



## Effects of zinc and boron application on onion and their residual effects on Mungbean

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### Abstract

The effect of zinc (Zn) and boron (B) on the growth and yield of onion as well as their residual effect on mungbean were investigated in this study. The field experiment was conducted at Bangladesh Agricultural University Farm, Mymensingh. The soil was silt loam having 6.92 pH, 2.82% organic matter, 0.63  $\mu\text{g g}^{-1}$  available Zn and 0.27  $\mu\text{g g}^{-1}$  available B contents. There were nine treatments comprising three rates of Zn (0, 2 and 4 kg  $\text{ha}^{-1}$ ) and three rates of B (0, 1.5 and 3 kg  $\text{ha}^{-1}$ ) in all combinations. The experiment was laid out in a randomized complete block design with three replications. Zinc as  $\text{ZnSO}_4 \cdot 7\text{H}_2\text{O}$  and boron as  $\text{H}_3\text{BO}_3$  were applied to the first crop (onion cv. Faridpuri). Mungbean (cv. BINA Mung8) was grown on the same plots after harvesting of onion, with no further addition of Zn and B. For both crops, N, P, K and S fertilizers were added to the all plots as per recommendation (FRG-2012). Application of Zn and B significantly influenced the growth and yield parameters of crops viz. plant height, bulb diameter, bulb length and bulb yield for onion, and plant height, pods plant<sup>-1</sup>, pod length, 1000-seed weight and seed yield for mungbean. Addition of Zn at 4 kg  $\text{ha}^{-1}$  and B at 3 kg  $\text{ha}^{-1}$  compared to control ( $\text{Zn}_0\text{B}_0$ ) gave 52% yield benefits for onion and 99% yield benefits for mungbean. Zinc and B concentrations as well as their uptake by onion bulb were also positively influenced by the added Zn and B. The results suggest that application of Zn at 4 kg  $\text{ha}^{-1}$  coupled with B at 3 kg  $\text{ha}^{-1}$  along with NPKS is required to achieve higher yield of onion and mungbean in Old Brahmaputra Floodplain (AEZ 9).

**Key words:** Zinc, boron, onion, mungbean, old brahmaputra floodplain

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### Introduction

Onion (*Allium cepa*) among the spice crops occupies the first position in respect of production and the second position in respect of area in Bangladesh. Still, country's onion production is far below the requirement and to meet the demand the country is importing a huge quantity of onion mainly from India each year. After cultivation of winter onion, mungbean (*Vigna radiata*) as a grain legume is a good fit to crop calendar in Bangladesh. Mungbean is called poor man's meat since its seed contains almost triple amount of protein as compared to rice grain. It

has a unique capacity to synthesize nitrogen in symbiosis with *Rhizobium*.

Increased cropping intensity along with cultivation of modern crop varieties having high yield potential has resulted in deterioration of soil fertility with an emergence of micronutrient deficiency in Bangladesh. Among the micronutrients, zinc and boron deficiencies have widely been reported (Hossain *et al.*, 2008; Jahiruddin, 2011; Jahiruddin and Islam, 2014). Nevertheless, micronutrients have great roles in the fertilizer programme to achieve

higher and sustainable crop yields. Micronutrients are also important for seed formation and seed quality (Jahiruddin *et al.*, 1992; Cakmak *et al.*, 1996; Ahmed *et al.*, 2007). Boron deficiency may induce grain sterility in crops. Usually dicots have higher boron requirement than monocots.

Only four plant nutrients viz. N, P, K and S are commonly used by the farmers in Bangladesh. The importance of the use of micronutrients is mostly ignored although they could be chief limiting factor for crop production. However, micronutrient application needs a careful control. It is essential, but the amount of requirement is much less compared to macronutrient. Every crop application of micronutrient fertilizer may not be needed since its residual effect might be sufficient for achieving sustainable yield over a cropping pattern. There is a report that elevated concentration of boron would have toxic effect on crops (Metwally *et al.*, 2012). Toxicity may arise in plants due to continuous application of micronutrients. Keeping the above points in view, the experiments were conducted at BAU farm, Mymensingh in Old Brahmaputra Floodplain soil with the objective of investigating the effects of Zn and B on onion and subsequently their residual effects on mungbean.

