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Influence of boron and zinc on growth yield and quality of knolkhol cv. Early White Veinna

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ABSTRACT

Among various treatments, combined application of Boron and Zinc @ 15 kg ha^{-1} each exhibited better response than alone soil and foliar application either of Zn and B and their combinations. This treatment also proved better in improving growth, yield and quality than other treatments including control i.e. recommended dose of NPK alone. The plants supplied with 15 kg ha^{-1} of B and Zn each @ of 15.kg ha^{-1} recorded significantly higher knob yield (390.50 q ha^{-1}) followed by 382.17 q ha^{-1} when B @ 10 kg ha^{-1} + Zn @ 15 kg ha^{-1} was applied and 357.77 q ha^{-1} when B @ 15 kg ha^{-1} + Zn @ 10 kg ha^{-1} was applied. The higher dose of both B and Zn decreased the growth, yield and quality of Knolkhol. These treatments also exhibited higher values for growth, yield and quality traits. The knob quality in respect of TSS and ascorbic acid content were also enhanced appreciably in these treatment combinations. The combined foliar and soil application of zinc @ 100 ppm and 15 kg ha^{-1} respectively, took more days (59.66) to marketable maturity. However, soil application of B @ 15 kg ha^{-1} or combined foliar and soil application of B @ 100 ppm and 15 kg ha^{-1}, respectively, recorded 57.33 days to marketable maturity. Economic studies indicated that treatment combination of foliar application of B and Zn @ 100 ppm each was most profitable with maximum benefit cost ratio of 4.34. However, the treatment which produced higher yielding treatment (B and Zn @ 15 kg ha^{-1} each) gave the benefit cost ratio of 1.35. The higher values for growth, yield and quality attributes were also recorded in the plants which were supplied with basal application of B and Zn @ 15 kg ha^{-1} each. Hence, for getting maximum profits one should go for foliar application of both B and Zn @ 100 ppm each, whereas for harnessing better growth yield and quality apply B and Zn @ 15 kg ha^{-1} each in the soil.

Key words: Boron, zinc, growth yield, quality, knolkhol.

INTRODUCTION

Knolkhol (*Brassica Oleracea var. gongylodes* L.) is an important cole crop and widely, cultivated in West Bengal, Jammu and Kashmir, Punjab and Karnataka (Nath *et al.,* 10). In Kashmir, it is a traditional vegetable crop and is under cultivation since ancient time. Besides having anticarcinogemic properties (Thamburaj and Singh, 18), it is a good source of minerals (Ca, P, K, Se, Fe, I, Mg) and Vitamins (A and C) (Nath, *et al.* 10). With increasing population, the demand of knolkhol has significantly increased, but the production, productivity and quality has remained low both in the country as well as in the state as compared to developed country, mainly due to poor nutrition and cultural management practices together with deficiency of some micro and macro-nutrients in the production layer of soil. Like macronutrients, micronutrients are also important in growth and development of crop plant. Among the macronutrients, Boron (B) and Zinc (Zn) are essentially required by plants for normal growth, development and quality of knolkhol plants and knobs. In general, Kashmir soils are deficient in boron and zinc, which is one of the major causes of low yield and poor quality of knolkhol. The increase in cropping intensity and changes in the soil and fertilizer management practices have altered the B and Zn status of the soils, hence boron and zinc fertilization in deficient soils needs careful attention. So far no any efforts have been made on the effect of boron and zinc on yield and quality of knolkhol under Kashmir conditions. In the light of the above background, this study was taken up to find out the optimum dose and best combination of B and Zn and their method of application for obtaining high quality knob yield of knolkhol cv. 'Early White Veinna' under agro-climatise conditions of Kashmir.

