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Effect of zinc on growth, yield and quality of knol-khol (*Brassica caulorapa* L.)

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Abstract
The field experiment was conducted at Horticulture Farm, S.K.N. College of Agriculture, Jobner (Jaipur) during *Rabi* season 2015-16. The experiment consisting four levels of Zinc (control, 2.5 kg, 5.0 kg and 7.5 kg) with three replications. The application of 7.5 kg zinc per ha found significant effect with maximum plant height, number of leaves per plant leaf area index, volume and diameter of knob, average weight of knob, yield per plant and per ha, N,P,K, Zn, Protein content of knob but being at par with 5.0kg zinc per ha.
The application of 5.0 kg zinc per ha found significantly statistically best with net returns (Rs 299783) and highest B:C ratio (3.03).

Keywords: knolkhol, growth, quality, yield and zink

Introduction
The knol-khol (*Brassica caulorapa* L.) is a member of the cole crops belongs to family cruciferaceae. It has been under cultivation by Romans since 600 B.C. (Bose, 2001) [2]. The knob of knoll khol is generally used as cooked vegetable and utilized for making salad and pickles. Occasionally young leaves are also cooked as vegetable. The modified stem tuber is fairly rich in carbohydrates, proteins, minerals like calcium, magnesium, phosphorus, sodium, sulphur, antioxidants, vitamin A, C, E, carotene and dietary fibre. It also contains sulphoraphanes and other isothiocyanates which are believed to stimulate the production of protective enzymes in the body. It is popular in Kashmir, West Bengal, Maharashtra, Assam, Uttar Pradesh, Punjab, Orissa and some parts of South India.
The plant is greatly influenced by a wide range of nutrients. Among these, zinc is also an essential micro nutrient to increase the production. Zinc is applied in the form of zinc sulphate for the synthesis of tryptophan, precursor of IAA, which is essential for normal cell division and other metabolic process Zinc also plays an important role in oxidation reduction process and helps in the formation of chlorophyll. Zn deficiencies cause interveinal chlorosis, reduced fruit growth, blossoming and fruiting. Similarly, shortened internodes and chlorotic areas on older leaves and yellowing of young leaves due its deficiency well reported by (Shanmugavlu, 1989) [11].

Materials and Methods
The experiment was conducted at Horticulture Farm, S.K.N. College of Agriculture, Jobner (Jaipur) during *Rabi* season 2015-16. In Rajasthan, this region falls under agro-climatic zone-IIIA (Semi-Arid Eastern Plains). The experiment was laid out in Randomized Block Design with four levels of Zinc (Z_0 - control, Z_1 - 2.5 kg zinc/ha, Z_2 - 5.0 kg zinc/ha and Z_3 - 7.5 kg zinc/ha) with three replications. Znic was supplied through znic sulphat (field grade) as soil application at the time of field preparation as per treatment combinations. Each plot measured 1.5 × 1.0 m^2 area. The crop geometry was kept at 30 x 20 cm. All the cultural operations were followed which were necessary to raise the good crop. The observations like Plant height, Average number of leaves per plant, Leaf area index, Volume of knob, Diameter of knob, Average weight of knob, Yield per plot, yield of knob per ha, taken manually. chlorophyll content was determined using the method of Hiscox and Israelstom (1979) with slight modifications. Nitrogen content in the knob was estimated by using Nesselar's reagent by spectrophotometer method (Snell and Snell, 1949) [13],

Phosphorus was estimated by spectrophotometer method using Triacid ammonium molybdnate ammonium vabnadete solution (Jackson, 1967) [5]. Potassium content in knob was estimated by using flame photometer method using triacid (Richards, 1954). Zinc content (%) in knob was estimated by Atomic Absorption Spectrophotometer (AAS) method (Lindsay and Norwell.1978) [7] and protein content were worked out adopting recommended procedures. The data obtained from the trial were subjected to statistical analysis and the results were documented, analysed and presented in tabular form.

