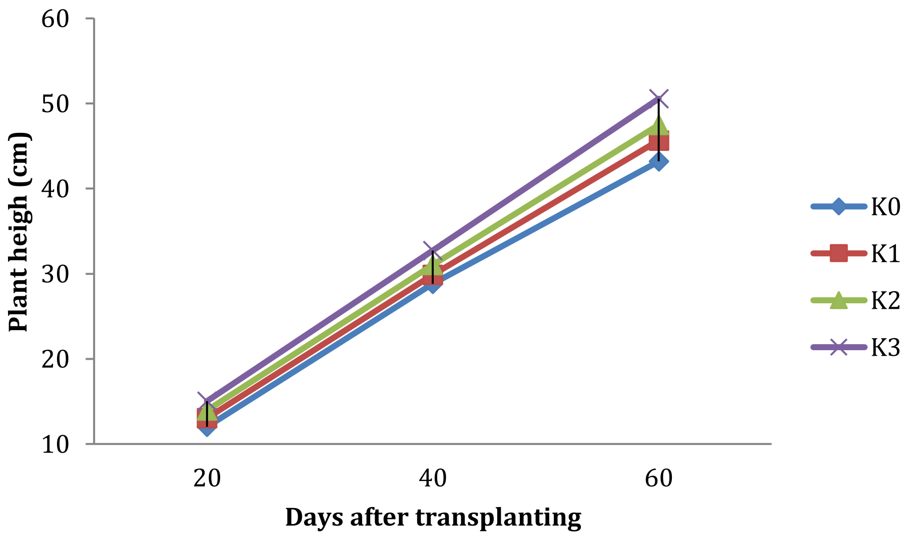


Figure 01. Effect of potassium doses on plant height of broccoli at different days after transplanting.
** = Significant at 1% level of probability K_0 = 0 kg/ha, K_1 = 50 kg/ha, K_2 = 75 kg/ha, K_3 = 100 kg/ha

The application of different levels of zinc also had a significant effect on plant height of broccoli. At 20, 40 and 60 DAT the maximum plant height (14.60 cm), (32.90cm) and (49.61 cm) was obtained from Zn_3 (3 kg/ ha) and lowest from control (Figure 02).

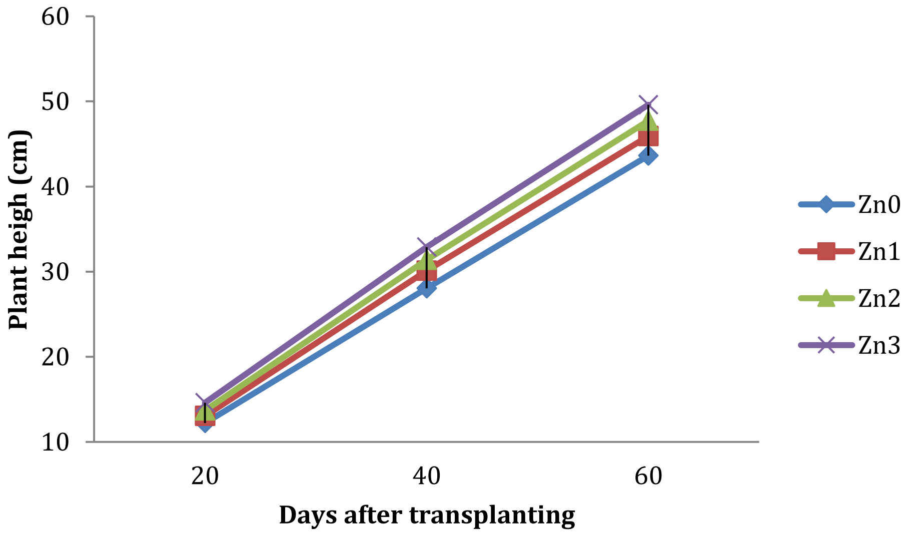


Figure 02. Effect of zinc doses on plant height of broccoli at different days after transplanting.

