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Research Article

Response of Okra verities, to zinc and boron supplement under the agro-climatic condition of Tandojam-Pakistan

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Abstract

The present experiment was carried out during the Kharif season March 2017, at the Department of Horticulture Sindh Agriculture University Tandojam, Pakistan. The experiment was laid out in three replication and six treatments combination. Hence, consider to each levels of Zinc (Zn 10 kg ha^{-1} and B 4 kg ha $^{-1)}$ and results of the design to indicated the application of Significantly, increase plant height cm, number of branches plant^{-1}, number of pods plant^{-1}, Weight of pods plant^{-1} g, pod length cm, Single pod weight g, pod yield ha^{-1}, pod yield plot kg. Among the different levels of different Zinc and Boron, the number of branches plant^{-1} and the increased application plant height cm immature, the Zn and Boron to improve the different recommended dose of fertilizer and yield of okra.

Keywords: *Abelmoschus esculentus* L.; Growth yield; Okra; Zinc and Boron

Introduction

Okra (*Abelmoschus esculentus* L.) is one of the most important vegetable grown in Pakistan. It is a vegetable crop *Malvaceae* family grown in tropical and subtropical region around the world [1]. It is originated somewhere, around Ethiopia and the rest of the world within historic times, it is not surprising that little is known about the early history and distribution of Okra. The cultivated the ancient Egyptians by the 12th century B.C. its cultivation spread throughout North Africa and the Middle East. The okra immature fruits (green seed pods), which are consumed as vegetables can be used in salads, soups and stews, fresh or dried, fried or boiled [2]. It offers mucilaginous consistency after cooking as vegetable is renowned and favorable vegetable grown for tender fruits and fresh market consumption. It is one the most nutritious rich for its taste and status of vegetable and plays an important role to meet the demands in the country during the crisis period in early summer [3]. The fertile soil is most suitable under optimum levels of soil organic matter and other essentially required nutrient elements. The fertilizer application methods have a critical role so far the nutrient utilization by the plants [4, 5]. The Okra which is currently grown mainly as a vegetable crop has potential for cultivation as an essential oilseed crop because Okra seeds contains high amount of oil (20-40%). The Okra covering 75 percentage of the total area under the vegetable accounting for 74 percentage of total production in our country the major share in the production is Punjab 63 percentage followed by Sindh 14 percentage, Baluchistan 12 percentage and KPK 11 percentage. The increasing more bringing under cultivation and present situation it's not possible to increase the production of okra under the different verities and supply of irrigation water to Zinc and Boron Moreover, the alternate increasing production in the country the deficiency of particularly Zinc and Boron causes the poor crop quality and yield.

Among micronutrients, Zinc (Zn) has the significant role in pollination and in seed setting process [6]. The Zinc plays very important role in plant metabolism by influencing the activities of hydrogenise and carbonic anhydrates the plant enzymes activated by Zinc are involved in carbohydrate metabolism, maintains of integrity of cellular Zinc is required in a large number of enzymes and plays an essential role in plants the deficiency of Zinc occurs when plants growth is limited because that plant takes up sufficient quality of these essential nutrients from its growing medium. It is one of the most widespread micronutrients in crop and pastured worldwide and causes large losses in crop production and quality [7, 8], moreover, soil and Zinc deficiency may be the causative to decreased seed formation to result poor yields as well as micronutrient, Zinc has proved its essentiality and crop response to Zinc deficiency has been well recognized by the scientists in the world. As reported the zinc in inadequacy soil has become a serious issue in worldwide. The Zinc improvement in cereal grains and legumes by soil applied Zinc [8]. Boron exists primary in soil solutions the commonly take up by plants and boron supports the structural and functional integrity of plant cell membranes the similarly, boron play an important role water relations and metabolism of carbohydrate and fats [9]. The deficiency, of boron in plant terminate the bud growth and death of young leaves the formation of seed germination and development of nodules also affected in its absence and also reduced with low boron and well produce the maximum fruit yield.