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MATERIALS AND METHODS

A field experiment was conducted at Vegetable Experimental Farm, Sher-e-Kashmir University of Agricultural Science & Technology of Kashmir, Shalimar Campus, Srinagar (J&K) during Rabi 2004-05. The test crop (Knolkhol cv. Early White Veinna) was planted at a spacing of 30 x 20 cm. The Physico-chemical composition of soil (0-15 cm) was: clay 33.60%, silt 41.90% and sand 23.60%, 6.5 pH, electrical conductivity (EC) 0.30 dsm^{-1}, organic carbon 1.4 percent, available N 230.00 kg/ha^{-1}, available P_2O_5 22.00 kg/ha^{-1}, available K_2O 186.50 kg/ha^{-1}, available Boron (B) 0.37 ppm and available zinc (Zn) 0.149 ppm.. A total of 17 treatment viz, T_1-Control (RFD-15t FYM, 125 kg, 50 kg P_2O_5 and 60 kg K_2O_2/ha). T_2-foliar spray B @ 100 ppm, T_3-sparay of Zn @ 100 ppm, T_4-spray of B and Zinc @ 100ppm each, T_5-soil application of B @ 10kg/ha, T_6 application of B @ 15 kg/ha, T_7-application of Zn @ 10 kg/ha, T_8-application of Zn @ 15 kg/ha, T_9-application of B and Zn @ 10 kg/ha each, T_{10}-application of B @ 10kg/ha and Zn @ 15 kg/ha, T_{11}-application of B @ 15 kg/ha, T_{12}-application of B and Zn @ 15 kg/ha each, T_{13}- foliar and soil application of B @ 100 ppm and 10 kg/ha, T_{14}-folial and soil application of B @ 100 ppm and 15 kg/ha, T_{15}-foilar and soil application of Zn @ 100 pm and 10 kg/ha, T_{16}-foliar and soil application of Zn @ 100 ppm and 15kg /ha, T_{17}-foliar application of B @ 10 kg/ha were taken into consideration under randomized block design with three replications. The boron was supplied in the form of boresx as soil application and boric acid as foliar spray, while zinc was applied in the form zinc shulphate both as soil and foliar application. The soil application was done before transplanting whereas as foliar spray was done 30 days after transplanting the crop. A basal recommended dose of 15 t FYM/ha, 125 kg N/ha, 50 kg P_2O_5/ha and 60 kg K_2O ha^{-1} were also applied and the crop was transplanted on 1st October 2004. Observations on different growth yield and quality traits are recorded on ten randomly selected plants from each treatment in every replication eliminating the border effect and analysed statistically as per the standard procedures to test the significance. Total soluble solids content in fresh knob was determined with help of hand refractomets, whereas Vitamin C content was estimated by 2, 6 dichlorophenol indophenols visual titnation method (AOAC, 2).

RESULTS AND DISCUSSION

The application of boron and zinc either alone or in combination through soil or foliar or both exhibited non significant effect on days to marketable maturity. A minimum of 57.33 days were taken to marketable maturity with the soil application of B @ 15 kg ha^{-1} and both soil and foliar application of B @ 15 kg ha^{-1} and 100 ppm, respectively (Table 1). This might be due to counteract effect of N (Mehrotra and Mishra, 7).

Growth expressed in terms of number of leaves plant/ plant, leaf length and area and most of the treatments showed significant difference for these traits over control (Table 1). The combined application of boron and zinc either in soil or foliar or both soil and foliar increased the values of growth attributes over control. The plant received both boron and zinc @ 15$kgha^{-1}$ each, exhibited maximum number of leaves $plant^{-1}$ (16.18), leaf length (18.31 cm) and leaf area (171.60 cm^2) which were significantly superior over other treatments except treatment combination of 10 kg B +15 kg/ha Zn as soil application which were found statistically at per with each other. These results are in line with those of Thakur *et. al* (18) and Singh (14) in cauliflower, and Anonymous (1) in Cabbage. Mishra (9) suggested that boron has beneficial effect on vegetative parameters of cauliflower thereby increased the member of leaves with the increasing dose of boron. According to Devlin (6) and Tisdale and Nelson (19), enhanced plant growth with the combined application of B and Zn might be due to the role of boron in transaction of carbohydrates and uptake of other elements. Infact individual and combined application of boron and zinc in both the form increased the growth parameters over control however, combined soil and foliar application of any one (either B or Zn) decreases the values of growth parameters, and indicated that the increased dose of either boron or zinc or both significantly decreases the values of most of growth parameters. This might be due to toxic effect of excessive application of boron and zinc (Nieuwhoff, 11, Randhawa and Bhail, 12).

