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Impact of foliar application of micronutrients on growth, yield and its attributes of bitter gourd [*Momordica charantia*] cv. F_1 LHB – Swathi

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Abstract
The present experiment was carried out during June to October 2018 in Departmental Research Field of Department of Horticulture, SHUATS, Prayagraj. The experiment was conducted in Factorial Randomized Block Design (FRBD), with sixteen treatments, replicated thrice with two Micronutrients i.e. Zinc and Boron on Bitter Gourd. The treatments were T_0 (Control), T_1 (Boron 0.25%), T_2 (Boron 0.50%), T_3 (Boron 0.75%), T_4 (Zinc 0.25%), T_5 (Zinc 0.25% + Boron 0.25%), T_6 (Zinc 0.25% + Boron 0.50%), T_7 (Zinc 0.25% + Boron 0.75%), T_8 (Zinc 0.50%), T_9 (Zinc 0.50% + Boron 0.25%), T_{10} (Zinc 0.50% + Boron 0.50%), T_{11} (Zinc 0.50% + Boron 0.75%), T_{12} (Zinc 0.75), T_{13} (Zinc 0.75% + Boron 0.25%), T_{14} (Zinc 0.75% + Boron 0.50%) and T_{15} (Zinc 0.75% + Boron 0.75%). From the findings it was found that the Boron level B_3 (Boron 0.75%) was found best in terms of growth, yield and quality of Bitter Gourd cv. F_1 LHB – Swathi, followed by Boron level B_2 (Boron 0.50%), in most of the parameters.

Keywords: Micronutrients, zinc and boron., bitter gourd

Introduction
Vegetables are rich and comparatively cheaper source of vitamins. The importance of vegetable crops in India can be judged from the fact that the majority of Indian population is vegetarian. India produces the largest variety of vegetables. Consumption of vegetable provides taste, palatability, increases appetite and provides fiber for digestion and prevents constipation.

Bitter gourd (*Momordica charantia* L.; 2n= 2x=22), which belongs to family Cucurbitaceae, is an important vegetable mainly valued for its nutritional and medicinal properties. The origin of this crop is probably India with secondary centre of diversity in China (Grubben, 1977) [5].

India being the second largest producer of vegetables in the world next only to China, share about 15 per cent of the world output of vegetable and about 3 per cent of total cropped area in the country. The current production level is over 0.77 million tonnes from an area of 0.08 million hectares (NHB 2014-15). The productivity (6.87t/ha) of bitter gourd is far below than the national productivity (11t/ha). The per capita per day availability (210g) of vegetable is quite low against the requirement of about three hundred gram as recommended by human dieticians. Such a large gap can be filled up by increasing the production by the use of improved varieties/hybrids, balanced use of macro and micronutrient in combination with adopting better crop management technology. Micronutrients such as iron, zinc, boron, manganese, etc., have been reported to play a vital role in modifying the growth and development of many horticultural crops. They improve general condition of plants and are known to act as catalyst in promoting organic reactions taking place in plant. Foliar application of micronutrients to crop plants is gaining popularity in increasing crop yield and quality of improving the shelf life of the produce. Similarly, the influence of micronutrients on growth, development and yield of bitter gourd are of immense magnitude. It is realized that productivity of crop is being adversely affected in different areas due to deficiencies of micro nutrients (Bose and Tripathi, 1996) [1]. Recently which has been increased markedly due to intensive cropping, loss of top soil by erosion, loss of micro nutrients by leaching, liming of soil and decreased availability and use of farm yard manure. (Fageria *et al.*, 2002) [4].

Materials and Methods

The present Experiment was conducted in Factorial Randomized Block Design (FRBD) with 16 treatments of Micronutrients with three replications in the Research field of Department of Horticulture, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj during June to October, 2018. Total number of treatments were sixteen *viz.* T_0 (Control), T_1 (Boron 0.25%), T_2 (Boron 0.50%), T_3 (Boron 0.75%), T_4 (Zinc 0.25%), T_5 (Zinc 0.25% + Boron 0.25%), T_6 (Zinc 0.25% + Boron 0.50%), T_7 (Zinc 0.25% + Boron 0.75%), T_8 (Zinc 0.50%), T_9 (Zinc 0.50% + Boron 0.25%), T_{10} (Zinc 0.50% + Boron 0.50%), T_{11} (Zinc 0.50% + Boron 0.75%), T_{12} (Zinc 0.75), T_{13} (Zinc 0.75% + Boron 0.25%), T_{14} (Zinc 0.75% + Boron 0.50%) and T_{15} (Zinc 0.75% + Boron 0.75%), Cultivar, F_1 LHB - Swathi were used.