## Materials and Methods

Two field experiments in sequence were conducted at BAU farm, Mymensingh in January –June 2013 with an objective of determining the effects of Zn and B on onion (cv. Faridpuri) and the residual effects on mungbean (cv. BINA mung 8). The BAU farm soil belongs to ‘Sonatala’ soil series under the AEZ 9 (Old Brahmaputra Floodplain). The soil was silt loam having 6.92 pH, 2.82% organic matter, 0.63  $\mu\text{g g}^{-1}$  available Zn and 0.27  $\mu\text{g g}^{-1}$  available B contents. The experiment was designed with nine Zn-B treatments with three rates of Zn (0, 2 & 4  $\text{kg ha}^{-1}$ ) and three rates of B (0, 1.5 & 3  $\text{kg ha}^{-1}$ ). The field trial was laid out in a randomized complete block design with three replications. The layout was made for the first crop and kept undisturbed for the second crop. Zinc as  $\text{ZnSO}_4 \cdot 7\text{H}_2\text{O}$  and boron as  $\text{H}_3\text{BO}_3$  were applied to the first crop (onion) only. Every plot received an

equal amount of some macronutrients, the rates being 80  $\text{kg N ha}^{-1}$ , 30  $\text{kg P ha}^{-1}$ , 100  $\text{kg K ha}^{-1}$  and 25  $\text{kg S ha}^{-1}$  for onion and 20  $\text{kg N ha}^{-1}$ , 15  $\text{kg P ha}^{-1}$  and 20  $\text{kg K ha}^{-1}$  for mungbean. All fertilizers except urea were incorporated to soil during final land preparation. Urea was applied in three equal splits, the first split during final land preparation, the second and the third splits at growth stages, with 20-25 days’ intervals. Mungbean (cv. BINA Mung 8) was grown on the same plots after harvesting of onion. Intercultural operations e.g. weeding, irrigation, etc. were done as usual to support normal crop growth. Plot-wise yield and yield components were recorded. Bulb samples from every plot were chemically analyzed for P, K, S and B contents following standard methods (Chapman and Pratt, 1964; Yoshida *et al.*, 1976). Data were statistically analyzed following F-test and the mean comparisons were made by DMRT (Duncan's Multiple Range Test) at 5% level of significance.

## Results and Discussion

A significant effect of Zn and B was observed on the first crop (onion) and their residual effect was also significant on the second crop (mungbean). This study indicates that application of Zn and B is required for achieving higher bulb yield of onion and seed yield of mungbean. The results are discussed under two crop headings.

### *Effects of Zn and B on onion*

**Plant height:** Plant height was measured at 65 days after planting. There was a significant effect of Zn-B treatments on the plant height of the crop (Table 1). The  $T_9$  ( $\text{Zn}_4\text{B}_3$ ) treatment produced the tallest plants (34.0 cm) which did not differ significantly from  $T_8$  treatment ( $\text{Zn}_4\text{B}_{1.5}$ ) showing 33.7 cm height plants. The control treatment ( $\text{Zn}_0\text{B}_0$ ) caused the shortest plants (31.4 cm). Similarly, Abedin *et al.* (2012) observed that plant parameters including plant height were the maximum when Zn and B were applied.

**Bulb length:** The length of bulb measured after harvest was significantly affected by the different treatments. Like plant height, the highest bulb length (1.32 cm) was observed with the  $T_9$  treatment ( $\text{Zn}_4\text{B}_3$ ) while the lowest length (1.12 cm) was recorded in the  $T_1$  treatment where Zn or B was not

applied (Table 1). Treatment T<sub>9</sub> (Zn<sub>4</sub>B<sub>3</sub>) differed significantly with all other treatments except T<sub>8</sub> (Zn<sub>4</sub>B<sub>1.5</sub>). The bulb length due to T<sub>8</sub> treatment was statistically similar to that due to T<sub>3</sub> (Zn<sub>0</sub>B<sub>3</sub>), T<sub>6</sub> (Zn<sub>2</sub>B<sub>3</sub>) and T<sub>7</sub> (Zn<sub>4</sub>B<sub>0</sub>) treatments.

**Bulb diameter:** The highest bulb diameter (3.5 cm) was observed in the T<sub>9</sub> treatment (Zn<sub>4</sub>B<sub>3</sub>) and that was significantly different from all other treatments (Table 1). The lowest bulb diameter (2.8 cm) was recorded in the T<sub>1</sub> treatment (control) and statistically similar result was observed by the T<sub>4</sub> (Zn<sub>2</sub>B<sub>0</sub>) treatment. This result indicates a greater effect of B supplement over Zn supplement which in turn influenced the bulb yield.

