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Response of zinc on growth, yield and quality of blackgram (*Vigna mungo* L.)

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Abstract

In Bangladesh, many experiments have been done on various pulse crop production treated with micronutrient (Zn) but at the same time less emphasis was given on blackgram production with the same micronutrient. Therefore, a field experiment was conducted to evaluate the growth, yield and quality performance of blackgram cv. BARI mash–3 as influenced by various levels of Zn fertilizer in Sher-e- Bangla Agricultural University, Sher-e- Bangla nagor, Dhaka- 1207. It was consisted of four Zn levels *viz.* 0, 1.25, 2.50 and 3.75 kg ha^{-1} as soil application. A blanket dose of N_{20} P_{150} K_{50} Kg ha^{-1} was also used as recommended dose. The experiment was laid out in randomized complete block design (RCBD) with three replications. All the characters were influenced by Zn fertilization and significantly increased up to 2.5 kg Zn ha^{-1} and started to decrease of subsequent Zn levels. Obtained results showed that the plant height (52.28 cm), branches per plant (5.71), number of pods per plant (48.99), pod length (5.06 cm), seeds per pod (6.98), 1000- seed weight (41.60 g), grain yield (1.54 t ha^{-1}), straw yield (3.69 t ha^{-1}), biological yield (5.24 t ha^{-1}), harvest index (29.47%) and protein content of harvested seed (23.44%) had a significant positive effects up to 2.50 kg Zn ha^{-1}. These results indicated that the application of 2.5 kg Zn ha^{-1} would be the most optimum level for maximizing the quality seed yield of blackgram under the region of AEZ–28.

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Introduction

Blackgram (*Vigna mungo* L.) is an important pulse crop in Bangladesh which is locally known as 'Mashkalai'. After India, central Asia is considered as the secondary centre of origin of blackgram. In Bangladesh, its cultivation is scattered over the northern districts, especially in Rajshahi and Chapai Nawabganj. It occupies an area of 70,000 ha producing 29,000 MT a mean yield of 1000 kg ha^{-1} and shares about 12.55% of the total pulse production which is very low compared to other pulses (BBS, 2012). However, it also ranked fourth position both in area coverage and production among the pulses (BBS, 2012). Pulses are good source of proteins, minerals, vitamins and carbohydrates which plays an important role in human nutrition and is called the poor men's meat (Mian, 1976). Moreover, it contains sulphur, amino acids, methionine, cysteine and also lycine which are excellent components of balanced human nutrition. The dried whole seeds or splits are used to make dal, sours, curries and are added to various spiced or fried dishes. Sprouted seeds are also used as quality vegetable ingredients in Malaysia. Legumes are also good source of calcium, iron, phosphorus, magnesium, sodium, potassium, copper, sulphur and vitamins (Thiamine, riboflavin, nicotinic acid, vitamin C, carotene etc.). The thiamine content in different pulses varies from 3.1 to 5.0 µg g^{-1}. Moreover, pulses are capable to fix atmospheric nitrogen to soil and are also used as fodder, green manuring as well as cover crops.

However, blackgram production is not sufficient in our country and each year government imports it from our neighboring countries. Besides, malnutrition is a serious problem that has been a great threat to cripple the whole nation in Bangladesh. So, we should increase the productivity of blackgram along with its multiple uses. Nutrient deficiency in soil is the key factor for poor productivity of pulses. The magnitude of yield losses due to nutrient deficiency also varies among nutrients to nutrients (Ali *et al.*, 2002). Especially, Zn deficiency decreases crop yield and delays crop maturity. Also, Zn deficiency reduces water use and water use efficiency (Khan *et al.*, 2004) and also reduces nodulation and nitrogen fixation process (Ahlawat *et al.*, 2007), which contributes to yield loss. The Zn essentially is being employed in functional and structural components of carbonic anhydrase, alcohol dehydrase, alkaline phosphatase, phospholipase, carboxy peptidase (Coleman, 1991) and RNA polymerase (Romheld and Marschner, 1991). Calhor, 2006 reported that, Zn influenced the seed protein content of pulse and cereal. Zinc enriched seeds performs better over untreated seed to germination, seedling growth and yield of crops (Cakmak *et al.*, 1996). Therefore, the importance of Zn as a micronutrient in crop production has increased in recent years (Fageria, 2006) and considered the most yield–limiting micronutrient (Duffy, 2007).