Interaction of different levels of Potassium and Zinc on plant height was found to be statically significant at different days after transplanting. At 20 DAT the highest plant height (16.20 cm) was observed in the treatment combination of K_3Zn_3 ($K_{100}Zn_3$ kg/ha), while the lowest height (11.02 cm) was observed in the treatment combination of K_0Zn_0 (K_0Zn_0 kg/ha). In case of 40 DAT, the highest plant height (35.47 cm) was observed in the treatment combination of K_3Zn_3 ($K_{100}Zn_3$ kg/ha), while the lowest height (26.84 cm) was observed in the treatment combination of K_0Zn_0 (K_0Zn_0 kg/ha). In case of 60 DAT, the highest plant height (54.75 cm) was observed in the treatment combination of K_3Zn_3 (K_{100} Zn_3 kg/ha), while the lowest height (40.52 cm) was observed in the treatment combination of K_0Zn_0 (K_0 Zn_0 kg/ha) (Table 01). Trehan and Grewal (1981) agreed with the present findings.

Table 01. Combined effects of potassium and zinc doses on plant height and plant spread of broccoli at different days after transplanting.

Treatment combination	Plant height (cm) at different days after transplanting		
	20 DAS	40 DAS	60 DAT
K_0Zn_0	11.02	26.84	40.52
K_0Zn_1	11.80	28.50	42.68
K_0Zn_2	12.15	29.47	44.22
K_0Zn_3	13.10	30.39	45.34
K_1Zn_0	12.09	27.63	42.72
K_1Zn_1	12.75	29.25	45.33
K_1Zn_2	13.25	30.47	46.72
K_1Zn_3	14.11	32.14	47.88
K_2Zn_0	12.75	28.65	44.62
K_2Zn_1	13.89	30.22	46.50
K_2Zn_2	14.17	31.75	48.33
K_2Zn_3	15.00	33.58	50.48
K_3Zn_0	12.96	29.09	46.64
K_3Zn_1	13.71	32.47	49.17
K_3Zn_2	15.18	33.89	51.66
K_3Zn_3	16.20	35.47	54.75
$LSD_{0.05}$	0.20	0.33	0.37
$LSD_{0.01}$	0.28	0.44	0.50
Level of significance	**	**	**

**= Significant at 1% level of probability; K_0=0 kg/ha, K_1=50 kg/ha, K_2=75 kg/ha, K_3=100 kg/ha, Zn_0=0 kg/ha, Zn_1=1 kg/ha, Zn_2 =2 kg/ha, Zn_3=3 kg/ha

Spread of plant

Different levels of Potassium fertilizer significantly influenced the highest plant spreading. The maximum plant spreading at 20 DAT was (14.64 cm) in K_3 (K_{100} kg/ha) and minimum plant spreading was recorded (10.79 cm) in K_0 (K_0 kg/ha). At 40 DAT, the maximum plant spread (34.65 cm) was found in K_3 (K_{100} kg/ha) while the minimum plant spread (30.68 cm) was obtained from K_0 (K_0 kg/ha). In case of 40 DAT, the maximum plant spread (42.37 cm) was found in K_3 (K_{100} kg/ha), while the minimum plant spread (36.96 cm) was found in K_0 (K_0 kg/ha) (Table 02).

Table 02. Effect of potassium doses on plant spreads of broccoli on different days after transplanting.

Potassium doses	Plant spreads (cm) at different days after transplanting		
	20	40	60
K_0	10.79	30.68	36.96
K_1	12.34	32.09	38.31
K_2	13.64	33.51	39.82
K_3	14.64	34.65	42.37
$LSD_{0.05}$	0.109	0.053	0.075
$LSD_{0.01}$	0.146	0.071	0.100
Levels of significance	**	**	**

** = Significant at 1% level of probability K_0 = 0 kg/ha, K_1 = 50 kg/ha, K_2 = 75 kg/ha, K_3 = 100 kg/ha

The spread of plants was also significantly influenced by the different levels of zinc fertilizer. At 20 DAT, the maximum plant spread (13.30 cm) was found in Zn_3 (Zn_3 kg/ha), while the minimum plant spread (12.38 cm) was found in Zn_0 (Zn_0 kg/ha). In case 40 DAT, the maximum plant spread (33.19 cm) was found in Zn_3 (Zn_3 kg/ha), while the minimum plant spread (32.24 cm) was found in Zn_0 (Zn_0 kg/ha). In case 60 DAT, the maximum plant spread (39.99 cm) was found in Zn_3 (Zn_3 kg/ha), while the minimum plant spread (38.78 cm) was found in Zn_0 (Zn_0 kg/ha) (Table 03).

Table 03. Effect of zinc doses on plant spread of broccoli at different days after transplanting.

