INNSPUB

International Journal of Agronomy and Agricultural Research (IJAAR)
ISSN: 2223-7054 (Print) 2225-3610 (Online)
http://www.innspub.net
Vol. 16, No. 4, p. 11-19, 2020

RESEARCH PAPER OPEN ACCESS

Effect of zinc, iron and boron on growth, yield and quality of Bitter gourd (*Momordica charantia* L.) in Punjab

M. Irfan Ashraf[1], Bakhatawar Liaqat*[2], Kanwal Shahzadi[2], Shazia Kiran[2], Laraib Anam[2], M. Bilal Shaukat[1], Nazar Hussain[3]

[1]*Institute of Horticultural Sciences, University of Agriculture, Faisalabad, Pakistan*

[2]*Department of Botany, University of Agriculture, Faisalabad, Pakistan*

[3]*Continuing Education, University of Agriculture, Faisalabad, Pakistan*

Article published on April 19, 2020

Key words: Bitter gourd, Zinc, Iron, Boron, Growth, Yield and quality

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(14.45mm) and fruit length (26.3cm) as compared to control treatment (without foliar spray). Fruit yield per plant (1.75kg per plant), average fruit weight (170.09gm), number of fruits per plant (9.66) and male and female ratio of bitter gourd responded significantly to the foliar application of Iron, Boron and Zinc.

* **Corresponding Author:** Bakhatawar Liaqat ✉ bakhatawarliaqat777@gmail.com

Introduction

Bitter gourd (*Momordica charantia*) is an important vegetable crop which belongs to the family Cucurbitaceae. Bitter gourd belongs to genus *Momordica* which includes approximately fifty nine species (Renner and Schaefer 2010). This family contains many beneficial vegetables and bitter gourd is among them. Bitter gourd is very important due to its different health benefits. 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 Sri Lanka (Nadkarni, 2000).

Many vegetables are cultivated in Pakistan in which bitter gourd has a major place due to its economic and nutritional value. In Pakistan, bitter gourd is generally cultivated in March to September. In Punjab, bitter gourd is grown in March or April and a second crop is grown in June or July but not in common practice (Tahir and Haider, 2005).

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 (Ahmed *et al.,* 2007). The production of bitter gourd in India is greater than that of other countries as China, Pakistan, Vietnam, Philippines, Thailand, Siri 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%. According to Provincial Crop Reporting Service Centers 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 bitter gourd 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 (GOP, 2018).

Bitter gourd is an important vegetable crop of India, the more harvest and extreme yields make it the most favored vegetable crop of Indian growers (Naveen *et al.,* 2012). Micronutrients for example zinc, iron, boron and manganese etc., have been professed to play an energetic role in modifying the development and growth of many horticultural crops. The deficiency of micronutrients badly affects the production of vegetable besides quality.

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 (Cakmak, 2008). Iron is necessary for the biosynthesis of chlorophyll and cytochrome resulting significant increases the growth and yield. 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. (Borax, 2002).

However, the micronutrients play vital role in better growth and development of crops. The production and quality of crops is decreasing, therefore micronutrient applications to maintain health of the soil, crop production and quality as well are the immense needs of the era. Micronutrients are helpful in improving growth, yield, fruit setting, post-harvest life of crops and resistant development against stresses.

Therefore, this study is conducted to examine 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 bitter gourd were used in this experiment. Foliar use of zinc, iron and boron were applied on the bitter gourd 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. 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.

Methods

Land preparation

The land for plantation was prepared ploughing three to four times followed by planking. Raised beds were prepared keeping a distance of three feet after adding DAP@ one bag per acre. The FYM was mixed one month before the land preparation.

Plot size and Dimension

The dimension of the plot was 30m length and 6.0 m width. So, dimensions of the plot was (30m * 6.0m) 180m^2.

Transplanting

Seedling were transplanted into the prepared field on both sides of raised beds with keeping space about 45cm between plants. While bed to bed distance was kept at 75cm.

Cultural practices

Standard cultural practices were followed. Care was taken to avoid flood irrigation in order to protect plant from wilting.

Irrigation and fertilizer application

After transplantation of seedlings, the first irrigation was applied through drip irrigation. Later on irrigations were applied as per crop requirements, usually at interval of two to three days Moreover, the crop was fertigated using a $ZnSO_4$(0.5%), $FeSO_4$(0.5%) and B_4O_7 (0.1%) per kanal.