Climatic condition in the experimental site

The area of Prayagraj district comes under subtropical belt in the south east of Uttar Pradesh, which experience extremely hot summer and fairly cold winter. The maximum temperature of the location reaches up to 46º C- 48º C and seldom falls as low as 4ºC- 5ºC. The relative humidity ranges between 20 to 94%. The average rainfall in this area is around 1013.4 mm annually. However, occasional precipitation is also not uncommon during winter months.

Results and Discussion

The present investigation entitled "Effect of Foliar application of Micronutrients on Growth, Yield and Quality of Bitter Gourd [*Momordica charantia*] cv. F_1 LHB - Swathi" was carried out during June to October 2018 in Research Field of Department of Horticulture, Naini Agricultural Institute, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj (U.P.) India. The results of the present investigation, regarding the effect of Micronutrients on growth, Flowering and yield of Bottle gourd, have been discussed and interpreted in the light of previous research work done in India and abroad. The experiment was conducted in Factorial Randomized block design with 16 treatments, three replications. The results of the experiment are summarized below.

A. Growth Parameters

In terms of Days taken for Germination minimum was recorded in B_3 (Boron 0.75%) with (7.01 days) followed by Zn_1 (Zinc 0.25%) (7.75 days) and maximum (8.57 days) was recorded in Boron Level B_0 (Control). In different treatments of Zinc and Boron minimum was recorded in T_3 (Zn_0B_3: Boron 0.75%) with (6.78 days) followed by T_7 (Zn_1B_3: Zinc 0.25% + Boron 0.75%) with (7.03 days) whereas maximum (9.46 days) was observed in treatment Control.

In terms of Vine length (m) maximum (5.25 m) were recorded in B_3 (Boron 0.75%), followed by Zn_0 (Zinc 0%) with (4.69 m) whereas minimum (4.08 m) was recorded in Control. In different treatments of zinc and boron maximum was recorded in treatment T_3 (Zn_0B_3: Boron 0.75%) with (5.77 m) followed by T_7 (Zn_1B_3: Zinc 0.25% + Boron 0.75%) with (5.32 m) whereas minimum (3.53 m) was observed in Control. Minimum days taken for germination and Maximum vine length, it might be due to enhanced photosynthetic and other metabolic activities which lead to increase in various plant metabolites responsible for cell division and elongation as opined by Hatwar *et al.* (2003) [7] and Hazra *et al.* (1987) [8]. These results are in agreement with the findings of earlier workers Narayanamma *et al.* (2009) [16] in bitter gourd, Rab and Haq (2012) [18] in tomato and Kumar *et al.* (2010) [10] in cauliflower.

In terms of Number of primary branches per plant, maximum branches (23.04) were recorded in B_3 (Boron 0.75%), followed by B_2 (Boron 0.50%) with (20.66) whereas minimum (19.05) was recorded in Control. In terms of different treatments of zinc and boron maximum was recorded in T_3 (Zn_0B_3: Boron 0.75%) with (25.16) followed by T_7 (Zn_1B_3: Zinc 0.25% + Boron 0.75%) with (23.64) whereas minimum branches (17.61) was observed in Control. The increased number of branches/vine might be due to better sink developed by auxiliary branches to a large amount of available nutrients as reported by Maya (1996) [12] in sweet pepper cv. (Califlornia Wonder). The results of present experiment are in consonance with the findings of Sabina (1995) in geraminium, Meenakshi and Vadivel (2003) [13] in bitter gourd, Rab and Haq (2012) [18] in tomato, Shukla (2011) [20] in gooseberry and Narayanamma *et al.* (2009) [16] in bitter gourd.

