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Effect of micronutrients on growth and yield of onion under problematic soil environment

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Abstract

The field experiment was conducted to study the effect of micronutrients on growth and yield of onion (*cv.* Taherpuri) in High Ganges River Floodplain Soils (AEZ 11) during the period from November 2008 to February 2009. The experimental field soil was medium fertile with pH = 7.6 and silty loam in texture. The micronutrient combinations *viz.* T_1=control, T_2=Zn, T_3=B, T_4=Zn+B, T_5=Zn+B+Mo, T_6=Zn+B+Mn, T_7=Zn+B+Cu, T_8=Zn+B+Cl, T_9=Zn+B+Mo+Mn, T_{10}=Zn+B+Mo+Mn, T_{11}=Zn+B+Mo+Cu+Cl and laid out in RCBD with three replications. The rate of micronutrients were Zn:B:Mo:Mn:Cu:Cl=3:3:0.5:4:1:20 kg/ha in the treatments and also N:P:K:S=50:50:100:20 kg/ha used as basal. The results were found to be significant in most of the yield contributing parametrs of onion. The maximum yield and yield contributing parameters of onion i.e. leaves/plant (14.63), plant height (61.30 cm), diameter of bulb (14.97 mm), fresh weight of leaves (31.42 g), fresh weight of bulb (9.21g), diameter of bulb (4.36 cm) and bulb yield (13.38 t/ha) were obtained from T_4 (Zn + B) but splitting of bulb (9.72) in T_7 (Zn + B + Cu) and fresh weight of roots (1513 mg) in T_6 (Zn + B + Mn). The minimum growth and yield contributing parameters were recorded in control (T_1). The response of Zn is more than B but both are statistically similar in most cases and the combination of (Zn + B) is better for vegetative growth and yield of onion. It can be concluded that the response of different micronutrients for onion cultivation in calcareous soils can be expressed the following orders: Zn+B>Zn>B>Mo.

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Introduction

Intensive cropping, imbalanced fertilization and no use of micronutrients, less or no use of organic manures have resulted the depletion of soil fertility in Bangladesh. Consequently, micronutrients statuses have been decreasing day by day and finally fertility status of Bangladesh soils have been declining. A good soil should have an organic matter content of more than 3 %. But in Bangladesh, most soils have less than 1.5 %, some soils have less than 1 % matter content (BARC, 2005). There are 30 AEZs in Bangladesh (Bhuiya *et al.* 2005) and High Ganges River Floodplain soils (AEZ 11) is one of the most important calcareous soils of Bangladesh containing large amount of $CaCO_3$ as well as high concentration of available Ca^{2+} in that soil. The pH is generally ranges from 7.0-8.5 but in most of the upland soils ranges between 8.0-8.5 (Alam, 2006). Normally, zinc (Zn) and boron (B) become less available to plants with increasing soil pH. Requirement of B for plant growth and yield is greater when calcium (Ca) availability is high (Tisdale *et al.* 1995). Boron (B) requirements are common on upland crops in humid regions and also in calcareous soil. Deficiencies of B are widespread in humid regions by leaching losses (Troeh *et al.* 1993). It is wide spread and often incipient that B deficiency seems to exist in Bangladesh soils (Protch and Islam, 1984).

Among the spices crops grown in Bangladesh onion ranks top in respect of production and second position in respect of area. The yield of onion are very lower than those of other countries because of our farmer's inadequate knowledge about benefits of micronutrients. It is estimated that the yearly requirement of onion is about 5 lakh tones where as the domestic production is only about 1.50 lakh tones. To meet up the shortage a huge quantity of onion is imported each year (Anonymous, 2004). The most important character of onion is its flavor which increases the taste of food and is widely used to increase taste of different type of food and varies like gravies, soups, stew stuffing, fried fish and meat. Havlin *et al.* (2007) stated that Zn, B, Mn and Mo shows high sensitivity in onion production. Mattew *et al.* (2000) found that Cu, Mn, Zn, Mo showed high responsiveness to onion but low in B. Under these circumstances, the present study was undertaken to study the the effect of micronutrients on growth and yield of onion in calcareous soils of Bangladesh.

