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Different zinc levels on growth, yield and nutrient content of BRRI dhan 33

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ABSTRACT

The experiment was conducted at the farm of Sher-e-Bangla Agricultural University, Dhaka, Bangladesh during the period from June to November 2012 to study the effect of zinc on growth, yield and nutrient content on BRRI dhan-33. The experiment consisted 4 levels of zinc viz. Z_0: 0 kg Zn ha^{-1} (control), Z_1: 2.0 kg Zn ha^{-1}, Z_2: 3.0 kg Zn ha^{-1}, Z_3: 4.0 kg Zn ha^{-1} following randomized complete block design with three replications. Tallest plant (88.3 cm at harvest), maximum number of effective tillers $hill^{-1}$ (13.3), grain yield ha^{-1} (5.1 ton) were found from Z_3 treatment which was statistically similar with Z_2 treatment whereas minimum from the control Z_0. While on the other hand, Zn content in grain was found 0.028% in Z_3 treatment while found 0.018% in Z_0.

Key Words: *BRRI dhan 33, Zinc, Yield and Nutrient content*

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I. Introduction

Rice (*Oryza sativa* L.) is the most important food for the people of Bangladesh and it is the staple food for more than two billion people in Asia (Hien *et al*,. 2006) and it provides 21% and 15% per capita of dietary energy and protein, respectively (Maclean *et al*., 2002). However, the national average rice yield in Bangladesh (4.2 t ha^{-1}) is very low compared to those of other rice growing countries, like China (6.30 t ha^{-1}), Japan (6.60 t ha^{-1}) and Korea (6.30 t ha^{-1}) (FAO, 2009). Zinc is one of the most important micronutrient essential for plant growth especially for rice grown under submerged condition and a major component and activator of several enzymes involved in metabolic activities. Zinc deficiency is prevalent worldwide in temperate and tropical climates (Fageria *et al*., 2003; Slaton *et al*., 2005) also one of the key factors in determining rice production in several parts of the country (Chaudhary *et al*., 2007). Zinc deficiency and response of rice to zinc under flooded condition have been studied by many workers (Kausar *et al*., 2004; Naik and Das, 2007; Mollah *et al*.,2009; Fageria *et* *al*., 2011). Under this circumstance the present research work has been taken with a view to find out the effects of zinc on growth, yield and N, P, K, S and Zn content of BRRI dhan-33.

II. Materials and Methods

The experiment was conducted at the Farm of Sher-e-Bangla Agricultural University, Dhaka, Bangladesh during the period from June to November 2012 to study the effect of zinc on growth, yield and nutrient content of transplanted (T.) aman rice BRRI dhan-33. The experiment consisted four levels of zinc viz. Z_0: 0 kg Zn ha^{-1} (Control), Z_1: 2.0 kg Zn ha^{-1}, Z_2: 3.0 kg Zn ha^{-1}, Z_3: 4.0 kg Zn ha^{-1} followed by Randomized Complete Block Design with three replications, where the experimental area was divided into three blocks representing the replications to reduce soil heterogenetic effects. The unit plot size was 3.0 m × 2.0 m and was separated from each other by 0.5 m ails. The distance maintained between two blocks and two plots were 1.0 m and 0.5 m respectively. Cowdung (5 tha^{-1}), urea (150 $kgha^{-1}$), TSP (150 $kgha^{-1}$), MP (120 $kgha^{-1}$), Gypsum (100 $kgha^{-1}$), Borax (10 $kgha^{-1}$) as recommended by BRRI, 2011 (Adunik Dhaner Chash). Entire amount of the all fertilizers and 1/3 of the urea were applied as a basal dose. Rest amount of the urea were applied in two installment, 1st installment (tillering stage) and 2nd installment (panicle initiation stages). Different doses of zinc (zinc sulphate form) were applied during final land preparation.