In terms of Number of days to first male flower emergence, minimum (41.79 days) were recorded in B_3 (Boron 0.75%), followed by Zn_0 (Zinc 0%) with (44.61 days) whereas maximum (48.77 days) was recorded in Control. In terms of different treatments of zinc and boron minimum was recorded in T_3 (Zn_0B_3: Boron 0.75%) with (40.87 days) followed by T_{11} (Zn_2B_3: Zinc 0.50% + Boron 0.75%) with (41.52) whereas maximum (49.57 days) was observed in treatment T_0 Zn_0B_0 (Zinc 0% + Boron 0%).

In terms of Number of days to first female flower emergence, minimum (46.26 days) were recorded in B_3 (Boron 0.75%), followed by Zn_0 (Zinc 0%) with (49.07 days) whereas maximum (53.11 days) was recorded in Boron Level B_0 (Control). In different treatments of zinc and boron minimum was recorded in treatment T_3 (Zn_0B_3: Boron 0.75%) with (45.26 days) followed by T_{11} (Zn_2B_3: Zinc 0.50% + Boron 0.75%) with (45.64 days) whereas maximum (53.77 days) was observed in Control. Minimum days for Number of days to first male and female flower emergence, it may be due to the fact that the boron has significant role in mobilization of food materials from source to sink. Similar results were have also been obtained by Shukla (2011) [20] in Gooseberry.

In terms of Number of days to first picking, minimum (63.94 days) were recorded in B_3 (Boron 0.75%), followed by Zn_0 (Zinc 0%) with (68.60 days) whereas maximum (71.96 days) was recorded in Control. In different treatments of Zinc and Boron minimum was recorded in treatment T_{15} (Zn_3B_3: Zinc 0.75% + Boron 0.75%) with (63.14 days) followed by T_{11} (Zn_2B_3: Zinc 0.50% + Boron 0.75%) with (63.83 days) whereas maximum (73.79 days) was observed in Control.

In terms of Number of days to last picking, minimum (106.04 days) were recorded in B_3 (Boron 0.75%), followed by Zn_2 (Zinc 0.50%) with (111.57 days) whereas maximum (117.30 days) was recorded in Control. In different treatments of Zinc and Boron minimum was recorded in T_3 (Zn_0B_3: Boron 0.75%) with (104.72 days) followed by T_{15} (Zn_3B_3: Zinc 0.75% + Boron 0.75%) with (105.67 days) whereas maximum (122.19 days) was observed in Control. Minimum days for first and last picking, might be due to enhanced photosynthetic and other metabolic activities which lead to increase in various plant metabolites responsible for cell division and elongation as opined by Hatwar *et al.* (2003) [7] and Hazra *et al.* (1987) [8]. These results are in agreement with the findings of earlier workers Narayanamma *et al.* (2009) [16] in bitter gourd, Rab and Haq (2012) [18] in tomato and Kumar *et al.* (2010) [10] in cauliflower.

In terms of Number of leaves per plant, maximum (93.69 leaves) were recorded in B_3 (Boron 0.75%), followed by Zn_1 (Zinc 0.25%) with (85.56 leaves), whereas minimum (77.51 leaves) was recorded in Control. In different treatments of Zinc and Boron maximum was recorded in treatment T_3 (Zn_0B_3: Boron 0.75%) with (96.60 leaves) followed by T_7 (Zn_1B_3: Zinc 0.25% + Boron 0.75%) with (94.24 leaves) whereas minimum (71.96 leaves) was observed in Control.

In terms of Leaf area index, maximum (1.511 LAI) were recorded in B_3 (Boron 0.75%), followed by Zn_0 (Zinc 0%) with (1.509), whereas minimum (1.503 LAI) was recorded in Control. In different treatments of Zinc and Boron maximum was recorded in T_3 (Zn_0B_3: Boron 0.75%) with (1.513) followed by T_7 (Zn_1B_3: Zinc 0.25% + Boron 0.75%) with (1.512) whereas minimum LAI (1.502) was observed in T_8 (Zn_2B_0: Zinc 0.50%) and Control.

