International Journal of Biosciences (IJB)
ISSN: 2220-6655 (Print) 2222-5234 (Online)
Vol. 2, No. 8, p. 95-101, 2012
http://www.innspub.net

RESEARCH PAPER OPEN ACCESS

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

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Received: 02 July 2012
Revised: 15 August 2012
Accepted: 16 August 2012

Key words: Micronutrients, calcareous soils, onion growth, onion bulb yield.

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). Eight combinations of micronutrients were used. The rate of micronutrients were Zn:B:Mo:Mn:Cu:Cl::3:3:0.5:4:1:20 kg/ha in the treatments and N:P:K:S=50:50:100:20 kg/ha were also used as basal. The results were found to be significant in most of the yield contributing parameters of onion like in leaves/plant, plant height, diameter of bulb, fresh weight of leaves, fresh weight of bulb, diameter of bulb and bulb yield of onion. The maximum yield and yield contributing parameters of onion i.e. leaves/plant, plant height, diameter of bulb, fresh weight of leaves, fresh weight of bulb, diameter of bulb and bulb yield were obtained from T_4 but splitting of bulb in T_7 and fresh weight of roots in T_6. The minimum growth and yield contributing parameters were recorded in T_1. The response of Zn is more than B but both are statistically similar in most cases and the combination of Zn and B is better for vegetative growth and yield of onion. The response of different micronutrients for onion cultivation in calcareous soils can be expressed the following orders: (Zn + B)>Zn>B>Mo. Any commercial producers or marginal farmers will be benefited if they followed this fertilizer recommendation because Benefit Cost Ration has been calculated in conducting the research.

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Introduction

Among the spices crops grown in Bangladesh onion ranks top in respect of production and second position in respect of area. 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 (Rahim, 1992). The yield of onion in our country is 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).

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. (Hunter, 1984). 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% (BARC, 2005). 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 to 8.5 but in most of the upland soils ranges is between 8.0 and 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) requirement is 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). The present study was undertaken to study 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 period from November, 2008 to February, 2009. The 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, Triple super phosphate (TSP), Potasium 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 days after planting (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 (0-15cm) was analyzed of soil texture by Hydrometer method and other parameters by Hunter (1984) method.

Results and discussion

Number of leaves

The numbers of leaves per plant at different days after planting were found to be significant in different treatments (Table: 1). The combination T_4 performed the highest number of leaves in all growth periods and lowest was found in T_1. Similar observation was also observed by EL-Gamelli *et al.* (2000).

Table 1. Effect of micronutrients on number of leaves per plant and plant height at different days after planting (DAP).

Treatments	Effect of micronutrients on number of leaves/plant			Effect of micronutrients on plant height			
	30 DAP	**45 DAP**	**60 DAP**	**30 DAP**	**45 DAP**	**60 DAP**	**75 DAP**
T_1 = Control	6.51 c	9.17 d	10.70 e	33.48 c	40.18 c	51.45 ab	55.22 b
T_2 = Zn	8.04 b	10.30 bcd	12.05 cd	37.65 b	43.01 b	51.99 ab	56.69 b
T_3 = B	7.85 b	10.20 bcd	13.02 b	38.08 b	42.85 b	52.58 ab	55.19 b
T_4 = Zn+B	9.90 a	12.53 a	14.63 a	41.58 a	46.60 a	56.01 a	61.30 a
T_5 = Zn+B+Mo	8.16 b	11.33 ab	12.99 b	37.69 b	41.52 bc	52.70 ab	57.28 b
T_6 = Zn+B+Mn	7.93 b	9.74 cd	13.26 b	36.85 b	42.41 b	49.85 b	57.60 b
T_7 = Zn+B+Cu	8.30 b	9.65 cd	11.69 d	37.99 b	42.59 b	52.42 ab	56.53 b
T_8 = Zn+B+Cl	7.86 b	11.17 b	12.46 c	37.56 b	42.95 b	53.95 ab	58.88 ab
T_9 = Zn+B+Mo+Mn	8.25 b	9.20 cd	12.36 d	35.45 bc	41.49 bc	52.60 ab	57.04 b
T_{10} = Zn+B+Mo+Mn+Cu	8.37 b	9.61 cd	13.21 b	36.34 b	41.42 bc	52.58 ab	56.36 b
T_{11} = Zn+B+Mo+Mn+Cu+Cl	8.94 ab	10.57 bc	12.22 c	36.69 b	41.82 bc	53.52 ab	58.53 ab
CV (%)	8.38	6.90	2.10	3.87	2.64	5.49	3.42

Note: In the table a,b,c.. deals with the data ranges and in a column values having the same letter(s) do not differ significantly as per DMRT at 0.05 levels. Each parameter represents 30 plants.

Table 2. 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

Note: In the table a,b,c.. deals with the data ranges and in a column values having the same letter(s) do not differ significantly as per DMRT at 0.05 levels. Each parameter represents 30 plants; DAP= Days After planting.

Table 3. Effect of micronutrients on fresh and dry weights of onion plant.

