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Effect of Zinc, Iron and Boron on Growth, Yield and Quality of Bitter Gourd (*Momordica charantia* L.) in Punjab

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ABSTRACT

The present research was carried out to evaluate the effects of micronutrients such as boron, iron and zinc on growth and yield of bitter gourd at research area of vegetables, institute of horticultural sciences, university of agriculture Faisalabad during the year of 2019. Trial was conducted in randomized complete block design comprising of 2 varieties and 9 treatments replicated three times. Various reproductive and vegetative parameters like fruit weight, fruit yield per vine, fruit length etc. were recorded. Data was recorded by following the standard procedures. When fruit would get ready to harvest they were harvested. Data was investigated by ANOVA techniques and by using LSD test means were compared at 5% probability level. Different varieties and micronutrients showed significant variations among, germination percentage, fruit fresh weight, fruit diameter and chemical parameter like vitamin C, TSS and chlorophyll contents. The treatment T_4 ($ZnSO_4$ 0.5%+$FeSO_4$ 0.5%) found best for number of days 40-50 taken to first flowering, fruit diameter(14.45 mm) and fruit length (26.3 cm) as compared to control treatment (without foliar spray). Fruit yield per plant (1.75 kg per plant), average fruit weight (170.09 gm), number of fruits per plant (9.66) and male and female ratio of bitter **gourd responded signi icantly to the foliar application of iron, boron and zinc**.

Keywords: Bitter gourd; Zinc; Iron; Boron; Growth; Yield and quality

INTRODUCTION

Bitter gourd (*Momordica charantia*) is an important vegetable crop which belongs to the family *Cucurbitaceae* [1]. Bitter gourd belongs to genus *Momordica* which includes approximately fifty nine species. The highest species diversity is found in Africa and South East Asian countries. Recently it has been found that six species closely related to bitter gourd are found in India, of which four are dioecious and two monoecious in nature. *M. balsamina* and *M. charant a* are monoecious, while *M. sahyadrica*, *M. dioica*, *M. cochhinchinensis* and *M. subangulata* are dioecious. The regional names of bitter gourd are Karela, goo-fash, bitter melon and balsam pear etc. It is used as a tonic, laxative and it is used as emetic in India and Siri Lanka. This family contains many bene icial vegetables and bittergourd is among them. Bittergourd is very important due to its different health bene its [2].

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Bitter gourd fruits rank first among the cucurbits due to vitamin C and iron. Its fruit is said to be wormicidal and it is a cure for stomach disorders.

Many vegetables are cultivated in Pakistan. In which bittergourd has a major place due to its highly economic and nutritional values. In most area of Pakistan, bittergourd is generally cultivated in March to checkout September [3]. In Punjab, bittergourd is grow in March-April and a second crop is grown in June-July which is not common practice.

Inadequate irrigation facilities, soil erosion, lack of credit and marketing facilities and improper usage of fertilizers are some reasons of low production of bitter gourd (*Momordica charantia* L.) in Pakistan. Bitter gourd initiated in India and in 14^{th} century it was introduced into China. The production of bitter gourd in India is greater than that of other countries as China, Pakistan, Vietnam, Phillipines, Thailand, Sri Lanka, Myanmar, Saudi Arabia, Malaysia, Bangladesh and Nepal. The production of bitter gourd in India is 31% of world, in Pakistan it is 9% and in China it is 22% [4]. According to Provincial Crop Reporting Service Centres in 2017, the total production of bitter gourd is about 66563 tons but in 2018, the total production is about 66942 tons. The yield of bittergourd in 2017 is lesser as compared to yield 2018. In Punjab province, bitter gourd is cultivated on area of about 6670 with production of about 66942 tons.

Micronutrients such as iron, zinc, boron, manganese, etc., have been described to play a vital role in enhancing the growth and development of many horticultural crops. Foliar application of micronutrients to crop plants is gaining popularity in increasing crop yield and quality of improving the shelf life of the produced [5]. Similarly, the effect of micronutrients on growth, development and harvest of bitter gourd are of the supreme importance.

