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EFFECT OF MICRONUTRIENT APPLICATION ON THE GROWTH AND YIELD OF OKRA IN OLD MEGHNA ESTUARINE FLOODPLAIN (AEZ 19) SOILS OF BANGLADESH

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Abstract

There was an attempt of searching out of deficient micronutrient for okra in the Old Meghna Estuarine Floodplain (AEZ 19). The study was conducted in Chandina upazila of Comilla district covering AEZ 19. The experiment was laid out in a Randomized Complete Block Design with 3 (three) replications at farmers' field during 2011-2012. In this study 7 (seven) treatment combinations including a control were tested and the treatments were designed taking all essential micronutrients except Cl following additive element trial technique. The rates of micronutrients were 3 kg Zn, 2 kg B, 2 kg Cu, 3 kg Mn, 5 kg Fe and 1 kg Mo ha^{-1}. Sole application of Zn along with recommended doses of N, P, K and S was found sufficient for the highest yield of pod and stover, pod length and pod diameter whereas pod yield $plant^{-1}$ and average pod weight were showed the highest responses by the combine application of Zn and B. Although, the highest yield of pod and stover (11.23 and 3.21 t ha^{-1}, respectively) was produced from T_7 treatment, there was observed no additive effect due to the application of micronutrients other than Zn and B. Almost similar trend was observed in other growth and yield parameters, and uptake of different nutrient elements.

Keywords: AEZ 19, okra, micronutrients.

Introduction

Bangladesh has primarily an agro-based economy and soil is the greatest natural resource of its agricultural system. In the recent years, intensification of agricultural land use with modern crop varieties increased remarkably in the country. This situation in turn has resulted in deterioration of soil fertility with emergence of new micronutrient deficiencies. Farmers seldom use micronutrient fertilizers e.g. zinc sulphate, boric acid etc. This practice creates an unbalanced use of fertilizers which in turn produces a negative impact in crop production (Rijpma and Jahiruddin, 2004).

Micronutrient deficiency can limit the crop growth and production. Furthermore, micronutrients help increase the efficiency of the use of macronutrients. Thus micronutrients have great role in the fertilizer programme to achieve higher and sustainable crop yields. Unfortunately micronutrients have received less attention in fertilizer management research, development and extension programme to farmers. On the other hand, continued use of micronutrients may lead to an accumulation of excessive levels that will threaten food safety or quality. In Bangladesh, field trials with micronutrients were concentrated mostly on cereal crops, but it is scanty with vegetables. Among the cereal crops micronutrient trials have been made principally on rice (Jahiruddin *et al*., 1994), wheat (Hossain, 2005) and maize (Alam *et al*., 2000). Recently few field trials with micronutrients in vegetables cultivation have been made (Nasreen *et al*., 2009). The Old Meghna Estuarine Floodplain (AEZ 19) covering a considerable portion of Comilla district is one of the highly intensive agricultural zones of the country. Keeping the above points in view, the present study was undertaken to evaluate the effect of micronutrient application on the growth and yield parameters of okra in the soils of AEZ 19.

Materials and Methods

The experiment was carried out in the soils of AEZ 19 at farmer's field in Bokshir Pool village under Chandina upazila of Comilla district during 10 May to 5 October 2011. The soil of the experimental field belongs to Chandina

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soil series under Non-Calcareous Dark Grey Floodplain Soil type. The variety of okra used in the study was Shorosh (hybrid). The initial concentrations of Zn, B, Cu, Mn and Fe in soils of experimental plot were 0.82, 0.26, 2.49, 37.0 and 5.08 mg kg^{-1}, respectively.