Zinc doses	Plant spread (cm) at different days after transplanting		
	20	40	60
Zn_0	12.38	32.24	38.78
Zn_1	12.71	32.55	39.16
Zn_2	13.01	32.94	39.54
Zn_3	13.30	33.19	39.99
$LSD_{0.05}$	0.109	0.053	0.075
$LSD_{0.01}$	0.146	0.071	0.100
Levels of significance	**	**	**

** = Significant at 1% doses of probability; Zn0 = 0 kg/ha, Zn1 = 1 kg/ha, Zn2 = 2 kg/ha, Zn3 = 3 kg/ha

Spreading of plants with different DAT was found to be statistically due to effect of different doses of K and Zn fertilizer (Table 04). At 20 DAT, the maximum plant spread (14.96 cm) was found from treatment combinations K_3Zn_3 (K_3Zn_3 kg/ha), while the minimum plant spread (10.25 cm) was found from treatment combinations K_0Zn_0 (K_0Zn_0 kg/ha). In case of 40 DAT, the maximum plant spread (34.98 cm) was found from treatment combinations K_3Zn_3 (K_3Zn_3 kg/ha) while the minimum plant spread (30.09 cm) was found from treatment combinations K_0Zn_0 (K_0Zn_0 kg/ha). In case of 60 DAT, the maximum plant spread (43.05 cm) was found from treatment combinations K_3Zn_3 (K_3Zn_3 kg/ha), while the minimum plant spread (36.33 cm) was found from treatment combinations K_0Zn_0 (K_0Zn_0 kg/ha).

Diameter of primary curd

The diameter of primary curd per plant was found to be highly significant due to different levels of K fertilizer. The maximum diameter of primary curd (13.76 cm) was found from K_3 (K_{100} kg/ha). The lowest diameter of curd (9.84 cm) of broccoli was found from K_0 (K_0 kg/ ha) (Table 05). Different levels of Zinc fertilizer had a significant effect on diameter of broccoli. The maximum diameter of primary curd (12.26 cm) was found in Zn_3 (Zn_3 kg/ha) and the lowest diameter of primary curd in Zn_0 (Zn_0 kg/ha) (Table 06). The combined effect of K and Zn fertilizer on diameter of broccoli plant was found significant. The maximum curd diameter (14.22 cm) was found from a treatment combination of K_3Zn_3 ($K_{100}Zn_3$ kg/ha) and the lowest curd diameter was found treatment combination of K_0Zn_0 (K_0 Zn_0 kg/ha) (Table 07). Higher amounts of potassium contribute to higher curd weight and curd diameter, at least at a specific range of K application (Patwary et al., 2015).

Table 04. Combined effects of potassium and zinc doses on plant spread of broccoli on different days after transplanting.

Treatment combination	Plant spread (cm) on different days after transplanting		
	20	40	60
K_0Zn_0	10.25	30.09	36.33
K_0Zn_1	10.41	30.57	36.85
K_0Zn_2	11.09	30.93	37.12
K_0Zn_3	11.41	31.13	37.56
K_1Zn_0	11.83	31.66	37.86
K_1Zn_1	12.26	31.84	38.09
K_1Zn_2	12.42	32.29	38.45
K_1Zn_3	12.83	32.55	38.82
K_2Zn_0	13.12	32.91	39.17
K_2Zn_1	13.68	33.26	39.62
K_2Zn_2	13.77	33.76	39.96
K_2Zn_3	14.01	34.10	40.52
K_3Zn_0	14.35	34.30	41.77
K_3Zn_1	14.50	34.54	42.07
K_3Zn_2	14.76	34.77	42.61
K_3Zn_3	14.96	34.98	43.05
$LSD_{0.05}$	0.217	0.105	0.149
$LSD_{0.01}$	0.293	0.142	0.201
Level of significance	**	**	**

**= Significant at 1% doses of probability; K_0 =0 kg/ha, K_1=50 kg/ha, K_2=75 kg/ha, K_3=100 kg/ha; Zn_0=0 kg/ha, Zn_1=1 kg/ha, Zn_2=2 kg/ha, Zn_3=3 kg/ha

