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Growth and yield response of chickpea to different levels of boron and zinc

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A B S T R A C T

Like other pulses, chickpea (*Cicer arietinum* L.) responses well to boron and zinc fertilization. Therefore, it is necessary to identify optimum boron and zinc fertilizer levels for higher yield of chickpea The experiment was conducted at the Agronomy Field Laboratory, Department of Agronomy and Agricultural Extension, University of Rajshahi during the period from November 2013 to April 2014 to study the effect of boron and zinc on the growth and yield of chickpea. The experiment was carried out in a Randomized Complete Block Design (RCBD) with three replications. Five levels of boron viz. 0, 1, 2, 3 and 4 kg B ha^{-1} and four levels of zinc viz. 0, 2, 4 and 6 kg Zn ha^{-1} were used as treatments. It was observed that boron level had significant effect on total dry matter at 20, 30 and 40 DAS but not significant at 50, 60, 70 and 80 DAS. The highest total dry matter was recorded from 3 kg B ha^{-1} and the lowest one was recorded from control (0 kg B ha^{-1}). Application of boron showed non-significant effect on crop growth rate. Effect of Zinc on total dry matter was significant at 20, 30, 40, 50 and 60 DAS but not significant at 70 and 80 DAS .The maximum total dry matter was recorded from 4 kg Zn ha^{-1}. Effect Zinc on crop growth rate was not significant. Application of boron showed significant effect on the yield attributes and yield of chickpea. The highest seed yield (1.829 t ha^{-1}) was obtained from 3 kg B ha^{-1} and lowest one (1.377 t ha^{-1}) was found in control treatment. Zinc showed significant effect on almost all the yield attributes and yield of chickpea. The highest seed yield (1.742 t ha^{-1}) was obtained from 4 kg Zn ha^{-1} and lowest one (1.325 t ha^{-1}) was found in control treatment. Therefore, the combination of 3 kg B ha^{-1} with 4 kg Zn ha^{-1} may be recommended for better plant growth and higher yield of chickpea.

INTRODUCTION

Chickpea (*Cicer arietinum* L.), commonly known as gram, is a major pulse crop in Bangladesh. The chickpea as a healthy vegetarian food has an important role in human food and domestic animal feed in Bangladesh. Chickpea also plays a key role in organic cropping systems. Chickpea is a drought tolerant crop. It is a temperate crop which has become adapted to sub-tropical conditions. This pulse does not like excessive moisture in the soil, high humidity and cloudy weather. Cool night and warm days are optimum for growth and yield. Recently high Barind tract, north-west part of Bangladesh, is becoming an important area for production of chickpea after harvest of *T. aman* rice (Shahjahanel. al. 2003). As the area is drought-prone having compact and low fertile soil (Ali et al. 2000), drought tolerant and comparatively early maturing cultivar should be explored to get better yield.

Micronutrients play an important role in increasing yield of pulses. Zinc (Zn) is a micronutrient and it plays an important role in increasing yield of pulse legumes. Zinc regulates the auxin concentration in plants. It helps in synthesis of chlorophyll, protein, nucleic acid, carotene, IAA etc. It is also required for seed production, RNA synthesis and ribosome stability. Zn deficiency is common in the chickpea growing regions of the world and is perhaps the most widespread of micronutrient deficiency (Ahlawat et al. 2007). Boron (B) is

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another micronutrient that plays an important role in increasing yield of pulse crops. It is very important for cell division and in pod and seed formation. Boron ranks third place among micronutrients in its concentration in seed and stem as well as its total amount (Shilet al. 2007). Boron significantly affected the seed yield of chickpea as stated by Khanamet al. (2000), chickpea yield of more than 1 t ha^{-1} can be obtained by applying 3 kg B ha^{-1} of boron.

The soils of different parts of Bangladesh are more or less deficient in boron and zinc, which causes poor yield of chickpea. However, there is a great possibility to increase its production by applying boron and zinc fertilizers. Therefore, the present study was undertaken to study the effect of boron and zinc on the growth and yield of chickpea and to identify their optimum doses for higher productivity in Rajshahi region.