Treatments: There were six micronutrient containing fertilizer treatments and one control treatment in the experiment. The treatments were designed taking all micronutrients except Cl following additive element trial technique. The treatments were Control (T_1), Zn (T_2), Zn+B (T_3), Zn+B+Cu (T_4), Zn+B+Cu+Mn (T_5), Zn+B+Cu+Mn+Fe (T_6) and Zn+B+Cu+Mn+Fe+Mo (T_7). The rates of micronutrients were 3 kg Zn, 2 kg B, 2 kg Cu, 3 kg Mn, 5 kg Fe and 1 kg Mo ha^{-1}. The elements (Zn, B, Cu, Mn, Fe and Mo were added as $ZnSO_4.7H_2O$, H_3BO_3, $CuSO_4.5H_2O$, $MnCl_2$, $FeSO_4.7H_2O$ and Na_2MoO_4, respectively. Other nutrients (macronutrients) were used according to Fertilizer Recommendation Guide (BARC, 2005) for all plots and the doses were 100, 30, 60 and 10 kg ha^{-1} for N, P, K and S, respectively.

Experimental design and layout: The experiment was laid out in a randomized complete block design with three replications, each plot measuring 4m × 5m. The treatments were randomly distributed to the plots in each block. The plots were surrounded by 40cm wide and 10cm high earthen bunds. One meter wide and 10cm deep irrigation channel was made in-between two blocks. The layout of the experiment was done in accordance with the statistical design.

Seed sowing and intercultural operations: Okra seeds were sown in 15 May 2011 maintaining 50cm × 40cm spacing. Irrigation, weeding and plant protection measures (e.g., pesticide application) were done as and when necessary.

Data collection: The okra fruits (pod) were harvested when they attained at edible stage. Six square meter area in each plot was selected to harvest pod and stover. The weights of pod were taken just after harvest. Harvesting of edible pods was done in 25 June 2011 for the first time and it was continued in every alternate day up to 5 October 2011. The stover yield was expressed on sundry basis. Data on the growth and yield contributing characters were recorded from 10 randomly selected plants from outside the harvested area within a plot, as described by Gomez and Gomez (1984). The growth and yield components on which data recorded were plant height (cm), pod yield $plant^{-1}$, edible pods $plant^{-1}$, average pod weight (g), pod length (cm), pod diameter (cm), pod yield (t ha^{-1}) and stover yield (t ha^{-1}).

Collection and preparation of plant samples for chemical analysis: Plant samples (pod and stover) were collected at the time of harvesting. The stover samples were air dried immediately after collection and the dry samples were chopped off into smaller pieces. The collected plant samples were then oven dried at 65°C for 24 hours. To obtain homogenous powder, the samples were finely ground by using a grinding-mill to pass through a 60-mesh sieve. The samples were stored in desiccators for determination of N, P, K, S, Zn and B contents.

Chemical analysis of plant samples: The processed plant samples were chemically analyzed for determination of N, P, K, S, Zn and B concentrations following standard methods. Nutrient uptake was calculated from the yield and nutrient concentration data using the following formulae-

For N, P, K and S:

$$\text{Nutrient uptake (kg ha}^{-1}\text{)} = \text{Nutrient concentration in plant sample (\%)} \times \text{Yield (kg ha}^{-1}\text{)/100}$$

For Zn and B:

$$\text{Nutrient uptake (g ha}^{-1}\text{)} = \text{Nutrient concentration in plant sample (}\mu\text{g g}^{-1}\text{)} \times \text{Yield (kg ha}^{-1}\text{)/1000}$$

Data analysis: The collected data were compiled and tabulated in proper form which was subjected to statistical analyses following standard methodology and the mean differences were adjudged by Duncan's Multiple Range Test (Gomez and Gomez, 1984).

Results and Discussion

The effects of different treatments were evaluated in terms of growth parameter, pod and stover (crop residue) yield, and nutrient uptake.

Plant height: Height of okra plant at final harvest was unaffected by different treatments (Table 1) and it ranged from 112.8 cm in control treatment to 119.5 cm in both T_3 and T_7 treatments.

Edible pods plant^{-1}: The number of edible pods plant^{-1} differed significantly by the treatments (Table 1). The highest number (21.1 plant^{-1}) was obtained in T_6 treatment which was statistically similar to T_3, T_4, T_5 and T_7 treatments.

Pod length: Pod length responded significantly with the treatments applied and it ranged from 12.01 to 13.69 cm (Table 1). The highest length was produced in T_6 treated plot and it was statistically similar with the results obtained from all other micronutrient treated plots. The control treatment produced the lowest pod length. Kumar *et al.* (2009) reported higher length and diameter of pod by the application of both Zn and B.