In Bangladesh, many research works have been done on pulse production with Zn but less emphasis was given on blackgram with Zn to study its growth, yield and quality characters. So, the present study was carried out to investigate the growth, yield and quality performance of blackgram as influenced by different levels of Zn fertilizer.

Materials and methods

The experiment was carried out at the Agronomy field laboratory, Department of Agronomy, Sher–e–Bangla Agricultural University, Dhaka. The soil of the experimental site was general soil type of shallow red brown terrace under Tejgaon series and the upper level soils was clay loam in texture under the AEZ–28 and belonged to the Madhupur Tract. The plot was high land, low in micronutrients but fertile and well having p^H 5.8. The experiment consists of the variety BARI Mash–3 and four Zn levels *viz*. 0 Kg ha^{-1} (Zn_0), 1.25 Kg ha^{-1} ($Zn_{1.25}$), 2.5 Kg ha^{-1} ($Zn_{2.5}$) and 3.75 Kg ha^{-1} ($Zn_{3.75}$). The size of unit plot was $(2.5 \times 2.0)m^2$ and block to block and plot to plot distances were both 0.50 m. Row to row and plant to plant distances were also 30 and 10 cm, respectively, in each plot. The land was fertilized with different levels of Zn as per treatment and urea (20 kg ha^{-1}); TSP (150 kg ha^{-1}) and MOP (50 kg ha^{-1}) were also used as recommended dose of BARI (2006). Harvesting of the crop was done after 65 days of sowing when about

80% of the pods attained maturity, yield attributes data were recorded at harvest. Total N was determined by using Microkjeldal method. The protein content was determined by multiplying the nitrogen content of seed by 6.25. The data were statistically analyzed with MSTAT–C computer program and the mean values were adjusted by Duncan's Multiple Range Test (DMRT) at 5% level of probability (Russel, 1986; Gomez and Gomez, 1984).

Results and discussions

Plant height (cm)

Plant height is the key yield contributing character and proportionately related to the production of straw yield. Analysis of variance showed significant variation ($P<0.01$) on plant height at different growth stages where 2.5 kg Zn ha^{-1} recorded the tallest plant (52.28 cm) at harvest which was statistically different from others Zn levels. At these stages, the shortest plant (45.33 cm) was noticed from the control treatment (Fig. 1).

Results indicated that the 2.5 kg Zn ha^{-1} showed maximum plant height which might be the positive effect of Zn fertilizer as it increased the availability soil nutrients and moisture which helps better plant growth over other treatments. Similar result with the present study was also reported by Quddus *et al.* (2011) where 1.5 kg Zn ha^{-1} was best in their study. The findings of Ashok *et al.* (2010); Sharma *et al.* (2010) also supported present findings.

Table 1. Effect of Zn fertilizers on various yield characters and percent protein content of blackgram.

Different levels of Zn (kg ha^{-1})	Grain yield (t ha^{-1})	Straw yield (t ha^{-1})	Biological yield (t ha^{-1})	Harvest index (%)	Protein (%)
Zn_0	1.47 c	3.62 c	5.09 c	28.86 b	21.63 d
$Zn_{1.25}$	1.52 b	3.67 b	5.19 b	29.26 a	23.00 b
$Zn_{2.5}$	1.55 a	3.69 a	5.24 a	29.74 a	23.44 a
$Zn_{3.75}$	1.52 b	3.67 b	5.18 b	29.25 a	22.20 c
CV (%)	3.57	5.29	4.19	1.21	2.65

Figures followed by same letter(s) are statistically similar as per DMRT at 5%.

Number of branches plant^{-1}

Zinc fertilizer significantly influenced the number of branches per plant; the highest number of branches per plant (5.71) was recorded with 2.5 kg Zn ha^{-1} at harvest over control and other treatment also (Fig. 2). Almost similar results were obtained by Islam (2014) on the number of branches of three chickpea cultivars. He stated that application of 2.0 kg Zn ha^{-1} perform best over other treatment combination.