Materials and methods

The present study was conducted in the field of a farmer which is situated at the eastern side of wheat research centre, Shyampur, Rajshahi, during the during the period from November 2008 to February 2009The trial involved in the field with onion (*cv.* Taherpuri) with different treatments *viz.* T_1=control, T_2=Zn, T_3=B, T_4=Zn+B, T_5=Zn+B+Mo, T_6=Zn+B+Mn, T_7=Zn+B+Cu, T_8=Zn+B+Cl, T_9=Zn+B+Mo+Mn, T_{10}=Zn+B+Mo+Mn, T_{11}=Zn+B+Mo+Cu+Cl and laid out in Randomized Complete Block Design (RCBD) with three replications. The rate of micronutrients were Zn:B:Mo:Mn:Cu:Cl=3:3:0.5:4:1:20 kg/ha in the treatments and also N:P:K:S=50:50:100:20 kg/ha used as basal. Urea, TSP, potssium sulphate, gypsum, zinc oxide, boric acid, sodium molybdate, manganees oxide, copper sulphate and sodium chloride were used as source of N, P, K, S, Zn, B, Mo, Mn, Cu and Cl respectively. All fertilizers except urea were applied during land preparation. Urea was used in three splits i.e. land preparation, 30 and 60 DAP. There were no organic manures used in the experimental field.

The size of each plot was 1 m × 1 m and plant spacing was 15 cm × 10 cm. Intercultural operations were performed carefully. Data on growth and yield components were collected. Data were analyzed statistically by using MSTAT-C (Russel, 1996). The soil sample (0-15 cm) was analyzed of soil texture by Hydrometer method and other parameters by Hunter (1984) method. The Physical and chemical properties of the experimental field soil are as follows:

Results and discussion

Number of leaves

The number of leaves per plant at different days after planting were found to be significant (Table 3). The combination T_4 (Zn + B) performed the highest number of leaves in all growth periods and lowest was found in T_1. Similar observation were also observed by EL-Gamelli *et al.* (2000).

Plant height

Plant height was recorded at different days after planting (DAP) and it was observed that the effects of micronutrients at 30 DAP was significant but it was not-significant at 75 DAP. The plant height of onion was nearly same at the maturity of the plants. The highest plant (61.30 cm) was recorded in T_4 (Zn + B) and the lowest in control, where plant height at 75 DAP was higher in T_8 (58.88 cm) and followed by T_2 (56.69 cm). BARI (2007-08) reported that the application of Zn and B significantly increased the plant height of onion. However, the application of T_4 increased the height of plants and ultimately leaves numbers were also increased due to the influence of T_2 and T_3.

Table 1. Physical and chemical properties of the experimental field soil.

(a) Physical properties	Value
Sand	22.8 %
Silt	62.0 %
Clay	15.2 %
Textural class	Silty loam

(b) Chemical properties	Value	Nutrient status (According to Thana Nirdeshika*)
Organic matter (%)	1.10	Low
pH	7.6	Slightly alkaline
Total N (%)	0.05	Very low
Available P (mg Kg^{-1})	18.70	Medium
Exchangeable K (meq/100g)	0.26	Medium
Available S(mg Kg^{-1}))	1.7	Very low
Ca (C mol^+ kg^{-1})	14.76	Very high
Mg (C mol^+ kg^{-1})	1.76	Medium
Available Fe (mg Kg^{-1})	6.64	Optimum
Available Cu (mg Kg^{-1})	1.65	Optimum
Available Zn (mg Kg^{-1}))	1.09	Medium
Available Mn (mg Kg^{-1})	2.73	Optimum
Available B (mg Kg^{-1})	0.23	Low

Diameter of stem

Diameter of stem of onion were not-significant at 80 DAP. The highest diameter of stem at 30 DAP was performed by T_3 (2.58 mm) followed by T_2 but both are statistically similar and the second or lowest also found in T_{11} (1.45 mm).

Diameter of bulb

The highest value was recorded from treatment T_4 (4.36 cm) but treatment T_4 to T_7 are statistically similar. The lowest diameter of bulb was observed in T_9 (3.31 cm). Mo and Mn expressed negative role in diameter of onion bulbs. Application of Zn and B to soils more or less increased the bulb diameter. Similar results were also observed by Baghel and Sarnik (1988) and they showed that significant increased of bulb diameter was influenced with a combined application of Zn at 0.50 % and B at 0.20 % applied on foliage.