MATERIALS AND METHODS

Experimental Site and Soil

The research work was carried out at the Agronomy Field Laboratory, Department of Agronomy and Agricultural Extension, University of Rajshahi during the period from November 2013 to April 2014 to study the growth and yield of chickpea as affected by boron and zinc. The experimental plot is of poorly drained soil with moderately slow permeability. The top soil is sandy loam and slightly alkaline in reaction.

Experimental Treatments and Design

Five levels of boron viz. 0, 1, 2, 3 and 4 kg B ha^{-1} and four levels of zinc viz. 0, 2, 4 and 6 kg Zn ha^{-1} were combined in the treatments. The experiment was laid out in a Randomized Complete Block Design (RCBD) with three replications. The size of the each plot was 4 m^2 (2 m × 2 m).

Crop Husbandry

The experimental land was opened by a power tiller. Later on it was ploughed and cross ploughed followed by laddering for breaking the clods and leveling the soil to obtain desirable tilth. Weeds and stubbles were then removed. The first ploughing was done on 16 November and final land preparation was done on 19 November 2013. Urea, triple super phosphate (TSP) and muriate of potash (MoP) were applied to the plots @ 45, 85 and 35 kg ha $^{-1}$ respectively. Boron was applied in the form of Borax and zinc was applied from zinc sulphate. Boron and zinc was applied as basal dose before final land preparation as per experimental treatments. All the fertilizers were thoroughly mixed to the soil. Before sowing collected seeds were treated with Vitavex-200WP @ 4 g kg^{-1} seed to prevent seeds from the attack of soil borne diseases. Seeds were sown on 21 November 2013. The seed rate was 45 kg ha^{-1}. Weeding and thinning were done when necessary. Two irrigations were given during the whole growing season. First irrigation was applied at 35 DAS and second irrigation at 55 DAS. Insects, pests and diseases were controlled properly. The crop was harvested at full maturity on 5 April 2014 at 135 DAS.

Date Collection

Data were recorded on different growth parameters and yield attributes. The data collection for growth parameter was started at 20 DAS. Five plants were randomly selected from each plot for collecting data on total dry matter (TDM) and crop growth rate (CGR) from 20 DAS to 80 DAS at 10 days interval. After harvesting, crop of each plot was dried separately for four days, then threshing, cleaning and drying of seeds were done plot wise. At maturity data on yield and yield components were recorded from 10 randomly selected plants in each plot. Then the yield of seed and straw of each plot were recorded and the yields were then converted to hectare basis.

Statistical Analysis

The recorded data were compiled and tabulated for statistical analysis. The data were analyzed statistically using the analysis of variance technique and the mean differences among the treatments were adjudged by Duncan's Multiple Range Test (Gomez and Gomez, 1984) with the help of MSTAT-C software.

RESULTS AND DISCUSSION

Effect of Boron on Growth Parameters

It was observed that boron level had significant effect on total dry matter of chickpea at 20, 30 and 40 DAS but was non-significant at 50, 60, 70 and 80 DAS. Total dry matter was lower at the early stages of plant growth and higher at later growth stages. At 20, 30 and 40 DAS, the TDM production was significantly higher in Boron treatment than control condition. At 50, 60, 70 and 80 DAS, the highest total dry matter was recorded from B_3 treatment (3 kg B ha^{-1}) and the lowest total dry matter was recorded from control condition (Table 1). Similar result was observed by Shil et al. (2007). They found that higher dose of boron showed better performance regarding total dry matter of chickpea. Crop growth rate was not influenced significantly by boron level. Crop growth rate increase slowly at the early stages of plant growth and reached to maximum level at 60-70 DAS and thereafter it declined. With some exception numerically the highest crop growth rate was observed at 3 kg B ha^{-1} and the lowest one was obtained from control condition (Table 1).