Pod diameter: Like pod length, diameter of pod also affected significantly by the treatments (Table 1). The highest diameter (1.749 cm) was recorded from T_3 treatment and it was statistically similar to those of all other treatments except T_1.

Table 1. Effects of micronutrients on the yield and yield contributing parameters of okra in AEZ 19.

Treatments	Plant height (cm)	Edible pods plant^{-1} (no.)	Pod length (cm)	Pod diameter (cm)	Average pod weight (g)	Pod yield plant^{-1} (g)	Pod yield (t ha^{-1})	Stover yield (t ha^{-1})
T_1: Control	112.8	17.65b	12.01b	1.602b	10.15c	176c	8.39b	2.35b
T_2: Zn	118.9	18.24b	13.13a	1.733a	10.34bc	199b	9.66a	3.09a
T_3: Zn+B	119.5	20.48a	13.25a	1.749a	11.12a	210ab	10.94a	3.12a
T_4: Zn+B+Cu	118.1	20.57a	13.30a	1.733a	10.83ab	208ab	10.81a	3.07a
T_5: Zn+B+Cu+Mn	118.2	20.40a	13.53a	1.730a	11.05a	210ab	11.04a	3.10a
T_6: Zn+B+Cu+Mn+Fe	119.1	21.14a	13.69a	1.743a	11.03a	211ab	11.15a	3.15a
T_7: Zn+B+Cu+Mn+Fe+Mo	119.5	20.97a	13.62a	1.737a	11.27a	214a	11.23a	3.21a
CV (%)	2.09	5.87	2.94	2.57	2.73	3.90	4.02	7.70
Significance level	NS	*	**	*	**	**	**	**
SE (±)	1.43	0.68	0.23	0.026	0.17	4.59	0.24	0.13

*For all Tables: Means followed by same or no letter in a column are not significantly different at 5 % level by DMRT; SE (±) = Standard error of means, CV= Co-efficient of variation, *= Significant at 5% level, **= Significant at 1% level, NS=Non-significant*

Average pod weight: The applied Zn and B significantly affected average pod weight where the highest weight (11.27 g) was obtained in T_7 treatment (Table 1). No added benefit was noticed by the application of other micronutrients. Kumar *et al.* (2009) found the highest average pod weight by soil application of zinc sulphate and borax along with recommended dose of NPK.

Table 2. Effects of micronutrients on the nutrient content of okra in AEZ 19.

Treatments	N (%)		P (%)		K (%)		S (%)		Zn (µg g^{-1})		B (µg g^{-1})	
	Pod	Stover	Pod	Stover	Pod	Stover	Pod	Stover	Pod	Stover	Pod	Stover
T_1: Control	0.195b	0.71b	0.063	0.174b	0.096	0.446c	0.025	0.289	4.73b	23.5b	2.77b	22.8b
T_2: Zn	0.214a	0.76ab	0.055	0.132a	0.103	0.491bc	0.026	0.286	5.48a	29.5a	2.70b	23.8b
T_3: Zn+B	0.217a	0.81a	0.054	0.136a	0.105	0.577a	0.025	0.319	5.46a	29.8a	4.12a	29.8a
T_4: Zn+B+Cu	0.216a	0.81a	0.056	0.140a	0.104	0.564a	0.026	0.305	5.41a	30.6a	4.10a	29.4a
T_5: Zn+B+Cu+Mn	0.215a	0.79a	0.054	0.140a	0.107	0.544ab	0.027	0.299	5.52a	29.9a	4.16a	29.7a
T_6: Zn+B+Cu+Mn+Fe	0.214a	0.82a	0.056	0.142a	0.104	0.549ab	0.027	0.304	5.43a	30.5a	4.10a	28.8a
T_7: Zn+B+Cu+Mn+Fe+Mo	0.215a	0.77a	0.055	0.137a	0.109	0.542ab	0.027	0.305	5.33a	29.2a	3.99a	28.5a
CV (%)	3.62	4.64	7.22	5.22	4.61	6.26	5.57	4.58	3.00	3.76	3.47	3.65
Significance level	*	*	NS	**	NS	**	NS	NS	**	**	**	**
SE (±)	0.004	0.021	0.002	0.004	0.003	0.019	0.008	0.002	0.093	0.63	0.07	0.58

Note: Nutrient concentration of okra pod was expressed as fresh weight basis

Pod yield plant^{-1}: Pod yield plant^{-1} was significantly affected by different treatments under study (Table 1). The highest pod yield plant^{-1} (214 g) was obtained in T_7 treatment which was similar to the yields obtained from T_3 - T_6 treatments.