Weight of primary curd

A significant variation was found due to application of K fertilizer with respect to weight of primary curd per plant. The highest primary curd weight per plant (228.86 g) was obtained from K_3 (100 kg/ ha) and the lowest weight (128.07 g) was from K_0 (0 kg/ha) (Table 05). The application of Zn fertilizer influenced the weight of primary curd. The highest primary curd weight (214.39 g) was recorded from K_3 (100 kg/ha) and the lowest curd weight (153.77 g) was obtained from Zn_0 (0 kg/ha) (Table 06). A similar finding was reported by Guan and Chen (2001). The combined effect of P and Zn fertilizer on weight of primary curd is statistically significant. The highest curd weight (276.04 g) was recorded in the treatment combination of K_3Zn_3 ($K_{100}Zn_3$ kg/ha), while the lowest curd weight (116.37 g) was obtained from treatment combination of K_0Zn_0 (K_0Zn_0 kg/ha) (Table 07). Patwary et al. (2015) reported a similar trend of results.

Table 05. Effect of potassium doses on diameter of primary curd, weight of primary curd, diameter of secondary curd, weight of secondary curd, stem diameter, yield/plant, yield/plot and yield/ha. of broccoli.

Potassium doses	Diameter of primary curd (cm)	Weight of primary curd (g)	Weight of secondary curd (g)	Stem diameter (cm)	Yield/ plant (g)	Yield/ plot (kg)
K_0	9.84	128.07	26.41	2.50	154.48	1.85
K_1	11.01	164.59	28.58	3.06	193.17	2.32
K_2	12.38	211.04	32.08	3.26	243.13	2.92
K_3	13.76	228.86	36.37	3.49	265.23	3.18
$LSD_{0.05}$	0.079	6.23	0.376	0.026	6.36	0.075
$LSD_{0.01}$	0.107	8.39	0.506	0.036	8.56	0.100
Levels of sig.	**	**	**	**	**	**

**= Significant at 1% doses of probability; K_0 =0 kg/ha, K_1 =50 kg/ha, K_2 =75 kg/ha, K_3 =100 kg/ha

Weight of secondary curd

There was a significant influence of K fertilizer on the weight of secondary plant. The Maximum weight of secondary curds per plant (36.37) was obtained from K_3 (100 kg/ha) and the lowest weight of secondary curd (26.41) was obtained from K_0 (0 kg/ha) (Table 05). The weight of secondary curds per plant showed significant variation with the application of different levels of Zinc fertilizer. The highest weight of secondary curds per plant (32.55) was found in Zn_3 (3 kg/ha) and the lowest secondary curd weight curds per plant (29.43) was recorded in Zn_0 (0 kg/ha) (Table 06). The highest weight of secondary curds per plant (39.22) was recorded with the treatment K_3Zn_3 ($K_{100}Zn_3$ kg/ha), while the lowest curd weight (25.61) was obtained from the treatment combination of K_0Zn_0 (0 kg/ha) (Table 07).

Stem diameter

The diameter of stem showed highly significant response to different doses of potassium treatment. Application of potassium at K_3 (100 kg/ha) gave the highest stem diameter of 3.49 cm, while K_2 (75 kg/ha) and K_1 (50 kg/ha) gave the stem diameters of 3.26 cm and 3.06 cm, respectively, which were statistically similar (Table 05). The lowest stem diameter (2.50 cm) was recorded in control treatment. The application of zinc showed a highly significant influence on diameter of stem of broccoli. The stem diameter was found to be the highest (3.21 cm) in Zn_3 (3 kg/ha), followed by Zn_2 (3 kg/ha), producing stem of 3.14 cm diameter. The lowest stem diameter (2.93 cm) was noticed in control treatment (Table 06). The combined as well as interaction effects of potassium and zinc on diameter of stem were found to be highly significant. The highest diameter of stem (3.56 cm) was obtained from K_3Zn_3 ($K_{100}Zn_3$ kg/ha) and the lowest (2.21 cm) was recorded in control treatment as K_0Zn_0 (Table 07).

Table 06. Effect of Zinc doses on diameter of primary curd, weight of primary curd, diameter of secondary curd, weight of secondary curd, stem diameter, yield/plant, yield/plot and yield/ha. of broccoli.