Effect of Zinc on Growth Parameters

Effect of zinc on total dry matter was significant at 20, 30, 40, 50 and 60 DAS but not significant at 70 and 80 DAS. The total dry matter increased with the advancement of plant age. The cause of rapid increase of total dry matter at later stage was possibly due to the development of considerable number of branches. With some exception highest total dry matter was recorded from Zn_2 treatment (4 kg Zn ha^{-1}) and the lowest result was found in Zn_0 treatment (Table 2). Similar results were reported by Shukla and Yadav (1982). They observed that total dry matter was increased with higher dose of zinc application. Crop growth rate was not significantly influenced by zinc level at all sampling dates. With some exception numerically the highest crop growth was observed at 4 kg Zn ha^{-1} (Zn_2) and the lowest one was observed at control treatment (Table-2).

Table 1. Effect of boron level on total dry matter (g m^{-2}) and crop growth rate (g m^{-2} day^{-1}) at different days after sowing

Boron level	Total dry matter (g m^{-2}) 20 DAS	30 DAS	40 DAS	50 DAS	60 DAS	70 DAS	80 DAS	Crop growth rate (g m^{-2} day^{-1}) 20-30 DAS	30-40 DAS	40-50 DAS	50-60 DAS	60-70 DAS	70-80 DAS
B_0	21.28 b	31.04 b	61.05 b	92.206	137.591	196.450	227.324	0.975	3.002	3.116	4.538	5.886	3.025
B_1	22.70 a	32.74 a	62.92 ab	94.146	139.741	198.818	229.554	1.004	3.020	3.123	4.559	5.908	3.073
B_2	23.11 a	32.69 a	63.22 ab	94.554	140.090	199.203	231.223	0.957	3.055	3.134	4.553	5.910	3.202
B_3	23.88 a	33.84 a	64.52 a	95.909	141.402	200.301	234.106	0.994	3.069	3.139	4.548	5.890	3.381
B_4	23.43 a	33.29 a	63.80 ab	94.693	140.189	199.243	231.901	0.985	3.052	3.089	4.549	5.906	3.226
LS	0.01	0.01	0.01	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
CV%	4.83	4.47	4.54	4.49	4.63	4.78	4.49	17.15	7.10	6.62	13.49	8.21	46.30

In a column figures having similar letters (S) or without letters (s) do not differ significantly as per DMRT.
NS = Not Significant, LS = Level of significance, CV = Co-efficient of variation, B_0 = control, B_1 = 1 kg B ha^{-1}, B_2 = 2 kg B ha^{-1}, B_3 = 3 kg B ha^{-1}, B_4 = 4 kg B ha^{-1}

Interaction Effect of Boron and Zinc on Growth Parameters

The interaction effect of boron and zinc level on TDM was not significant at all sampling dates. Numerically the highest result was found in the treatment combination of B_3Zn_2 and the lowest one was found in the treatment combination of B_0Zn_0 at all sampling dates (Table3). Effect of boron and zinc level was not significant on crop growth rate. With some exceptions numerically the highest value was noted from the treatment combination of B_3Zn_2 and the lowest crop growth rate was obtained from the treatment combination of B_0Zn_0 at all sampling dates (Table3).

Effect of Boron on Yield Contributing Characters and Yield

Boron level had significant effects on the all yield contributing characters and yield of chickpea. The highest plant height, number of primary branches plant^{-1}, number of secondary branches plant^{-1}, number of pods plant^{-1}, pod length, number of seeds pod^{-1}, stover yield and 1000-seed weight were obtained from the application of 3 kg B ha^{-1}. Control treatment gave the lowest result regarding all this parameters. Seed yield was influenced significantly by different levels of boron. Significantly the highest seed yield was produced at 3 kg B ha^{-1} and the lowest seed yield was produced at 0 kg B ha^{-1} (Table 4). This result is in agreements with the findings of Shil et al. (2007). Grain yield is the ultimate goal of chickpea cultivation. Grain yield increased with the increase of boron level up-to of 3 kg B ha^{-1}. Grain yield is associated with plant height, number of primary branches plant^{-1}, number of secondary branches plant^{-1} number of pods plant^{-1}, pod length (cm), number of seed pod^{-1} and 1000-seed weight. Boron level increases the plant height, number of primary branches plant^{-1}, number of secondary branches plant^{-1} number of pods plant^{-1}, pod length, number of seeds pod^{-1} and 1000-seed weight which ultimately led to increase grain yield.