**Bulb yield:** Crop yield was the most important parameter in this study. Bulb yield varied from 8.5 t ha<sup>-1</sup> recorded in Zn<sub>0</sub>B (control) to 12.3 t ha<sup>-1</sup> noted in Zn<sub>4</sub>B<sub>3</sub> treatment (Table 1). All the treatments (T<sub>2</sub>-T<sub>9</sub>) showed significantly higher bulb yield over the control (T<sub>1</sub>). The highest yield due to Zn<sub>4</sub>B<sub>3</sub> treatment was 51.9% higher over control (Fig.1). When the results of Zn and B effect are carefully looked into, it appears that the effect of B application was dominant over that of Zn. Alam et al. (2010)

found that combined application of Zn and B increased the bulb yield by 49.7% over no application of Zn and B.

The significant effect of Zn and B treatments can be related to soil test values that the experimental field had low level of Zn (0.63 µg g<sup>-1</sup>) and B (0.27 µg g<sup>-1</sup>). As outlined in FRG-2012, the critical limit (C.L.) of DTPA extractable soil Zn is 0.60 mg kg<sup>-1</sup> and that of hot water extractable soil B is 0.20 mg kg<sup>-1</sup> and crop response to added nutrient is expected when the soil status of that nutrient lies within 225% of the C. L.

**Nutrient concentration:** We measured the phosphorus (P), potassium (K), sulphur (S) and boron (B) concentrations in bulb. The P concentration in bulb ranged from 0.162% to 0.188% (Table 2). The highest P concentration was recorded in T<sub>4</sub> (Zn<sub>2</sub>B<sub>0</sub>) treatment which was statistically similar to T<sub>7</sub> (Zn<sub>4</sub>B<sub>0</sub>), T<sub>8</sub> (Zn<sub>4</sub>B<sub>1.5</sub>) and T<sub>9</sub> (Zn<sub>4</sub>B<sub>3</sub>) treatments. The lowest P concentration was observed in T<sub>6</sub> treatment (Zn<sub>2</sub>B<sub>3</sub>) which was statistically similar to T<sub>3</sub> (Zn<sub>0</sub>B<sub>3</sub>) and T<sub>5</sub> (Zn<sub>2</sub>B<sub>1.5</sub>) treatments. The highest K concentration was observed as 0.705% in T<sub>7</sub> treatment (Zn<sub>4</sub>B<sub>0</sub>) which was not significantly different from other treatments, except T<sub>3</sub> (Zn<sub>0</sub>B<sub>3</sub>).

**Table 1.** Effects of Zn and B on plant height, bulb length, bulb diameter and bulb yield of onion

Treatments	Plant height (cm)	Bulb length (cm)	Bulb diameter (cm)	Bulb yield (t ha <sup>-1</sup> on fresh wt. basis)
T <sub>1</sub> : Zn <sub>0</sub> B <sub>0</sub>	31.4e	1.12e	2.80e	8.1c
T <sub>2</sub> : Zn <sub>0</sub> B <sub>1.5</sub>	31.7de	1.15de	3.05cd	10.6ab
T <sub>3</sub> : Zn <sub>0</sub> B <sub>3</sub>	32.6b	1.22bc	3.15bc	12.0a
T <sub>4</sub> : Zn <sub>2</sub> B <sub>0</sub>	31.6de	1.15de	2.90de	9.4bc
T <sub>5</sub> : Zn <sub>2</sub> B <sub>1.5</sub>	32.2c	1.19cd	3.10bc	11.1ab
T <sub>6</sub> : Zn <sub>2</sub> B <sub>3</sub>	33.0b	1.23bc	3.25b	11.4ab
T <sub>7</sub> : Zn <sub>4</sub> B <sub>0</sub>	32.0cd	1.23bc	2.99cd	10.3b
T <sub>8</sub> : Zn <sub>4</sub> B <sub>1.5</sub>	33.7a	1.27ab	3.15bc	11.5ab
T <sub>9</sub> : Zn <sub>4</sub> B <sub>3</sub>	34.0a	1.32a	3.50a	12.3a
SE (±)	0.15	0.01	0.03	0.26
CV (%)	2.83	5.67	6.71	14.7

In a column, the figures having same letter do not differ significantly at 5% level.

