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Effect of zinc and boron on growth parameters of blackgram (V*igna mungo* L.)

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ABSTRACT

Blackgram (Vinga mungo L.) is one of the most valued pulses due to its culinary values. It has been able to draw a special attention from the scientist and growers for the intensified and inorganic cropping system of Bangladesh. Use of proper micronutrients in appropriate amount is the key factor of pulse productivity. Therefore, a field experiment was conducted at Sher-e- Bangla Agriculture University, Sher-e- Bangla nagor, Dhaka-1207, Bangladesh from September 2012 to December 2012 to evaluate the performance of blackgram (BARI Mash- 3) influenced by the various levels of Zinc (Zn) and Boron (B) fertilizers. Four levels of Zn (0, 1.25, 2.5 and 3.75 kg ha^{-1}) and five levels of B (0, 0.5, 1.0, 1.5 and 2.0 kg ha^{-1}) were studied in a randomized complete block design with three replications. The results revealed that the single application of Zn=2.50 kg ha^{-1}, B=1.50 kg ha^{-1} and their combination ($Zn_{2.5}$ × $B_{1.5}$ kg ha^{-1}) showed more significant increase in growth characteristics viz. Leaf area index, total dry matter, crop growth rate and relative growth rate of blackgram in this study. The application of these two fertilizers as singly or their interaction would be the most appropriate level for getting the superior growth and yield performance of Blackgram.

Key Words: *Leaf area index, Total dry matter, Crop growth rate, Relative growth rate, $ZnSO_4$ and Boric Acid*

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I. Introduction

Blackgram (*Vigna mungo* L.) ranks fourth among the pulses for both in terms of cultivation area coverage about 70,000 ha and production of 12.55% in total pulse production (BBS, 2012). Blackgram is one of the highly prized pulses in Bangladesh. It improves the soil fertility status by fixing a tremendous amount (63-342 kg ha^{-1}per season) of atmospheric nitrogen in soil by (Kaisher *et al.,* 2010). Its foliage and stems are also used as good source of fodder as well as green manuring and cover crops. Nutrient deficiency in soil is the key factor for the low productivity of pulse crop in Bangladesh. Intensive

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cultivation and repeatedly use of common (NPK) fertilizers in same land based on farmers blind assumption have forced the extent and magnitude of micronutrient nutrient deficiency in soils of Bangladesh (Anonymous, 2009). Micronutrients needs in lower amount but its presence at proper ratio contributes efficient use of primary and secondary nutrients, plant itself and in biological nitrogen fixation process in soil, maximizing the yield through their effects on crop growth parameters and yield contributing characters. Among the micronutrient deficiency, Zinc (Zn) and Boron (B) deficiency is wide spread in the country and much common in wet rice cultivation soil, light texture and calcareous soils (Islam *et al.,* 1997). Alpaslan and Gunes (2001) reported that, optimum level of Zn and B are essential from the very beginning of the plant life as these two elements help to maintain cell wall plasticity and elongation, plasma membrane integrity and related to other physiological and metabolic activities otherwise hampered and that leads to lower leaf area index, dry matter accumulation and finally yield. Zn fertilizer is being considered as yield-limiting micronutrients for pulse crop production in dry region, soil with high p^H, soil with low organic matter and the soils which are not treated with Zn and B for long time (Kumar and Dhiman, 2004). Therefore, its use and importance are increased in recent years (Fageria, 2006). Zn increased assimilates production, carbohydrate and nitrogen metabolism and photosynthesis efficiency at grain filling stage (Jacson and Miller 2003; Calhor, 2006). Plants emerged from low Zn content seed response by decrease in membrane integrity, susceptible to biotic, abiotic stress, and decrease in synthesis of carbohydrates, cytochromes, nucleotides, auxin chlorophyll and delay crop maturity. Khan *et al.* (2004) reported that the deficiency of Zinc in crop field significantly reduce the water use efficiency of the cultivated crop while Ahlawat *et al.* (2007) reported that the nodulation and nitrogen fixation also reduce by the same reason, which may cause poorer vegetative performance and subsequently leads to lower reproductive performance also. Deficient or excess application of B causes impairments in several metabolic and physiological processes in plants (Camacho–Cristobal *et al.,* 2008) including cell wall formation, (O'Neill *et al.,* 2004), cellular membrane functions (Goldbach *et al.,* 2001), and anti-oxidative defense systems (Cakmak and Romheld, 1997), pod and seed formation (O'Neill *et al*., 2004). Boron influences the absorption of N, P, K from soil and translocation of water and carbohydrates in plant body (Quddus *et al.,* 2011). Boron deficiency at reproductive stages especially in flowering and pod formation are more harmful than early stages (Dear and Lipsett, 1987). Valenciano *et al.* (2010) reported that combined application of Zn and B could be more effective for pulse cultivation. So, therefore, attention has been given in this research work to promote the blackgram growth parameters through the optimum doses of Zn and B fertilizers.