Hoeing and Weeding

Hoeing and weeding were practiced frequently only in furrows between beds. Weeding practices were performed as per requirement.

Harvesting

Fruits were harvested on once a week and respective data was recognized.

Data Collection

The individual and combine effect of different levels of Zn, Fe and B were studied in terms of different growth and production attributes.

The following treatments were studied

T_0 = Control

T_1 = $ZnSO_4$ 0.5%

T_2 = $FeSO_4$ 0.5%

T_3 = B_4O_7 0.1%

T_4 = $ZnSO_4$ 0.5%+$FeSO_4$ 0.5%

T_5 = $FeSO_4$ 1.0 %+$B4O_7$ 0.1%

T_6 = $ZnSO_4$ 1.0%+ $FeSO_4$ 1.0%

T_7 = $ZnSO_4$ 1.0%+ $FeSO_4$ 0.5%

T_8 = $ZnSO_4$ 1.0%+ $FeSO_4$ 0.5%

Fertilizer application

Bitter gourd requires a balance of nutrients from organic and chemical fertilizers. Fertilizer application rates depend upon soil type, fertility level and soil organic matter.

Number of days taken to first flower

Plants were selected from every treatment and days were counted for first flowering. Then calculated the average.

Number of days taken to first female flower appearance

Plants were selected from every treatment and days were counted for first female flower. Then calculated the average.

Number of days taken to first harvesting

Plants were selected & days were taken for first harvesting.

Number of fruits per vine

Plants were nominated from every management and totaled the number of fruit and finally the average was calculated.

Fruit weight (kg)

Weight of the fresh fruits was recorded at the time of picking by numeral mass stability in kilograms (kg) from casually designated vegetation their regular was considered & statistically examined.

Fruit diameter (mm)

Diameter of berry was dignified by numeral Vernier caliper of selected randomly fruit from every treatment from upper to lowest and mid of the fruit and average was considered as fruit diameter.

Number of leaves per vine at maturity

Leaves of every plant were counted and noted. Every leaf of visible on the vine was counted.

Number of branches per vine at maturity

Plants from every management were selected arbitrarily, number of total branches were counted & finally, average was attained.

Final vine length (m)

Vine length was determined with the support of a measuring tape at the time of maturity**.**

Fruit yield per vine (kg)

Fruit yield per plant was determined by picking the fruits from each selected plant. Weight of fruits from each plant was measured in the laboratory with the help of electrical balance. At the end, total weight of fruits per plant was recorded by adding the fruit weight of all pickings.

Fruit yield per hectare (tons)

The data of yield per hectare was recorded by multiplying the number of plants in hectare with the total fruit weight (g) per plant. The weight of fruits from each plant was measured with the help of electrical balance. Total fruit weight per hectare in grams was then converted into Kilograms by dividing it with 1000.

Chemical analysis

Sample collection

Bitter gourd fruits were collected. The sources prepared from fruit were ready by boiling in purified water for five minutes. The fraction between extraction medium and sample was 1:25. The mixture were clarified through a clean paper (Whatman international Ltd., Maid stone, England and stored (-80°C) which should be used to conduct the biochemical analysis of bitter gourd cultivars.

Chlorophyll Contents (SPAD reading)

The contents of chlorophyll (SPAD) was dignified with the SPAD 502 meter of chlorophyll (Inc., CCM-200, NH, Opti-Sciences USA, Hudson.), which resolute the absolute quantity of chlorophyll in the leaf by calculating the absorbance in the near-infrared regions (650 and 940 nm, respectively) and red. Meter chlorophyll analyses were occupied.

From every plant in the leaves of third or second (grown-up) from the highest on ten casually nominated vegetation (one leaf/plant) at the conclusion of every agriculture sequence.

Vitamin C (mg 100^{-1})

Substances of Vitamin C were intended by investigation (Ruck, 1969). Bitter gourd 10gm sample of fruit was occupied with 2.5ml of 20% Meta phosphoric acid & cleaned H_2O was then further up to 100ml spot. Acid of ascorbic was amount govern conferring to 2, 6-dichloro indo phenol color technique. 10 ml of the deferment was titrated with typical 2, 6-dichloro indo phenol newly organized dye pending bright pink color keep on for 15 sec.

Their normal were designed and examined statistically. Vitamin C in every model was then designed as mg per 100grams.