CV = Co-efficient of variation, SE = Standard error of means

The lowest K concentration of bulb was recorded as 0.605% in T<sub>3</sub> (Zn<sub>0</sub>B<sub>3</sub>) treatment which was

significantly different from all other treatments, except T<sub>7</sub> (Zn<sub>4</sub>B<sub>0</sub>). The S concentration of bulb

### *Effect of Zn and Br on onion and mungbean*

varied from 0.224% to 0.298% over the treatments. The highest S content in bulb was observed in T<sub>8</sub> treatment (Zn<sub>4</sub>B<sub>1.5</sub>) which was significant over all other treatments except T<sub>2</sub>, T<sub>3</sub>, T<sub>4</sub> and T<sub>9</sub>. The lowest S content was noted in control treatment which was statistically similar to T<sub>5</sub>, T<sub>6</sub> and T<sub>7</sub> treatments (Table 2). Boron concentration of bulb was the highest (85 µg g<sup>-1</sup>) due to T<sub>3</sub> (Zn<sub>0</sub>B<sub>3</sub>) treatment and the lowest (44 µg g<sup>-1</sup>) for T<sub>1</sub> treatment (Zn<sub>0</sub>B<sub>0</sub>). The

highest B concentration recorded by the T<sub>3</sub> treatment was statistically similar to that measured with the T<sub>8</sub> (Zn<sub>4</sub>B<sub>1.5</sub>) and T<sub>9</sub> (Zn<sub>4</sub>B<sub>3</sub>) treatments. The control treatment (Zn<sub>0</sub>B<sub>0</sub>) was also statistically similar to T<sub>4</sub> (Zn<sub>2</sub>B<sub>0</sub>) and T<sub>7</sub> (Zn<sub>4</sub>B<sub>0</sub>) treatments which result otherwise indicates that B supplement enhanced the B concentration of bulb. The critical level of boron in crops ranges from 5 to 10 µg g<sup>-1</sup> for monocots and 20 to 70 µg g<sup>-1</sup> for dicots (Mortvedt, 1991).

**Table 2.** Effects of Zn and B application on P, K, S and B concentrations of onion bulb

Treatments	P conc. (%)	K conc. (%)	S conc. (%)	B conc. (µg g <sup>-1</sup> )
T <sub>1</sub> : Zn <sub>0</sub> B <sub>0</sub>	0.167abc	0.680ab	0.244bc	44d
T <sub>2</sub> : Zn <sub>0</sub> B <sub>1.5</sub>	0.183ab	0.680ab	0.279ab	68bc
T <sub>3</sub> : Zn <sub>0</sub> B <sub>3</sub>	0.170bc	0.605b	0.277ab	85a
T <sub>4</sub> : Zn <sub>2</sub> B <sub>0</sub>	0.188a	0.655ab	0.275ab	45d
T <sub>5</sub> : Zn <sub>2</sub> B <sub>1.5</sub>	0.168bc	0.630ab	0.248bc	58c
T <sub>6</sub> : Zn <sub>2</sub> B <sub>3</sub>	0.162bc	0.630ab	0.224c	59c
T <sub>7</sub> : Zn <sub>4</sub> B <sub>0</sub>	0.184a	0.705a	0.255bc	47d
T <sub>8</sub> : Zn <sub>4</sub> B <sub>1.5</sub>	0.186a	0.680ab	0.298a	71abc
T <sub>9</sub> : Zn <sub>4</sub> B <sub>3</sub>	0.175a	0.680ab	0.272ab	82ab
SE (±)	0.002	0.008	0.005	0.03
CV (%)	6.35	7.19	10.73	4.44

In a column, the figures having same letter do not differ significantly at 5% level.