Treatments	Fresh weight			Dry weight		
	Fresh weight of leaves (g)	Fresh weight of bulbs (g)	Fresh weight of roots (mg)	Dry weight of leaves (g)	Dry weight of bulbs (g)	Dry weight of roots (mg)
T_1 = Control	6.82 def	20.60 de	693.40 e	1077 c	1960 d	160.00 e
T_2 = Zn	8.88 b	26.52 b	1084 bcd	1479 ab	2760 abc	323.40 a
T_3 = B	7.24 cdef	25.32 bc	1229 b	1617 a	2420 c	190.10 cde
T_4 = Zn+B	9.21 a	31.42 a	1035 bcd	1460 ab	3050 a	273.70 ab
T_5 = Zn+B+Mo	7.55 bcde	23.72 bcde	1513 a	1454 ab	2320 cd	140.00 e
T_6 = Zn+B+Mn	4.97 g	24.25 bcde	1141 bc	1324 abc	2630 abc	200.00 cde
T_7 = Zn+B+Cu	8.78 c	22.66 bcde	887 cde	1431 ab	2930 ab	233.40 bc
T_8 = Zn+B+Cl	7.70 bcde	21.76 cde	984.10 bcd	1216 bc	1910 d	160.00 de
T_9 = Zn+B+Mo+Mn	6.60 ef	25.79 bc	986.70 bcd	1250 bc	2720 abc	170.00 cde
T_{10} = Zn+B+Mo+Mn+Cu	5.91 fg	25.03 bcd	816.80 de	1288 bc	2540 bc	202.00 cde
T_{11}=Zn+B+Mo+Mn+Cu+Cl	8.55 abc	19.94 e	1169 b	1370 abc	2730 abc	230.00 bcd
CV (%)	9.71	10.22	13.49	12.23	9.16	17.53

Note: In the table a,b,c.. deals with the data ranges and in a column values having the same letter(s) do not differ significantly as per DMRT at 0.05 levels. Each parameter represents 30 plants.

Table 4. Effect of micronutrients on splitting and yield of onion.

Treatments	Splitting of bulb (number)	Yield (t/ha)	% of Yield increase over control
T_1 = Control	8.39 ab	8.94 b	-
T_2 = Zn	6.99 cd	11.50 ab	28.64
T_3 = B	7.79 bc	11.42 ab	27.74
T_4 = Zn+B	8.42 ab	13.38 a	49.66
T_5 = Zn+B+Mo	8.72 ab	11.65 ab	30.31
T_6 = Zn+B+Mn	7.39 bcd	9.89 b	10.63
T_7 = Zn+B+Cu	9.72 a	11.18 ab	25.06
T_8 = Zn+B+Cl	8.75 ab	10.25 b	14.65
T_9 = Zn+B+Mo+Mn	6.38 d	9.83 b	9.96
T_{10} = Zn+B+Mo+Mn+Cu	7.71 bc	10.57 b	18.23
T_{11} = Zn+B+Mo+Mn+Cu+Cl	8.72 abc	10.83 ab	21.14
CV (%)	8.83	13.04	-

Note: In the table a,b,c.. deals with the data ranges and in a column values having the same letter(s) do not differ significantly as per DMRT at 0.05 levels. Each parameter represents 30 plants.

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 and the lowest in T_1 where plant height at 75 DAP was higher (58.88 cm) in T_8 and followed by (56.69 cm) in T_2 (Table: 1). 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.

Diameter of stem

Diameter of stem of onion were not-significant at 80 DAP. The highest diameter (2.58 mm) of stem at 30 DAP was performed by T_3 followed by T_2 but both are statistically similar and the second or lowest (1.45 mm) found in T_{11} (Table 2).

Diameter of bulb

The highest value (4.36 cm) was recorded from treatment T_4 but treatment T_4 to T_7 are statistically similar. The lowest diameter (3.31 cm) of bulb was observed in T_9 (Table: 2). 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: 3). 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). EL-Gamelli *et al.* (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 is in partial accord with the findings of Sindhu and Tiwari (1989).

Fresh weight of bulbs

Application of different micronutrient treatments significantly influenced the fresh weight of bulb of onion (Table: 3). The highest fresh weight (31.42 g) of bulb was performed by the application of T_4 and second highest value was 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 treatments from T_5 to T_{10} performed the similar response on fresh weight of bulb. It is indicated that Mo, Cu, Mn and Cl_2 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.

Fresh weight of roots

Application of different micronutrients caused highly significant variation in terms of fresh weight of roots per plant (Table: 3). The maximum fresh weight of roots (1513 mg) was produced by the plants having treatment T_5 (Zn+B+Mo) followed by T_3, while the minimum (693.40 mg) was found in 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 (1617 mg) in plants treated with B while the lowest value (1077mg) was found in control (Table: 3). 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: 3). The present study revealed that maximum bulb weight (3050 mg) was found in T_4 followed by T_7, T_2, T_9, and T_6 but T_2, T_9 & T_6 are statistically similar. EL-Gamelli *et al.* (2000) narrated that dry weight of bulb was increased significantly by Zn and this result is so interrelated with this experiment.

Dry weight of roots

Applications of micronutrients caused significant variation on the production of dry weight of roots of onion (Table: 3). The highest value (323.40 mg) was obtained from treatment T_2 while the lowest value (160 mg) was found from the treatments T_1 and T_8. The response of T_8 and T_9 were statistically identical.

Splitting of bulb

Micronutrients exhibited significant variation in respect of splitting of bulb (Table 4). The highest value (9.72) was obtained from treatment T_7 while the lowest value (6.380) was performed by the treatment T_9. 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. Ellerbrock *et al.* (1997) carried out an experiment which was similar to this result.

Bulb yield

Different micronutrient produced significant variations for bulb yield of onion (Table 4). An upward trend of yield (13.38 t/ha) was observed with the treatment T_4 when the downward trend of yield (8.94 t/ha) was found in T_1. Yield 11.65 t/ha was marked from treatment T_5, whereas 11.50 t/ha and (11.42 t/ha) were found in T_2 and T_3. Response of T_2, T_3, T_5, T_7 and T_{11} were statistically 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. The yield increased significantly by the use of Zn and B. The highest yield (13.38) was observed from the treatment of T_4. This result is closely related to Mishra *et al.* (1990). They stated that yield of onion was enhanced most by B followed by Zn. The bulb yields increased over control have been presented in table 4. 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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