Results and Discussion

It is revealed from the Table 1 and Fig 1 that the maximum plant height (28.96 cm), number of leaves (22.7) at harvest and leaf area index (1.75) were recorded with 7.5 kg zinc/ha which were found significantly higher over rest treatments but it was statistically at par with 5.0kg zinc. This is might be due to physiological aspects pertaining to photosynthesis, stomatal conductance and transpiration also exhibited significant increment with znic supplied through zinc sulphate. It indicates that the increase in these parameters might be attributed to increasing in absorption of nutrients from soil which enhanced carbohydrate assimilation and production of new tissue increased vegetative growth. These results are close conformity with the findings of Singh and Singh (2004) [12], in cauliflower, Kazemi (2013) [6] and Harriss and Mathuma (2015) [4] in tomato.

The maximum volume of knob (116.5 cc), diameter of knob (6.93 cm), average weight of the knob (134.0 g), yield per plot (3.07 kg) and yield (204.6 q/ha) were recorded in 7.5 kg zinc per ha treatment which was found significantly higher over others but statistically at par with 5.0 kg znic per ha. The beneficial effect of zinc on yield attributes and yield might be due to enhanced supply of micronutrients during entire growing season. Significant increase in yield under the influence of zinc was largely a function of improved growth and the consequent increase in different yield attributes and yield.

Further, zinc might have increased the efficiency of added chemicals fertilization in soil and increase the rate of humification of zinc enhances the availability of both native and added nutrients in soil and thus yield of knol-khol increased. These results are in accordance with the finding of Raj *et al.* (2001) [8] in brinjal, and Shah *et al.* (2010) [10] in knol khol.

It is evident from the data (Table 2 and fig 2) that the application of different levels of zinc significantly influenced the maximum N_2 content (0.84 %), P content (0.48%), K content (3.28%), Zn content (53.00 ppm), chlorophyll content (0.705 mg/g) and protein content (5.25 %) were observed under 7.5 kg zinc per ha which was statistically at par with 5.0 kg zinc per ha. Due to adequate supply of nutrients with higher dose of zinc might have utilization more nutrients as compared to lower doses resulting in increased N, P, K, Zn and protein content in knob. It is established fact that nutrient uptake by the crop depends primarily on zinc accumulation and secondary nutrient concentration at cellular levels. The increase photosynthic efficiency there by more dry matter production and nutrient concentration in plant seems to be major factor responsible for higher NPK content of knob under the influence of zinc application. The results obtained in the present investigation are in close conformity with the findings of Balyan *et al.* (1994) [1] in cauliflower, Dube *et al.* (2003) [3] in cabbage and Shah *et al.* (2010) [10] in knol khol.

It is also indicated that the higher net returns (Rs 307620) obtained under the7.5 kg zinc per ha and higher B:C ratio(3.03) was obtained under 5.00 kg zinc per ha.

Table 1: Effect of zinc on growth and yield attributes of knol-khol

characters	Treatment combinations					
	Z_0	Z_1	Z_2	Z_3	SEm±	CD at 5%
Plant height (cm)	24.88	26.94	28.75	28.96	0.54	1.53
Number of leaves per plant	18.6	21.4	22.6	22.7	0.40	1.15
Leaf area index	0.99	1.35	1.68	1.75	0.03	0.09
Volume of knob (cc)	101.5	109.4	116.0	116.5	2.19	6.28
Diameter of knob (cm)	5.05	6.00	6.71	6.93	0.12	0.33
Average weight of knob (g)	81.1	115.5	130.8	134.0	2.12	6.06
Yield per plot (kg)	1.73	2.49	2.99	3.07	0.04	0.11
yield of knob per ha (q/ha)	115.3	166.0	199.3	204.6	2.59	7.43