In terms of Harvest index, maximum (68.96) were recorded in B_3 (Boron 0.75%), followed by B_2 (Boron 0.50%) with (67.60), whereas minimum (65.51 HI) was recorded in Control. In different treatments of Zinc and Boron maximum HI was recorded in T_3 (Zn_0B_3: Boron 0.75%) with (69.31) followed by T_7 (Zn_1B_3: Zinc 0.25% + Boron 0.75%) with (69.14) whereas minimum HI (65.26) was observed in treatment T_4 (Zn_1B_0: Zinc 0.25%). It might be due to enhanced photosynthetic and other metabolic activities which lead to increase in various plant metabolites responsible for cell division and elongation as opined by Hatwar *et al.* (2003) [7] and Hazra *et al.* (1987) [8]. These results are in agreement with the findings of earlier workers Narayanamma *et al.* (2009) [16] in bitter gourd, Rab and Haq (2012) [18] in tomato and Kumar *et al.* (2010) [10] in cauliflower.

B. Yield Parameters

In terms of Fruit length, maximum (18.17 cm) were recorded in B_3 (Boron 0.75%), followed by Zn_0 (Zinc 0%) with (15.96 cm), whereas minimum (13.63 cm) was recorded in Control. In different treatments of Zinc and Boron maximum fruit length was recorded in T_3 (Zn_0B_3: Boron 0.75%) with (19.23 cm) followed by T_7 (Zn_1B_3: Zinc 0.25% + Boron 0.75%) with (18.41 cm) whereas minimum (12.13 cm) was observed in Control.

In terms of Fruit weight, maximum (127.66 g) were recorded in B_3 (Boron 0.75%), followed by Zn_0 (Zinc 0%) with (118.63 g), whereas minimum (95.02 g) was recorded in Control. In different treatments of Zinc and Boron. Maximum fruit weight was recorded in T_3 (Zn_0B_3: Boron 0.75%) with (139.98 g) followed by T_7 (Zn_1B_3: Zinc 0.25% + Boron 0.75%) with (127.25 g) whereas minimum (81.93 g) was observed in Control.

In terms of Fruit diameter, maximum (6.75 cm) were recorded in B_3 (Boron 0.75%), followed by Zn_0 (Zinc 0%) with (6.40 cm), whereas minimum (5.93 cm) was recorded in Control. In different treatments of Zinc and Boron maximum Fruit diameter was recorded in treatment T_3 (Zn_0B_3: Boron 0.75%) with (6.85 cm) followed by T_7 (Zn_1B_3: Zinc 0.25% + Boron 0.75%) with (6.79 cm) whereas minimum (5.78 cm) was observed in Control. Increased fruit size attributed due to micronutrients application might be attributed to enhanced photosynthesis, accumulation of carbohydrates and favourable effect on vegetative growth which increased the fruits variety besides increasing the fruit size. These results get support from the findings of Kumbhlar and Deshmukh (1993) [11], Bose and Tripathi (1996) [1] in tomato, Meenakshi *et al.* (2007) [14] and Narayanamma *et al.*, (2009) [16] in bitter gourd.

In terms of Fruit yield per plant (kg), maximum (1.96 kg) were recorded in B_3 (Boron 0.75%), followed by Zn_0 (Zinc 0%) and B_2 (Boron 0.50%) with (1.71 kg), whereas minimum (1.24 kg) was recorded in Control. In different treatments of Zinc and Boron maximum was recorded in treatment T_3 (Zn_0B_3: Boron 0.75%) with (2.48 kg) followed by T_7 (Zn_1B_3: Zinc 0.25% + Boron 0.75%) with (1.90 kg) whereas minimum (0.64 kg) was observed in Control. The fruit growth and final yield depends on the continued supply of food material and water (Huett and Deltmann, 1988). Since boron helps in the absorption of water and carbohydrates metabolism (Haque *et al.*, 2011) [6], its deficiency may cause sterility, small fruit size and poor yield (Davis, *et al.*, 2003). The results of the present investigation in terms of number of fruits/vine are in collaborative with the findings of Narayanamma *et al.* (2009) [16] in bitter gourd and Meenakshi *et al.* (2007) [14] in bitter gourd and Venkatasalam and Krishnasamy (2011) [21], Rab & Haq (2012) [18] in tomato.

In terms of Harvest Duration (days), minimum (11.12 days) were recorded in B_3 (Boron 0.75%), followed by Zn_0 (Zinc 0%) with (12.17 days), whereas maximum (13.79 days) was recorded in Control. In different treatments of Zinc and Boron. Minimum was recorded in treatment T_3 (Zn_0B_3: Boron 0.75%) with (10.41 days) followed by T_7 (Zn_1B_3: Zinc 0.25% + Boron 0.75%) with (11.14 days) whereas maximum (14.70 days) was observed in Control.