Number of pods plant^{-1}

The number of pods per plant is the most potential yield component of pulses and is directly related to yield. A significant data variation was also found on number of pods per plant due to the effect of Zn fertilizer. Application of 2.5 kg Zn ha^{-1} produced the highest number of pods per plant (48.99) and the lowest number (42.49) was observed in control (Fig. 3). Similar experiment was also conducted by Dashadi *et al.* (2013), he reported that soil application of Zn fertilizer had a significant influenced on number of pods per plant. Khorgamy and Farnia (2009) also found significant variation on pod number of chickpea cultivars with Zn.

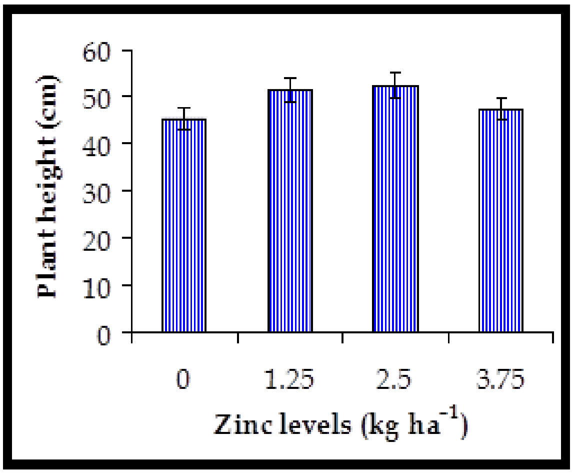

Fig. 1. Effect of Zinc on plant height at harvest. Vertical bar represent SE values.

Number of seeds pod⁻¹

The highest number of seeds per pod (6.98) was obtained by the application of 2.5 kg ha^{-1} of Zn. In control, 1.5 and 3.75 kg ha^{-1} of Zn produced a considerable amount of seeds per pod and this was statistically different from each other (Fig. 4). This result is similar with Salehin and Rahman (2012); they showed that foliar application of Zn (0 and 1 g L^{-1}) was significant on seeds per pod of *Phaseolus vulgaris* at maturity. Quddus *et al.* (2012) also found significant observation on seeds yield of mungbean where it was highest with $N_{21}P_{23}K_{30}S_{18}Zn_2B_{1.5}$.

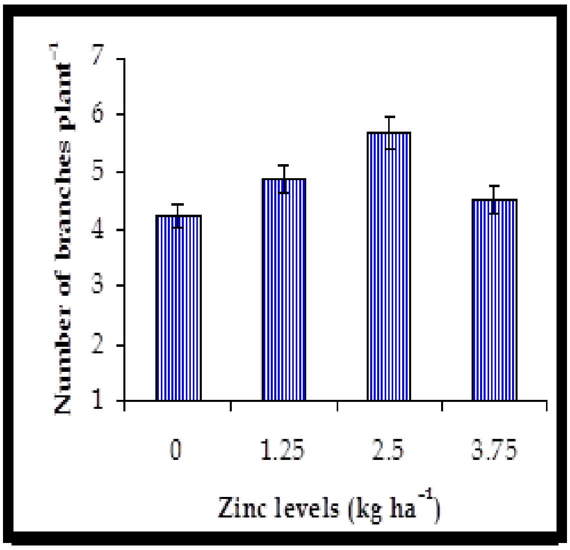

Fig. 2. Effect of Zinc on branches plant^{-1} at harvest. Vertical bar represent SE values.

Pod length (cm)

Zinc had a significant influenced on the pod length of blackgram. Application of Zn 2.5 kg ha^{-1} gave the longest pod (5.06 cm) and the shortest pod (4.70 cm) was obtained from without Zn treated plant (Fig. 5). Habib *et al* (2018), reported that blackgram perform best at early stages with the application Zn of 2.5 kg ha^{-1}.

Thousand seed weight (g)

Application of 2.5 kg Zn ha^{-1} recorded the heaviest weight of 1000–seed (41.60 g) followed by 1.5 kg Zn ha^{-1} (41.46 g). Similarly, control treatment recorded the lowest weight of 1000–seed (40.54 g) which was statistically differed from other treatments (Fig.6).