Thirty days old seedlings of BRRI dhan-33 were carefully uprooted and transplanted on 03 July, 2012 in well puddled plot. Three seedlings $hill^{-1}$ were used following a spacing of 20 cm × 20 cm. After one week of transplanting all plots were checked for any missing hill, which was filled up with extra seedlings whenever required. Leaf roller (*Chaphalocrosis medinalis*) was observed in the field and used Malathion @ 1.12 L ha^{-1} to control. The crop was harvested at full maturity when 80-90% of the grains were turned into straw colored. The crop was cut at the ground level and plot wise crop was bundled separately and brought to the threshing floor. Data were collected on plant height, effective tillers $hill^{-1}$, non-effective tillers $hill^{-1}$, total tillers $hill^{-1}$, filled grains $panicle^{-1}$, unfilled grains $panicle^{-1}$, total grains $panicle^{-1}$, weight of 1000 seeds, grain yield, straw yield, biological yield, harvest index also content of N, P, K, S, Zn on grain samples. Data were recorded as the average of 10 plants selected at random from the inner rows of each plot. Grains and straw obtained from each unit plot were sun-dried and weighed carefully. The dry weight of grains and straw of central 1 m^2 area and five sample plants were added to the respective unit plot yield to record the final grain yield $plot^{-1}$ and finally converted to ton $hectare^{-1}$ (tha^{-1}). The summation of grain and straw yield were considered as biological yield.

Harvest index was calculated from the grain and straw yield of rice for each plot and expressed in percentage.

Chemical analysis of grain samples

Determination of N: 0.2 g oven dry ground sample were taken in a micro Kjeldahl flask. 1.1 g catalyst mixture (K_2SO_4: $CuSO_4$. $5H_2O$: Se in the ratio of 100: 10: 1), and 5 ml conc. H_2SO_4 were added. The flasks were heating at 120^{0}C and added 2.5 ml 30% H_2O_2 then heated was continued at 180^{0}C until the digests became clear and colorless. After cooling, the content was taken into a 100 ml volumetric flask and the volume was made up to the mark with de-ionized water. A reagent blank was prepared in a similar manner. Nitrogen in the digest was estimated by distilling the digest with 10 N NaOH followed by titration of the distillate trapped in H_3BO_3 with indicator solution and titrated with 0.01N H_2SO_4.

Digestion of grain samples with nitric-perchloric acid for P, K, S and Zn determination:A sub sample weighing 0.5 g was transferred into a dry, clean 100 ml digestion vessel. 10 ml of di-acid (HNO_3: $HClO_4$ in the ratio 2:1) mixture was added to the flask. After leaving for a while, the flasks were heated at a temperature slowly raised to 200^{0}C. Heating were stopped when the dense white fumes of $HClO_4$ occurred. The content of the flask were boiled until they were became clean and colorless. After cooling, the content was taken into a 100 ml volumetric flask and the volume was made up to the mark with de-ionized water. P, K, S and Zn were determined from this digest.

Determination of P: Phosphorus in the digest was determined by using 1 ml for grain sample from 100 ml extract was then determined by developing blue color with reduction of phosphomolybdate complex using ascorbic acid and the color intensity were measured colorimetrically at 660 nm wavelength and readings were calibrated with the standard P curve (Page *et al*., 1982).

Determination of K: Five ml of digest sample for the grain were taken and diluted 50 ml volume to make desired concentration so that the emission of K of sample were measured within the range of standard solutions. The K was determined by flame photometer.

Determination of S: Sulphur content was determined from the digest of the grain samples (with $BaCl_2$ solution as described by Page *et al*. 1982. The digested S was determined by developing turbidity by adding $BaCl_2$ seed solution. The intensity of turbidity was measured by spectrophotometer at 420 nm wavelengths (Hunter, 1984).

Determination of Zinc: Zinc content was determined from the digest of the grain samples (with $BaCl_2$ solution as described by Page *et al*. 1982. The digested Zn was determined by developing turbidity by adding $BaCl_2$ seed solution. The intensity of turbidity was measured by spectrophotometer at 420 nm wavelengths (Hunter, 1984).

Collected data were statistically analyzed using MSTAT-C program. The significance of the differences among the treatment means were estimated by the Duncan's Multiple Range Test (DMRT) at 1% level of probability (Gomez and Gomez, 1984).

III. Results and Discussion

Plant height

Plant height of BRRI dhan-33 varied significantly to different levels of zinc at different DAT (days after transplanting) and harvest. Tallest plant was found from Z_3 (88.3 cm) which was statistically similar with Z_2 (87.9 cm) whereas shortest from Z_0 (80.5 cm) at harvest (Figure 01). Zinc ensured the availability of other macro and micro nutrients that created a favorable condition for the growth of BRRI dhan-33 with optimum vegetative growth and the ultimate results was the tallest plant. Ullah *et al.* (2001)obtained the tallest plants (75.7 cm) with zinc sulfate 20 kg ha^{-1}. Cheema *et al.* (2006) reported that plant height, showed positive correlation with the increase in $ZnSO_4$ levels from 2.5 to 10 kg ha^{-1}.