CV = Co-efficient of variation, SE = Standard error of means

**Nutrient uptake:** Uptake of P, K, S and B by bulb was calculated from yield and nutrient concentration data as presented in Table 3. The P uptake ranged from 3.26 - 5.19 kg ha<sup>-1</sup> across the treatments. The highest P uptake was recorded by the T<sub>9</sub> treatment (Zn<sub>4</sub>B<sub>3</sub>) which was statistically similar to all other treatments except T<sub>1</sub>, T<sub>4</sub> and T<sub>6</sub>. The lowest P uptake was observed in control treatment (Zn<sub>0</sub>B<sub>0</sub>) which was statistically different from all other treatments. The K uptake by onion bulb varied between 13.29 kg ha<sup>-1</sup> and 20.12 kg ha<sup>-1</sup> over the treatments, the highest K uptake being noted with T<sub>9</sub> treatment (Zn<sub>4</sub>B<sub>3</sub>) and the lowest K uptake observed with control treatment (Zn<sub>0</sub>B<sub>0</sub>). The T<sub>9</sub> treatment showing the highest K uptake was statistically similar to all other treatments except T<sub>1</sub> (Zn<sub>0</sub>B<sub>0</sub>), T<sub>4</sub> (Zn<sub>2</sub>B<sub>0</sub>) and T<sub>5</sub> (Zn<sub>2</sub>B<sub>1.5</sub>).

For the S uptake by bulb, the highest result (8.27 kg ha<sup>-1</sup>) was observed with T<sub>8</sub> treatment (Zn<sub>4</sub>B<sub>1.5</sub>) which was statistically similar to T<sub>9</sub>, T<sub>2</sub> and T<sub>3</sub> treatments (Table 3). The lowest S uptake by bulb (4.27 kg ha<sup>-1</sup>) was observed in T<sub>1</sub> treatment that received no Zn and B (control) application which was statistically different from all other treatments. Boron uptake by bulb was found to vary from 85.8 to 246.1 g ha<sup>-1</sup> across the treatments. The highest B uptake by bulb was due to T<sub>9</sub> treatment (Zn<sub>4</sub>B<sub>3</sub>) which was statistically different from all treatments except T<sub>3</sub> (Zn<sub>0</sub>B<sub>3</sub>). The lowest B uptake was found in T<sub>1</sub> treatment (Zn<sub>0</sub>B<sub>0</sub>) that received no B and Zn application. This can be related to initial status of soil Zn and B which showed deficient status.

**Table 3.** Effects of Zn and B application on P, K, S and B uptake by onion

Treatments	P (kg ha <sup>-1</sup> )	K (kg ha <sup>-1</sup> )	S (kg ha <sup>-1</sup> )	B (g ha <sup>-1</sup> )
T <sub>1</sub> : Zn <sub>0</sub> B <sub>0</sub>	3.26bc	13.29c	4.77c	85.8e
T <sub>2</sub> : Zn <sub>0</sub> B <sub>1.5</sub>	4.68a	17.39ab	7.13ab	173.9bc
T <sub>3</sub> : Zn <sub>0</sub> B <sub>3</sub>	4.92ab	17.52ab	8.02a	243.3a
T <sub>4</sub> : Zn <sub>2</sub> B <sub>0</sub>	4.26b	14.85bc	6.24b	102.1d
T <sub>5</sub> : Zn <sub>2</sub> B <sub>1.5</sub>	4.50a	16.87b	6.64b	155.3c
T <sub>6</sub> : Zn <sub>2</sub> B <sub>3</sub>	4.45b	17.33ab	6.16b	162.3c
T <sub>7</sub> : Zn <sub>4</sub> B <sub>0</sub>	4.57a	17.52ab	6.34b	116.8d
T <sub>8</sub> : Zn <sub>4</sub> B <sub>1.5</sub>	5.16a	18.87a	8.27a	197.0b
T <sub>9</sub> : Zn <sub>4</sub> B <sub>3</sub>	5.19a	20.12a	8.07a	246.1a
SE (±)	0.0013	0.005	0.0032	0.0019
CV (%)	2.40	2.60	3.25	36.33

In a column, the figures having same letter do not differ significantly at 5% level.

CV = Co-efficient of variation; SE = Standard error of means

#### Effects of Zn and B application on mungbean

**Plant height:** The tallest plants were observed in Zn<sub>4</sub>B<sub>3</sub>-treated plots (T<sub>9</sub>) which was significantly different from all other treatments (Table 4). The shortest plants were noted in T<sub>1</sub> treatment (Zn<sub>0</sub>B<sub>0</sub>). Next to T<sub>9</sub>, the T<sub>6</sub> treatment (Zn<sub>2</sub>B<sub>3</sub>) followed by T<sub>7</sub> (Zn<sub>4</sub>B<sub>0</sub>) and T<sub>8</sub> (Zn<sub>4</sub>B<sub>1.5</sub>) treatments showed higher plant height.