Among micronutrients, zinc occupies a significant place due to its capability to positively affect plant development and growth. Zinc increases seedling vigor, seed-viability and mitigates harms of stresses [6]. Zinc is extremely fixed in soil and its shortage is common in mango, guava, banana, litchi, apple, pomegranate and grape. Little-leaf and rosette symptoms are the most common graphic indicators of Zn deficiency.

Iron is necessary for the biosynthesis of chlorophyll and cytochrome resulting significant increases the growth and yield. Application of micronutrients at proper stage helps in correcting micronutrients deficiency and improves yield and quality of cucumber.

Boron is a micronutrient which is very much effective on bitter gourd production. The micronutrient are elaborate in enzymatic schemes as a cofactors with the exclusion of Mn, Zn, Cu and B. Acting as the 'electron carriers' these are accomplished in the enzyme systems and in the plant systems these are accountable for the oxidative-reduction procedures. Boron obtainability reductions with most of the total soil B and the growing pH, becomes unobtainable to the plants at high pH.

This research is performed to see the effect of foliar application of micronutrients (Zn, B and Fe) on growth, yield and quality of bitter gourd.

MATERIALS AND METHODS

Present experiment was conducted at vegetable research area, institute of horticultural sciences, university of agriculture Faisalabad. Two varieties (Cobra and Parachi) of bittergourd were used in this experiment. Foliar use of zinc, iron and boron were applied on the bittergourd crop. The seed was sowing at 20 December. First spraying was done at 5 February then second spraying at 20 March and third spray was done at 5 May. Different vegetative and reproductive parameters of bitter gourd were studied by following the standard procedures [7]. 4-5 days duration would be maintained as a period between pickings and further quality parameters were analyzed. Rendering to Randomized Complete Block Design (RCBD) this experiment was performed with three replications and each replication contain 9 plants. The experimentation was put out conferring to Factorial in RCBD. Data were collected and examined statistically and means were associated by using statistix 8.1. LSD test was recycled to associate the change amongst treatment means at 5% possibility stage. Analysis of Variance (ANOVA) test was used to estimate importance of the data.

RESULTS AND DISCUSSION

Different concentrations of micronutrients Zn, Fe and B gave greatest outcomes regarding the performance of growth, yield and quality of bitter gourd. Number of leaves per vine at maturity in Cobra variety extreme was attained maximum from T_7 ($ZnSO_4$ 1.0%+$FeSO_4$ 0.5%) 70.000. But number of leaves per vine was minimum 60.342 in T_0. Parachi variety showed that maximum number of leaves per vine at maturity 70.000 was obtained from T_7 ($ZnSO_4$ 1.0%+$FeSO_4$ 0.5%) but minimum 60.110 in T_0. Our findings are related to Gedam, et al., who obtained extreme number of leaves per vine at maturity by use of micronutrients on muskmelon [8]. Number of branches/vine at maturity obtained from T_7 ($ZnSO_4$ 1.0% +$FeSO_4$ 0.5%) with an average of 70.000 in Cobra variety but minimum 60.342 in T_0. Parachi variety showed that highest No. of branches/vine at ripeness (77.399) was obtained from T_7 ($ZnSO_4$ 1.0%+$FeSO_4$ 0.5%) whereas no. of branches/vine at adulthood was minimum 60.110 in T_0. Our findings are related to Lashkari, et al., who obtained extreme number of branches per vine at maturity on watermelon by use of iron and boron on muskmelon. Same results were also obtained by Panse, et al. Number of days taken from propagating to first female flower in Cobra variety shown that smallest number of days were noted in T_0 with an average of 50.331 days but maximum number of days were noted in T_7 ($ZnSO_4$ 1.0% +$FeSO_4$ 0.5%) with an usual of 57.000 days [9]. Parachi variety shown that minimum numbers of days were recorded in T_0 with an average of 50.000 days. But maximum number of days were recorded in T_7 ($ZnSO_4$ 1.0%+$FeSO_4$ 0.5%) with an average of 57.000 days.