II. Materials and Methods

The research work was conducted in the research field of the Department of Agronomy, at Sher–e–Bangla Agricultural University; Dhaka during the period kharif–II from September 2012 to December 2012. The experimental site is located at 23.41˚ N and 90.22˚ E latitude and at an altitude of 8.6 m from the sea level. The area is situated in the sub-tropical climatic zone and characterized by heavy rainfall from April to August and scanty rainfall during the rest period of the year. Low temperature observed in October to March and plenty of sunshine from November to February. Soil type was shallow red brown terrace. Prior to setting the experiment and after harvest soil samples were collected from the experimental site and analyzed their physical and chemical properties using atomic absorption and spectrophotometric methods for Zn and B, respectively. The test variety was BARI Mash- 3. The experiment was laid out at Randomized Complete-Block Design (RCBD) with three replications of 20 treatment combinations comprising four levels of Zinc 0, 1.25, 2.5, 3.75 kg $ha^{-1}$and five levels of Boron 0, 0.5, 1.0, 1.5. 2.0 kg ha^{-1}along with recommended fertilizer N_{20} P_{25} K_{35}kg ha^{-1}as per soil test based (BARC, 2005). Zinc and Boron levels were assign to main and sub-plot, respectively. The size of unit plot was 2.5 m × 2.0 m where, block to block and plot to plot distance was 0.50 m and 0.50 m, respectively. Row to row and plant to plant distances were also 0.30 m and 0.10 m, respectively, in each plot. The treatment combinations were as follows: T_1=Zn_0B_0, T_2=$Zn_0B_{0.5}$, T3=$Zn_0B_{1.0}$, T_4=$Zn_0B_{1.5}$, T_5=$Zn_0B_{2.0}$, T_6=$Zn_{1.25}B_0$, T_7=$Zn_{1.25}B_{0.5}$, T_8=$Zn_{1.25}B_{1.0}$, T_9=$Zn_{1.25}B_{1.5}$, T_{10}=$Zn_{1.25}B_{2.0}$, T_{11}=$Zn_{2.5}B_0$, T_{12}=$Zn_{2.5}B_0$.5, T13=$Zn_{2.5}B_{1.0}$, T_{14}=$Zn_{2.5}B_{1.5}$, T_{15}=$Zn_{2.5}B_{2.0}$, T_{16}=$Zn_{3.75}B_0$, T_{17}=$Zn_{3.75}B_{0.5}$, T_{18}=$Zn_{3.75}B_{1.0}$, T_{19}=$Zn_{3.75}B_{1.5}$, T_{20}=$Zn_{3.75}B_{2.0}$. NPK fertilizers were applied during final land preparation. Zinc and Boron were applied as zinc sulphet and boric acid, respectively as per treatment during final land preparation. Intercultural operations such as thinning, weeding, gap filling and plant protection measures were done as needed. Five Plants sample were randomly collected from the middle portion ($1m^2$) of each plot beginning from 20 days after sowing (DAS) at 15 days interval up to harvest. The leaf area of each sample was measured by LICOR automatic leaf area meter (LICOR– 2000, UK) before drying and then converted into LAI. The total dry matter production was determined at oven at 70° C for 72 hours (Asaduzzaman et al., 2010). On the basis of leaf area index and dry mater accumulation rate, the growth parameters i.e. Crop Growth Rate {CGR = 1/ GA× W_2- W_1/ T_2-T_1 g $m^{-2}day^{-1}$ Where, W_1= Total dry matter production at previous sampling date, W_2= Total dry matter production at current sampling date, T_1= Date of previous sampling ,T_2= Date of current sampling, GA= Ground area (m^2)}, Relative Growth Rate (RGR= Log_e W_2- Log_e W_1/ T_2-T_1 g $g^{-1}day^{-1}$) were calculated according to the equation of Gardner *et al.* (1985). Statistical analysis was done by MSTAT–C computer program with Randomized Complete Block Design (Russel, 1986).