Materials and methods

The present research was conducted to investigate the response of okra varieties, to zinc and boron supplement under the agro-climatic condition of Tandojam-Pakistan. The experiment was laid out at the experimental areas in the orchard, Department of Horticulture, Sindh Agriculture University Tandojam during kharif season march 2017 in a three replicated Randomized Complete Block Design (RCBD). Okra varieties (Sabz pari and Bemisal) were planted in a plot size 3m x 3.5m (10.50m^2). The land was prepared by giving 2 dry plowings followed by land leveling. The different fertilizer combinations Zinc and Boron levels viz; Control (NPK 120-100-75 kg ha^{-1}, Zn 5 kg ha^{-1}, Zn 5 kg ha^{-1} + B 2 kg ha^{-1}, Zn 7.5 kg ha^{-1}+ B 4 kgha^{-1}, Zn 10 kg ha^{-1} + B 2 kg ha^{-1} and Zn 10 kg ha^{-1} + B 4 kg ha^{-1}) were tested and applied at the time of sowing by mixing in the soil, while the remaining Zinc and Boron was applied in doses first after one month of sowing and second at one month interval. The

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observation was recorded on the parameters that included. Plant height (cm), number of branches plant^{-1}, number of pod plant^{-1}, weight of pod plant^{-1} (g), pod length (cm), single pod weight (g), pod yield plot (kg), pod yield ha^{-1} (kg).

Statistical analysis

All collected data were analyzed concluded statistical computer software named Statistix 8.1 [10]. LSD test was performed. The data were exposed to analysis of modification technique and means were matched via least significant at ($P \leq 0.05$). Probability level to compare treatment superiority.

Results and discussion

Plant height cm

The okra crop supplied with Zinc and boron application in (Table 1) The RDF Zn 10 kg ha^{-1} + B 4 kg ha^{-1} of maximum height (94.64 cm) followed by the treatments compared of Zn 10 kg ha^{-1} + B 2 kg ha^{-1} and RDF + Zn 7.5 kg ha^{-1} + B 4 kg ha^{-1} with the average okra plant height (93.35 cm) and (92.28 cm) respectively, while the lowest plant height (83.45 cm) was recorded under control [NPK 120-100-75 Kg ha^{-1}] the Zinc application regardless the form of application was significantly ($P<0.05$) effect against plant height of okra variety Bemisal. However, plant height was more positively influenced by zinc and boron application. Moreover, Zinc 10 kg ha^{-1} + B 4 kg ha^{-1} concentration showed similarly in their effect on plant height. Similar result has been reported by [11, 12], who reported that zinc solution applied by spraying on foliage produce good results for plant height and branching in okra.

Table 1. Plant height cm of two okra verities under different zinc and boron levels

Treatments	Varieties		Mean
	Sabz Pari	Bemisal	
F1= Control[NPK@ 120-100-75 Kg ha-1]	85.59	81.31	83.45 F
F2= RDF + Zn 5 kg ha-1	89.66	85.18	87.42 E
F3= RDF + Zn 5 kg ha-1 + B 2 kg ha-1	93.24	88.57	90.90 D
F4= RDF + Zn 7.5 kg ha-1+ B 4 kg ha-1	94.65	89.92	92.28 C
F5= RDF + Zn 7.5 kg ha-1+ B 4 kg ha-1	95.74	90.96	93.35 B
F6= RDF + Zn 10 kg ha-1 + B 4 kg ha-1	97.08	92.23	94.65 A
Mean	92.66 A	88.03 B	

S.E. 0.2495
LSD 0.05, 0.5174

Number of branch plant^{-1}

The okra crop supplied with boron and zinc application of Zn 10 kg ha^{-1} + B 4 kg ha^{-1} (Tables 2) produce plant with the maximum number of branches (6.15) followed by the treatments compared of RDF Zn 10 kg ha^{-1} + B 2 kg ha^{-1} and Zn 7.5 kg ha^{-1} + B 4 kg ha^{-1} with the 5.83 and 5.80 branches plant^{-1} respectively while the minimum number of branches plant^{-1} (5.19) was recorded control [NPK 120-100-75 kg ha^{-1}] these results according to with those of [13], who founded that foliar application of Zinc as basal application through soil has significant and positive yield.

Number of pods plant^{-1}

The result regarding plant^{-1} pod of okra verities influenced by the Zinc and Boron levels as given (Table 3) The analysis variance to suggested that number of pods plant-1 ok Okra showed to significant variation number of plant^{-1} the highest (23.27) plots given by the Zinc and Boron levels at 5 kg ha^{-1} with the average (22.04), (21.94) and (21.23) average number of Boron plants respectively, the okra crop fertilizer and with the Zn 5 kg ha^{-1} Zn to produce the number of plant^{-1} 20.37 respectively while the lowest number of pods plant^{-1} 19.02 result found the interaction of both verity [14].