The basal application of B and Zn @ 15 kg ha^{-1} each exhibited significant superiority over other treatments, for gross weight of plant, knob diameter, knob volume, net weight of knob and knob yield The increase in knob yield might be due to increase in gross weight of plant, knob diameter, knob volume and net weight of knob. Mehratna and Mishra (7) and Chakraborty (5) also observed positive effect of Boron application in seasoning cauliflower curd yield. Similarly, zinc also played role in enhancing curd yield in cauliflower as reported by Balyan *et al.* (4), Singh *et al.* (15), Balyan and Singh (3) and Singh and Singh (16). This treatment recorded 338.69 g of gross plant weight 201.35 g net knob weight, 8.36 cm knob diameter and 294.79 cc knob volumes, whereas control recorded only 214.60 g gross plant weight, 109.5 g net knob weight, 5.06 cm knob diameter and 221.52 cc knob volume. Data further reveals that application of boron or zinc alone or in combination at all levels showed significant superiority for most of the yield attributes over

Table 1. Influence of zinc and boron on growth, yield and quantity of Knolkhol cv. Early White Vienna

Treatment	1	2	3	4	5	6	7	8	9	10	11	12	13
T1: Control (RFD)	58.00	11.62	13.88	125.16	214.60	5.06	221.52	109.50	12.98	300.46	-	6.00	46.59
T2 : Boron @ 100	57.66	12.44	14.13	132.86	229.50	5.60	224.99	154.89	13.92	322.37	7.20	6.20	47.76
T3 : Zinc @ 100ppm	58.33	12.55	14.15	147.40	235.91	6.10	226.52	168.30	15.00	247.22	15.56	6.50	48.63
T4 : Boron @ 100 ppm + zinc @ 100 ppm	58.00	14.22	14.77	155.23	268.75	6.96	282.70	170.47	15.45	357.63	19.02	6.69	49.37
T5 : Boron @ 10 kg ha^{-1}	58.00	14.40	13.97	130.96	227.93	5.30	224.01	141.23	13.40	310.18	3.23	6.10	47.01
T6 : Boron @ 15 kg ha^{-1}	57.33	12.50	14.14	139.68	231.59	6.03	225.43	156.83	14.14	327.31	8.93	6.30	48.42
T7 : Zinc @ 10 kg ha^{-1}	58.33	13.44	14.44	149.54	254.66	6.26	241.40	169.51	14.88	344.44	14.63	6.50	49.05
T8 : Zinc @ 15 kg ha^{-1}	59.00	14.00	14.45	154.01	257.77	6.80	245.97	169.81	14.93	345.60	15.92	6.60	49.13
T9 : Boron @ 10 kg ha^{-1} + zinc @ 10 kg ha^{-1}	58.66	15.11	14.95	159.09	282.47	7.10	290.22	184.63	16.08	372.29	23.90	6.83	5.34
T10 : Boron @ 10 kg ha^{-1} + zinc @ 15 kg ha^{-1}	59.00	16.07	17.78	169.74	305.21	7.56	292.57	199.33	16.51	382.17	27.19	7.16	52.16
T11 : Boron @ 15 kg ha^{-1} + zinc @ 10 kg ha^{-1}	58.00	15.18	15.88	162.91	299.21	7.43	291.50	187.40	16.23	375.77	25.06	6.90	51.71
T12 : Boron @ 15 kg ha^{-1} + zinc @ 15 kg ha^{-1}	59.00	16.18	18.31	171.60	338.69	8.36	294.79	201.35	16.87	390.50	29.96	7.19	53.26
T13 : Boron @ 100 ppm + boron @ 10 kg ha^{-1}	57.66	11.00	13.00	115.61	207.41	4.96	208.52	100.53	11.19	259.10	-13.76	5.50	45.14
T14 : Boron @ 100 ppm + boron @ 15 kg ha^{-1}	57.33	10.62	12.93	115.06	191.67	4.56	202.36	98.24	10.96	253.78	-15.53	5.03	44.86
T15 : Zinc @ 100 ppm + zinc @ 10 kg ha^{-1}	59.00	11.25	13.82	120.81	209.95	5.03	218.90	108.24	12.07	279.39	-7.01	5.90	46.21
T16 : Zinc @ 100 ppm + zinc @ 15 kg ha^{-1}	59.66	11.36	13.40	116.86	209.30	4.90	216.50	104.23	11.48	265.81	-11.53	5.70	45.33
T17 : Boron @ 100 ppm + zinc @ 100 ppm + boron @ 10 kg ha^{-1}	58.00	10.19	12.76	106.94	140.49	4.16	191.37	84.19	10.49	242.97	-19.13	4.80	44.38
CD at 5%	NS	1.50	0.92	2.40	8.00	0.89	3.72	1.06	1.20	27.82	-	0.54	0.84