Zinc doses	Diameter of primary curd (cm)	Weight of primary curd (g)	Weight of secondary curd (g)	Stem diameter (cm)	Yield/ plant (g)	Yield/ plot (kg)
Zn_0	11.16	153.77	29.43	2.93	183.20	2.20
Zn_1	11.56	168.41	30.38	3.03	198.79	2.39
Zn_2	12.02	196.00	31.08	3.14	227.08	2.72
Zn_3	12.26	214.39	32.55	3.21	246.94	2.96
$LSD_{0.05}$	0.079	6.23	0.376	0.026	6.36	0.075
$LSD_{0.01}$	0.107	8.39	0.506	0.036	8.56	0.100
Levels of significance	**	**	**	**	**	**

**= Significant at 1% doses of probability; Zn_0 = 0 kg/ha, Zn_1 = 1 kg/ha, Zn_2 = 2 kg/ha, Zn_3 = 3 kg/ha

Yield per plant

K was the most critical element for yield (Ying et al., 1997). The curd yield per plant showed highly significant variation with the application of different levels of K fertilizer. The highest yield per plant (265.23 g) was found in K_3 (100 kg/ha) and the lowest yield per plant (154.84 g) was found in K_0 (0 kg/ha) (Table 05). The effect of different levels of Zn fertilizer on the yield of broccoli per plant was found to be significant. The highest yield per plant (246.94 g) was found in Zn_3 (3 kg/ha) and the lowest (183.20 g) was obtained from Zn_0 (0 kg/ha) (Table 06). Balyan et al. (1994) also observed an increase in curd yield of broccoli by increasing Zn application up to 4.2 $kgha^{-1}$. Balyan and Shankhar (1988) observed that application of 20 kg $ZnSO_4ha^{-1}$ increased the curd size (201 gha^{-1}) of broccoli significantly. The interaction effect of K and Zn fertilizers on the curd yield per plant was found to be statistically significant. The highest curd yield per plant (315.26 g) was recorded from the treatment combination K_3Zn_3 ($K_{100}Zn_3$ kg/ha) and the lowest yield per plant (141.98 g) was obtained from the treatment combination K_0Zn_0 (0 kg/ha) (Table 07). Increased growth attributes might be because, besides the role of zinc in chlorophyll formation, it also influences cell division, meristematic activity of tissues, expansion of cells, and formation of cell walls. Similar results were also reported by Singh and Ram (2001).

Yield per plot and per hectare

The yields of broccoli per plot as well as per hectare were significantly influenced by different levels of K fertilizers. The highest broccoli curd per plot (2.92 kg) (Table 05) and per hectare (12.35 t) (Figure 03) were recorded from K_3 (100 kg/ha), while the lowest yield per plot (9.16 t) was found in K_0 (0 kg/ha). The increase in yields per plot and per hectare was due to the application of high potassium fertilizer. The present study showed that the increased dose of the maximum yield was fairly in agreement with the findings of Sarker et al. (1991) and Haque (1999). Different levels of Zn fertilizers significantly influenced the yields of broccoli per plot as well as per hectare. The maximum yield per plot (2.96 kg) (Table 06) and per hectare (12.35 t) (Figure 04) were recorded from Zn_3 (3 kg/ha), while the lowest yield per plot (2.20 kg) and per hectare (9.16 t) (Figure 04) was obtained from Zn_0 (0 kg/ha). These results indicated that yields per plot and hectare can be enhanced with the application Zn_1 fertilizer and almost same effect of Zn_2 fertilizer and Zn_3 treatment. Sharma and Grewal (1988) observed that zinc increased the yield of curd. Pandey et al. (1974) reported that broccoli grown in zinc deficient soil responded markedly in terms of yield and quality to the application of 20 kg $ZnSO_4ha^{-1}$.

Table 07. Combined effects of potassium and zinc doses on diameter of primary curd, weight of primary curd, weight of secondary curd, stem diameter, yield/plant, yield/plot on broccoli.