III. Results and Discussion

Effect of Zn and B fertilizers on leaf area index (LAI) and total dry matter (TDM)

LAI and TDM of blackgram were directly influenced by the single and combined application of Zn and B fertilizers and significant data variation shown in Table 01 to Table 03.The maximum LAI and TDM were recorded with Zn=2.5 kg ha^{-1}which was statistically different from other Zn treatments but LAI with Zn=1.25 kg $ha^{-1}$was statistically close with Zn=2.5 kg ha^{-1}at different DAS (Table 01). Similarly, data revealed that application of B=1.5 kg ha^{-1}had the maximum LAI and TDM over other treatments while B @0.5 kg $ha^{-1}$and 1.5 kg ha^{-1} did not differed with each other in crop life cycle. Control treatment ($T_{1=}B_0$) always showed the lowest performance (Table 02). Among the interactions, the most effective interaction level was $Zn_{2.5}$×$B_{1.5}$ (T_{14}) for LAI and TDM while LAI was statically close to T_9=$Zn_{1.25}$×$B_{1.5}$. In contrast, the lowest LAI and TDM were found from interaction of T_1=Zn_0×B_0 treatment (Table 03). LAI and TDM were slowly increased with age till 35 DAS followed by a rapid increase at flowering (started after 35 DAS). However, LAI starts to decrease after 50 DAS due to abscission of older leaves and associated with re-translocation of metabolites from leaves to developing pods (Prased *et al.,* 1978) where TDM was continuously increased with age till harvest. LAI was significantly changed from one growth stage to another growth stages in this study. Similar trends were also observed by Islam *et al.* (2010) in blackgram, Ferdous (2001) in pea, Hossain (1999) in groundnut.

Table 01. Effect of Zn fertilizer on leaf area index (LAI) and total dry weight (TDW) of blackgram at different days after sowing

Zn Fertilizer (kg ha^{-1})	LAI at different days after Sowing				TDW (g $plant^{-1}$) at different days after sowing				
	20	35	50	65	5	20	35	50	65
0	0.70 c	1.17 c	1.73 c	1.44 c	0.025 d	0.276 d	0.748 d	2.247 d	3.491 d
1.25	0.73 ab	1.20 ab	1.76 ab	1.46 ab	0.031 b	0.378 b	0.874 b	2.415 b	3.695 b
2.5	0.76 a	1.22 a	1.78 a	1.49 a	0.034 a	0.431 a	0.938 a	2.499 a	3.795 a
3.75	0.72 bc	1.19 bc	1.74 bc	1.45 bc	0.027 c	0.345 c	0.818 c	2.358 c	3.63 c
CV (%)	*5.66*	*3.35*	*4.26*	*3.33*	*4.40*	*2.31*	*5.31*	*3.76*	*2.29*

Values within a column having same letter (s) do not differ significantly (p= 0.05)

Table 02. Effect of B fertilizer on leaf area index (LAI) and total dry weight (TDW) of blackgram at different days after sowing