Fresh weight of leaves

Various combinations of micronutrients exhibited significant variations in respect of fresh weight of leaves per plant (Table 6). The maximum fresh weight of leaves (9.21 g) was observed in T_4 followed by T_2 (8.88 g) and the lowest number was recorded in T_6 (4.97 g). Marteens *et al.* (1991) stated that bulb uptakes micronutrient swiftly at the stage of bulb initiation. EL-Gamelli (2000) studied that fresh weight of leaves were positively affected by application of micronutrients. The results indicated that Zn and B had significant role on the vegetative growth of onion which are in partial accord with the findings of some authours (Sindhu and Tiwari, 1989).

Table 2. Monthly weather condition during experimental period.

Month	Air temperature(°C)			Total rainfall (mm)	Average relative humidiy (%)
	Maximum	Minimum	Average		
November'08	32.0	12.2	26.0	0	79
December'08	29.0	10.0	21.5	0	86
January '09	26.8	8.0	20.5	1.0	84
February'09	33.8	9.5	23.0	70	78

Source: Agro-meteorological center, Bangladesh Rice Research Institute (BRRI), regional station, Shyampur, Rajshahi, Bangladesh.

Fresh weight of bulbs

Application of different micronutrient treatments significantly influenced the fresh weight of bulb of onion (Table 6). The highest fresh weight of bulb was performed by the application of Zn + B (31.42 g) and second highest value were found by the application of Zn or B but both are statistically similar. The lowest value was recorded in T_{11} and T_1. The treatment from T_5 to T_{10} peformed the similar response on fresh weight of bulb. It is indicated that Mo, Cu, Mn and Cl had negative response on growth of onion bulb.

The results are in agreement with the findings of Satbir *et al.* (1989). They stated that fresh weight of bulb significantly increased in Zn and B. Similar result was also found from Mauraya and Lal (1975) and they reported that application of Zn at 1, 2 and 3 ppm significantly increased the yield and bulb quality.

Table 3. Effect of micronutrients on number of leaves per plant at different DAP.

Treatments	30 DAP	45 DAP	60 DAP
T_1 = Control	6.51 c	9.17 d	10.70 e
T_2 = Zn	8.04 b	10.30 bcd	12.05 cd
T_3 = B	7.85 b	10.20 bcd	13.02 b
T_4 = Zn+B	9.90 a	12.53 a	14.63 a
T_5 = Zn+B+Mo	8.16 b	11.33 ab	12.99 b
T_6 = Zn+B+Mn	7.93 b	9.74 cd	13.26 b
T_7 = Zn+B+Cu	8.30 b	9.65 cd	11.69 d
T_8 = Zn+B+Cl	7.86 b	11.17 b	12.46 c
T_9 = Zn+B+Mo+Mn	8.25 b	9.20 cd	12.36 d
T_{10} = Zn+B+Mo+Mn+Cu	8.37 b	9.61 cd	13.21 b
T_{11} = Zn+B+Mo+Mn+Cu+Cl	8.94 ab	10.57 bc	12.22 c
CV (%)	8.38	6.90	2.10

In a column, figures having same letter(s) do not differ significantly by DMRT at 5% level; each parameter represents 30 plants; DAP= Days after planting.

Fresh weight of roots

Application of different micronutrients caused highly significant variation in terms of fresh weight of roots per plant (Table 6). The maximum fresh weight of roots (1513 mg) was produced by the plants having treatment T_5 (Zn+B+Mo) followed by T_3 (B), while the minimum (693.40 mg) was found in control (T_1). The combination of Zn+B performed the negative response than Zn or B alone. It is indicated that Zn and B had antagonistic relationship in respect of root growth. On the other hand, Zn or B alone had positive effects than control on root growth of onion.

Dry weight of leaves

The dry weight of onion leaves were comparatively higher in plants treated with B (1617 mg) while the lowest value was found in control (1077 mg). Application of Zn significantly influenced the dry weight of onion. The results showed that the response of B is more dominant than other micronutrients for vegetative growth of onion plant. Dry weight of leaves significantly increased with Zn (3 ppm) which was noticed from Lal and Maurya (1981).