1. Days to marketable maturity, 2. No. of leaves $plant^{-1}$, 3. Leaflength (cm), 4. Leaf area (cm^2), 5. Gross\weightof theplant (g), 6. Knob Diameter (cm). 7. Knob volume (cc), 8. Net Weight of the knob (g), 9. Knobyield $plot^{-1}$ (kg), 10. Knob yield (q ha^{-1}), 11. Percentincrease in yield over control, 12. Total soluble solids (^{0}Brix), 13. Vitamin C content (mg 100^{-1} g)

Table 2. Cost of production of Knolkhol cv. Early White Veinna under different treatments of Boron and Zinc.

Treatments		1	2	3	4	5	6	7	8	9	10	11	12
T_1	T1: Control (RFD)	366.20	300.46	65.74	6574	33446	6574	26872	89.43	500	156804	123358	3.68
T_2	T2 : Boron @ 100	440.45	322.37	78.08	7808	34576	7808	26768	83.03	500	168993	134417	3.88
T_3	T3 : Zinc @ 100ppm	425.46	347.22	78.24	7824	34199	7824	26375	75.96	500	181434	147235	4.30
T_4	T4 : Boron @ 100 ppm + zinc @ 100 ppm	438.65	357.63	81.02	8102	34979	8102	26877	75.15	500	186917	151938	4.34
T_5	T5 : Boron @ 10 kg ha^{-1}	400.00	310.18	89.82	8982	59290	8982	50308	162.08	500	164072	104782	1.76
T_6	T6 : Boron @ 15 kg ha^{-1}	415.74	327.31	88.43	8843	72070	8843	63227	199.17	500	172498	100428	1.39
T_7	T7 : Zinc @ 10 kg ha^{-1}	433.10	344.44	88.66	8866	43421	8866	34555	100.32	500	181086	137665	3.17
T_8	T8 : Zinc @ 15 kg ha^{-1}	435.41	445.60	89.91	8981	48496	8981	39515	114.33	500	181781	133285	2.74
T_9	T9 : Boron @ 10 kg ha^{-1} + zinc @ 10 kg ha^{-1}	453.00	372.29	80.71	8071	69265	8071	61194	164.37	500	194216	124951	1.80
T_{10}	T10 : Boron @ 10 kg ha^{-1} + zinc @ 15 kg ha^{-1}	478.25	382.17	96.08	96.08	74340	9608	64732	169.38	500	200693	126353	1.60
T_{11}	T11 : Boron @ 15 kg ha^{-1} + zinc @ 10 kg ha^{-1}	464.25	375.77	88.81	8881	82045	8881	73164	194.70	500	196766	114721	1.39
T_{12}	T12 : Boron @ 15 kg ha^{-1} + zinc @ 15 kg $ha^{-111.}$	488.42	390.50	97.92	9792	87120	9792	77328	198.02	500	205042	117922	1.35
T_{13}	T13 : Boron @ 100 ppm + boron @ 10 kg ha^{-1}	328.70	259.10	69.60	6960	60070	6960	53110	204.97	500	136510	76440	1.27
T_{14}	T14 : Boron @ 100 ppm + boron @ 15 kg ha^{-1}	317.12	253.78	63.34	6334	73200	6334	66866	263.48	500	133224	60024	0.82
T_{15}	T15 : Zinc @ 100 ppm + zinc @ 10 kg ha^{-1}	352.31	279.39	72.92	7292	44174	7292	36882	132.00	500	146987	102813	2.32
T_{16}	T16 : Zinc @ 100 ppm + zinc @ 15 kg ha^{-1}	346.52	265.81	80.71	8071	49249	8071	41178	154.91	500	140976	91727	1.86
T_{17}	T17 : Boron @ 100 ppm + zinc @ 100 ppm + boron @ 10 kg ha^{-1}	313.65	242.97	70.68	7068	60823	7068	53755	221.24	500	128553	67730	1.11
	CD at 5%	33.89	27.82	-	-								