Table 2. Effect of zinc level on total dry matter (g m^{-2}) and crop growth rate (g m^{-2} day^{-1}) at different days after sowing

Zn level	Total dry matter (g m^{-2}) 20 DAS	30 DAS	40 DAS	50 DAS	60 DAS	70 DAS	80 DAS	Crop growth rate (g m^{-2} day^{-1}) 20-30 DAS	30-40 DAS	40-50 DAS	50-60 DAS	60-70 DAS	70-80 DAS
Zn_0	19.92 c	29.08 d	59.19 c	90.49 b	135. 7 b	194.372	226.356	0.917	3.012	3.130	4.523	5.867	3.199
Zn_1	22.06 b	32.24 c	62.75b	93.67 ab	139.2 ab	198.281	230.016	1.018	3.052	3.093	4.548	5.911	3.174
Zn_2	25.07 a	35.49 a	65.88 a	97.43 a	143.4 a	202.713	235.096	1.041	3.040	3.155	4.598	5.930	3.237
Zn_3	24.48 a	34.06 b	64.59 ab	5.62 a	140.9 a	199.847	231.819	0.957	3.055	3.102	4.530	5.892	3.147
LS	0.01	0.01	0.05	0.01	0.01	NS	NS	NS	NS	NS	NS	NS	NS
CV %	4.83	4.47	4.45	4.49	4.63	4.78	4.49	17.15	7.10	6.62	13.49	8.21	46.30

In a column figures having similar letters (S) or without letters (s) do not differ significantly as per DMRT.
NS = Not Significant, LS = Level of significance, CV = Co-efficient of variation, Zn_0 = Control, Zn_1 = 2 kg Zn ha^{-1} , Zn_2 = 4 kg Zn ha^{-1} , Zn_3 = 6 kg Zn ha^{-1}

Table 3. Interaction of boron and zinc level on total dry matter (g m^{-2}) and crop growth rate (g m^{-2} day^{-1}) at different days after sowing