In terms of Yield q/ha, maximum (174.18 q/ha) were recorded in B_3 (Boron 0.75%), followed by B_2 (Boron 0.50%) with (152.39 q/ha), whereas minimum (110.43 q/ha) was recorded in Control. In different treatments of Zinc and Boron maximum was recorded in treatment T_3 (Zn_0B_3: Boron 0.75%) with (220.41 q/ha) followed by T_2 (Zn_0B_2: Boron 0.50%) with (191.98 q/ha) whereas minimum (56.88 q/ha) was observed in Control. The increase in yield and yield attributes due to micronutrients application might be attributed to enhanced photosynthesis, accumulation of carbohydrates, development of cell wall and cell differentiations as they boost up overall vegetative growth, biological activity of the plants and retention of more flowers and fruits which increased number of fruits per vine and size of fruits besides increasing the yield. The production of more number of hermaphrodite flowers in watermelon by the application of calcium and boron might be due to attraction in the GA metabolism (Brantley and Warren, 1960). These results are in agreement with the findings of Kumbhlar and Deshmukh, (1993) [11] and Bose and Tripathi (1996) [1] in tomato, Meenakshi *et al.* (2009) Narayanamma *et al.* (2009) [16] and Patil *et al.* (2013) [17] in bitter gourd.

C. Quality Parameters

In terms of Fiber Content, maximum (1.40%) were recorded in B_3 (Boron 0.75%), followed by Zn_0 (Zinc 0%) with (1.31%), whereas minimum (1.16%) was recorded in Boron Level B_0 (Control). In different treatments of Zinc and Boron maximum was recorded in treatment T_3 (Zn_0B_3: Boron 0.75%) with (1.44%) followed by T_7 (Zn_1B_3: Zinc 0.25% + Boron 0.75%) and T_{11} (Zn_2B_3: Zinc 0.50% + Boron 0.75%) with (1.40%) whereas minimum (1.15%) was observed in Control.

In terms of Ascorbic Acid (mg), maximum (104.18 mg) were recorded in B_3 (Boron 0.75%), followed by Zn_1 (Zinc 0.25%) with (91.17 mg), whereas minimum (67.76 mg) was recorded in Control. In different treatments of Zinc and Boron maximum was recorded in treatment T_3 (Zn_0B_3: Boron

0.75%) with (110.58 mg) followed by T_7 (Zn_1B_3: Zinc 0.25% + Boron 0.75%) with (104.48 mg) whereas minimum (48.19 mg) was observed in Control.

In terms of Total Soluble Solid (^{0}Brix), maximum (4.19 ^{0}Brix) were recorded in B_3 (Boron 0.75%), followed by Zn_3 (Zinc 0.75%) and B_2 (Boron 0.50%) with (4.08 ^{0}Brix), whereas minimum (3.92 ^{0}Brix) was recorded in Control. In different treatments of Zinc and Boron maximum was recorded in treatment T_3 (Zn_0B_3: Boron 0.75%) with (4.22 ^{0}Brix) followed by T_{11} (Zn_2B_3: Zinc 0.50% + Boron 0.75%) with (4.20 ^{0}Brix) whereas minimum (3.77 ^{0}Brix) was observed in Control.

In terms of Specific Gravity (g), maximum (3.19 g) were recorded in B_3 (Boron 0.75%), followed by Zn_0 (Zinc 0%) with (2.66 g), whereas minimum (2.10 g) was recorded in Boron Level B_0 (Control). In different treatments of Zinc and Boron. Maximum was recorded in treatment T_3 (Zn_0B_3: Boron 0.75%) with (3.26 g) followed by T_7 (Zn_1B_3: Zinc 0.25% + Boron 0.75%) with (3.23 g) whereas minimum (1.87 g) was observed in Control. This lead to higher concentration of NPK and micronutrients in leaves and fruits and resulted in better accumulation of assimilates resulting in better quality parameters (Meenakshi *et al.*, 2007) [14] in bitter gourd. The TSS content of tomato fruits have been shown to correlate with available boron and are increased by both foliar and soil application of boron (Sathya *et al.*, 2010) [19]. These results are in consonance with the findings of Shukla (2011) [20] in Indian goose berry and Rab and Haq (2012) [18] in tomato.