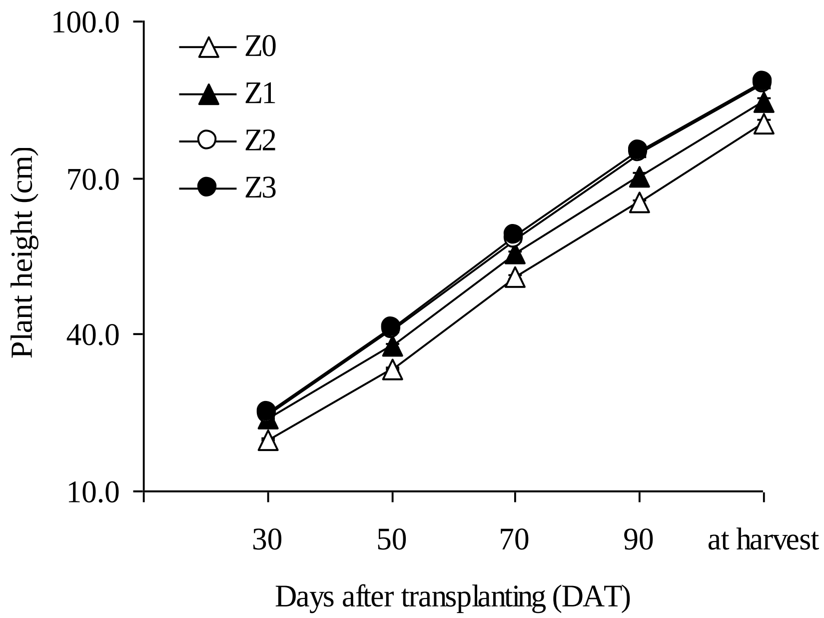

Figure 01. Plant height response of BRRI dhan 33 to different levels of zinc.

Number of effective tillers

Number of effective tillers hill^{-1} showed significant variation to the different levels of zinc in BRRI dhan-33. Maximum number of effective tillers hill^{-1} was found from Z_3 (13.3) which were statistically similar with Z_2 (13.0) while minimum from Z_0 (10.2) (Table 01). Cheema *et al.* (2006) reported that panicle bearing tillers showed positive correlation with the increase in $ZnSO_4$ levels from 2.5 to 10 kg ha^{-1}.

Number of non-effective tillers

Number of non-effective tillers hill^{-1} of BRRI dhan-33 showed significant variation among the different levels of zinc. Minimum number of non-effective tillers hill^{-1} from Z_3 (2.6) whereas maximum from Z_0 (3.3) followed by with Z_1 (3.0) and Z_2 (2.9) (Table 01). Khan *et al.* (2007)reported that Zn significantly influenced non-effective tillers.

Number of total tillers

Variation was observed for number of total tillers hill^{-1} of BRRI dhan-33 at different levels of zinc. Maximum total tillers number hill^{-1} was recorded from Z_3 (15.9) which was statistically similar with Z_2 (15.9) and closely followed by Z_1 (15.1) while minimum from Z_0 (13.4) (Table 01). Ullah *et al.* (2001)obtained the highest number of tillers (10.600 hill^{-1}) with 20 kg zinc sulfate ha^{-1}.

Length of panicle

Length of panicle of BRRI dhan-33 showed statistically significant differences to different levels of zinc (Table 01). Longest panicle was found from Z_3 (22.7 cm) which was statistically similar with Z_2 and closely followed by Z_1 whereas shortest from Z_0 (19.1 cm). Cheema *et al.* (2006) reported that panicle size showed positive correlation with the increase in $ZnSO_4$ levels from 2.5 to 10 kg ha^{-1}.

Weight of 1000-grain

Significant variation was found in 1000-grain weight of BRRI dhan-33 to different levels of zinc. Maximum weight of 1000-grain was found from Z_3 (22.2 g) which was statistically similar with Z_2 (22.1 g) while minimum from Z_0 (19.7 g) (Table 01). Ullah *et al.* (2001) reported that the highest 1000-grain weight (28.700 g), from 20 kg zinc sulfate ha^{-1}.