Yield: Fruit (Pod) and stover yield of okra significantly responded to the application of Zn only, while the other added five micronutrients had no effects (Table 1). Pod yield ranged from 8.39 t ha^{-1} in control treatment to 11.23 t ha^{-1} in T_7 treatment. The T_7 as the highest yield producing treatment was statistically similar to the yield of T_2 - T_6 treatments. The highest stover yield (3.21 t ha^{-1}) was recorded in T_7 treatment and that had statistical similarities to all other micronutrient treaments. The lowest stover yield (2.35 t ha^{-1}) was noticed from control plot. Kumar and Sen (2004) observed the highest pod yield (147.2 q ha^{-1}) of okra with the application of Zn.

Nutrient uptake by okra: The concentrations of N, Zn and B in both okra pod and stover responded positively to the micronutrient application while S concentration did not affect (Table 2). P and K concentration in pod was unaffected but those in stover were affected significantly. The nutrient uptake as calculated from the yield and nutrient concentration data are presented in Table 3(a) and 3(b) and discussed below.

Table 3(a). Effects of micronutrients on the nutrient (N, P & K) uptake of okra in AEZ 19.

Treatments	N uptake (kg ha^{-1})			P uptake (kg ha^{-1})			K uptake (kg ha^{-1})		
	Pod	Stover	Total	Pod	Stover	Total	Pod	Stover	Total
T_1: Control	16.3c	16.7b	33.0c	5.27b	4.09	9.64b	8.05c	10.5b	18.52c
T_2: Zn	20.7b	23.4a	44.1b	5.29b	4.09	9.51b	9.94b	15.2a	25.17b
T_3: Zn+B	23.7a	25.2a	48.9a	5.96a	4.22	10.27ab	11.53a	17.9a	29.44a
T_4: Zn+B+Cu	23.4a	24.8a	48.2a	6.00a	4.30	10.37ab	11.21ab	17.4a	28.58ab
T_5: Zn+B+Cu+Mn	23.7a	24.5a	48.2a	5.98a	4.34	10.30ab	11.85a	16.9a	28.71ab
T_6: Zn+B+Cu+Mn+Fe	23.9a	25.7a	49.6a	6.21a	4.48	10.75a	11.66a	17.3a	28.96ab
T_7: Zn+B+Cu+Mn+Fe+Mo	24.1a	24.8a	48.9a	6.13a	4.41	10.65a	12.20a	17.4a	29.60a
CV (%)	4.71	7.62	4.69	5.48	8.16	4.60	7.63	10.19	7.46
Significance level	**	**	**	*	NS	*	**	**	**
SE (±)	0.61	1.04	1.24	0.19	0.20	0.27	0.48	0.95	1.16

Table 3(b). Effects of micronutrients on the nutrient (S, Zn & B) uptake of okra in AEZ 19.