Table 2: Effect of znic on quality and economic attributes of knol-khol

Characters	Treatments					
	Z_0	Z_1	Z_2	Z_3	SEm±	CD at 5%
N content in knob (%)	0.49	0.69	0.81	0.84	0.01	0.04
P content in knob (%)	0.39	0.44	0.47	0.48	0.01	0.02
K content in knob (%)	2.90	3.10	3.25	3.28	0.04	0.12
Zinc content in knob (ppm)	40.11	47.51	51.88	53.00	0.81	2.32
Protein content in knob (%)	3.06	4.31	5.06	5.25	0.08	0.23
Chlorophyll content(mg/g)	0.615	0.666	0.698	0.705	0.01	0.028
Net returns (Rs/ha)	144037	238197	299783	307620	4776	13672
B:C ratio	1.66	2.53	3.03	3.02	0.04	0.12

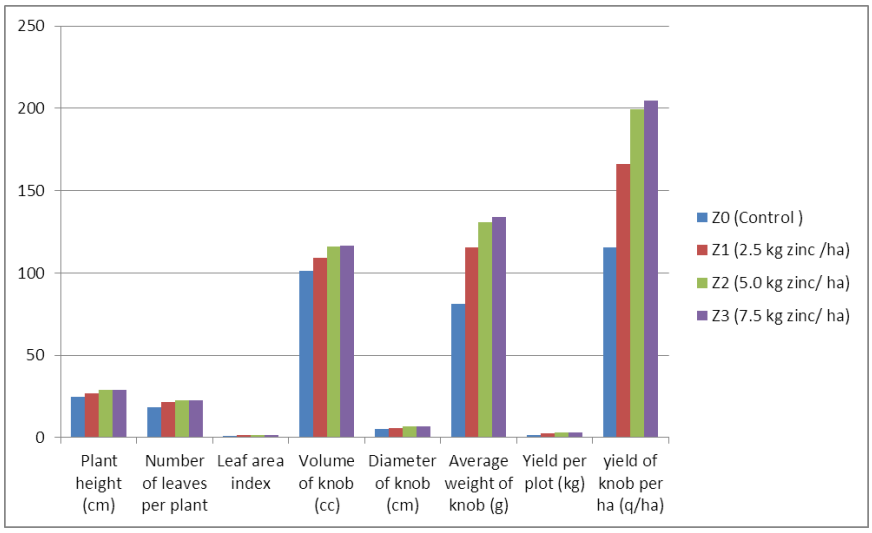

Fig 1: Effect of Zinc on Growth and yield characters of knol-khol

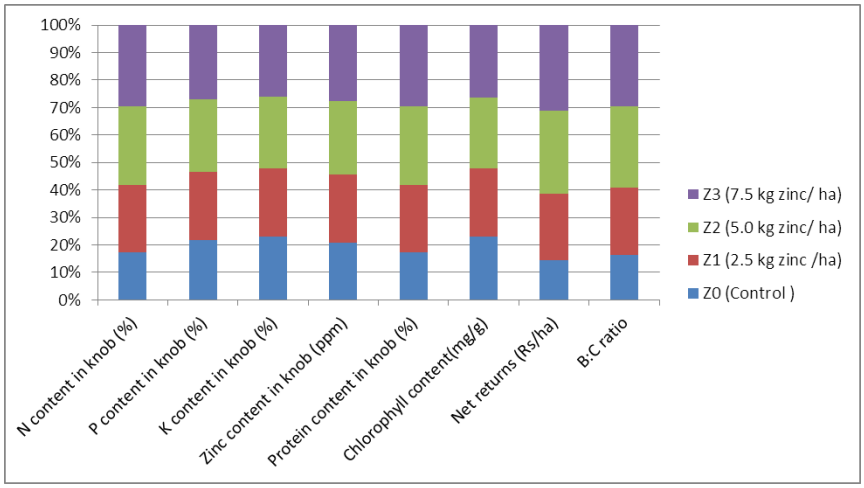

Fig 2: Effect of zinc on quality and economic characters of knol-khol

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