Dry weight of bulbs

The variations of dry weight of bulbs were highly significant by the application of micronutrients (Table 7). The present study revealed that maximum bulb weight (3050 mg) was found in T_4 (Zn+B) followed by T_7 (Zn+B+Cu), T_2, T_9, and T_6 but T_2, T_9 & T_6 are sstatistically similar. EL-Gamelli *et al.* (2000) narrated that dry weight of bulb significantly was increased by Zn and this result is so interrelated with this experiment.

Table 4. Effect of micronutrients on plant height of onion at different DAP.

Treatments	30 DAP (cm)	45 DAP (cm)	60 DAP (cm)	75 DAP (cm)
T_1 = Control	33.48 c	40.18 c	51.45 ab	55.22 b
T_2 = Zn	37.65 b	43.01 b	51.99 ab	56.69 b
T_3 = B	38.08 b	42.85 b	52.58 ab	55.19 b
T_4 = Zn+B	41.58 a	46.60 a	56.01 a	61.30 a
T_5 = Zn+B+Mo	37.69 b	41.52 bc	52.70 ab	57.28 b
T_6 = Zn+B+Mn	36.85 b	42.41 b	49.85 b	57.60 b
T_7 = Zn+B+Cu	37.99 b	42.59 b	52.42 ab	56.53 b
T_8 = Zn+B+Cl	37.56 b	42.95 b	53.95 ab	58.88 ab
T_9 = Zn+B+Mo+Mn	35.45 bc	41.49 bc	52.60 ab	57.04 b
T_{10} = Zn+B+Mo+Mn+Cu	36.34 b	41.42 bc	52.58 ab	56.36 b
T_{11} = Zn+B+Mo+Mn+Cu+Cl	36.69 b	41.82 bc	53.52 ab	58.53 ab
CV(%)	3.87	2.64	5.49	3.42

In a column, figures having same letters do not differ significantly by DMRT at 5% level; each parameter represents 30 plants; DAP= Days After planting.

Table 5. Effect of micronutrients on diameter of stem and bulbs of onion.

Treatments	Diameter of stem at 30 DAP (mm)	Diameter of stem at 80 DAP (mm)	Diameter of bulb (cm) at harvest
T_1 = Control	1.48 b	11.69 a	3.45 b
T_2 = Zn	2.28 ab	14.20 a	4.09 ab
T_3 = B	2.58 a	14.65 a	3.69 ab
T_4 = Zn+B	2.04 ab	14.97 a	4.36 a
T_5 = Zn+B+Mo	2.02 ab	14.60 a	3.97 ab
T_6 = Zn+B+Mn	1.99 ab	14.19 a	3.93 ab
T_7 = Zn+B+Cu	1.81 ab	14.03 a	4.00 ab
T_8 = Zn+B+Cl	1.88 ab	13.81 a	3.38 b
T_9 = Zn+B+Mo+Mn	2.13 ab	12.68 a	3.31 b
T_{10} = Zn+B+Mo+Mn+Cu	1.78 ab	12.65 a	3.61 ab
T_{11} = Zn+B+Mo+Mn+Cu+Cl	1.45 b	14.37 a	3.75 ab
CV (%)	22.86	12.17	10.95

In a column, figures having same letters do not differ significantly by DMRT at 5% level; each parameter represents 30 plants; DAP= Days After planting.

Dry weight of roots

There were not significant variations among the other treatments in production of dry weight of onion roots. Applications of micronutrients caused significant variation on the production of dry roots of onion (Table 7). The highest value was obtained from treatment T_2 (323.40 mg) while the lowest value was found from (160 mg) from the treatments control and T_8. The response of T_8 and T_9 were statistically identical.

Table 6. Effect of micronutrients on fresh weight of onion plant.