1. Gross weight (q ha^{-1}), 2. Knob yield (q ha^{-1}), 3. Quantity of by-product i.e. leaves (q ha^{-1}), 4. Value of by-product @ Rs. 1 kg^{-1}, 5. Gross cost, 6. Value of by-product, 7. Net cost (gross cost-value of by-product), 8. Cost of production (Rs. q^{-1}) [net cost/yield of main product], 9. Market price of main product (Rs. q^{-1}), 10. Gross income, 11. Net income, 12. B: C ratio

control and combined soil and foliar application of either boron or zinc or both. Further it was observed that the combined soil and foliar application of either boron or zinc decreased the gross weight of plant, knol diameter, net weight of the knob and knob yield. The useful role of Boron and Zinc in knob yield of Knolkhol has been reflected in the form of significant increase of characters viz, gross weight of plant knob diameter, knob volume and net weight of the knob (Table 1). Both boron and zinc appeared to be more effective in increasing the aforesaid yield attributes. The alone and combined application of these micronutrients in any form increases the yield parameters of Knolkhol significantly. Enhanced plant growth with the combined application of boron might be due to the translocation of carbohydrates and uptake of other elements as reported by Devlin (6), Tisdale and Nelson (19), and synergetic effect of B and Zn. However, the increase dose of either of B or Zn decreased the values of yield parameters, might be due to toxic effect of higher dose of B and Zn (Nieuwhoff, 11, Randhawa and Bhail, 12).

The quality parameters like total soluble solids (TSS) and Vitamin C content in knolkhol were significantly influenced with the application of boron and zinc. These were increased with the application of either of boron or zinc or their combination in any form but decreased with the combined soil and foliar application of any one of this micronutrient (Table 1). The maximum of T.S.S. (7.19^{o}B) and Vitamin C contents (53.26 mg 100g) were recorded in the knobs of plants supplied with the basal dose of boron and Zinc @ 15kg/ha each followed by treatment combination of 15 kg ha B + 10 kg ha Zn and 10 kg ha B + 15kg ha Zn which recorded 7.16, 6.90^{o} B T.S.S. and 52.16, 51.71 mg 100^{-1} g Vitamin C content respectively. All these three treatments were significantly superior over control as well as most of other treatments for both the traits, but statistically at par with each other for T.S.S. content, whereas highest Vitamin C content treatment was statistically at par with only the treatment combination of B @ 10 kg ha +Zn @ 15 kg ha. The increase in T.S.S. and Vitamin C content by the application of boron and zinc might be due to synergistic effect of boron and zinc. Mehrotra *et al* (8) also recorded increased Vitamin C content in Cauliflower with the soil as well as foliar application of boron. Similarly, Sindhu and Tiwari (13) also recorded high T.S.S. and ascorbic acid content in onion bulb with the application of boron and zinc. Further, it was noticed that the combined soil and foliar application either of boron or zinc decreased the T.S.S. and Vitamin C content, might be due to toxic effect of heavy dose of these elements on growth, yield and quality attributes of the crop (Nierewhop, 1969, Randhawa and Bhail, 1976).

The cost of cultivation of knolkhol varied from Rs. 33,446 (in control) to Rs. 87120/ha (in soil application of both B and Zn @ 15 kg /ha each). Owing to the use of different doses and sources of micronutrients, the cost of production was the lowest of Rs. 75.15 q^{-1} of produce for the plots which sprayed with both the B and Zn @ 100 ppm each, the same treatment also fetches maximum net return (Rs. 151935 ha) with the highest B: C ratio of 4.34, whereas the gross return was maximum (Rs. 205042 ha) in the treatment contribution of soil application of both B and Zn @ 15 kg /ha^{-1} each, which is not only highest yielding one treatment but also recorded higher values for other growth, yield and quality traits under study. Unfortunately the highest yield and better quality were recorded in the same treatment but its B: C ratio is very poor i.e. 1.35. Hence, for getting maximum benefit, one show spray the knolkhol crop with B and Zn @ 100 ppm each. While for harnessing better yield and quality of knolkhol, soil application of B and Zn @ 15 kg /ha each is suggested under Kashmir conditions.

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