B Fertilizer (kg ha^{-1})	LAI at different days after Sowing				TDW (g $plant^{-1}$) at different days after sowing				
	20	35	50	65	5	20	35	50	65
0	0.67 c	1.14 c	1.65 c	1.39 c	0.015 e	0.199 e	0.650 e	2.006 e	3.291 e
0.5	0.72 b	1.20 b	1.76 b	1.47 b	0.032c	0.376 c	0.852 c	2.266 c	3.696 c
1.0	0.74 b	1.21 b	1.78 b	1.48 b	0.034 b	0.413 b	0.920 b	2.331 b	3.773 b
1.5	0.78 a	1.25 a	1.82 a	1.52 a	0.035 a	0.441 a	0.968 a	2.424 a	3.860 a
2.0	0.71 b	1.20 b	1.75 b	1.46 b	0.031 d	0.359 d	0.833 d	2.206 d	3.643d
CV (%)	*5.66*	*3.35*	*4.26*	*3.33*	*4.40*	*2.31*	*5.31*	*3.76*	*2.29*

Values within a column having same letter (s) do not differ significantly (p= 0.05)

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Table 03. Effect of interaction of Zn and B fertilizers on leaf area index (LAI)and total dry weight (TDW) of blackgram at different days after sowing

Fertilizers	LAI at different days after Sowing				TDW (g plant^{-1}) at different days after sowing				
(kg ha^{-1})	20	35	50	65	5	20	35	50	65
T_1=Zn_0B_0	0.65 h	1.11 h	1.63 g	1.36 i	0.011 p	0.130 n	0.574 n	2.00 m	3.13o
T_2=$Zn_0B_{0.5}$	0.70 d–h	1.17 d–g	1.74 d-f	1.44 d–g	0.027 k	0.288 j	0.736 j	2.26i	3.53 j
T_3=$Zn_0B_{1.0}$	0.72 b–g	1.19 b–f	1.76 b–e	1.46 b–f	0.028 j	0.330 i	0.825 h	2.33h	3.59 i
T_4=$Zn_0B_{1.5}$	0.76 a–d	1.23 a–d	1.79 a–d	1.50 a–d	0.032 i	0.358 gh	0.877 fg	2.42 f	3.67g
T_5=$Zn_0B_{2.0}$	0.69 e–h	1.16 e–h	1.73 ef	1.43 e–h	0.026 l	0.272 k	0.723 jk	2.20j	3.51 k
T_6=$Zn_{1.25}B_0$	0.68 f–h	1.15 f–h	1.66 g	1.39 g–i	0.016 n	0.211 l	0.672 l	2.13k	3.35m
T_7=$Zn_{1.25}B_{0.5}$	0.73 b–f	1.20 b–f	1.77 b–e	1.47 b–f	0.033 f	0.399 e	0.888 f	2.43ef	3.74f
T_8=$Zn_{1.25}B_{1.0}$	0.74 b–f	1.22 b–e	1.78 b–e	1.49 b–e	0.036 d	0.434 d	0.947 de	2.52c	3.80e
T_9=$Zn_{1.25}B_{1.5}$	0.78 ab	1.25 ab	1.82 ab	1.52 ab	0.037 c	0.464 c	0.994 c	2.59 b	3.89c
T_{10}=$Zn_{1.25}B_{2.0}$	0.72 b–g	1.19 b–f	1.76 b–e	1.47 b–f	0.032 g	0.381 f	0.865 g	2.38 g	3.67g
T_{11}=$Zn_{2.5}B_0$	0.70 d–h	1.17 e–h	1.68 fg	1.42 f–i	0.018 m	0.262 k	0.715 k	2.18 j	3.41l
T_{12}=$Zn_{2.5}B_{0.5}$	0.75 a–e	1.22 a–e	1.79 a–e	1.49 a–e	0.036 d	0.453 c	0.955 d	2.51 c	3.83d
T_{13}=$Zn_{2.5}B_{1.0}$	0.77 a–c	1.24 a–c	1.80 a–c	1.51 a–c	0.038 b	0.487 b	1.018 b	25.91b	3.93b
T_{14}=$Zn_{2.5}B_{1.5}$	0.81 a	1.28 a	1.84 a	1.55 a	0.039 a	0.517 a	1.065 a	2.72a	4.03a
T_{15}=$Zn_{2.5}B_{2.0}$	0.74 b–f	1.21 b–e	1.78 b–e	1.48 b–e	0.035 e	0.434 d	0.936 de	2.47 d	3.75f
T_{16}=$Zn_{3.75}B_0$	0.67 gh	1.13 gh	1.64 g	1.38 hi	0.012 o	0.191 m	0.636 m	2.09 l	3.26n
T_{17}=$Zn_{3.75}B_{0.5}$	0.72 c–g	1.19 c–f	1.76 c–e	1.46 c–f	0.028 j	0.365 g	0.825 h	2.37 g	3.67g
T_{18}=$Zn_{3.75}B_{1.0}$	0.73 b–f	1.20 b–f	1.77 b–e	1.47 b–f	0.031 i	0.399 e	0.888 f	2.45 de	3.75 f
T_{19}=$Zn_{3.75}B_{1.5}$	0.76 a–c	1.24 a–c	1.80 a–c	1.51 a–c	0.032 h	0.423 d	0.934 e	2.53 c	3.83d
T_{20}=$Zn_{3.75}B_{2.0}$	0.72 c–h	1.18 c–g	1.75 c–e	1.45 c–g	0.027 k	0.346 h	0.806 i	2.32 h	3.62h
CV(%)	*5.66*	*3.35*	*4.26*	*3.33*	*4.40*	*2.31*	*5.31*	*3.76*	*2.29*

