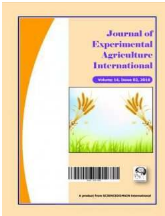

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Yield and Yield Component of Chickpea as Affected by Boron Application

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Authors' contributions

This work was carried out in collaboration between all authors. Author MSA designed the study, wrote the protocol, performed the statistical analysis and critically reviewed the first draft. Author KJA carried out the field work, collected and compiled data, literature searches and wrote the first draft. Author AH provided technical support and gave valuable suggestions in writing the manuscript. All authors read and approved the final manuscript.

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ABSTRACT

The present research work was carried out to study the yield of chickpea as affected by boron application. Five varieties of chickpea namely BARI Chola-5, BARI Chola-6, BARI Chola-7, BARI Chola-8 and BARI Chola-9 and four levels of boron (0, 1, 2, 3 kg B ha^{-1}) were used in this experiment. A Randomized Complete Block Design was used for the experiment with three replications. Variety had significant effects on yield and its components of chickpea. BARI Chola-8 showed better performance and produced the highest seed yield (1.74) as compared to other varieties used in the study. Application of boron significantly improved yield and yield attributes of chickpea. The highest seed yield (1.70 t ha^{-1}) was obtained at 3 kg B ha^{-1} as compared to other levels of boron application. Results revealed that BARI Chola-8 integrated with 3 kg B ha^{-1} was found to be the best treatment for higher yield of chickpea.

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Keywords: Boron; chick pea; variety; yield.

1. INTRODUCTION

Pulse is one of the most important legume crops in Bangladesh. Pulse occupies the important place in the daily diet of the people. Most of the people in our country eat pulses as a source of protein. Chickpea (*Cicer arietinum*) is an ancient cultivated plant, domesticated during early age of civilization and being cultivated throughout the world. It is an edible legumes belonging to the family "Fabaceae" with slightly round, irregular shape and are slightly longer in size than the normal peas. Its nomenclature in different countries is well documented as gram, chickpea, hommos, chana, chieting vetch, nakhud, nakhut, kicher, pois chice, garbarzo etc. [1]. In respect of area and production the total yield of chickpea was 6488 MT produced in 8250 ha in Bangladesh [2]. It is the third most important pulse crop in Bangladesh with an average yield of 765 kg ha^{-1} [3]. It is the cheap source of high quality protein in the diet of millions of people in developing countries, who cannot afford animal protein for balanced nutrition [4]. On chemical analysis of chickpea seed with and without seed coat contain (%) water, protein, fat, minerals, ash, carbohydrate, energy (Cal.) at (9.9), (20.8), (5.6), (2.7), (1.2), (61.5), and (372) respectively. It is also rich in Ca and Fe. Yield of chickpea is affected by varietal differences.

Boron is a micronutrient plays an important role in increasing yield of pulse legumes. It is very important in cell division and in pod and seed formation. Boron ranks third places among micronutrients in its concentration in seed and stem as well as its total amount after zinc [3]. Boron significantly affected the seed yield of chickpea [5]. The deficiency of boron has been very pronounced under multiple cropping systems due to excess removal by HYV of crops and hence its exogenous supply is urgently required. Boron deficiency limits chickpea productivity less than Zn deficiency [6], it has been shown to have a significant limiting effect on chickpea yield in some regions with acid soil conditions [7]. Boron application is most important when boron concentration in soil is below 0.3 mg kg^{-1} and crop response to boron application is higher in chickpea than in some cereals [6]. Boron deficiency causes flower drop and, consequently, poor podding in chickpeas [7] and poor yields. Seed yield of chickpea increased with the application of boron @ 1.5-2.5 kg ha^{-1} [8]. The application of boron resulted in a higher production of dry matter, due to an increase of the dry weight of pods including seeds [9].

Variety also plays an important role in producing high yield of chickpea because different varieties responded differently for their genotypic characters, input requirements, growth process and the prevailing environment during growing season. Good quality chickpea variety produces good quality seed and good quality seed produces higher yield. Varieties vary morphologically and the variation is distinctly visible at different growth stages due to their inherent characters. The use of varieties with low yield potential also limits gram yield to a considerable extent [10]. High yielding cultivars usually have extensive root system, taller in height [11], relatively more number of pods and grains pod^{-1} [12]. If we just replace our present varieties with high yielding varieties which are very response to heavy fertilization and may enhance our yield per unit area up to 8-12% [10]. Chickpea is an important crop yet little work has been done for the improvement of this crop in this country. Therefore, the present study was undertaken to study the yield and yield components of chick pea as affected by boron fertilization.