D. Economics

In terms of Economics maximum gross return and Net Return was recorded in treatment T_3 (Zn_0B_3: Boron 0.75%) with Rs.440820/ha and Rs. 182556/ha respectively, minimum Gross Return Rs. 113760/ha was recorded in Control, and minimum Net Return Rs.7440/ha was recorded in treatment T_{15} (Zn_3B_3: Zinc 0.75% + Boron 0.75%), but Cost benefit ratio was recorded in treatment T_4 (Zinc 0.25% + Boron 0%) with (1:1.43) and the minimum (1:1.02) was recorded in treatment T_{15} (Zn_3B_3: Zinc 0.75% + Boron 0.75%).

As the economics is the need of the farmers while taking decision regarding the adoption of the techniques and scientific knowledge Hence, T_4 (Zinc 0.25% + Boron 0%) recorded highest cost benefit ratio is due to low cost of zinc and high productivity and enhanced shelf life of fruits, which increase the market value of the fruits.

Table 1: Effects of Foliar application of Micronutrients on Growth parameters of Bitter Gourd

Levels of Zinc (Zn)	Days taken for germination					Levels of Zinc (Zn)	Vine length (m)					Levels of Zinc (Zn)	Number of Primary branches per plant					Levels of Zinc (Zn)	Number of days to first male flower emergence				
	Levels of Boron (B)						Levels of Boron (B)						Levels of Boron (B)						Levels of Boron (B)				
	B_0	B_1	B_2	B_3	Mean (Zn)		B_0	B_1	B_2	B_3	Mean (Zn)		B_0	B_1	B_2	B_3	Mean (Zn)		B_0	B_1	B_2	B_3	Mean (Zn)
Zn_0	9.46	8.22	7.43	6.78	7.97	Zn_0	3.53	4.67	4.81	5.77	4.69	Zn_0	17.61	19.46	20.14	25.16	20.59	Zn_0	49.57	44.51	43.52	40.87	44.61
Zn_1	8.13	8.02	7.81	7.03	7.75	Zn_1	4.21	3.58	4.58	5.32	4.42	Zn_1	18.71	19.23	20.77	23.64	20.58	Zn_1	48.99	46.45	44.73	41.96	45.53
Zn_2	8.44	8.05	7.92	7.18	7.90	Zn_2	4.19	4.73	4.33	5.01	4.56	Zn_2	19.56	18.92	20.56	22.09	20.28	Zn_2	48.04	47.74	47.28	41.52	46.14
Zn_3	8.57	8.51	8.25	7.06	8.10	Zn_3	4.39	4.11	4.26	4.93	4.42	Zn_3	20.33	19.55	21.19	21.30	20.59	Zn_3	48.48	48.16	46.54	42.83	46.50
Mean (B)	8.65	8.20	7.85	7.01		Mean (B)	4.08	4.27	4.49	5.25		Mean (B)	19.05	19.29	20.66	23.04		Mean (B)	48.77	46.71	45.51	41.79	

Factors	F-Test	SE(d)	C.D.	Factors	F-Test	SE(d)	C.D.	Factors	F-Test	SE(d)	C.D.	Factors	F-Test	SE(d)	C.D.
Factor (Zn)	S	0.071	0.146	Factor (Zn)	S	0.044	0.089	Factor (Zn)	NS	0.231	N/A	Factor (Zn)	S	0.309	0.635
Factor (B)	S	0.071	0.146	Factor (B)	S	0.044	0.089	Factor (B)	S	0.231	0.474	Factor (B)	S	0.309	0.635
Factor(Zn X B)	S	0.142	0.292	Factor(Zn X B)	S	0.087	0.179	Factor(Zn X B)	S	0.462	0.947	Factor(Zn X B)	S	0.619	1.270

Table 2: Effects of Foliar application of Micronutrients on Growth parameters of Bitter Gourd.