Our findings are related to Mulani, et al., who obtained maximum number of days taken to first female flower form by application of zinc and iron on bitter gourd. Typical number of days occupied from propagating to first harvesting in Parachi variety showed 55.000 days in T_0. But in T_7 ($ZnSO_4$ 1.0%+$FeSO_4$ 0.5%) maximum number of days 59.222 days were noted. Cobra variety shown in T_0 with an average of 55.331 days but in T_7 ($ZnSO_4$ 1.0%+$FeSO_4$ 0.5%) determined number of days were noted with an average of 60.000 days. Our findings are related to Bose, et al., who obtained minimum days taken for 1st harvesting by the use of micronutrients (zinc and iron) on bittergourd) [10]. Final vine length in Cobra variety was 450.00 that obtained from T_7 ($ZnSO_4$ 1.0%+$FeSO_4$ 0.5%) and it was minimum 396.34 in T_0. Parachi variety showed that maximum final vine length 449.00 was obtained from T_7 ($ZnSO_4$ 1.0%+$FeSO_4$ 0.5%) but final vine length was minimum 390.11 in T_0. Our findings are related to Palada, et al., who obtained maximum final vine length by use of zinc and iron on bottle gourd. Same results were also obtained by Harman et al. (**Table 1**).

Table 1: Vegetative attributes of bitter gourd affected by B, Zn and Fe.

Treatments	No. of leaves/ vine		No. of branches/ vine at maturity		No. of days taken to female-flower appearence		No. of days taken to first harvesting		Final vine length (m)	
Varieties	V1	V2	V1	V2	V1	V2	V1	V2	V1	V2
T_0	60.342 H	60.110 G	60.342 H	60.110 H	50.331 H	50.000 H	55.331 F	55.000 G	396.34 MN	390.11 QR
T_1	61.466 FG	61.330 G	61.466 G	61.330 G	53.325 DE	53.220 E	56.325 E	56.220 EF	398.46 L	391.33 R
T_2	61.215 G	61.211 G	61.215 G	61.211 G	54.333C D	54.321 D	56.333 E	56.321 E	397.21 M	394.21 P
T_3	63.355 DE	63.332 E	63.355 E	63.332 E	52.252 F	52.242 F	57.252 D	57.242 D	402.35 J	400.33 JK
T_4	62.212 F	62.205 F	62.212 F	62.205 F	56.222 AB	56.215 B	56.222 E	56.215 E	410.21 EF	408.20 I
T_5	66.200 C	66.250 BC	66.200 C	66.250 C	51.200 G	51.212 G	55.200 F	55.250 F	420.20 E	415.25 FG
T_6	64.456 CD	64.315 D	64.456 D	64.315 D	55.456 C	55.321 C	58.456 C	58.321 C	430.45 BC	428.31 E
T_7	70.000 A	70.000 A	70.000 A	70.000 A	57.000 A	57.333 A	60.000 A	59.999 AB	450.00 A	449.00 A
T_8	69.600 AB	69.441 AB	69.600 B	69.441 B	56.222 B	56.357 AB	59.222 B	59.357 B	440.60 AB	440.44 AB
Mean	64.316	64.243	64.316	64.243	54.037	54.024	57.149	57.102	416.2	413.02

Number of fruit/vine 65.000 was obtained from T7 ($ZnSO_4$ 1.0%+$FeSO_4$ 0.5%) in cobra variety but was smallest 55.331 in T_0. Maximum number of fruit/vine 65.999 was obtained from T_7 ($ZnSO_4$ 1.0%+$FeSO_4$ 0.5%) in Parachi variety. But number of fruit per vine was lowest 55.000 in T_0. Our results about number of fruits per vine resembles with the findings of Jame, et al. Fresh weight of fruit in Cobra variety was 74.490 obtained from T_7 ($ZnSO_4$ 1.0%+$FeSO_4$ 0.5%). But fruit fresh weight was minimum 70.552 in T_0. Parachi variety showed fruit fresh weight 74.500 obtained from T_7 ($ZnSO_4$ 1.0%+$FeSO_4$ 0.5%) but minimum 70.445 in control T_0. Our findings are related to Abd-el-Baky, who obtained maximum number of fruit/vine by the use of micronutrients (Zn and Fe) in bittergourd.