Interaction (B × Zn)	Total dry matter (g m^{-2}) 20 DAS	30 DAS	40 DAS	50 DAS	60 DAS	70 DAS	80 DAS	Crop growth rate (g m^{-2} day^{-1}) 20-30 DAS	30-40 DAS	40-50 DAS	50-60 DAS	60-70 DAS	70-80 DAS
cB_0Zn_0	18.347	27.420	57.313	88.483	133.630	192.290	223.390	0.907	2.990	3.117	4.513	5.870	3.100
B_0Zn_1	20.443	30.543	60.493	91.573	136.960	195.893	226.083	1.010	2.997	3.107	4.540	5.890	3.020
B_0Zn_2	23.423	33.853	63.793	95.283	141.050	200.193	231.303	1.043	2.993	3.150	4.577	5.913	3.100
B_0Zn_3	22.923	32.340	62.587	93.483	138.723	197.423	228.520	0.940	3.027	3.090	4.523	5.870	2.860
B_1Zn_0	19.720	29.020	59.113	90.380	135.730	194.590	224.780	0.930	3.010	3.127	4.533	5.890	3.020
B_1Zn_1	21.840	32.433	62.290	93.570	139.060	198.267	228.817	1.060	2.987	3.130	4.55	5.920	3.053
B_1Zn_2	24.923	35.553	65.800	97.183	143.250	202.593	223.697	1.063	3.027	3.137	4.607	5.933	3.110
B_1Zn_3	24.320	33.937	64.490	95.450	140.923	199.823	230.923	0.963	3.057	3.097	4.547	5.890	3.110
B_2Zn_0	20.080	29.223	59.513	90.783	136.030	194.893	226.893	0.917	3.020	3.140	4.523	5.887	3.200
B_2Zn_1	22.413	32.143	62.693	93.870	139.557	198.593	230.603	0.970	3.057	3.117	4.567	5.940	3.203
B_2Zn_2	25.420	35.250	66.000	97.680	143.650	203.087	235.073	0.980	3.077	3.170	4.600	5.930	3.197
B_2Zn_3	24.523	34.137	64.790	95.883	141.123	200.240	232.323	0.960	3.067	3.110	4.523	5.910	3.207
B_3Zn_0	20.920	30.123	60.413	92.020	137.130	195.193	229.233	0.920	3.030	3.160	4.510	5.807	3.403
B_3Zn_1	22.940	33.243	64.260	95.120	140.557	199.793	232.993	1.030	3.067	3.087	4.540	5.923	3.320
B_3Zn_2	26.153	36.753	67.403	99.213	145.297	204.593	238.783	1.057	3.103	3.180	4.610	5.930	3.420
B_3Zn_3	25.520	35.237	65.990	97.283	142.623	201.893	235.413	0.970	3.077	3.130	4.533	5.900	3.380
B_4Zn_0	20.520	29.620	59.710	90.783	136.130	194.893	227.783	0.910	3.010	3.107	4.533	5.880	3.260
B_4Zn_1	22.640	32.843	63.993	94.230	139.657	198.860	231.583	1.020	3.117	3.027	4.543	5.920	3.273
B_4Zn_2	25.423	36.050	66.403	97.780	143.750	203.097	236.623	1.060	3.037	3.137	4.597	5.933	3.50
B_4Zn_3	25.120	34.640	65.090	95.980	141.220	200.123	231.913	0.950	3.047	3.087	4.523	5.890	3.180
LS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
CV%	4.83	4.47	4.54	4.49	4.63	4.78	4.49	17.15	7.10	6.62	13.49	8.21	46.30

In a column figures having similar letters (S) or without letters (s) do not differ significantly as per DMRT.
NS = Not Significant, LS = Level of significance, CV = Co-efficient of variation, B_0 = control, B_2 = 2 kg B ha^{-1}, B_3 = 3 kg B ha^{-1}, B_4 = 4 kg B ha^{-1}, Zn_0 = Control, Zn_1 = 2 kg Zn ha^{-1} , Zn_2 = 4 kg Zn ha^{-1} , Zn_3 = 6 kg Zn ha^{-1}

Effect of Zinc on Yield Contributing Characters and Yield

Zinc had a significant effect on all the yield contributing characters and yield. The highest plant height, number of primary branches plant^{-1}, number of secondary branches plant^{-1}, number of pod plant^{-1}, 1000-seed weight, stover yield and biological yield were obtained from the application of 4 kg Zn ha^{-1}. Control treatment gave the lowest result regarding all these parameters. Zinc doses exerted significant influence on seed yield of chickpea. From the result of the experiment we can see that the highest seed yield was obtained from the application of 4 kg Zinc ha^{-1} and the lowest seed yield was obtained from control treatment (Table5). This result is supported by Valenciano et al. (2010).

Interaction Effect of Boron and Zincon Yield Contributing Characters and Yield

The interaction effect of boron and zinc was significant for number of pods plant^{-1}, number of seed pod^{-1} and seed yield and non-significant on rest of the yield and contributing characters. With some exceptions B_3Zn_2 showed the best performance for almost all the parameters studied (Table6).