**Pod length:** Pod length ranged from 7.5 - 8.9 cm over the treatments (Table 4). Like other parameters, T<sub>9</sub> treatment (Zn<sub>4</sub>B<sub>3</sub>) exhibited the biggest pod size which was statistically superior to all other treatments. The smallest sized pods were noted in T<sub>1</sub> treatment (control) which however was statistically similar with T<sub>2</sub> (Zn<sub>0</sub>B<sub>1.5</sub>), T<sub>3</sub> (Zn<sub>0</sub>B<sub>3</sub>) and T<sub>4</sub> (Zn<sub>2</sub>B<sub>0</sub>) treatments.

**Number of pods plant<sup>-1</sup>:** Per plant pods ranged from 8 to 11 over the Zn-B treatments. The highest number of pods plant<sup>-1</sup> was recorded by the T<sub>9</sub> treatment (Zn<sub>4</sub>B<sub>3</sub>) which was statistically similar to T<sub>6</sub> (Zn<sub>2</sub>B<sub>3</sub>), T<sub>3</sub> (Zn<sub>0</sub>B<sub>3</sub>) and T<sub>8</sub> (Zn<sub>4</sub>B<sub>1.5</sub>) treatments. Except T<sub>2</sub>, T<sub>4</sub>, T<sub>5</sub> and T<sub>7</sub> all other treatments produced significantly higher number of pods plant<sup>-1</sup> over control.

**Thousand seed weight:** Thousand seed weight was the maximum as 38.4g and the minimum as 36.2g over the treatments (Table 4). The highest 1000-seed

weight was observed with T<sub>6</sub> (Zn<sub>2</sub>B<sub>3</sub>) treatment which was statistically significant over all other treatments. The minimum 1000-seed weight was found in T<sub>1</sub> treatment which was only comparable with T<sub>6</sub> (Zn<sub>2</sub>B<sub>3</sub>) treatment.

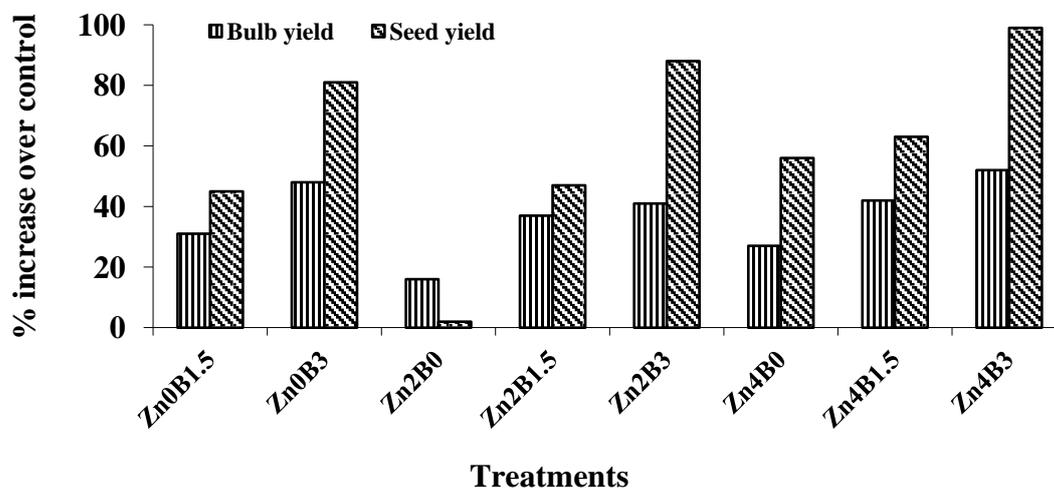
**Seed yield:** There was a significant residual effect of the Zn-B treatments on the seed yield of mungbean (Table 4). The T<sub>9</sub> treatment (Zn<sub>4</sub>B<sub>3</sub>) produced the maximum seed yield (853.5 kg ha<sup>-1</sup>) and the control treatment (Zn<sub>0</sub>B<sub>0</sub>) did the minimum yield (429.4 kg ha<sup>-1</sup>). The highest seed yield recorded by the T<sub>9</sub> treatment was comparable to that recorded by the T<sub>6</sub> treatment (Zn<sub>2</sub>B<sub>3</sub>). The control yield was statistically similar to that recorded with the T<sub>4</sub> treatment (Zn<sub>2</sub>B<sub>0</sub>) indicating that seed yield was more influenced by B than by Zn addition. The yield increased by 02-99% due to residual effect of Zn and B application (Fig. 1). Hossain et al. (2008) from a 3-year field experiment with maize-mungbean-rice in calcareous soil of Jessore (AEZ 11) have reported 2 kg Zn ha<sup>-1</sup> as the optimum rate of Zn for both maize and rice, and reduction of Zn rate by 1 kg ha<sup>-1</sup> is possible for rice when mungbean residue is incorporated into the plot before transplanting of T. Aman rice. Boron application at 1.5 kg ha<sup>-1</sup> to the first crop can meet up their requirement for the subsequent crops in a pattern (Khanom, 2013; Jahiruddin and Islam, 2014).