2. MATERIALS AND METHODS

The present research work was carried out at the Agronomy Field Laboratory, Department of Agronomy and Agricultural Extension, University of Rajshahi during the period from December, 2012 to April, 2013 to study the yield of chickpea as affected by boron application. The experiment consisted of two factors i.e. five chickpea varieties viz. BARI Chola-5, BARI Chola-6, BARI Chola-7, BARI Chola-8 and BARI Chola-9 and four boron levels viz. 0, 1, 2 and 3 kg B ha^{-1}. A Randomized Complete Block Design was used for the experiment. The treatments were replicated three times. The physical and chemical properties of the soil and environmental condition of the study period has been presented in Table 1 and Fig. 1 respectively. The total number of plots was 5×4×3=60.The size of the each plot was 2 m × 2 m. The experimental field was fertilized with urea, TSP, MoP @ 45, 85, 35 kg ha^{-1} respectively. All the fertilizers were applied during the final land preparation. Boron was applied as per experimental treatment in the form of boric acid. Seeds were sown on 6 December, 2012 in 40 cm apart rows opened by specially made iron hand tine. Three weeding operations at 22, 32 and 50 DAS were done to control weeds in the experimental field. Thinning was done when necessary for maintaining 5 cm plant to plant distance. Two irrigations were applied at 35 and 60 DAS. Data on yield and yield components were recorded. 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 new Duncan's Multiple Range Test (DMRT) with the help of MSTAT software [13].

3. RESULTS

3.1 Plant Height

Significant variation was not observed in respect of plant height amongst different varieties. BARI Chola-8 produced the tallest plant (75.28 cm) whereas BARI Chola-5 produced shortest one (67.67 cm). Plant height did not respond significantly to the boron application. The highest plant height (72.33 cm) was observed at 3 kg B ha^{-1} and the lowest (68.24 cm) was recorded at 0 kg B ha^{-1} (Table 2). The interaction between variety and boron level on plant height was not statistically significant. The tallest plant (76.88 cm) was obtained from BARI Chola-8 with 3 kg B ha^{-1} and the shortest one (66.73 cm) from BARI Chola-5 at 0 kg B ha^{-1} (Table 3).

3.2 Primary Branches Plant^{-1}

Variety had significant effect on the number of primary branches $plant^{-1}$. The highest number of primary branches $plant^{-1}$ (5.10) was produced by BARI chola-8 and lowest number (4.21) was produced by BARI Chola-5. The number of primary branches $plant^{-1}$ was significantly influenced by boron level. The highest number of primary branches $plant^{-1}$ (4.93) was observed at 3 kg B ha^{-1} and the lowest one (4.24) was observed at control treatment (0 kg B ha^{-1}) (Table 2). Variety and boron level interacted significantly on the number of primary branches plant. The maximum number of primary branches $plant^{-1}$ (5.46) was obtained from BARI Chola-8 at the highest level of boron application (3 kg B ha^{-1}) and lowest one (13.36) from BARI Chola-5 at control treatment (0 kg B ha^{-1}) (Table 3).

3.3 Secondary Branches Plant^{-1}

The number of secondary branches $plant^{-1}$ was significant due to variety. The maximum number of secondary braches $plant^{-1}$ (28.41) was produced by BARI chola-8 and the minimum one (17.39) was produced by BARI Chola-5 (Table 2). Different boron levels showed significant variation in respect of number of secondary branches $plant^{-1}$. However, the highest secondary branches $plant^{-1}$ was recorded when 3 kg B ha^{-1} was applied, which was higher over control (0 kg B ha^{-1}). Variety and boron level interacted significantly on number of secondary branches $plant^{-1}$. The maximum number of secondary branches $plant^{-1}$ (37.00) was obtained from BARI Chola-8 with 3 kg B ha^{-1} whereas same variety produced minimum branches (21.40) at control application of boron (Table 3). The lowest value (13.36) for this trait was noted from the treatment combination of V_1B_1.