Application of Zn 2.5 kg ha^{-1} was more efficient in soil that might play a crucial role in nutrients supply to plant and partitioning of DM from source to sink. Dashadi *et al.* (2013) obtained a positive response of lentil 1000-seed weight by the application of Zn. While Salehin and Rahman (2012); Quddus *et al.* (2011) also found similar observation with above and these findings.

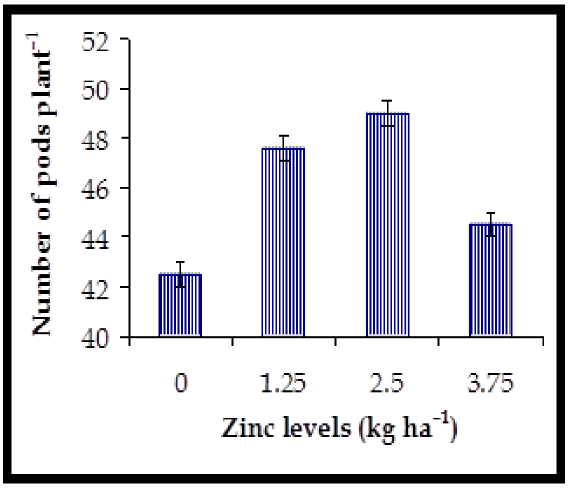

Fig. 3. Effect of Zinc on number of pods plant^{-1} at harvest. Vertical bar represent SE values.

Grain yield (t ha⁻¹)

A significant variation was found on grain yield of blackgram with different levels of Zn fertilizer. Grain yield (1.54 t ha^{-1}) was the highest with 2.5 kg Zn ha^{-1}. Similarly, control treatment gave the comparatively lower grain yield (1.470 t ha^{-1}) which was also statistically different from other treatments (Table 1).

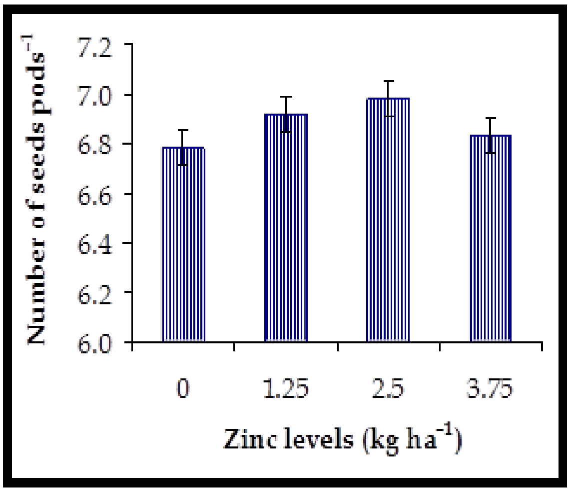

Fig. 4. Effect of Zinc on number of seeds pod^{-1} at harvest. Vertical bar represent SE values.

However, application of Zn 1.25 and 3.75 kg ha^{-1} produced statistically identical seed yield (1.51 t ha^{-1}). Results revealed that grain yield of blackgram in association with Zn were more significant than control. This result agreed with the findings of Dashadi *et al.* (2013). Ali and Mahmoud (2013) also found that the highest values of seed weight plant^{-1} were obtained when foliar application of Zn was used at rate of 500 ppm. Similarly, Quddus *et al.* (2011) also found that the treatment $T_2= N_{21}P_{23}K_{30}S_{18}Zn_2B_{1.5}$ produced significantly the highest average seed yield (1.52 t ha^{-1}).

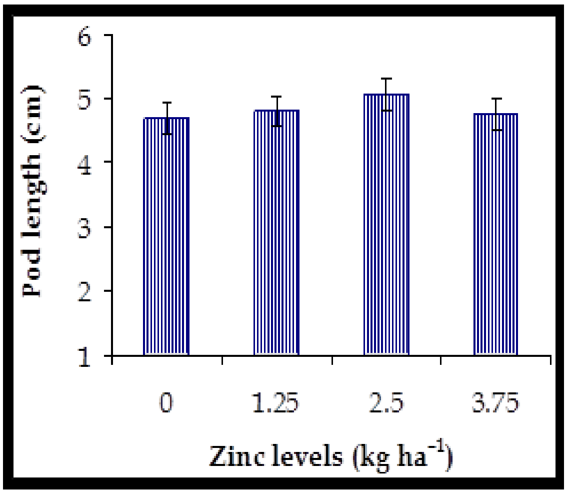

Fig. 5. Effect of Zinc on pod length at harvest. Vertical bar represent SE values.