**Table 4.** Residual effects of Zn and B application on the growth, yield and yield components of mungbean

Treatments	Plant height (cm)	Pod length (cm)	Pods plant <sup>-1</sup> (No.)	1000-seed weight (g)	Seed yield (kg ha <sup>-1</sup> )
T <sub>1</sub> : Zn <sub>0</sub> B <sub>0</sub>	32.3 <sup>f</sup>	7.5 <sup>e</sup>	8 <sup>c</sup>	36.2 <sup>b</sup>	429.4 <sup>e</sup>
T <sub>2</sub> : Zn <sub>0</sub> B <sub>1.5</sub>	36.3 <sup>d</sup>	7.7 <sup>de</sup>	9 <sup>bc</sup>	36.8 <sup>b</sup>	623.4 <sup>d</sup>
T <sub>3</sub> : Zn <sub>0</sub> B <sub>3</sub>	36.5 <sup>cd</sup>	7.9 <sup>cde</sup>	10 <sup>ab</sup>	37.0 <sup>b</sup>	777.9 <sup>b</sup>
T <sub>4</sub> : Zn <sub>2</sub> B <sub>0</sub>	33.5 <sup>e</sup>	7.9 <sup>b-e</sup>	8 <sup>c</sup>	36.4 <sup>b</sup>	439.3 <sup>e</sup>
T <sub>5</sub> : Zn <sub>2</sub> B <sub>1.5</sub>	36.5 <sup>cd</sup>	8.1 <sup>bc</sup>	9 <sup>bc</sup>	36.5 <sup>b</sup>	629.1 <sup>d</sup>
T <sub>6</sub> : Zn <sub>2</sub> B <sub>3</sub>	37.5 <sup>b</sup>	8.4 <sup>b</sup>	11 <sup>a</sup>	38.4 <sup>a</sup>	806.0 <sup>ab</sup>
T <sub>7</sub> : Zn <sub>4</sub> B <sub>0</sub>	37.3 <sup>bc</sup>	8.0 <sup>bcd</sup>	9 <sup>bc</sup>	36.7 <sup>b</sup>	671.7 <sup>cd</sup>
T <sub>8</sub> : Zn <sub>4</sub> B <sub>1.5</sub>	36.6 <sup>bcd</sup>	8.3 <sup>bc</sup>	10 <sup>ab</sup>	36.5 <sup>b</sup>	698.4 <sup>c</sup>
T <sub>9</sub> : Zn <sub>4</sub> B <sub>3</sub>	40.1 <sup>a</sup>	8.9 <sup>a</sup>	11 <sup>a</sup>	36.8 <sup>b</sup>	853.5 <sup>a</sup>
SE (±)	0.35	0.07	0.22	0.12	23.36
CV (%)	6.07	5.57	14.49	1.98	13.55

In a column, the figures having same letter do not differ significantly at 5% level.

CV = Co-efficient of variation; SE = Standard error of means



**Figure 1.** Percent yield increase due to Zn-B treatments over control

### Conclusions

Application of Zn and B had significant positive effect on onion and its residual effect on mungbean in respect of crop growth, yield and nutrient uptake. Addition of Zn at 4 kg ha<sup>-1</sup> along with B at 3 kg ha<sup>-1</sup> was found as the best treatment. Effect of B on the growth and yield of crops was more prominent than that of Zn.

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