Levels of Zinc (Zn)	Number of days to first female flower emergence					Levels of Zinc (Zn)	Leaf area index					Levels of Zinc (Zn)	Number of leaves per plant					Levels of Zinc (Zn)	Number of days to first Picking				
	Levels of Boron (B)						Levels of Boron (B)						Levels of Boron (B)						Levels of Boron (B)				
	B_0	B_1	B_2	B_3	Mean (Zn)		B_0	B_1	B_2	B_3	Mean (Zn)		B_0	B_1	B_2	B_3	Mean (Zn)		B_0	B_1	B_2	B_3	Mean (Zn)
Zn_0	53.77	49.35	47.93	45.26	49.07	Zn_0	1.502	1.508	1.512	1.513	1.509	Zn_0	71.96	82.31	87.09	96.60	84.49	Zn_0	73.79	68.52	67.24	64.87	68.60
Zn_1	53.14	50.57	49.38	46.41	49.87	Zn_1	1.503	1.504	1.503	1.512	1.506	Zn_1	79.75	80.31	87.96	94.24	85.56	Zn_1	71.98	69.87	68.70	63.92	68.61
Zn_2	52.43	52.13	51.42	45.64	50.40	Zn_2	1.502	1.503	1.508	1.510	1.506	Zn_2	79.50	82.74	82.49	93.11	84.46	Zn_2	71.30	70.56	69.14	63.83	68.70
Zn_3	53.11	51.60	50.92	47.75	50.84	Zn_3	1.504	1.504	1.507	1.510	1.506	Zn_3	78.83	80.71	82.56	90.82	83.23	Zn_3	70.77	71.58	70.12	63.14	68.90
Mean (B)	53.11	50.91	49.91	46.26		Mean (B)	1.503	1.505	1.508	1.511		Mean (B)	77.51	81.51	85.02	93.69		Mean (B)	71.96	70.13	68.80	63.94	

Factors	F-Test	SE(d)	C.D.	Factors	F-Test	SE(d)	C.D.	Factors	F-Test	SE(d)	C.D.	Factors	F-Test	SE(d)	C.D.
Factor (Zn)	S	0.175	0.359	Factor (Zn)	S	0.000	0.001	Factor (Zn)	NS	0.877	N/A	Factor (Zn)	NS	0.257	N/A
Factor (B)	S	0.175	0.359	Factor (B)	S	0.000	0.001	Factor (B)	S	0.877	1.800	Factor (B)	S	0.257	0.528
Factor(Zn X B)	S	0.350	0.717	Factor(Zn X B)	S	0.001	0.001	Factor(Zn X B)	S	1.754	3.600	Factor(Zn X B)	S	0.514	1.055

Table 3: Effects of Foliar application of Micronutrients on yield parameters of Bitter Gourd .

Levels of Zinc (Zn)	Fruit length (cm)					Levels of Zinc (Zn)	Fruit weight (g)					Levels of Zinc (Zn)	Fruit diameter (cm)					Levels of Zinc (Zn)	Harvest duration (days)				
	Levels of Boron (B)						Levels of Boron (B)						Levels of Boron (B)						Levels of Boron (B)				
	B_0	B_1	B_2	B_3	Mean (Zn)		B_0	B_1	B_2	B_3	Mean (Zn)		B_0	B_1	B_2	B_3	Mean (Zn)		B_0	B_1	B_2	B_3	Mean (Zn)
Zn_0	12.13	15.43	17.06	19.23	15.96	Zn_0	81.93	117.21	135.43	139.98	118.63	Zn_0	5.78	6.40	6.58	6.85	6.40	Zn_0	14.70	12.28	11.32	10.41	12.17
Zn_1	13.75	15.73	15.90	18.41	15.94	Zn_1	97.12	104.89	107.72	127.25	109.24	Zn_1	6.12	6.16	6.32	6.79	6.34	Zn_1	13.37	13.25	12.63	11.14	12.59
Zn_2	14.36	15.05	15.19	18.28	15.72	Zn_2	98.52	104.19	107.37	125.96	109.01	Zn_2	5.95	5.78	5.57	6.64	5.98	Zn_2	13.65	13.59	12.97	11.28	12.87
Zn_3	14.31	13.30	14.68	16.76	14.76	Zn_3	102.53	100.81	106.64	117.45	106.85	Zn_3	5.90	5.88	5.66	6.72	6.04	Zn_3	13.46	13.64	12.93	11.65	12.92
Mean (B)	13.63	14.87	15.70	18.17		Mean (B)	95.02	106.77	114.29	127.66		Mean (B)	5.93	6.05	6.03	6.75		Mean (B)	13.79	13.19	12.46	11.12	
Factors			F-Test	SE(d)	C.D.	Factors			F-Test	SE(d)	C.D.	Factors			F-Test	SE(d)	C.D.	Factors			F-Test	SE(d)	C.D.
Factor (Zn)			S	0.198	0.406	Factor (Zn)			S	0.726	1.491	Factor (Zn)			S	0.060	0.124	Factor (Zn)			NS	0.307	N/A
Factor (B)			S	0.198	0.406	Factor (B)			S	0.726	1.491	Factor (B)			S	0.060	0.124	Factor (B)			S	0.307	0.631
Factor(Zn X B)			S	0.395	0.811	Factor(Zn X B)			S	1.453	2.981	Factor(Zn X B)			S	0.121	0.248	Factor(Zn X B)			NS	0.615	N/A

