Research Article

Evaluation of Best Dose of Micronutrients (Zinc, Iron and Boron) to Combat Malnutrition in Brinjal (*Solanum melongena* L.)

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Abstract | The study was carried out in the farmer's fields of Bahawalpur during Kharif-2018 and Kharif-2019 to examine the impact of different doses of micronutrients (Zn, Fe and Boron) on the yield and quality of brinjal. The experiment was laid out in Randomized Complete Block Design (RCBD) with three replications. Five different levels of micronutrients were applied. The treatment T_5 i.e. (100-60-50)+ Borax (0.2) + ZnSO4 (0.5%)+$FeSO_4$ (0.5%) exhibited maximum plant height, fruit weight, total yield, number of fuits plant^{-1} and survival percentage except number of leaves plant^{-1} which were maximum in T_4 i.e. (100-60-50)+ ZnSO4 0.5%. Concludingly, growth parameters of all the theree cultivars of egg plant showed maximum performance i.e plant height (88.57, 139.77 and 135.11 cm), fruit weight (213, 284 and 261 g), yield (10.11, 11.98 and 12.39 t ha^{-1}), survival percentage (95.71, 99.63 and 90.23%) and number of fruits per plant (9.81, 8.67 and 8.11) due to T_5 in black boy, twinkle star and shamli varieties, respectively. Hence, Borax (0.2) + $ZnSO_4$ (0.5%)+$FeSO_4$ (0.5%) kg ha^{-1} is recommended as best dose of micronutrient for brinjal.

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Introduction

Brinjal (*Solanum melongena* L.) also called as Egg plant is one of the most important vegetable of Pakistan. It is also grown in Japan, Turkey, Egypt, Indonesia and Italy. It belongs to family solanaceae. It contains phosphorus, different vitamins particularly B-complex. Bringal is considered as rich source of fiber and help in regulating the level of sugar in blood. The phenolics present in eggplant inhibit the enzymes involved with type 2 diabetes (Kumar and Sodh, 2015). Proper nutrition of plants is vital for increased yield and better quality of bringal. There is a dare need to adopt balanced use of both macro and micronutrients as micronutrient play vital role in different metabolic processes in plants. If nutrients are not applied to plants adequately ultimately the plants will go under stress with concomitant decrease in yield (Fageria, 2009). In our country we are getting very low yield of vegetables because of imbalanced use of fertilizers. As we are using only macronutrients (NPK) to vegetables but the use of micronutrients (Zn, Fe and B) is meager. Sankaran *et al.* (2005) also reported decline in yield of different vegetable due to imbalance use of fertilizers. This study was conducted with the objectives to evaluate the best dose of

fertilizers to combat brinjal malnutrition.

Materials and Methods

The experiment "Evaluation of best dose of micronutrients (zinc iron and boron) for brinjal to combat malnutrition" was carried out in the farmer's fields of Bahawalpur during Kharif-2018 and Kharif-2019.

Soil sampling and analysis

The soil samples were taken from the experimental site prior to sowing of eggplant. The samples were analyzed to evaluate the status of the fertility of experimental sites. Soil texture was clay loam, pH was 7.9 the electrical conductivity (EC) was 0.21 dSm^{-1}, soil available K found to be 180 mg kg^{-1} and Available P was 8 mg kg^{-1}.

Treatments

Control, Borax (0.2), $FeSO_4$ (0.5%), $ZnSO_4$ (0.5%) and Borax (0.2) + $ZnSO_4$ (0.5%)+$FeSO_4$ (0.5%).

The Survival %age was computed by using the following formula.

$$\text{Survival \%age} = \frac{Plant\ survived}{Total\ No.of\ plants\ transplanted} \times 100$$

The calculation of total yield (t ha^{-1}) was done by below given formula:

$$\text{Total yield (t ha} - 1) = \frac{Yield\ per\ plot\ (tones)}{Area\ of\ plot(m^2)} \times 10^4 m^2$$

Results and Discussion

Plant height (cm)

The yield data about the plant height of different cultivars of eggplant in response to different doses of micronutrients is given in Table 1. The statistical results revealed significant impact on the plant height of eggplant. The heighest height (88.75 cm) documented was in T_5 {Borax (0.2) + $ZnSO_4$ (0.5%)+$FeSO_4$ (0.5%)} lowest plant height was in control (65.31 cm) in Black boy cultivar. Correspondingly in Twinkle Star cultivar the minimum plant height (133.26 cm) was in control and maximum plant height (139.77 cm) was in T_5. Similar trend was observed in Shamli cultivar, where the plant height was maximum was 135.11cm in T_5.

It is evident that application of micronutrients resulted an increase in the in bringal plant height contrary to control treatment where decreased plant height was noticed. This enhancement in bringal plant height due to micronutrients is attributed towards increase in photosynthesis, formation of chlorophyll and metabolism of nitrogen which inturn increased the plant height. Thesse results are in agreement with the finding of (Kadari *et al.*, 2015; Suganiya and Kumuthini, 2015; Pandav *et al.*, 2016). Increased plant height might be due micronutrients application which acclerated the photosynthesis and formation of chlorophyll and increased auxin contents with concomitant increase in plant height (Gogoi *et al.*, 2014).