Treatment combination	Diameter of primary curd (cm)	Weight of primary curd (g)	Weight of secondary curd (g)	Stem diameter (cm)	Yield/ plant (g)	Yield/ plot (kg)
K_0Zn_0	9.14	116.37	25.61	2.21	141.98	1.70
K_0Zn_1	9.40	123.87	26.01	2.39	149.88	1.80
K_0Zn_2	10.35	133.22	26.80	2.66	160.02	1.92
K_0Zn_3	10.49	138.84	27.22	2.75	166.06	1.99
K_1Zn_0	10.66	146.68	27.67	2.89	174.35	2.09
K_1Zn_1	10.85	166.64	28.40	3.05	195.04	2.34
K_1Zn_2	11.05	168.86	28.82	3.13	197.68	2.37
K_1Zn_3	11.45	176.20	29.42	3.19	205.61	2.47
K_2Zn_0	11.77	170.36	30-.21	3.21	200.57	2.41
K_2Zn_1	12.24	173.15	31.46	3.23	204.61	2.46
K_2Zn_2	12.66	234.17	32.34	3.27	266.50	3.20
K_2Zn_3	12.85	266.49	34.32	3.33	300.82	3.61
K_3Zn_0	13.06	181.66	34.24	3.41	215.90	2.59
K_3Zn_1	13.75	209.98	35.66	3.47	245.64	2.95
K_3Zn_2	14.02	247.75	36.36	3.51	284.11	3.41
K_3Zn_3	14.22	276.04	39.22	3.56	315.26	3.78
$LSD_{0.05}$	0.158	12.45	0.751	0.053	12.71	0.149
$LSD_{0.01}$	0.213	16.77	1.01	0.071	17.12	0.201
Level of significance	**	**	**	**	**	**

**= Significant at 1% doses of probability; K_0= 0 kg/ha, K_1= 50 kg/ha, K_2= 75 kg/ha, K_3= 100 kg/ha; Zn_0= 0 kg/ha, Zn_1= 1 kg/ha, Zn_2= 2 kg/ha, Zn_3= 3 kg/ha

The interaction of different levels of K and Zn fertilizers had a significant influence on curd yields per plot and per hectare of broccoli (Table 07). The highest yield per plot (3.78 kg) and per hectare (15.76 t) (Figure 05) were recorded from the treatment combination of K_3Zn_3 ($K_{100}Zn_3$ kg/ha) and the lowest yield per plot (1.70 kg) and per hectare (7.10 t) (Figure 05) was recorded from the treatment combination of K_0Zn_0 (0 kg/ha). Theunissen et al. (2010) reported a similar trend of results. The results presented in this study conform well with those of other researchers.

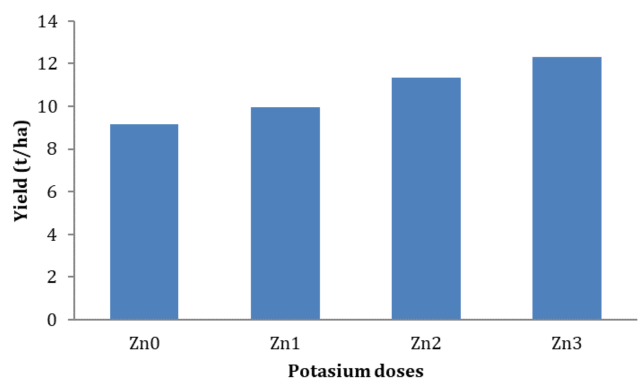


Figure 03. Effect of potassium doses on yield (t/ha) of broccoli.

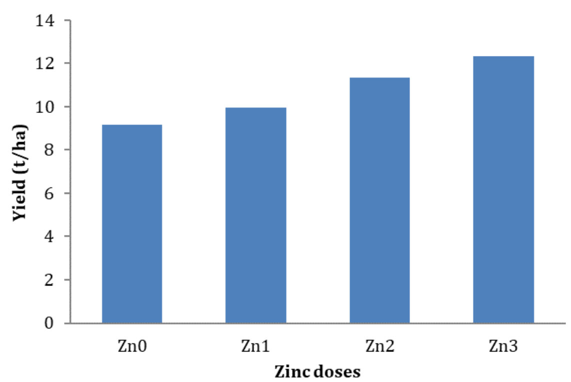


Figure 04. Effect of zinc doses on yield (t/ha) of broccoli.