Diameter of fruit in Cobra variety was 74.590 that obtained from T_7 ($ZnSO_4$ 1.0%+$FeSO_4$ 0.5%). But it was minimum 12.252 in T_0. Parachi variety shown that maximum fruit diameter 14.000 was obtained from T_7 ($ZnSO_4$ 1.0% +$FeSO_4$ 0.5%) but was minimum 12.000 in T_0 [11]. Our findings are related to Bharad, et al., who obtained maximum fruit diameter by use of micronutrients (Zn and Fe) on bitter gourd. Fruit yield per vine in Cobra variety was noted 5.000 from T_7 ($ZnSO_4$ 1.0%+$FeSO_4$ 0.5%) whereas in T_0 it was minimum 4.221. Parachi variety showed maximum yield of fruit per vine 5.000 was found from T_7 ($ZnSO_4$ 1.0%+$FeSO_4$ 0.5%) but it was minimum 4.220 in T_0. Our findings are related to Patel, et al., who obtained maximum fruit yield per vine by use of iron and zinc on gherkin.

Same results were also obtained by Yousuf, et al., on bottle gourd. Yield of fruit per hectare (tons) showed in Cobra variety 15.000 was got from T_7 ($ZnSO_4$ 1.0%+$FeSO_4$ 0.5%). But yield of fruit per hectare was minimum 12.252 in T_0. Parachi variety shown that higher yield of fruit per hectare 15.000 was attained from T7 (ZnSO4 1.0%+FeSO4 0.5%) but was smallest 12.000 in control T0 [12]. Our findings are related to Day, et al., who obtained maximum fruit yield per hectare by use of zinc and iron on bitter gourd (**Table 2**).

Table 2: Reproductive attributes of bitter gourd affected by B, Zn and Fe.

Treatments	No. of fruits/vine		Fruit fresh weight (Kg)		Fruit diameter (mm)		Fruit yield/vine (Kg)		Fruit yield/ ha (tons)	
Varieties	V1	V2	V1	V2	V1	V2	V1	V2	V1	V2
T_0	55.331 F	55.000 G	70.552 E	70.445 E	12.252 C	12.000 CD	4.221B CD	4.220 CB	12.252 CD	12.000 D
T_1	56.325 E	56.220 EF	72.346 BC	72.220 C	12.346 C	12.220 C	4.466 B	4.460 B	12.346 BC	12.220 CD
T_2	56.333 E	56.321 E	72.338 C	72.321 BC	13.335 B	13.321 B	4.210 BC	4.200 BC	13.335 C	13.321 BC
T_3	57.252 D	57.242 D	71.252 D	71.242 D	13.252 BC	13.242 B	5.351 A	5.350 A	13.252 C	13.242 C
T_4	56.222 E	56.215 E	70.222 E	70.215 E	12.222 C	12.215 CD	4.258 BC	4.250 B	12.222 D	12.215 D
T_5	55.200 F	55.250 F	73.200 B	73.150 B	13.200 BCD	13.250 B	5.201 A	5.200 A	13.200 BCD	13.250 C
T_6	58.456 C	58.321 C	72.456 C	72.321 C	13.456 B	13.321 B	4.452 AB	4.431 AB	13.456 B	13.321 C
T_7	65.000 A	65.999 AB	74.490 A	74.500 A	14.000 A	14.000 A	5.000 AB	5.000 AB	15.000 A	15.000 A
T_8	59.222 B	59.357 B	73.200 B	73.351 AB	13.200 AB	13.441 B	4.610 AB	4.609 B	13.200 BC	13.441 B
Mean	57.149	57.102	72.228	72.196	13.029	13.001	4.641	4.635	13.029	13.001

Content of chlorophyll in Cobra variety 40.000 was obtained from T_7 ($ZnSO_4$ 1.0%+$FeSO_4$ 0.5%). But chlorophyll content was minimum 30.202 in T_0. Parachi variety showed that maximum number of chlorophyll content 40.000 was obtained from T_7. But number of chlorophyll content was minimum 30.200 in T_0. Our findings are matching to Aruna, et al., who obtained maximum chlorophyll content by using micronutrients (zinc and iron) on bottle gourd. Vitamin C in Cobra variety 60.000 was obtained from T_7 ($ZnSO_4$ 1.0% +$FeSO_4$ 0.5%). But vitamin C was minimum 55.33 in T_0. Parachi variety revealed that maximum number of TSS 59.999 was gained from T_7 ($ZnSO_4$ 1.0%+$FeSO_4$ 0.5%). But vitamin C was minimum 55.000 in T_0. Consequences are matching with the conclusions of Akhter, et al. TSS (%) showed maximum TSS (%) 4.900 in Cobra variety found from T_7 ($ZnSO_4$ 1.0%+$FeSO_4$ 0.5%). But TSS was minimum 4.340 in T_0. Parachi variety showed that maximum number of TSS 4.900 was obtained from T_7 ($ZnSO_4$ 1.0%+$FeSO_4$ 0.5%). But number of chlorophyll content was minimum 4.339 in T_0.