Preparation of dye

Dye was ready by taking of 52mg 2, 6-dichloro phenol indo-phenols and 42mg $NaHCO_3$ in a 300 ml flask volumetric. Size was prepared active to the spot by cleaned water, strained and continuously newly organized color was recycled.

$$\text{Ascorbic acid mg/100ml} = \frac{1xRxVx100}{R1xWxV1}$$

R= ml of color recycled to titrate in contradiction of V_1 of aliquot (sample reading).

V= Volume of the aliquot ready by 0.4% oxalic acid

W= ml of juice engaged

V_1= ml juice occupied to titration

R_1= ml of color recycled to titrate in contradiction of (1ml standard ascorbic acid + 1.5ml 0.4% oxalic acid) of reference solution (standard reading).

TSS (%)

The sugar contents of sugar solution (juice of bitter gourd) were measured in which the sugar is the main constituent using refractometer. This is dignified by a refractometer and is referred to as Brix. Total Soluble Solids contented of a resolution is resolute by the index of deflection.

Zn (ppm)

The stock resolution of $ZnSO_4$ was ready by dissolving 20g of $ZnSO_4$ in minor quantity of distilled water and volume was complete to 1 liter by adding purified water to obtained concentration of 2%. The desired concentrations i.e. 0.0, 0.5 and 0.5 and 1.0% of $ZnSO_4$ were prepared from the stock solution by the addition of appropriate quantity of citric acid is added in proportion to $ZnSO_4$ used while preparing the solution to avoid the oxidation.

Iron (ppm)

The stock solution of $FeSO_4$ was arranged by dissolving 20g of $FeSO_4$ in slight quantity of cleaned water and size was ready equal to 1 liter by adding refined water to obtained concentration of 2%. The desired concentrations i.e. 0.0, 0.5 and 0.5 and 1.0% of $FeSO_4$ were prepared from the stock solution by addition of appropriate quantity of citric acid is added in proportion to $FeSO_4$ used while preparing the solution to avoid the oxidation.

Statistical Analysis

The experimentation was put out conferring to Factorial in RCBD. Data was together and examined statistically and means were associated by using statistic 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. (Steel *et al.,* 1997).

Results and discussion

Different concentrations of micronutrients Zn, Fe & 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.,* (1996) who obtained extreme number of leaves per vine at maturity by use of micronutrients on muskmelon. 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.,* (2013) 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.,* (2015). 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.

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.,* (2008) 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.,* (2003).

Who obtained minimum days taken for 1st harvesting by the use of micronutrients (Zinc & iron) on Bittergourd.

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.,* (2003) who obtained maximum final vine length by use of zinc and iron on Bottlegourd. Same results were also obtained by Harman *et al.,* (2014). Number of fruit/vine 65.000 was obtained from T_7 ($ZnSO_4$ 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.,* (2003).

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 appearance		No. of days taken to first harvesting		Final vine length (m)	
Varieties	V1	V2	V1	V2	V1	V2	V1	V2	V1	V2
T_0	60.342H	60.110G	60.342H	60.110H	50.331H	50.000H	55.331F	55.000G	396.34MN	390.11QR
T_1	61.466FG	61.330G	61.466G	61.330G	53.325DE	53.220E	56.325E	56.220EF	398.46L	391.33R
T_2	61.215G	61.211G	61.215G	61.211G	54.333CD	54.321D	56.333E	56.321E	397.21M	394.21P
T_3	63.355DE	63.332E	63.355E	63.332E	52.252F	52.242F	57.252D	57.242D	402.35J	400.33JK
T_4	62.212F	62.205F	62.212F	62.205F	56.222AB	56.215B	56.222E	56.215E	410.21EF	408.20I
T_5	66.200C	66.250BC	66.200C	66.250C	51.200G	51.212G	55.200F	55.250F	420.20E	415.25FG
T_6	64.456CD	64.315D	64.456D	64.315D	55.456C	55.321C	58.456C	58.321C	430.45BC	428.31E
T_7	70.000A	70.000A	70.000A	70.000A	57.000A	57.333A	60.000A	59.999AB	450.00A	449.00A
T_8	69.600AB	69.441AB	69.600B	69.441B	56.222B	56.357AB	59.222B	59.357B	440.60AB	440.44AB
Mean	64.316	64.243	64.316	64.243	54.037	54.024	57.149	57.102	416.20	413.02

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 (2010) who obtained maximum number of fruit/vine by the use of micronutrients (Zn & 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. Our findings are related to Bharad *et al.,* (2011) who obtained maximum fruit diameter by use of micronutrients (Zn &Fe) on bittergourd. 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.,* (2003) who obtained maximum fruit yield per vine by use of iron and zinc on gherkin. Same results were also obtained by Yousuf *et al.,* (2009) 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 T_7 ($ZnSO_4$ 1.0%+ $FeSO_4$ 0.5%) but was smallest 12.000 in control T_0. Our findings are related to Day *et al.,* (2014) who obtained maximum fruit yield per hectare by use of zinc and iron on Bitter gourd.