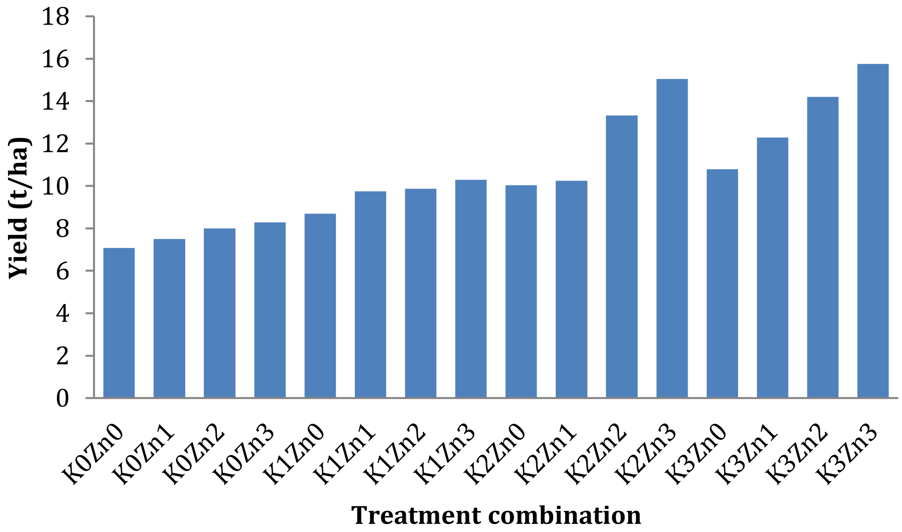


Figure 05. Combined effects of potassium and zinc doses on yield (t/ha) of broccoli.

IV. Conclusion

The present findings have indicated that the combined interaction of different levels of K and Zn fertilizers had a significant influence on curd yields per plot and hectare of broccoli. The highest yield per plot (3.78 kg) and per hectare (15.75 t) were recorded from the treatment combination of K_3Zn_3 ($K_{100}Zn_3$ kg/ha) and the lowest yield per plot (1.70 kg) and per hectare (7.08 t) was recorded from the treatment combination of K_0Zn_0 (0 kg/ha). However, further studies can be conducted using different levels of potassium and zinc in different agro-ecological zones of Bangladesh for a regional recommendation.

References

[1]. Abd El-All, H. M. (2014). Improving growth, yield, quality and sulphoraphan content as anticancer of broccoli (*Brassica oleracea* Var. *italic* L.) plants by some fertilization treatment. Middle East Journal of Agriculture Research, 3(1), 13-19.

[2]. Ambrosini, V. G., Voges, J. G., Benevenuto, R. F., Vilperte, V., Silveira, M. A., Brunetto, G. and Ogliari, J. B. (2015). Single-head broccoli response to nitrogen application. Científica, 43, 84-92. https://doi.org/10.15361/1984-5529.2015v43n1p84-92

[3]. Balyan, D. S., Shankhar, B. N. (1988). Effect of nitrogen, phosphorus and zinc on growth and yield of broccoli. Harayana Journal of Agriculture Research University, 18(3), 220-229.

[4]. Balyan, D. S., Singh, J., Srivastava, V. K. (1994). Nitrogen and Zinc interactions in broccoli. Crop Research, 8(3), 537-542.

[5]. Decoteau, D. R. (2000). Vegetable crops, upper river company; calcium, magnesium, and potassium interrelationships affecting cabbage production. Journal of American Society for Agronomy 106, 500– 503. https://doi.org/10.21273/JASHS.106.4.500

[6]. Dhaliwal, M. S. (2012). Handbook of Vegetable Crops. Kalyani Publishers, New Delhi, India.

[7]. Guan, P. C. and Chen, R. Y. 2001. Evaluation of N, K application on plant growth, curd yield characteristics of cauliflower and broccoli. Department of Horticulture, Acta Horticulturae Sinica, 23(4), 115-119.

[8]. Haque, A. F. M. Z. (1999). Effect of different levels of N and P on the growth and yield of broccoli. MS Thesis, Department of Horticulture, Bangladesh Agricultural University, Mymensingh pp. 33-40.

[9]. Islam, M. R. (2001). Effect of mulching and yields of N and K an growth and yield of broccoli. MS Thesis, Department of Horticulture, Bangladesh Agricultural University, Mymensingh pp 35-58.

[10]. Khatun, K. (1999). Effect of different mulching and potassium levels on the growth and yield of broccoli. MS Thesis, Department of Horticulture, Bangladesh Agricultural University, Mymensingh. pp 44-53.

EISSN 2706-5510

[11]. Kirsh, V. A., Peters, U., Mayne, S. T., Subar, A. F., Chatterjee, N., Johnson, C. C. and Hayes, R. B. (2007). Prospective study of fruit and vegetable intake and risk of prostate cancer. Journal of the National Cancer Institute. Published online ahead of print. https://doi.org/10.1093/jnci/djm065

[12]. Maggioni, L., Von Bothmer, R., Poulsen, G. and Branca, F. (2010). Origin and domestication of cole crops (*Brassica oleracea* L.): Linguistic and literary considerations. Economic Botany, 64, 109–123. https://doi.org/10.1007/s12231-010-9115-2

[13]. Pandey, U. C., Shukla, U. C. and Singh, K. (1974). Effect of Zinc and boron on yield and quality of broccoli. Haryana Journal of Horticultural Science, 3(3-4), 201-205.

