International Journal of Chemical Studies

P-ISSN: 2349–8528
E-ISSN: 2321–4902
www.chemijournal.com
IJCS 2021; 9(2): 310-312

Received: 02-01-2021
Accepted: 04-02-2021

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Influence of micronutrients on yield and economics of bitter gourd (*Momordica charantia*)

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DOI: https://doi.org/10.22271/chemi.2021.v9.i2e.11826

Abstract
The experiment was conducted during *Kharif* seasons of 2019-20 at AICRP (Vegetables) RHREC, Dharwad, Karnataka. Result reveled that significantly higher fruit length (13.56 cm), average fruit weight (110 g), Number of fruit per plant (17.28), yield (127.48/ha), while significantly lower fruit length (10.80 cm), average fruit weight (84.33 g), Number of fruit per plant (13.28), yield (96.45/ha) and The maximum cost benefit ratio of 2.38 was obtained by foliar spray of mixture of all the micronutrients (T_8) recording Rs 190863 /ha as net return and gross return of Rs 271200/ha. The lowest B:C ratio was found in control (1.66).

Keywords: Micronutrients, bitter gourd, yield and economics

Introduction
Bitter gourd (*Momordica charantia* L.) is one of the important vegetable crops belonging to the family Cucurbitaceae. In India, bitter gourd was cultivated in an area of about 79,000 hectare and the production was 8,07,000 metric tonnes (Anon, 2018) [1]. Among all cucurbitaceous vegetables, fruit of bitter gourd records the highest calorific value. In terms of medicinal properties, bitter gourd ranks first among the cucurbits due to higher nutritive value being rich in all the essential vitamins and minerals especially vitamin A (210 IU/100g), vitamin C (88 mg/100g), iron (1.8 mg/100g), phosphorus (55mg/100g), calcium (20 mg/100g) and momordicin (29 mg/g). Micronutrients are usually required in minute quantities, nevertheless, are vital to the growth of plant (Benepal, 1967) [2].

The micronutrients though required in small quantities are as important as macronutrients. Nutrients removal by crop depends on the nutrient availability and their absorption which is influenced by soil pH, soil moisture and soil temperature. Micronutrients play a greater role in regulation of plant growth and yield. The agronomic adaptations like crop management, cropping system and input management like use of organic manures, use of micronutrients, use of biofertilizers *etc.*, which are mitigations options of changing climate, require emphasis. Imbalance supply of organic inputs reduces the availability of essential micronutrients, which ultimately affect the growth, yield and quality of fruits. Boron, zinc and copper normally result in premature floral abscission that leads to failure of seed set (Brown *et al.*, 2002) [5]. The productivity of bitter gourd (6.87t/ha) in Bihar is comparatively lower than the national productivity (110 q/ha), which emphasizes the need of judicious and balanced use of macro as well as micronutrients together with better management practices for the improvement in the availability of nutrients. Therefore, the rational dose of micro nutrients in view of changing climate needs to be explored. Hence, the present investigation was made to study the effect of foliar application of micronutrients on yield and economics of bitter gourd.

Material and Methods
The experiment was conducted during *Kharif* seasons of 2019-20 at AICRP (Vegetables) RHREC, Dharwad, Karnataka, (15.475° N latitude, 74.979° E longitude and 655 m altitude), the experimental soil was well drained and sandy loam in texture. The experiment was laid out in a randomized block design (RBD) with fifteen treatments with three replications.

The experimental fields was ploughed three times and all the cultural practices were done as per the package of Practices of University of Horticultural Sciences Bagalkot. The treatments Details shown in Table No.1

Table 1: Treatment Details

Treatments	
T_1	Control
T_2	Boric acid (B)
T_3	Zinc sulphate ($ZnSo_4$)
T_4	Ammonium molybdate (Mo)
T_5	Copper sulphate ($CuSo_4$)
T_6	Ferrous sulphate ($FeSo_4$)
T_7	Manganese sulphate ($MnSo_4$)
T_8	Mixture of all
T_9	Mixture of all without B
T_{10}	Mixture of all without Zn
T_{11}	Mixture of all without Mo
T_{12}	Mixture of all without Cu
T_{13}	Mixture of all without Fe
T_{14}	Mixture of all without Mn
T_{15}	Commercial formulation

Results and Discussions

Foliar application of micronutrients on bitter gourd resulted reveled that, significantly improvement towards growth yield and as compare to control. The data displayed in Table 2 revealed that the foliar feeding of mixture of all the micronutrients (T_8) being statistically at par with commercial formulation (T_{15}) recorded significantly higher fruit length (13.56 cm), average fruit weight (110 g), Number of fruit per plant (17.28), yield (127.48/ha), while significantly lower fruit length (10.80 cm), average fruit weight (84.33 g), Number of fruit per plant (13.28), yield (96.45/ha) however were recorded in control (T_1). The improvement in vine length as a result of foliar feeding of micronutrients 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), Karthick *et al.*, 2018 [6] and Bharati *et al.*, 2018 [3].