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.,* (2012) 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.

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	55.331F	55.000G	70.552E	70.445E	12.252C	12.000CD	4.221BCD	4.220CB	12.252CD	12.000D
T_1	56.325E	56.220EF	72.346BC	72.220C	12.346C	12.220C	4.466B	4.460B	12.346BC	12.220CD
T_2	56.333E	56.321E	72.338C	72.321BC	13.335B	13.321B	4.210BC	4.200BC	13.335C	13.321BC
T_3	57.252D	57.242D	71.252D	71.242D	13.252BC	13.242B	5.351A	5.350A	13.252C	13.242C
T_4	56.222E	56.215E	70.222E	70.215E	12.222C	12.215CD	4.258BC	4.250B	12.222D	12.215D
T_5	55.200F	55.250F	73.200B	73.150B	13.200BCD	13.250B	5.201A	5.200A	13.200BCD	13.250C
T_6	58.456C	58.321C	72.456C	72.321C	13.456B	13.321B	4.452AB	4.431AB	13.456B	13.321C
T_7	65.000A	65.999AB	74.490A	74.500A	14.000A	14.000A	5.000AB	5.000AB	15.000A	15.000A
T_8	59.222B	59.357B	73.200B	73.351AB	13.200AB	13.441B	4.610AB	4.609B	13.200BC	13.441B
Mean	57.149	57.102	72.228	72.196	13.029	13.001	4.641	4.635	13.029	13.001

Consequences are matching with the conclusions of Akhter *et al.,* (2009). 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.*, (2012) 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.,* (2011) 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 findings are related to Yadav *et al.,* (2001).

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

Treatments	Chlorophyll Contents		Vitamin C (mg 100^{-1})		TSS %		Zn (ppm)		Iron (ppm)	
Varieties	V1	V2	V1	V2	V1	V2	V1	V2	V1	V2
T_0	30.202	30.200	55.331F	55.000F	4.340BC	4.339BC	4.221C	4.220C	9.852FG	9.000H
T_1	32.316	32.315	56.325E	56.220E	4.403B	4.402B	4.466B	4.460B	11.346DE	11.220E
T_2	33.225	33.220	56.333E	56.321E	4.076CD	4.075CD	4.210CD	4.200CD	12.335CD	12.321D
T_3	34.212	34.209	57.252D	57.242D	4.516C	4.515C	5.351A	5.350A	10.252F	10.242F
T_4	33.202	33.200	56.222E	56.215E	4.483D	4.482D	4.258C	4.250C	13.222C	13.215C
T_5	36.210	36.209	55.200F	55.250F	4.430D	4.429 D	5.201A	5.200A	13.200C	13.250C
T_6	38.456	38.450	58.456C	58.321C	4.452C	4.450C	4.452BC	4.431BC	14.456AB	14.321AB
T_7	40.000	40.000	60.000A	59.999B	4.900A	4.900A	5.000AB	5.000AB	15.000A	15.000AA
T_8	39.250	39.249	59.222B	59.357B	4.850AB	4.849 AB	4.610B	4.609B	14.200B	14.351AB
Mean	35.230	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.

References

Abd-el-Baky MMH, Ahmed AA, El-Nemr MA, Zaki MF. 2010. Effect of potassium fertilizer and foliar zinc application on yield and quality of sweet potato Research. Journal of Agricultural and Biological Science **6,** 386-394.

Agarwala SC, Sharma CP, Farooq S. 1985. Effect of iron supply on growth, chlorophyll, tissue iron and activity of certain enzymes in maize and radish Journal of Plant Physiology **3,** 493-499.

Ahmed, MS, Rasul MG, Bashar MK, Mian ASM. 2007. Variability and heterosis in snake gourd. *(Trichosanthes anguina* L.*)*. Bangladesh Journal of Plant Breeding and Genetics **13,** 27-32.