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Table 2. Number of branches plant^{-1} of two okra varieties under zinc and boron levels

Treatments	Varieties		Mean
	Subs Pari	Bemisal	
F1= Control (RDF [NPK@120-100-75 kg ha-1]	5.32	5.06	5.19 E
F2= RDF + Zn 5 kg ha-1	5.52	5.25	5.38 D
F3= RDF + Zn 5kg ha-1 + B 2 kg ha-1	5.76	5.47	5.61 C
F4= RDF + Zn 5 kg ha-1 + B 2 kg ha-1	5.95	5.65	5.80 B
F5= RDF + Zn 10 kg ha-1 +B 2 kg ha-1	5.98	5.68	5.83 B
F6= RDF + Zn 10 kg ha-1 + B 4 kg ha-1	6.31	5.99	6.15 A
Mean	5.81 A	5.51 B	

S.E. 0.0227
LSD 0.05, 0.0470

Table 3. Number of pods plant^{-1} of two okra varieties under the different zinc and boron levels

Treatments	Varieties		Mean
	Sabz Pari	Bemisal	
F1= Control (RDF [NPK@120-100-75 kg ha-1]	20.24	19.02	19.63 F
F2= RDF + Zn 5 kg ha-1	21.00	19.74	20.37 E
F3= RDF + Zn 5 kg ha-1 + B 2 kg ha-1	21.89	20.57	21.23 D
F4= RDF + Zn 7.5 kg ha-1 +B 4 kg ha-1	22.62	21.26	21.94 C
F5= RDF + Zn 10 kg ha-1 + B 2 kg ha-1	22.72	21.36	22.04 B
F6= RDF + Zn 10 kg ha-1 + B 2 kg ha-1	23.99	22.55	23.27 A
Mean	22.07 A	20.75 B	

S.E. 0.0778
LSD 0.05, 0.1613

Weight of pods plant^{-1} (g)

Okra plantation supplies the Zinc and boron RDF Zn 10 kg ha^{-1} + B 4 kg ha^{-1} the results in highest pod weight plant^{-1} (204.54 g) followed by (193.75 g) and (192.88 g) average pod weight plant^{-1} recorded in the (Table 4) The treatments comprised of zinc and boron RDF Zn 10 kg ha^{-1} B 2 kg ha^{-1} and RDF + Zn 7.5 kg ha^{-1} + B 4 kg ha^{-1} while the minimum pod weight plant^{-1} (172.58 g) was recorded in control [NPK 120-100-75 kg ha^{-1}] these results have been supported by the number of past research including [15, 16], who was consolidated experience that fruit quality of okra is improved considerably if zinc application through soil is ensured, because the zinc inadequacy has been reported in most of the value.

Table 4. Weight of pods plant^{-1} (g) of two okra varieties under the different zinc and boron levels

Treatments	Varieties		Mean
	Sabz Pari	Bemisal	
F1= Control (RDF) [NPK@120 100-75 Kg ha-1]	176.10	169.06	172.58 F
F2= RDF + Zn 5 kg ha-1	182.71	175.40	179.06 E
F3= RDF + Zn 5 kg ha-1 + B 2 kg ha-1	190.43	182.81	186.62 D
F4= RDF + Zn 7.5 kg ha-1 +B 4 kg ha-1	196.82	188.95	192.88 C
F5= RDF + Zn 10 kg ha-1 + B 2 kg ha-1	197.70	189.79	193.75 B
F6= RDF + Zn 10 kg ha-1 + B 4 kg ha-1	208.72	200.37	204.54 A
Mean	192.08 A	184.40 B	

S.E. 0.6859
LSD 0.05, 1.4226

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Pod length (cm)