3.4 Nodules Plant^{-1}

Variety had significant effect on the number of nodules $plant^{-1}$. The highest number of nodules $plant^{-1}$ (25.98) was produced by BARI Chola-8 than rest of the varieties. This is the inherent characters of BARI Chola-8 in producing higher nodules $plant^{-1}$. Number of nodules $plant^{-1}$ was significantly influenced by boron level. Nodules $plant^{-1}$ increased with the increasing level of boron (Table 2). The interaction between variety and boron level produced significant variation in respect of number of nodules $plant^{-1}$. The maximum number of nodules $plant^{-1}$ (30.77) was obtained from BARI Chola-8 with 3 kg B ha^{-1} whereas the minimum one (16.30) was observed in BARI Chola-5 at 0 kg B ha^{-1} (Table 3).

3.5 Total Pods Plant^{-1}

BARI Chola-8 produced the highest number of total pod $plant^{-1}$ (48.18) whereas BARI Chola-5 produced the lowest (39.00) for this yield component of chickpea. The number of total pod $plant^{-1}$ was significantly influenced by boron level. The highest number of total pods $plant^{-1}$ (49.52) was observed at 3 kg B ha^{-1} and the lowest one (36.52) was observed at control treatment (Table 2). The interaction effect between variety and boron level on the number of total pod $plant^{-1}$ was not significant. The maximum number of total pods (55.26) was obtained from BARI Chola-8 with 3 kg B ha^{-1}. This result supported by [9]. The minimum number of total pod $plant^{-1}$ (29.46) was obtained from BARI Chola-5 at 0 kg B ha^{-1} (Table 3).

3.6 Effective Pods Plant^{-1}

Variety had significant effect on the number of effective pod plant^{-1}. The maximum number of effective pod plant^{-1} (44.48) was produced by BARI Chola-8. Number of effective pods plant^{-1} was significantly affected by boron level. The maximum number of effective pods plant^{-1} (44.94) was obtained from BARI Chola-8 with 3 kg B ha^{-1}. The minimum number of effective pods plant^{-1} (29.52) was obtained from control treatment (Table 2). The interaction between variety and boron level failed to produce significant variation in case of number of effective pod plant^{-1}. Numerically the highest number of effective pod plant^{-1} (51.26) was obtained from BARI Chola-8 at the highest level of boron (3 kg B ha^{-1}) and the lowest one (34.00) was obtained from BARI Chola-5 at control treatment (Table 3).

3.7 Non-effective Pods Plant^{-1}

Number of non-effective pod plant^{-1} varied significantly in different varieties. The maximum number of non-effective pod plant^{-1} (7.47) was produced by BARI Chola-5 and minimum number of non-effective pod plant^{-1} (4.70) was produced by BARI Chola-8. Different boron levels showed significant variation in terms of number of non-effective pod plant^{-1}. The maximum number of non- effective pod plant^{-1} (7.0) was found in BARI Chola-5 and the minimum one (5.57) was found in BARI Chola-8 (Table 2). There was no significant effect in respect of number of non-effective pod plant^{-1}of chickpea due to interaction of variety and boron level. Numerically the highest number of non-effective pod plant^{-1} (8.53) was recorded from BARI Chola-5 at control treatment and the lowest one (4.00) was recorded from BARI Chola-8 at 3 kg B ha^{-1} (Table 3).

3.8 Pod Length

Variety had significant effect on pod length. The highest pod length (1.97 cm) was produced by BARI Chola-8. The lowest pod length (1.68 cm) was given by BARI Chola-5. Pod length was significantly influenced by boron level. The highest length of pod (1.94 cm) was recorded at 3 kg B ha^{-1} and the lowest pod length (1.72 cm) was observed at control treatment (Table 2). The interaction between variety and boron level failed to produce significant variation in case of pod length. Numerically the highest pod length (2.02 cm) was recorded by the BARI Chola-8 at 3 kg B ha^{-1}. The lowest pod length (1.51 cm) was recorded by the BARI Chola-5 at control treatment (Table 3).

3.9 Seeds Pod^{-1}

The number of seeds pod^{-1} varied significantly in different varieties. The highest number of seeds pod^{-1} (1.91) was obtained from BARI Chola-8 and the lowest one from (1.50) BARI Chola-5. Significant variation was observed in respect of number of seeds pod^{-1}due to different boron level. The highest number of seeds pod^{-1} (1.90) was given by BARI Chola-8 with 3 kg B ha^{-1}. The lowest number of seeds pod^{-1} (1.56) was given by BARI Chola-5 at control treatment (Table 2). The number of seeds pod^{-1} was not statistically significant due to interaction of variety and boron level. Numerically the highest number of seeds pod^{-1} (2.00) was produced by BARI Chola-8 at 3 kg B ha^{-1}. The lowest number of seeds pod^{-1} (1.20) was produced by BARI Chola-5 at control treatment (Table 3).