Number of filled grains panicle^{-1}

Different levels of zinc showed significant variation in number of filled grains panicle^{-1} of BRRI dhan-33. Maximum number of filled grains panicle^{-1} was recorded from Z_3 (84.3) which was statistically similar with Z_2 (83.0) while minimum from Z_0 (72.3) (Table 02). Khan *et al.* (2007) reported that increasing levels of Zn significantly influenced yield components of rice.

Number of unfilled grains

Significant variation was found in number of unfilled grains panicle^{-1} of BRRI dhan-33 due to the application of different levels of zinc. Maximum number of unfilled grains panicle^{-1} was observed from Z_0 (10.6) followed by Z_1 (9.5) whereas minimum from Z_3 (7.9) which was statistically similar with Z_1 (8.1) (Table 02).

Number of total grains

Significant variation was observed for number of total grains panicle^{-1} of BRRI dhan-33 due to the application of different levels of zinc. Maximum number of total grains panicle^{-1} was observed from Z_3 (92.2) which was statistically similar with Z_2 (91.1) while minimum from Z_0 (82.9) (Table 02).

Grain yield

Grain yield ha^{-1} of BRRI dhan-33 varied significantly due to application of different levels of zinc. Maximum grain yield ha^{-1} was found from Z_3 (5.1 ton) which was statistically similar with Z_2 (4.9 ton) while minimum from Z_0 (3.3 ton). Cheema *et al.* (2006) reported that paddy yield showed positive correlation with the increase in $ZnSO_4$ levels from 2.5 to 10 kg ha^{-1}. Khan *et al.* (2007) reported that the increasing levels of Zn significantly influenced yield and yield components of rice.

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Straw yield

Significant differences were observed for straw yield ha^{-1} of BRRI dhan-33 to different levels of zinc. Maximum straw yield ha^{-1} was found from Z_3 (6.6 ton) which was statistically similar with Z_2 (6.5 ton) while minimum from Z_0 (4.9 ton) (Table 02).

Biological yield

Biological yield ha^{-1} of BRRI dhan-33 varied significantly due to different levels of zinc. It was observed that maximum biological yield ha^{-1} was provided by Z_3 (11.8 ton) which was statistically similar with Z_2 (11.4 ton) while minimum from Z_0 (8.2 ton) (Table 02).

Harvest index

Different levels of zinc showed significant variation for harvest index of BRRI dhan-33. Maximum harvest index was recorded from Z_3 (43.6 %) which was statistically similar with Z_2 (42.6%) and Z_1 (41.7%) whereas minimum from Z_0 (39.3%). Cheema *et al.* (2006) reported that harvest index showed positive correlation with the increase in $ZnSO_4$ levels from 2.5 to 10 kg ha^{-1}.

N content in grain

N content in grain of BRRI dhan-33 varied significantly due to application of different levels of zinc. Maximum N content in grain was found from Z_3 (1.35%) which was statistically similar with Z_2 (1.32%) closely followed by Z_1 (1.27%) whereas minimum from Z_0 (1.16%) (Table 03). Yadi *et al.* (2012) reported nitrogen content in grain were highest with application of 40 and 20 kg Zn ha^{-1}.

P content in grain

P content in grain of BRRI dhan-33 varied significantly due to application of different levels of zinc. Maximum P content in grain was found from Z_3 (0.29%) which was statistically similar with Z_2 (0.27%) closely followed by Z_1 (0.25%) whereas minimum from Z_0 (0.20%). Yadi *et al.* (2012)reported phosphorus content in grain were highest with application of 40 and 20 kg Zn ha^{-1}**.**

K content in grain

K content in grain of BRRI dhan-33 varied significantly due to application of different levels of zinc. Maximum K content in grain was recorded from Z_3 (0.64%) which was statistically similar with Z_2 (0.62%) whereas minimum from Z_0 (0.54%) (Table 03). Yadi *et al.* (2012) reported potassium content in grain were highest with application of 40 and 20 kg Zn ha^{-1}.