Table 4. Effect of boron level on yield components and yield of chickpea

Boron level	Plant height (cm)	Primary branches plant^{-1} (no.)	Secondary branches plant^{-1} (no.)	Total pods plant^{-1} (no.)	Effective pods plant^{-1} (no.)	Non effective pods plant^{-1} (no.)	Pod length (cm)	Seeds pod^{-1} (no.)	1000-seed weight (g)	Seed yield (t ha^{-1})	Stover yield (t ha^{-1})
B_0	60.13d	4.068d	19.25e	36.18e	27.13e	7.997a	1.706c	1.511d	155.5c	1.377 d	1.802b
B_1	60.72c	4.331c	23.79d	38.47d	31.14d	7.381b	1.800bc	1.606d	169.9c	1.411cd	1.870b
B_2	62.87b	4.773b	29.00c	42.69c	35.94c	6.738c	1.911ab	1.790c	172.7bc	1.493 c	1.945ab
B_3	64.78a	5.106a	34.62a	57.63a	51.96a	5.671d	2.014a	2.192a	201.7a	1.829 a	2.265a
B_4	63.41b	4.907ab	32.57b	48.75b	41.26b	7.490b	1.938a	1.952b	193.6ab	1.743 b	2.149ab
LS	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
CV%	4.69	4.88	5.17	4.95	4.36	4.86	5.86	5.39	10.93	5.64	5.77

In a column figures having similar letters (S) or without letters (s) do not differ significantly as per DMRT.
NS = Not Significant, LS = Level of significance, CV = Co-efficient of variation, B_0 = control, B_1 = 1 kg B ha^{-1}, B_2 = 2 kg B ha^{-1} , B_3 = 3 kg B ha^{-1} , B_4 = 4 kg B ha^{-1}

Table 5. Effect of zinc level on yield components and yield of chickpea

Zinc level	Plant height (cm)	Primary branches plant^{-1} (no.)	Secondary branches plant^{-1} (no.)	Total pods plant^{-1} (no.)	Effective pods plant^{-1} (no.)	Non effective pods plant^{-1} (no.)	Pod length (cm)	Seeds pod^{-1} (no.)	1000-seed weight (g)	seed yield (t ha^{-1})	Stover yield (t ha^{-1})
Zn_0	57.84d	4.244c	24.82d	39.62d	31.63c	7.986a	1.744c	1.491d	160.1b	1.325d	1.80b
Zn_1	60.83c	4.612b	27.13c	43.50c	36.83b	6.710c	1.851bc	1.751c	176.0ab	1.558c	1.954ab
Zn_2	66.37a	5.011a	30.81a	50.20a	43.84a	6.368d	1.966a	2.064a	192.3a	1.742a	2.167a
Zn_3	64.49b	4.680b	28.63b	45.66b	38.12b	7.156b	1.933ab	1.934b	186.3a	1.657b	2.105ab
LS	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
CV%	4.69	4.88	5.17	4.95	4.36	4.86	5.86	5.39	10.93	5.64	5.77

In a column figures having similar letters (S) or without letters (s) do not differ significantly as per DMRT.
NS = Not Significant, LS = Level of significance, CV = Co-efficient of variation, Zn_0 = Control, Zn_1 = 2 kg Zn ha^{-1} , Zn_2 = 4 kg Zn ha^{-1} , Zn_3 = 6 kg Zn ha^{-1}

Table 6. Interaction of boron and zinc level on yield components and yield of chickpea