The pod okra is a character prime of most importance because the yield of pods is to contributions the yield and relevant mean of pods and length of Oka varieties like Sabz pari and Bemisal as to the influence of different born levels and are to be presented in (Table5) The Zinc and boron RDF Zn 10 kg ha^{-1} + B 4 kg ha^{-1} produced okra pods of maximum length (6.63 cm) followed by (6.28 cm) and 6.25 cm average pod length recorded in the treatments comprises of zinc and boron RDF + Zn 10 kg ha^{-1} + B 2 kg ha^{-1} and Zn 7.5 kg ha^{-1} + B 4 kg ha^{-1} respectively, while the minimum pod length (6.45 cm) was noted in control plots where zinc application in any form was withdraw, irrespective of application method the zinc proved to be the significantly effective for improving the pod length of okra variety sabz pari. It was observed that higher levels of zinc and boron highest concentration applied improved the pod length of okra simultaneously the finding of the present research regarding pod length are in according with those of [17]. Who reported positive impact of zinc application in addition to NPK fertilizer for achieving the positive impacts.

Table 5. Pod length (cm) of two okra varieties under the different zinc and boron levels

Treatments	Varieties		Mean
	Sabz Pari	Bemisal	
F1= Control (RDF) [NPK @120-100-75 Kg ha-1	5.68	5.51	5.59 E
F2= RDF + Zn 5 kg ha-1	5.89	5.71	5.80 D
F3= RDF + Zn 5 kg ha-1 + B 2 kg ha-1	6.14	5.96	6.05 C
F4= RDF + Zn 7.5 kg ha-1 + B 4 kg ha-1	6.35	6.16	6.25 B
F5= RDF + Zn 10 kg ha-1 + B kg ha-1	6.38	6.19	6.28 B
F6= RDF + Zn 10 kg ha-1 + B 4 kg ha-1	6.73	6.53	6.63 A
Mean	6.19 A	6.01 B	

S.E. 0.0224

LSD 0.05, 0.0465

Single pod weight (g)

The okra varieties Zinc and boron levels presented in (Table 6) The Zn and boron RDF Zn 10 kg ha^{-1} and B 4 kg ha^{-1} produced heavier pods on average (9.24 g) followed by the (8.75 g) and (8.71 g) single pod weight recorded in the treatment comprised of zinc and boron RDF Zn 10 kg ha^{-1} + B 2 kg ha^{-1} and RDF Zn 7,5 kg ha^{-1} + B 4 kg ha^{-1} respectively, while the minimum single pod weight (7.79 g) was recorded in control [NPK 120-100-75 kg ha^{-1}] the zinc and boron concentration confirmed the validity of this element for improving the average pod weight in okra varieties Sabz pari [18, 19]. Who reported that for obtaining the high quality pods of okra varieties zinc application.

Table 6. Single pod weight (g) of two okra verities under different zinc and boron levels

Treatments	Varieties		Mean
	Sabz Pari	Bemisal	
F1= Control (RDF) NPK @ 120-100-75]	7.95	7.63	7.79 E
F2= RDF + Zn 5 kg ha-1	8.25	7.92	8.08 D
F3= RDF + Zn 5 kg ha-1 + B 2 kg ha-1	8.59	8.25	8.42 C
F4= RDF + Zn 7.5 kg ha-1 +B 4 kg ha-1	8.88	8.53	8.71 B
F5= RDF + Zn 10 kg ha-1 + B 2 kg ha-1	8.92	8.57	8.75 B
F6= RDF + Zn 10 kg ha-1 + B 4 kg ha-1	9.43	9.05	9.24 A
Mean	8.67 A	8.32 B	

S.E. 0.0307

LSD 0.05, 0.0637

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Pod yield plot^{-1} (kg)

The influence of Zinc and boron RDF Zn 10 kg ha^{-1} + B 4 kg ha^{-1} produce the maximum pod yield (7205.2 kg plot^{-1}) followed pod yield of (6824.8 kg) plot^{-1} and (6792.4 kg plot^{-1}) in (Table 7) The treatments comprised of zinc and boron RDF Zn 10 kg ha^{-1} + B 2 kg ha^{-1} and RDF + Zn (7.5 kg ha^{-1}) and B 4 kg ha^{-1} respectively, while the lowest pod yield (6079.2 kg plot^{-1}) was noted under control [NPK 120-100-75 kg ha^{-1}] the okra crop response to zinc and boron inadequacy of this element at the experimental soil site and the pod yield was significantly improved with zinc and boron application. The high zinc and boron levels proved to be more beneficial to increase pod yield ha^{-1} similar results have also been reported by [20, 21]. Who reported that soil applied zinc is more needed for correcting the soil zinc adequacy, while other also have argued that foliar application under water stress is highly beneficial to maintain the crop growth and yield.