Values within a column having same letter (s) do not differ significantly (p= 0.05)

Effect of Zn and B fertilizers on crop growth rate (CGR)

Figure 01 and Figure 02 showed the crop growth rate relationship with Zn and B fertilizers. Crop reached the maximum CGR at 35-50 DAS for the single effect of Zn (Figure 01) and B fertilizers (Figure 02). Data revealed that the higher CGR (0.08, 0.10, 0.31 and 0.26 g m^{-2} day^{-1}) was found with 2.5 kg ha^{-1} of Zn while without Zn treated plant recorded the lowest CGR (0.05, 0.09, 0.29 and 0.25 g m^{-2} day^{-1}) at 5–20, 20–35, 35–50 and 50–65 DAS, respectively while Zn_0 was statistically close to Zn=1.25 kg ha^{-1} at 5–20 DAS and 50–65 DAS, and Zn=3.75 kg ha^{-1} at 5–20 DAS, and 50–65 DAS. After attaining maximum CGR at 35-50 DAS, it started to decrease sharply (Figure 01). This trend of blackgram CGR is consisted with the findings of Biswas *et al.* (2002). In another observation, the higher CGR at the stage between 5–20, 2–35 and 35–50 DAS (0.08, 0.11 and 0.32 g m^{-2} day^{-1}) were recorded in B=1.5 kg ha^{-1} which was statistically identical with B=0.5, 1.0 and 2.0 kg ha^{-1} (0.07, 0.08 and 0.07 g m^{-2} day^{-1}, respectively) at 5–20 DAS and statistically close to B=1.0 kg ha^{-1} (0.10 g m^{-2} day^{-1}) at 20–35 DAS (Figure 02). Among the interactions, T_{14}=Zn $_{2.5}$ × B $_{1.5}$ kg ha^{-1} recorded the higher CGR (0.09, 0.11 and 0.33 g m^{-2} day^{-1}) at 5–20, 20–35 and 35–50 DAS, respectively while it was statistically close with the all interaction except T_1=Zn_0×B_0 at 5–20 DAS, T_1=Zn_0×B_0 and T_{16}=$Zn_{3.75}$×B_0 at 20–35 DAS, and T_9=$Zn_{1.25}$×$B_{1.5}$, T_{19}=$Zn_{3.75}$×$B_{1.5}$, T_8=$Zn_{1.25}$×$B_{1.0}$, T_{13}=$Zn_{2.5}$×$B_{1.0}$ at 35–50 DAS whereas T_9=$Zn_{1.25}$×$B_{1.5}$, and T_{19}=$Zn_{3.75}$×$B_{1.5}$, and T_8=$Zn_{1.25}$×$B_{1.0}$ and T_{13}=$Zn_{2.5}$×$B_{1.0}$ were statistically identical. On the other hand, the lowest CGR (0.02, 0.09, 0.29 and 0.23 g m^{-2} day^{-1}) was recorded in interaction of T_1=Zn_0×B_0 at 5–20, 20–35, 35–50 and 50–65 DAS, respectively (Table 04).