Treatments	Fresh weight of leaves (g)	Fresh weight of bulbs (g)	Fresh weight of roots (mg)
T_1 = Control	6.82 def	20.60 de	693.40 e
T_2 = Zn	8.88 b	26.52 b	1084 bcd
T_3 = B	7.24 cdef	25.32 bc	1229 b
T_4 = Zn+B	9.21 a	31.42 a	1035 bcd
T_5 = Zn+B+Mo	7.55 bcde	23.72 bcde	1513 a
T_6 = Zn+B+Mn	4.97 g	24.25 bcde	1141 bc
T_7 = Zn+B+Cu	8.78 c	22.66 bcde	887 cde
T_8 = Zn+B+Cl	7.70 bcde	21.76 cde	984.10 bcd
T_9 = Zn+B+Mo+Mn	6.60 ef	25.79 bc	986.70 bcd
T_{10} = Zn+B+Mo+Mn+Cu	5.91 fg	25.03 bcd	816.80 de
T_{11}=Zn+B+Mo+Mn+Cu+Cl	8.55 abc	19.94 e	1169 b
CV (%)	9.71	10.22	13.49

In a column, figures having same letters do not differ significantly by DMRT at 5% level; each parameter represents 30 plants; DAP= Days After planting.

Splitting of bulb

Micronutrients exhibited significant variation in respect of splitting of bulb (Table 8). The highest value (9.72) was obtained from treatment T_7, while the lowest value (6.380) was performed by the treatment T_9.

Table 7. Effect of micronutrients on dry weight of onion plant.

Treatments	Dry weight of leaves (mg)	Dry weight of bulbs (mg)	Dry weight of roots (mg)
T_1 = Control	1077 c	1960 d	160 e
T_2 = Zn	1479 ab	2760 abc	323.40 a
T_3 = B	1617 a	2420 c	190.10 cde
T_4 = Zn+B	1460 ab	3050 a	273.70 ab
T_5 = Zn+B+Mo	1454 ab	2320 cd	140 e
T_6 = Zn+B+Mn	1324 abc	2630 abc	200 cde
T_7 = Zn+B+Cu	1431 ab	2930 ab	233.40 bc
T_8 = Zn+B+Cl	1216 bc	1910 d	160 de
T_9 = Zn+B+Mo+Mn	1250 bc	2720 abc	170 cde
T_{10} = Zn+B+Mo+Mn+Cu	1288 bc	2540 bc	202 cde
T_{11}=Z n+B+Mo+Mn+Cu+Cl	1370 abc	2730 abc	230 bcd
CV (%)	12.23	9.16	17.53

In a column, figures having same letters do not differ significantly by DMRT at 5% level; each parameter represents 30 plants; DAP= Days After planting.

The value 8.72 was found in T_5 and T_{11}. The rest of the treatment influenced moderately. The above result indicated that the optimum level of Cu may increase the splitting of bulb. Rao and Deshpande (1971) carried out an experiment which was similar to this result. Ellerbrock *et al.* (1997) also studied on Cu requirements for quality of onion bulbs.

Bulb yield

Different micronutrient produced significant variations for bulb yield of onion (Table 8). An upward trend of yield was observed with the treatment T_4 (13.38 t/ha) when the downward trend was found in control T_1 (8.94 t/ha). Yield (11.65 t/ha) was marked from treatment T_5 whereas 11.50 t/ha was found in T_2 (Zn) and T_3 (11.42 t/ha). Response of T_2, T_{23}, T_5, T_7 and T_{11} were ststistically identical. Mauraya and Lal (1975) found that onion responded well to Zn nutrition (1-3 ppm) as regards yield and bulb quality. Phor *et al.* (1995) studied about the effects of Zn on the growth and yield of onion.They experimented that the effect of Zn at 0, 2.50 or 5 kg $ZnCl_2$ on the growth and yield of onion. Plant growth and yield increased significantly by the rates of Zn. The highest yield was observed from the application of Zn @ 5 kg/ha. This result is closely related to Mishra *et al.* (1990). They stated that yield of onion was enhanced most by B followed by Zn. Rahman (2009) stated that maximum root yield of radish and carrot were observed by the application of Zn+B in calcareous soils.

The bulb yield increased over control have been presented in Table 8. The treatment T_4 (Zn+B) performed the highest yield by 49.66% over control, and Zn and B increased bulb yield by 28.64% and 27.74% respectively. It can be concluded that the response of different micronutrients for onion production can be expressed the following orders: Zn+B>Zn>B>Mo.

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