Interaction	Plant height (cm)	Primary branches plant^{-1} (no.)	Secondary branches plant^{-1} (no.)	Total pods plant^{-1} (no.)	Effective pods plant^{-1} (no.)	Non effective podsplant^{-1} (no.)	Pod length (cm)	Seeds pod^{-1} (no.)	1000-seed weight (g)	seed yield (t ha^{-1})	Stover yield (t ha^{-1})
B_0Zn_0	56.486	3.792	15.369	31.23q	20.65l	10.55a	1.571	1.203j	108.000	1.241i	1.584
B_0Zn_1	59.298	4.090	18.878	33.63o	26.52jk	7.312de	1.662	1.450hi	157.960	1.329hij	1.791
B_0Zn_2	63.327	4.359	22.917	40.55k	34.01ij	6.548fghi	1.854	1.790ef	180.898	1.483g	1.943
B_0Zn_3	61.414	4.029	19.829	39.32l	29.74kl	7.581cd	1.739	1.600gh	175.263	1.454gh	1.891
B_1Zn_0	56.982	4.010	21.055	32.12p	23.43i	8.689b	1.649	1.290ij	153.796	1.279ij	1.726
B_1Zn_1	59.698	4.331	23.735	37.30m	30.29ef	7.002defg	1.789	1.610gh	162.678	1.372hi	1.839
B_1Zn_2	64.198	4.729	26.158	44.84h	38.52h	6.419ghi	1.891	1.823def	184.928	1.601cf	1.971
B_1Zn_3	62.014	4.253	24.213	39.63l	32.32ij	7.414de	1.872	1.700fg	178.265	1.393h	1.942
B_2Zn_0	57.691	4.356	26.668	36.30n	29.16fg	7.139defg	1.791	1.343ig	156.325	1.327hij	1.789
B_2Zn_1	60.921	4.718	27.896	42.97j	36.57de	6.416ghi	1.863	1.800ef	164.678	1.406ghi	1.891
B_2Zn_2	66.997	5.015	31.828	47.86f	41.62fg	6.206def	1.954	2.017bc	186.941	1.671e	2.102
B_2Zn_3	65.878	5.001	29.619	43.62i	36.42c	7.190hi	2.038	2.00cc	182.899	1.568f	2.00
B_3Zn_0	59.289	4.598	31.629	51.52d	45.29b	6.235ij	1.907	1.897cde	192.623	1.402ghij	1.986
B_3Zn_1	62.691	5.006	33.146	55.49c	49.47b	6.019k	1.998	1.977cd	199.981	1.896c	2.261
B_3Zn_2	69.989	5.681	37.598	66.44a	61.44a	5.001jk	2.121	2.523a	209.756	2.019a	2.437
B_3Zn_3	67.131	5.139	36.115	57.06b	51.63ef	5.428de	2.029	2.370a	204.326	1.998b	2.376
B_4Zn_0	58.756	4.463	29.364	46.94g	39.62de	7.323efgh	1.814	1.723fg	189.890	1.378hi	1.915
B_4Zn_1	61.531	4.916	32.019	48.12ef	41.32cd	6.799cd	1.941	1.917cde	194.652	1.789d	1.987
B_4Zn_2	67.328	5.271	35.526	51.30d	43.63de	7.668bd	2.009	2.167b	198.980	1.936bc	2.381
B_4Zn_3	66.031	4.978	33.358	48.66e	40.49	8.168	1.987	2.00c	190.678	1.871cd	2.315
LSD	NS	NS	NS	0.05	0.01	0.01	NS	0.05	NS	0.01	NS
CV (%)	4.69	4.88	5.17	4.95	4.36	4.86	5.86	5.39	10.93	5.64	5.77

In a column figures having similar letters (S) or without letters (s) do not differ significantly as per DMRT.
NS = Not Significant, LS = Level of significance, CV = Co-efficient of variation, B_0 = control, B_2 = 2 kg B ha^{-1}, B_3 = 3 kg B ha^{-1}, B_4 = 4 kg B ha^{-1}, Zn_0 Control, Zn_1 = 2 kg Zn ha^{-1} , Zn_2 = 4 kg Zn ha^{-1} , Zn_3 = 6 kg Zn ha^{-1}.

Conclusion

Among the boron levels, 3 kg B ha^{-1} performed the best regarding plant growth and yield of chickpea; while for zinc level, 4 kg Zn ha^{-1} exhibited the best performance. Therefore, the combination of 3 kg B and 4 kg Zn ha^{-1} can be recommended for better plant growth and higher yield of chickpea in Rajshahi region.

CONFLICT OF INTEREST

The authors declare that there is no conflict of interests regarding the publication of this paper.

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