Table 4: Effects of Foliar application of Micronutrients on Fruit yield parameters of Bitter Gourd.

Levels of Zinc (Zn)	Number of days to last Picking					Levels of Zinc (Zn)	Harvest index					Levels of Zinc (Zn)	Fruit yield per plant (kg)					Levels of Zinc (Zn)	Yield q/ha				
	Levels of Boron (B)						Levels of Boron (B)						Levels of Boron (B)						Levels of Boron (B)				
	B_0	B_1	B_2	B_3	Mean (Zn)		B_0	B_1	B_2	B_3	Mean (Zn)		B_0	B_1	B_2	B_3	Mean (Zn)		B_0	B_1	B_2	B_3	Mean (Zn)
Zn_0	122.19	110.51	110.94	104.72	112.09	Zn_0	65.29	66.28	67.24	69.31	67.03	Zn_0	0.64	1.56	2.16	2.48	1.71	Zn_0	56.88	138.65	191.98	220.41	151.98
Zn_1	117.46	116.32	109.46	106.73	112.49	Zn_1	65.26	66.48	67.62	69.14	67.12	Zn_1	1.53	1.42	1.85	1.90	1.67	Zn_1	135.98	126.10	164.42	168.81	148.82
Zn_2	116.72	114.18	108.35	107.05	111.57	Zn_2	65.50	66.62	67.86	68.86	67.21	Zn_2	1.45	1.25	1.34	1.74	1.44	Zn_2	128.87	111.09	118.96	154.65	128.39
Zn_3	112.84	113.48	114.84	105.67	111.70	Zn_3	66.01	67.36	67.70	68.54	67.40	Zn_3	1.35	1.44	1.51	1.72	1.50	Zn_3	119.99	127.99	134.21	152.85	133.76
Mean (B)	117.30	113.62	110.89	106.04		Mean (B)	65.51	66.68	67.60	68.96		Mean (B)	1.24	1.41	1.71	1.96		Mean (B)	110.43	125.95	152.39	174.18	
Factors			F-Test	SE(d)	C.D.	Factors			F-Test	SE(d)	C.D.	Factors			F-Test	SE(d)	C.D.	Factors			F-Test	SE(d)	C.D.
Factor (Zn)			S	0.283	0.581	Factor (Zn)			S	0.068	0.140	Factor (Zn)			S	0.034	0.070	Factor (Zn)			S	3.020	6.198
Factor (B)			S	0.283	0.581	Factor (B)			S	0.068	0.140	Factor (B)			S	0.034	0.070	Factor (B)			S	3.020	6.198
Factor(Zn X B)			S	0.567	1.163	Factor(Zn X B)			S	0.136	0.280	Factor(Zn X B)			S	0.068	0.139	Factor(Zn X B)			S	6.041	12.396

Conclusion

Based on the present investigation it is concluded that the Boron level B_3 (Boron 0.75%) and treatment combination T_3 (Boron 0.75%) was found best in terms of Growth, Yield and quality parameters of Bitter Gourd cv. F_1 LHB – Swathi. Followed by Boron level B_2 (Boron 0.50%), in most of the parameters. In terms of cost benefit ratio maximum Gross Return and Net Return was recorded in treatment T_3 (Boron 0.75%) and Cost Benefit ratio was found in treatment T_4 (Zinc 0.25%) with (1:1.43).

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