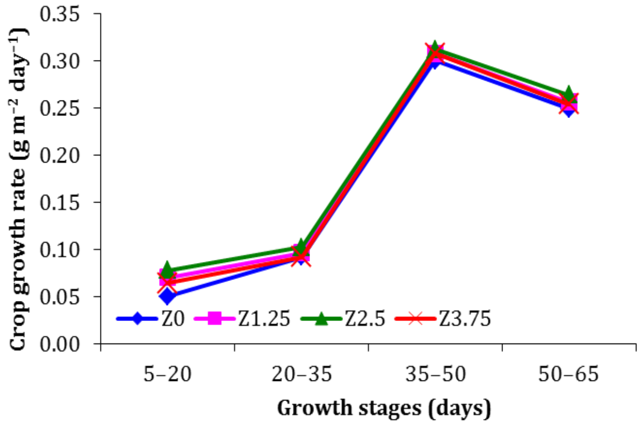

Figure 01. Effect of Zn fertilizer on CGR of blackgram at different days after sowing vertical bar represents SE value.

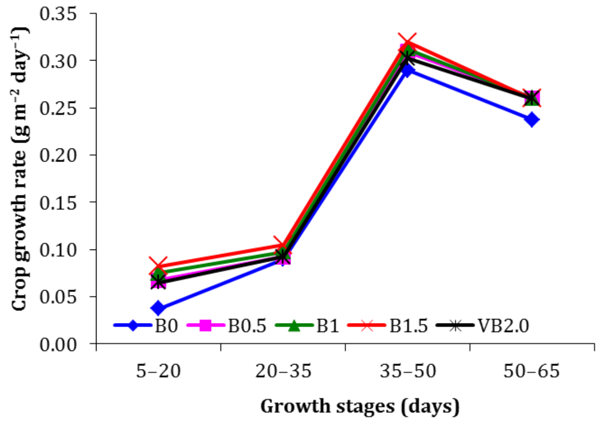

Figure 02. Effect of B fertilizer on CGR of blackgram at different days after sowing vertical bar represents SE value.

Table 04. Effect of interaction of Zn and B fertilizers on crop growth rate (CGR) and relative growth rate (RGR) of blackgram at different growth stages