Straw yield (t ha^{-1})

Straw yield affected significantly due to the effect of different doses of Zn fertilizer. Among the Zn fertilizer doses, the highest straw yield (3.69 t ha^{-1}) obtained from the application of 2.5 kg ha^{-1} of zinc. Control gave the lowest (3.62 t ha^{-1}). However, rest of the two treatments produced statistically identical (3.69 t ha^{-1}) straw yield (Table 1).

Biological yield (t ha^{-1})

Zinc fertilizer had a significant effect on biological yield (Table 1). Where the highest biological yield (5.24 t ha^{-1}) was recorded from the application of Zn 2.5 kg ha^{-1} while without Zn treated plant recorded the lowest biological yield (5.09 t ha^{-1}). However, the other two levels of Zn produced the statistically similar biological yield (5.19, 5.18 t ha^{-1}, respectively). Dishadi *et al.* (2013) found that basal application Zinc as $ZnSO_4$ had a significant effect on biological yield.

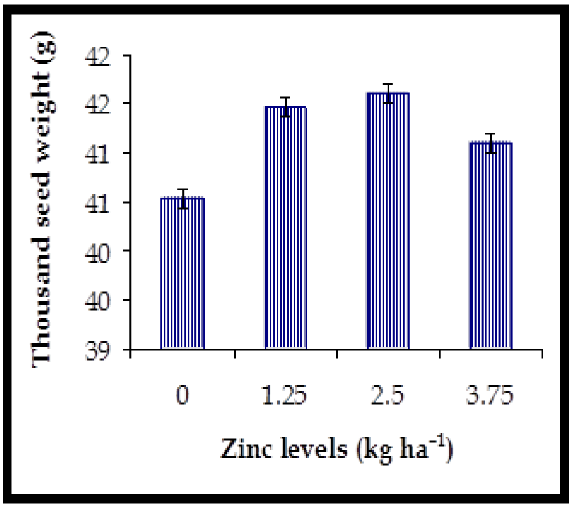

Fig. 6. Effect of Zinc on thousand grain weight at harvest. Vertical bar represent SE values.

Harvest index (%)

The maximum HI (29.47%) was obtained from the application of 2.5 kg Zn ha^{-1} which was statistically identical with the application of 1.25 and 3.75 kg Zn ha^{-1} (29.26% and 29.25%, respectively). Control treatment gave the lowest HI (28.86%). The result suggested that all the treatments (levels) of Zn were efficient to produced significantly higher seed yield of blackgram over control (Table 1). This might be due to the contribution of Zn to produce higher number of branch per plant, pods per plant, seeds per pod and thousand seed weight. The results were in agreement with the findings of Salam (2014). He reported that the application of 1.5, 2.0 and 2.5 kg ha^{-1} of Zn fertilizer gave significantly higher seed yield of chickpea over control and 3.0 kg ha^{-1} of Zn, respectively.

Percent protein content

Zinc fertilizer significantly increased percent protein content of harvested blackgram seeds. Lowest protein content 21.63% was recorded in without Zn treated plant and maximum 23.44% was recorded at 2.5 kg Zn ha^{-1} and then started to decrease (table 1).

This result is supported with Shukla (2013) concluded that, gradually rise up of Zn fertilizer rates to a certain limit also promotes the percent protein content of blackgram seeds. This observation is also supported with Calhor (2006) findings.

The highest amount of N (3.75) as well as protein rich seeds was obtained from the application of 2.5 kg Zn ha^{-1}. This might be the consequence of Zn fertilizer as it promotes the synthesis of IAA, nodulation and nitrogen fixation process in plant and soil , respectively (Ahlawat *et al.*, 2007).

Conclusion

From the study, it revealed that the application of 2.5 kg ha^{-1} of $ZnSo_4$ as zinc fertilizer could be the best dose for achieving highest and good quality seed yield of blackgram.

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