Table 1: *Impact of micronutrients on Plant height (cm).*

Treatments (Kg/ha)	Varieties		
	Black boy	Twinkle star	Shamli
(100-60-50)	65.31	133.26	93.81
(100-60-50)+Borax 0.2%	75.43	119.15	113.54
(100-60-50)+ $FeSO_4$ 0.5%	74.21	125.51	127.33
(100-60-50)+ $ZnSO_4$ 0.5%	83.18	131.22	131.77
(100-60-50)+ Borax (0.2) + $ZnSO_4$ (0.5%)+$FeSO_4$ (0.5%)	88.75	139.77	135.11

Table 2: *Impact of micronutrients on fruit weight (g).*

Treatments (Kg/ha)	Varieties		
	Black boy	Twinkle star	Shamli
(100-60-50)	163	185	155
(100-60-50)+Borax 0.2%	169	205	143
(100-60-50)+ $FeSO_4$ 0.5%	191	233	188
(100-60-50)+ $ZnSO_4$ 0.5%	201	267	211
(100-60-50)+ Borax (0.2) + $ZnSO_4$ (0.5%)+$FeSO_4$ (0.5%)	213	284	261

Fruit weight (g)

The data regarding the weight of fruit of different varieties of eggplant is presented in Table 2. The statistical results exposed significant impact on fruit weight of eggplant. The heighest fruit weight 213g was experienced in T_5 {Borax (0.2) + $ZnSO_4$ (0.5 %) + $FeSO_4$ (0.5 %)} in contrast to control where it was163g in Black boy cultivar. Similarly in case of cultivar Twinkle Star the minimum fruit weght (185g) was in control and maximum fruit weight (284 g) was in T_5 (Table 2). Similar trend was observed in Shamli cultivar, whre it was highest (261g) in T_5 Fruit

weight results considerably influenced by different doses of micronutrients. These findings are parallel to those reported by Dubey *et al.* (2013) who reported increase in fruit weight to micronutrients application.

Total yield (t ha^{-1})

The data regarding the total yield of different cultivars of eggplant in response to different doses of micronutrients is given in Table 3. The statistical results exposed significant impact on total yield of eggplant. The heighest total yield (10.11 t ha^{-1}) was noticed in T_5 {Borax (0.2) + $ZnSO_4$ (0.5 %) + $FeSO_4$ (0.5 %)} lowest yield was in control (4.31t ha^{-1}) in Black boy cultivar. Correspondingly in Twinkle Star cultivar the minimum total yield (3.78 t ha^{-1}) was found in control and the highest total yield (11.98 t ha^{-1}) observed was in T_5. Likewise tendency was noticed in Shamli cultivar, where the yield was highest (12.39 t ha^{-1}) in T_5. Our results are in accordance with the finding of (Khedr *et al.*, 2004) they experienced increase in bringal yield due to micronutrients application.

Table 3: *Impact of micronutrients on yield (t ha^{-1}).*

Treatments (Kg/ha)	Varieties		
	Black boy	Twinkle star	Shamli
(100-60-50)	4.21	3.78	4.13
(100-60-50)+Borax 0.2%	6.17	5.25	5.27
(100-60-50)+ $FeSO_4$ 0.5%	8.29	9.70	8.46
(100-60-50)+ $ZnSO_4$ 0.5%	9.13	11.81	10.21
(100-60-50)+ Borax (0.2) + $ZnSO_4$ (0.5%)+$FeSO_4$ (0.5%)	10.11	11.98	12.39

Survival percentage

The reorded data about the Survival %age of different cultivars of eggplant in response to different doses of micronutrients is given in Table 4. The statistical results exposed significant impact on Survival Percentage of eggplant. Contrary to other parameters under study, the heighest Survival Percentage (95.22%) was recorded where T_4 {$ZnSO_4$ (0.5%)} was applied and the lowest Survival Percentage (88.16%) was in T_3 ($FeSO_4$ 0.5%) in Black boy cultivar. In Twinkle Star cultivar the minimum Survival Percentage (85.76%) was in T_3 and maximum (94.19%) was in T_2 where Borax @0.2% was used. Opposite tendency was noticed in Shamli cultivar, where the Survival Percentage was highest (94.27%) in control treatment.

Number of leaves/plant

The data related to the number of leaves plant^{-1} of different cultivars of eggplant in response to different doses of micronutrients is given in Table 5. The results revealed significant effect of micronutrients on the number of leaves plant^{-1} of bringal. In Black Boy cultivar, the maximum number of leaves plant^{-1} were found in T_3 ($FeSO_4$ 0.5 %) and T_5 {Borax (0.2 %) + $ZnSO_4$ (0.5 %) + $FeSO_4$ (0.5 %)} which were 305 and 283, respectively. Whereas the minimum number of leaves plant^{-1} (106) were found in T_1 (control treatment). The Twinkle Star cultivar exhibited the maximum number of leaves plant^{-1} in T_3 (357) and T_1 (352) which were not ststistically significant with each other. Conversely in T_4 maximum number of leaves plant^{-1} (405) were observed than control where the number of leaves plant^{-1} were 252 in bringal cultivar Shamli. The foliar application of different micronutrients resulted increase in the the nitrogen content of the leaves. Increase in number of leaves might be attributed toward promotive impacts of micronutrients on the vegetative growth which in turn resulted enhanced photosynthesis (Tawab *et al.*, 2015). Gogoi *et al.* (2014) also reported parallel results.