Our findings were related to Kumar, et al., who obtained maximum TSS (%) by the use of zinc and iron on bitter gourd. Maximum Zn (ppm) in Cobra variety 60.000 was obtained from T_7 ($ZnSO_4$ 1.0%+$FeSO_4$ 0.5%). But zinc (ppm) was minimum 55.331 in T_0. Parachi variety showed that maximum number of Zn (ppm) 59.999 was obtained from T_7. But zinc (ppm) was minimum 55.000 in T_0. Our findings were related to Salami et al., who obtained maximum Zn (ppm) by the control treatment on bitter gourd. Iron (ppm) showed in Cobra variety maximum iron (ppm) 15.000 was obtained from T_7 ($ZnSO_4$ 1.0%+ $FeSO_4$ 0.5%). But iron (ppm) was minimum 9.852 in T_0. Parachi variety showed that maximum number of iron (ppm) 15.000 was obtained from T_7 ($ZnSO_4$ 1.0%+ $FeSO_4$ 0.5%). But iron (ppm) was minimum 9.000 in T_0. It is clear from results that maximum iron (ppm) was got by the mutual use of $ZnSO_4$ (1.0%) and $FeSO_4$ (0.5%). Our indings are related to Yadav et al. (**Table 3**).

Table 3: Biochemical attributes of bitter gourd affected by B, Zn and Fe.

Treatments	Chlorophyll contents		Vitamin C ($mg100^{-1}$)		TSS %		Zn (ppm)		Iron (ppm)	
Varieties	V1	V2	V1	V2	V1	V2	V1	V2	V1	V2
T_0	30.202	30.2	55.331 F	55.000 F	4.340 BC	4.339 BC	4.221 C	4.220 C	9.852 FG	9.000 H
T_1	32.316	32.315	56.325 E	56.220 E	4.403 B	4.402 B	4.466 B	4.460 B	11.346 DE	11.220 E
T_2	33.225	33.22	56.333 E	56.321 E	4.076 CD	4.075 CD	4.210 CD	4.200 CD	12.335 CD	12.321 D
T_3	34.212	34.209	57.252 D	57.242 D	4.516 C	4.515 C	5.351 A	5.350 A	10.252 F	10.242 F
T_4	33.202	33.2	56.222 E	56.215 E	4.483 D	4.482 D	4.258 C	4.250 C	13.222 C	13.215 C
T_5	36.21	36.209	55.200 F	55.250 F	4.430 D	4.429 D	5.201 A	5.200 A	13.200 C	13.250 C
T_6	38.456	38.45	58.456 C	58.321 C	4.452 C	4.450 C	4.452 BC	4.431 BC	14.456 AB	14.321 AB
T_7	40	40	60.000 A	59.999 B	4.900 A	4.900 A	5.000 AB	5.000 AB	15.000 A	15.000 AA
T_8	39.25	39.249	59.222 B	59.357 B	4.850 AB	4.849 AB	4.610 B	4.609 B	14.200 B	14.351 AB
Mean	35.23	35.228	57.149	57.102	4.494	4.493	4.641	4.635	12.651	12.546

CONCLUSION

From the above research it is concluded that the mixture of micronutrients Zn, Fe and B gave greatest outcomes regarding the performance of yield, quality and growth of bitter gourd. Results showed that treatment T_7 ($ZnSO_4$ 1.0%+$FeSO_4$ 1.0%) gave best results in stimulating the growth, quality, yield and chemical attributes of bitter gourd followed by T_8 ($ZnSO_4$ 1.0% +B_4O_7 0.1%). It is concluded that combination of micronutrients gave good results regarding growth, quality and yield attributes of bitter gourd.

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