The maximum cost benefit ratio of 2.38 was obtained by foliar spray of mixture of all the micronutrients (T_8) recording Rs 190863 /ha as net return and gross return of Rs 271200/ha. The lowest B:C ratio was found in control (1.66) which recorded minimum net return of Rs 131839. (table5). The highest net return and B: C ratio occured under these treatments was due to highest fruit yield. These findings are in conformity with the observations of Bhatt *et al.* (2004) [4], Patil *et al.* (2008) [7] and Singh and Verma (1991) [8] in tomato, who obtained maximum benefit cost ratio with micronutrients combinations.

Table 2: Response of bitter gourd to foliar feeding of micronutrients

Treatments		Fruit length (cm)	Average fruit weight in grams	Number of fruits per plant	Fruit yield /plot (kg)	Fruit yield q/ha
T_1	Control	10.80	84.33	13.28	8.68	96.45
T_2	Boric acid (B)	12.82	99.67	16.01	10.70	118.93
T_3	Zinc sulphate ($ZnSo_4$)	11.29	96.33	15.27	9.18	101.96
T_4	Ammonium molybdate (Mo)	11.20	83.67	14.90	9.34	103.74
T_5	Copper sulphate ($CuSo_4$)	11.60	79.33	14.46	10.09	112.11
T_6	Ferrous sulphate ($FeSo_4$)	12.46	87.67	15.71	10.18	113.07
T_7	Manganese sulphate ($MnSo_4$)	11.24	103.00	15.65	9.09	101.00
T_8	Mixture of all	13.56	110.00	17.28	11.47	127.48
T_9	Mixture of all without B	13.32	93.67	15.34	9.74	108.22
T_{10}	Mixture of all without Zn	13.03	102.67	16.45	10.57	117.48
T_{11}	Mixture of all without Mo	12.15	93.00	15.90	10.35	115.04
T_{12}	Mixture of all without Cu	12.52	98.67	15.70	10.36	115.07
T_{13}	Mixture of all without Fe	11.97	100.00	16.44	9.97	110.74
T_{14}	Mixture of all without Mn	11.91	94.00	16.12	10.29	114.37
T_{15}	Commercial formulation	13.58	110.00	16.70	10.97	121.92
	SE m±	0.56	6.35	0.76	0.81	9.10
	CD (0.05)	1.55	18.41	2.22	2.37	26.36
	CV (%)	7.60	11.49	8.47	14.09	14.09

Table 3: Effect of foliar application of different micronutrients on economics of bitter gourd

Treatments		Fruit yield q/ha	Cost of cultivation (Rs./ha)	Gross Return (Rs./ha)	Net returns (Rs./ha)	B:C Ratio
T_1	Control	96.45	79641	211480	131839	1.66
T_2	Boric acid (B)	118.93	79699	247580	167881	2.11
T_3	Zinc sulphate ($ZnSo_4$)	101.96	79689	219040	139351	1.75
T_4	Ammonium molybdate (Mo)	103.74	80041	224980	144939	1.81
T_5	Copper sulphate ($CuSo_4$)	112.11	79741	237880	158139	1.98
T_6	Ferrous sulphate ($FeSo_4$)	113.07	79671	239660	159989	2.01
T_7	Manganese sulphate ($MnSo_4$)	101.00	79701	219600	139899	1.76
T_8	Mixture of all	127.48	80337	271200	190863	2.38
T_9	Mixture of all without B	108.22	80279	234300	154021	1.92
T_{10}	Mixture of all without Zn	117.48	80289	253680	173391	2.16
T_{11}	Mixture of all without Mo	115.04	79937	248700	168763	2.11
T_{12}	Mixture of all without Cu	115.07	80307	248000	167693	2.09
T_{13}	Mixture of all without Fe	110.74	80267	239020	158753	1.98
T_{14}	Mixture of all without Mn	114.37	80277	247440	167163	2.08
T_{15}	Commercial formulation	121.92	80709	259980	179271	2.22

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