Fertilizers (kg ha^{-1})	CGR (g m^{-2} day^{-1}) at different growt stages				RGR (g g^{-1} day^{-1}) at different growth stages			
	5–20	20–35	35–50	50–65	5–20	20–35	35–50	50–65
T_1=Zn_0B_0	0.02 b	0.09 b	0.29 f	0.23e	0.35 m	1.29 g	4.16 m	3.28 i
T_2=$Zn_0B_{0.5}$	0.05 ab	0.09 ab	0.31 b–e	0.253 a–c	0.76 k	1.30 g	4.44 g–i	3.68 e
T_3=$Zn_0B_{1.0}$	0.06 ab	0.09 ab	0.30 b–f	0.253 a–c	0.88 j	1.44 ef	4.38 j	3.69 e
T_4=$Zn_0B_{1.5}$	0.07 ab	0.10 ab	0.31 b–e	0.25 a–d	0.95 i	1.51 b–d	4.49 fg	3.63 f
T_5=$Zn_0B_{2.0}$	0.05 ab	0.09 ab	0.29 c–f	0.26 a–c	0.72 k	1.31 g	4.31 k	3.80 bc
T_6=$Zn_{1.25}B_0$	0.04 ab	0.09 ab	0.29 d–f	0.24 cd	0.57 l	1.34 g	4.25 l	3.54 g
T_7=$Zn_{1.25}B_{0.5}$	0.07 ab	0.09 ab	0.31 b–d	0.26 a–c	1.06 fg	1.41 f	4.52 ef	3.79 c
T_8=$Zn_{1.25}B_{1.0}$	0.08 ab	0.10 ab	0.32 a–c	0.26 a–c	1.16 de	1.49 b–e	4.58 d	3.72 de
T_9=$Zn_{1.25}B_{1.5}$	0.09 ab	0.11 ab	0.32 ab	0.26 a–c	1.24 c	1.54 a–c	4.64 bc	3.80 bc
T_{10}=$Zn_{1.25}B_{2.0}$	0.07 ab	0.09 ab	0.30 b–f	0.26 a–c	1.01 gh	1.41 f	4.42 ij	3.75 cd
T_{11}=$Zn_{2.5}B_0$	0.05 ab	0.09 ab	0.29 d–f	0.25 b–d	0.71 k	1.31 g	4.26 l	3.59 fg
T_{12}=$Zn_{2.5}B_{0.5}$	0.08 ab	0.10 ab	0.31 b–d	0.27 ab	1.21 cd	1.46 d–f	4.52 ef	3.85 ab
T_{13}=$Zn_{2.5}B_{1.0}$	0.09 a	0.11 ab	0.32 a–c	0.27 a	1.30 b	1.54 ab	4.59 cd	3.88 a
T_{14}=$Zn_{2.5}B_{1.5}$	0.09 a	0.11 a	0.33 a	0.27 a–c	1.39 a	1.59 a	4.84 a	3.80 bc
T_{15}=$Zn_{2.5}B_{2.0}$	0.08 ab	0.10 ab	0.31 b–e	0.26 a–c	1.16de	1.46d–f	4.47 f–h	3.72 de
T_{16}=$Zn_{3.75}B_0$	0.04 ab	0.09 b	0.29 ef	0.23 de	0.52 l	1.29 g	4.23 l	3.40 h
T_{17}=$Zn_{3.75}B_{0.5}$	0.07 ab	0.09 ab	0.31 b–e	0.26 a–c	0.98 hi	1.34 g	4.51 f	3.77 cd
T_{18}=$Zn_{3.75}B_{1.0}$	0.07 ab	0.09 ab	0.31 bc	0.26 a–c	1.07 f	1.42 f	4.57 de	3.77 cd
T_{19}=$Zn_{3.75}B_{1.5}$	0.08 ab	0.10 ab	0.32 ab	0.26 a–c	1.14 e	1.49 c–e	4.65 b	3.77 cd
T_{20}=$Zn_{3.75}B_{2.0}$	0.06 ab	0.09 ab	0.31 b–f	0.26 a–c	0.93 ij	1.34 g	4.43 h–j	3.77 cd
CV (%)	*3.66*	*2.38*	*3.73*	*4.46*	*2.63*	*4.40*	*4.76*	*3.45*

Values within a column having same letter (s) do not differ significantly (p= 0.05)

Effect of Zn and B fertilizer on relative growth rate (RGR)