Akhter L, Islam MS, Uddin MN, Ahmed S. 2009. Evaluation of New Bitter Gourd Germplasm. Research Report, 2008-2009. Horticulture Research Centre, BARI, Gazipur. p.16.

Aruna, P, Swaminathan V. 2012. Effect of nitrogen and Evaluation of hybrids for high yield and yield attributes in bitter gourd *(Momordica Charantia* L.). Asian Journal of Horticulture **7,** 624-625.

Bharad SG, Kapgate, AM, Gonge, VS, Dalal SR, Chandan PM. 2011. Effect of foliar application of zinc and iron on growth and yield of bitter gourd. Wonder under net house Asian Journal of Horticulture **2,** 209-211.

Borax. 2002. Soil Tests for Available Boron In: Boron in agriculture Micronutrient.

Bose US, Tripathi SK. 2003. Effect of micronutrients on growth, yield and quality of bittergourd cv. Pusa Veshesh in M.P. Crops Research **12,** 61-64.

Day SC. 2014. Fruit yield response of water melon at different levels of Iron and Zinc New Dehli India **59,** 61-33.

Gedam, V M, Patil RB, Suryawanshi YB, Mate SN. 1996. Seed quality as influenced by growth regulators in bitter gourd. Seed Science Research **24,** 158-159.

Harman, GE, Howell CR, Viterbo A, Chet I, Lorito M. 2014. Effect of zinc and iron on growth and yield of bottle gourd. Nature Reviews Microbiology **2,** 43-56.

James, MS. 2003. Horticultural Sciences, Department. A reviewed. Institute of Food and Agricultural Sciences, University of Florida, Gainesville FL 32611.

Kumar APR, Vasudevan SN, Patil MG, Rajrajeshwari C. 2012. Influence of zinc, and boron spray on seed yield and quality of bitter gourd (*Momordica charantia*) cv. Pusavisesh. Asian Journal of Horticulture **7(1),** 36-39 40.

Lashkari, CO, Makwana AN, Meman MA. 2013. Effect of zinc and iron on growth and yield of water melon. Asian Journal of Horticulture **2(2),** 277-279.

Mulani, SA, Hussain AR, Wadan D. 2007. Effect of zinc levels and sowing dates on growth and production of bitter gourd. Department of |Horticulture, NWFP Agricultural University, Peshawer, Sarhad Journal of Agriculture **21,** 591-594.

Nadkarni AK. 2000. Indian Meteria Medica. Publ. Popular Prakashan PVT. Ltd., Bombay. **1,** 805-7.

Nasreen, S, Ahmad R, Nazm M. 2013. NPK and S for yield maximization of bitter gourd. ISSN 0258-7122. Journal of the Bangladesh Agricultural Research Unit **38,** 355-361.

Palada. MC, Chang. LC. 2003. Suggested cultural practices for bitter gourd. AVRJJC Pandey, UB and Singh L. 2001. Export of vegetables 321-332.

Panse VG, Sukhatme PV. 2015. Statistical methods for agricultural workers. ICAR, New Delhi. eed Science Research **24,** 158-159.

Patel AP, Tandel YN, Patel CR, Patel MA, Patel PB. 2007. Effect on combined application of zinc and iron on growth and yield of gherkin. Asian Journal of Horticulture **4(1),** 78-81. 31.

Salami MA, Siddique MA, Rahim MA, Rahman MA, Goffar MA. 2011. Quality of bottle gourd as influenced by boron and zinc in presence of different doses cow dung. Bangladesh Agricultural Research Unit **36,** 151- 163.

Tahir M, Haider MS. 2005. First report of tomato leaf curl New Delhi virus infecting bitter-gourd in Pakistan. Plant Pathology **54,** 807.

Verma VK, Sirohi PS, Choudhury B. 1984. Note on the response of chemicals to seed treatment on sex expression and fruiting in bitter gourd. Indian Journal of Horticulture **41,** 113-115.

Yadav, PVS, Abha T, Sharma NK, Tikko A. 2001. Effect of zinc and iron application on growth, flowering and fruiting of bitter gourd. Haryana Journal of Horticultural Sciences **30,** 105-107.

Yousuf MN, Islam MS, Karim AJMS, Rahman MM. 2009. Fruit yield response of bottle gourd at different levels of Iron and Zinc. Bangladesh Agricultural Research Unit **11(2),** 11-19.