Table 4: *Impact of micronutrients on survival %age.*

Treatments (Kg/ha)	Varieties		
	Black boy	Twinkle star	Shamli
(100-60-50)	91.21	90.14	89.11
(100-60-50)+Borax 0.2%	93.38	91.28	88.41
(100-60-50)+ $FeSO_4$ 0.5%	96.41	92.33	90.55
(100-60-50)+ $ZnSO_4$ 0.5%	95.55	88.72	91.71
(100-60-50)+ Borax (0.2) + $ZnSO_4$ (0.5%)+$FeSO_4$ (0.5%)	95.71	99.63	90.23

Table 5: *Impact of micronutrients on number of leaves/ plant.*

Treatments (Kg/ha)	Varieties		
	Black boy	Twinkle star	Shamli
(100-60-50)	101	254	223
(100-60-50)+Borax 0.2%	239	289	313
(100-60-50)+ $FeSO_4$ 0.5%	277	301	377
(100-60-50)+ $ZnSO_4$ 0.5%	282	303	388
(100-60-50)+ Borax (0.2) + $ZnSO_4$ (0.5%)+$FeSO_4$ (0.5%)	277	292	403

Number of fruits plant^{-1}

The number of fruits plant^{-1} data of various eggplant cultivars in response to different doses

of micronutrients is given in Table 6. The results exhibited significant effect of micronutrients on number of fruits plant^{-1} of bringal. But in Black Boy cultivar, the maximum number of fruits plant^{-1} were found in T_3 ($FeSO_4$ 0.5 %) and T_5 {Borax (0.2 %) + $ZnSO_4$ (0.5 %)+$FeSO_4$ (0.5%)} which were 9.41 and 9.81, respectively. minimum number of fruits plant^{-1} were noticed in T_1 (control). The twinkle star cultivar exhibited maximum number of fruits plant^{-1} in T_4 (8.25) and T_5 (8.29). On the other hand in T_3 (7.69), T_4 (7.88) and T_5 (6.860) statistically no significant difference was experienced in case of number of fruits perplant of bringal cultivar Shamli. Mohsin (2013) observed same increase in tomato yield due to iron and zinc application.

Table 6: *Impact of micronutrients on number of fruits/ plant.*

Treatments (Kg/ha)	Varieties		
	Black boy	Twinkle star	Shamli
(100-60-50)	7.33	5.22	6.62
(100-60-50)+Borax 0.2%	8.11	6.13	6.98
(100-60-50)+ $FeSO_4$ 0.5%	9.41	6.97	7.69
(100-60-50)+ $ZnSO_4$ 0.5%	8.73	8.25	7.88
(100-60-50)+ Borax (0.2) + $ZnSO_4$ (0.5%) +$FeSO_4$ (0.5%)	9.81	8.67	8.11

Conclusions and Recommendations

Outcmoes of the this study revealed that the growth parameters of all the theree cultivars of egg plant showed maximum performance i.e plant height (88.57, 139.77 and 135.11 cm), fruit weigh (213, 284 and 261 g), yield (10.11, 11.98 and 12.39 t ha^{-1}), survival percentage (95.71, 99.63 and 90.23%) and number of fruits per plant (9.81, 8.67 and 8.11) due to T_5 in Black boy, twinkle star and shamli varieties, respectively. Hence, micronutrients application @ Borax (0.2 %) + $ZnSO_4$ (0.5 %) + $FeSO_4$ (0.5 %) is recommended as best dose of micronutrient for egg plant to combat bringal malnutrion alongwith recommended dose of macronutrients as well.

Novelty Statement

A vast gap between the actual yeld and yield potential of bringal due to insufficient supply of micronutreints is the major cause of bringal malnutrition. Hence, it is inevitable to apply micronutrients (Zn, Fe and Boron) alongwith micronutrients. Application of Borax (0.2 %) + $ZnSO_4$ (0.5 %) + $FeSO_4$ (0.5 %) is hereby proposed to combat bringal malnutrition and to plug in gap between actual yield and potential yield.

Author's Contribution

The plan of research was proposed by Muhammad Nasir and Nadeem Iqbal, Zafar Abbas, Ghulam Murtaza, Muhammad Zahid Khan Nazar, executed the research, Muhammad Ashraf, contributed in analysis, Salma Kausar, wrote the Abstract, Ijaz Ahmad and Muhammad Atif Ghafoor wrote Materials and Methods and Shahzada Munawar Mehdi, supervised the research work.

Conflict of interest

The authors have declared no conflict of interest.

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