Table 7. Pod yield plot^{-1} (kg) of two okra varieties under different zinc and boron levels

Treatments	Varieties		Mean
	Sabz Pari	Bemisal	
F1= Control (RDF [NPK@120-100-75 kg ha-1]	6203.2	5955.1	6079.2 F
F2= RDF + Zn 5 kg ha-1	6436.2	6178.7	6307.4 E
F3= RDF + Zn 5 kg ha-1 + B 2 kg ha-1	6707.9	6439.6	6573.7 D
F4= RDF + Zn 7.5 kg ha-1 + B 4 kg ha-1	6933.0	6655.7	6794.4 C
F5= RDF + Zn 10 kg ha-1 + B 2 kg ha-1	6964.1	6685.5	6824.8 B
F6= RDF + Zn 10 kg ha-1 + B 4 kg ha-1	7352.3	7058.2	7205.2 A
Mean	6766.1 A	6495.5 B	

S.E. 24.154
LSD 0.05, 50.092

Pod yield ha^{-1} (kg)

The okra given Zinc and boron RDF Zn 10 kg ha^{-1} + B 4 kg ha^{-1} produced the maximum pod yield (7.56 kg ha^{-1}) given (Table 8) followed by pod yield of (7.16 kg ha)$^{-1}$ and (7.13 kg ha^{-1}) in the treatments comprised of zinc and boron the Zn 10 kg ha^{-1} + B 2 kg ha^{-1} and RDF Zn 7.5 kg ha^{-1} + B 4 kg ha^{-1} respectively, while the lowest pod yield (6.38 kg ha^{-1}) was noted under the control [NPK 120-100-75 kg ha^{-1}]. The okra crop response to zinc and boron application suggested inadequacy of these elements at the experimental soil site and the pod yield was significantly improved with zinc and boron application. The high zinc and boron levels proved to be more beneficial to increase pod yield ha^{-1} similar, results have also been reported by [22]. Who reported that soil applied zinc is more needed for correcting the soil zinc adequacy while, other also have argued that foliar application under the water stress is highly beneficial to maintain the crop growth and fruit yield.

Table 8. Pod yield ha^{-1} (kg) two okra varieties under different zinc and boron levels

Treatments	Varieties		Mean
	Sabz Pari	Bemisal	
F1= Control (RDF) NPK @120- 100-75 Kg ha-1	6.51	6.25	6.38 E
F2= RDF + Zn 5 kg ha-1	6.75	6.49	6.62 D
F3= RDF + Zn 5 kg ha-1 + B 2 kg ha-1	7.04	6.76	6.90 C
F4= RDF + Zn 7.5 kg ha-1 +B 4 kg ha-1	7.28	6.98	7.13 B
F5= RDF + Zn1 10 kg ha-1 +B 2 kg ha-1	7.31	7.02	7.16 B
F6= RDF + Zn 10 kg ha-1 + B 4 kg ha-1	7.72	7.41	7.56 A
Mean	7.10 A	6.82 B	

S.E. 0.0255
LSD 0.05, 0.0528

Conclusion
The overall results, it was concluded that Zinc and Boron concentration showed more positive effect on growth related traits of okra. The Zinc and boron at highest level of Zn 10 kg ha^{-1} and B 4 kg ha^{-1} produce pod yield of (7205.2 kg $plot^{-1}$) and reduction in Zinc and boron levels up to RDF Zn 10 kg ha^{-1} + B 2 kg ha^{-1} marginally decreased pod yield (6824.8 kg $plot^{-1}$) the differences in yield between Zinc and boron levels of RDF Zn 10 kg ha^{-1} + B 4 kg ha^{-1} and Zn 10 kg ha^{-1} + B 2 kg ha^{-1} were significant.

Authors' contributions
Designed & idea the experiments: MA Badini & AQ Gola, implemented the experiments: MI Jakhro, S Ahmed, T Aziz & MI Mengal, Contributed reagents/ materials/analysis tools: M Saleem, JA Abro & SIA Shah, Wrote the paper: AQ Gola.

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