S content in grain

S content in grain of BRRI dhan-33 varied significantly due to application of different levels of zinc. Maximum S content in grain was found from Z_3 (0.14%) which was statistically similar with Z_2 (0.13) whereas minimum from Z_0 (0.11%) (Table 03). Yadi *et al.* (2012) reported sulphur content in grain were highest with 40 and 20 kg Zn ha^{-1}.

Zn content in grain

Zn content in grain of BRRI dhan-33 varied significantly due to application of different levels of zinc. Maximum Zn content in grain was found from Z_3 (0.028%) which was statistically similar with Z_2 (0.027%) whereas minimum from Z_0 (0.018%) (Table 03). Ullah *et al.* (2001) reported the highest concentration of Zn in grain (73.33 ppm) with 20 kg zinc sulfate ha^{-1}.

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Table 01. Effect of different levels of zinc on yield contributing characters on BRRI dhan-33[x]

Levels of zinc	Number of effective tillers $hill^{-1}$		Number of non-effective tillers $hill^{-1}$		Number of total tillers $hill^{-1}$		Length of panicle (cm)		Weight of 1000 grains (g)	
Z_0	10.2	c	3.3	a	13.4	c	19.1	c	19.7	c
Z_1	12.1	b	3.0	b	15.1	b	21.1	b	20.9	b
Z_2	13.0	a	2.9	b	15.9	a	22.1	ab	22.1	a
Z_3	13.3	a	2.6	c	15.9	a	22.7	a	22.2	a
LSD(0.01)	*0.6*		*0.2*		*0.6*		*1.1*		*0.6*	
CV(%)	*5.7*		*8.6*		*4.9*		*5.9*		*3.6*	

[x] In a column means having similar letter (s) are statistically identical and those having dissimilar letter (s) differ significantly as per 0.05 level of probability

Table 02. Effect of different levels of zinc on yield contributing characters on BRRI dhan-33[x]

Levels of zinc	Number of filled grains $panicle^{-1}$		Number of unfilled grains $panicle^{-1}$		Number of total grain		Grain yield (tha^{-1})		Straw yield (tha^{-1})		Biological yield		Harvest index (%)	
Z_0	72.3	c	10.6	a	82.9	c	3.3	c	4.9	c	8.2	c	39.3	b
Z_1	78.8	b	9.5	b	88.3	b	4.4	b	5.8	b	10.1	b	41.7	ab
Z_2	83.0	a	8.1	c	91.1	a	4.9	a	6.5	a	11.4	a	42.6	a
Z_3	84.3	a	7.9	c	92.2	a	5.1	a	6.6	a	11.8	a	43.6	a
LSD(0.01)	*3.67*		*0.6*		*1.2*		*0.3*		*0.4*		*0.5*		*2.6*	
CV(%)	*5.53*		*8.3*		*3.7*		*8.4*		*7.8*		*1.9*		*7.4*	

[x] In a column means having similar letter (s) are statistically identical and those having dissimilar letter (s) differ significantly as per 0.05 level of probability

Table 03. Effect of different levels of zinc on nutrient content in grain on BRRI dhan-33[x]

Levels of zinc	Nutrient content (%) in grain									
	N		P		K		S		Zn	
Z_0	1.16	c	0.20	c	0.54	c	0.11	c	0.018	c
Z_1	1.27	b	0.25	b	0.58	b	0.13	b	0.024	b
Z_2	1.32	ab	0.27	ab	0.62	a	0.13	ab	0.027	a
Z_3	1.35	a	0.29	a	0.64	a	0.14	a	0.028	a
LSD(0.01)	*0.06*		*0.03*		*0.03*		*0.01*		*0.003*	
CV(%)	*5.78*		*9.92*		*6.31*		*4.92*		*4.950*	

[x] In a column means having similar letter (s) are statistically identical and those having dissimilar letter (s) differ significantly as per 0.05 level of probability

IV. Conclusion

It was observed that zinc application has significant positive effect on growth and yield of BRRI dhan-33. Application of 4.0 kg Zn ha^{-1} showed the best result for most of the yield parameters which was statistically almost similar result with 3.0 kg Zn ha^{-1}. It can be concluded that application of 3.0-4.0 kg Zn ha^{-1} can be more beneficial for farmers to get better yield. Further extended experiments are suggested in different soil and agro-climate of Bangladesh to validate and practice these results.

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