Main effect of Zn and B were significantly influenced on RGR of blackgram at different growth stages. Significant data variation was also observed in Figures 03 and Figure 04; data revealed that the application of Zn=2.5 kg ha^{-1} was more significant to produce higher RGR during the growth period (Figure 03). Among the B levels, B=1.5 kg ha^{-1} was more efficient to produced higher RGR and lowest RGR was recorded without B treated plants (Figure 04). In case of interaction, the higher RGR of blackgram (1.39, 1.59, 4.84 and 3.88 g g^{-1} day^{-1}) was recorded from the interaction effect of T_{14}=$Zn_{2.5}$×$B_{1.5}$, at 5–20, 20–35, 35–50 and 50–65 DAS, respectively (Table 04). This was statistically differed from other interactions. The lowest RGR (0.35, 1.29, 4.16 and 3.28 g g^{-1} day–^{1}) was recorded in interaction of both control at 5–20, 20–35, 35–50 and 50–65 DAS, respectively which was statistically identical to T_2=Zn_0×$B_{0.5}$, T_5=Zn_0×$B_{2.0}$, T_6=$Zn_{1.25}$×B_0, T_{11}=$Zn_{2.5}$×B_0, T_{16}=$Zn_{3.75}$×B_0 and T_{17}=$Zn_{3.75}$×$B_{0.5}$ at 20–35 DAS. From the above results investigation, RGR was significantly increased at 35–50 DAS and decreased at 50–

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65 DAS. Which might be lower morphological growth and much slower at maturity than other growth stages of blackgram. The trend of balckgram RGR was also similar with Biswas *et al.* (2002) and Rahman *et al.* (1994).

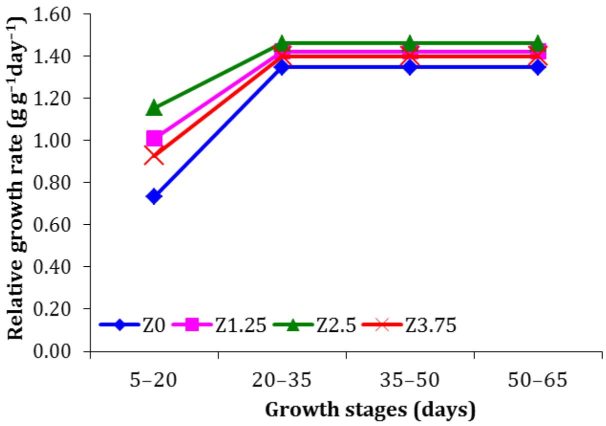

Figure 03. Effect of Zn fertilizer on RGR of blackgram at different days after sowing vertical bar represents SE value.

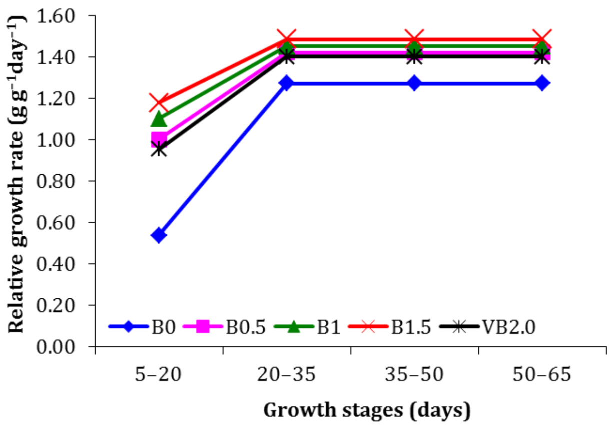

Figure 04. Effect of B fertilizer on RGR of blackgram at different days after sowing vertical bar represents SE value.

IV. Conclusion

Results indicate that the application of Zn and B fertilizers regarding to various morphological characters of blackgram were significantly influenced by Zn=2.5 kg ha^{-1} and B=1.5 kg ha^{-1} singly or their interactions were more effective for obtaining the greater results comparatively than that of other application of Zn and B also over control. So, it could be concluded that the application of Zn=2.5 kg ha^{-1} or B=1.5 kg ha^{-1} or their interaction ($Zn_{2.5} \times B_{1.5}$ kg ha^{-1}) effect would be optimum level for maximizing the growth and yield contributing characters of blackgram.

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