Treatments	S uptake (kg ha^{-1})			Zn uptake (g ha^{-1})			B uptake (g ha^{-1})		
	Pod	Stover	Total	Pod	Stover	Total	Pod	Stover	Total
T_1: Control	2.12c	6.80b	8.91b	39.7c	54.8b	95b	23.3b	53.2c	76.5c
T_2: Zn	2.53b	8.86a	11.38a	53.0b	91.3a	144a	26.1b	73.4b	99.5b
T_3: Zn+B	2.78ab	9.91a	12.69a	59.7a	92.7a	152a	45.0a	92.4a	137.5a
T_4: Zn+B+Cu	2.83ab	9.40a	12.23a	58.5a	94.0a	153a	44.4a	90.3a	134.7a
T_5: Zn+B+Cu+Mn	2.97a	9.27a	12.24a	60.9a	92.6a	154a	45.9a	92.0a	137.9a
T_6: Zn+B+Cu+Mn+Fe	3.02a	9.58a	12.60a	60.7a	96.3a	157a	45.8a	90.8a	136.6a
T_7: Zn+B+Cu+Mn+Fe+Mo	2.99a	9.79a	12.79a	59.8a	93.6a	153a	44.8a	91.5a	136.3a
CV (%)	7.54	9.78	8.10	4.14	7.47	5.15	6.10	6.44	5.69
Significance level	**	*	**	**	**	**	**	**	**
SE (±)	0.12	0.51	0.55	1.34	3.79	4.28	1.38	3.10	4.03

Nitrogen uptake: Nitrogen uptake by okra significantly responded to the treatments applied. The pod uptake of N ranged from 16.3 to 24.1 kg ha^{-1} where the highest uptake was observed in T_7 treatment which was similar to those of T_3 - T_6 treatments. The uptake of stover N ranged from 16.7 to 25.7 kg ha^{-1}. Accordingly, the highest total uptake of N (49.6 kg ha^{-1}) was resulted from T_6 treatment which was similar to those of all other treatments except T_1 and T_2. Ravi *et al.* (2008) reported the increment in uptake of NPK significantly over control by application of zinc.

Phosphorus uptake: Pod uptake and total uptake of phosphorus by okra was responded significantly by the treatments whereas stover uptake did not respond. The highest uptake of both pod P (6.21 kg ha^{-1}) and total P (10.75 kg ha^{-1}) was recorded in T_6 treatment and it was statistically similar to those of all other treatments except T_1 and T_2 for pod uptake. It could be noted that higher P concentration was observed in control treatment than other micronutrient treatments. This was possibly due to antagonistic relationship between Zn and P in soil-plant system. Barben *et al.* (2007) noticed a direct negative impact of increasing solution Zn concentration on P uptake in potato.

Potassium uptake: Uptake of potassium by okra was significant due to application of micronutrients. Pod uptake ranged from 8.05 to 12.20 kg ha^{-1} while the stover uptake varied from 10.5 to 17.9 kg ha^{-1}. The highest total uptake of K was recorded as 29.6 kg ha^{-1} in T_7 which was statistically similar to that of T_3 - T_6 treatments. It is clear from each fraction of uptake that among six micronutrients addition of only Zn and B was sufficient to have desired uptake of potassium.

Sulphur uptake: Sulphur uptake by okra was significantly influenced by the application of different treatments. The highest pod uptake of S (3.02 kg ha^{-1}) was recorded in T_6 treatment that was similar to those of other micronutrient treatments. The stover uptake ranged from 6.80 to 9.91 kg ha^{-1}. Accordingly, the total uptake of S varied from 8.91 to 12.79 kg ha^{-1}. The highest total uptake as recorded in T_7 treatment was similar to the remaining treatments effect other than the control.

Zinc uptake: Different micronutrient treatments significantly influenced Zn uptake by okra. The uptake of pod Zn ranged from 39.7 to 60.9 g ha^{-1} while the stover uptake varied from 54.8 to 96.3 g ha^{-1}. The highest total uptake (157 g ha^{-1}) was recorded in T_6 treatment which was statistically similar to the uptake induced by the treatments T_3 - T_6. Hossain *et al.* (2008) reported that the Zn and N concentrations of grains were significantly increased with Zn application.

Boron uptake: Boron uptake by okra was influenced significantly by different treatments. Uptake of pod B ranged from 23.3 g ha^{-1} in control plot to 45.9 g ha^{-1} in T_5 treatment whereas the stover B varied from 53.2 g ha^{-1} in T_1 to 92.4 g ha^{-1} in T_3 treatment. The highest total B (137.9 g ha^{-1}) was recorded in T_5 treatment which was statistically similar to those of all other treatments except T_1 and T_2. The control treatment induced the lowest total uptake of B (76.5 g ha^{-1}).

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