[14]. Patwary, N. H., Rahman, M. A., Mondal, M. F., Ahmed, S., Shahidullah, S. M. (2015). Effect of cultivation method and fertilizer management on the growth and yield of carrot. International Journal of National Social Science, 2(1), 72-85.

[15]. Sarker, N. K., Sharfuddin, A. F. M., Aditya, D. K. (1991). Effect of NPK Fertilizers on growth and yield of broccoli. Bangladesh Horticulture, 2(1) 29-34.

[16]. Sharma, U. C. and Grewal, J. S. (1988). Relative effectiveness of methods of micronutrients application of broccoli. Journal of Indian Social Soil Science, 36(1), 128-132.

[17]. Singh, A. K. and Ram, H. (2001). Effect of phosphorus and zinc on yield and quality of mungbean. Annals of Plant and Soil Research, 3, 307-309.

[18]. Theunissen, J., Ndakidemi, P. A. and Laubscher, C. P. (2010). Potential of cowdung produced from plant waste on the growth and nutrient status in vegetable production. International Journal of Physical Science, 5(13), 1964-1973.

[19]. Trehan, S. P. and Grewal, J. S. (1981). Comparative efficiency of methods of application of zinc to broccoli. Indian Journal of Agricultural Science, 51(4), 240-243.

[20]. Vasanthi, H., Mukherjee, S. and Das, D. (2009). Potential health benefits of broccoli- a chemico-biological overview. Mini-Reviews in Medical Chemistry, 9, 749–759. https://doi.org/10.2174/138955709788452685

[21]. Ying, W. G., Zheng, Z. C., Shan, Z. F. (1997). Effect nitrogen phosphorus and potassium fertilizer on the yield physiology target of broccoli. China Vegetable, 1, 14-17.

[22]. Yoldas, F., Ceylan, S., Yagmur, B. and Mordogan, N. (2008). Effect of nitrogen fertilizer on yield quality and nutrient content in broccoli. Journal of Plant Nutrition, 31, 1333-43. https://doi.org/10.1080/01904160802135118

[23]. Zhao, H., Lin, J., Grossman, H. B., Hernandez, L. M., Dinney, C. P. and Wu, X. (2007). Dietary isothiocyanates, GSTM1, GSTT1, NAT2 polymorphisms and bladder cancer risk. International Journal of Cancer, 120, 2208–2213. https://doi.org/10.1002/ijc.22549

HOW TO CITE THIS ARTICLE?

MLA

Roy et al. "Enhancement of growth and yield of broccoli (*Brassica oleracea* L. var. italica) through different doses of potassium and zinc". Asian Journal of Crop, Soil Science and Plant Nutrition, 10(01), (2024):377-386.

APA

Roy, M. R., Karim, M. R., Milon, M. R. K., Rashid, M. H. A. and Haque, T. (2024). Enhancement of growth and yield of broccoli (*Brassica oleracea* L. var. italica) through different doses of potassium and zinc. Asian Journal of Crop, Soil Science and Plant Nutrition, 10(01), 377-386.

Chicago

Roy, M. R., Karim, M. R., Milon, M. R. K., Rashid, M. H. A. and Haque, T. "Enhancement of growth and yield of broccoli (*Brassica oleracea* L. var. italica) through different doses of potassium and zinc". Asian Journal of Crop, Soil Science and Plant Nutrition, 10(01), (2024): 377-386.

Harvard

Roy, M. R., Karim, M. R., Milon, M. R. K., Rashid, M. H. A. and Haque, T. 2024. Enhancement of growth and yield of broccoli (*Brassica oleracea* L. var. italica) through different doses of potassium and zinc. Asian Journal of Crop, Soil Science and Plant Nutrition, 10(01), pp. 377-386.

Vancouver

Roy, MR, Karim, MR, Milon MRK, Rashid, MHA and Haque, T. Enhancement of growth and yield of broccoli (*Brassica oleracea* L. var. italica) through different doses of potassium and zinc. Asian Journal of Crop, Soil Science and Plant Nutrition, May 2024 10(01), 377-386.