Table 1. Physical and chemical analysis of soil properties at 0-15 cm depth of soil

Soil properties	Results
Sand (%) (0.0-0.02 mm)	60
Silt (%) (0.02-0.002 mm)	25
Clay (%) (<0.002 mm)	15
Soil texture class	Sandy loam
P^H	7.52
Organic matter (%)	1.12
Total nitrogen (%)	0.07
Available P (ppm)	28.1
Available K (ppm)	0.25
Available S (ppm)	17.4
Available Zn (ppm)	0.72
Available B (ppm)	0.90

3.10 1000-seed Weight

Variety had significant effect on 1000 seed weight of chickpea. The weight of 1000-seed was highest in BARI Chola-8 (175.45 g) and lowest of 1000-seed weight (129.91 g) was found on BARI Chola-5. The weight of 1000-seed was not statistically significant due to different boron level. The highest 1000-seed weight (161.70 g) was obtained from 3 kg B ha^{-1} and the lowest one (143.40 g) was obtained from control treatment (Table 2). 1000-seed weight was not significantly influenced by the interaction of variety and boron level. Numerically the highest weight of 1000-seed (204.50 g) was obtained from BARI Chola-8 at 3 kg B ha^{-1}. The lowest weight of 1000 seed (120.66 g) was recorded from BARI Chola-5 at control treatment (Table 3).

Table 2. Effect of variety and boron on the yield and yield components of chickpea

Variety	Plant height (cm)	Primary branches plant^{-1} (No.)	Secondary branches plant^{-1} (No.)	Nodules 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})
V_1	67.67	4.21^{c}	17.39^{d}	19.08^{d}	39.00^{c}	31.53^{b}	7.47^{a}	1.68^{b}	1.50^{c}	129.91^{c}	1.38^{d}	1.87^{c}
V_2	68.00	4.41b^{c}	19.03^{c}	21.08^{c}	39.09^{c}	32.79^{b}	6.25^{b}	1.79^{a}	1.68^{b}	137.25^{bc}	1.47^{cd}	1.96^{c}
V_3	70.03	4.61^{b}	18.68^{c}	22.97^{b}	46.53^{b}	40.46^{a}	6.13^{b}	1.86^{a}	1.76^{ab}	141.83^{bc}	1.57^{bc}	2.13^{b}
V_4	75.28	5.10^{a}	28.4^{a}	25.98^{a}	48.18^{a}	44.48^{a}	4.70^{c}	1.97^{ab}	1.91^{a}	175.45^{a}	1.74^{a}	2.28^{a}
V_5	70.40	4.63^{b}	25.15^{b}	23.28^{b}	46.57^{a}	41.00^{a}	5.57^{b}	1.91^{a}	1.85^{a}	163.41^{ab}	1.62^{b}	2.14^{b}
LS	NS	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.05	0.01	0.01
CV (%)	5.93	6.03	5.29	4.68	11.94	12.77	7.10	4.98	8.09	17.22	6.41	5.11
Boron levels												
B_1	68.24	4.24^{c}	16.69^{d}	18.51^{d}	36.52^{c}	29.52^{c}	7.00^{a}	1.72^{c}	1.56^{c}	143.40	1.39^{c}	1.85^{c}
B_2	69.20	4.50b^{c}	19.54^{c}	21.03^{c}	40.30^{bc}	34.01^{c}	6.29^{b}	1.81^{b}	1.69^{bc}	149.73	1.52^{b}	2.02^{b}
B_3	71.33	4.70^{ab}	23.13^{b}	23.92^{b}	44.65^{ab}	39.73^{b}	5.93b^{c}	1.89^{ab}	1.81^{ab}	143.46	1.62^{ab}	2.17^{a}
B_4	72.33	4.93^{a}	27.57^{a}	26.46^{a}	49.52^{a}	44.94^{a}	5.57^{c}	1.94^{a}	1.90^{a}	161.70	1.70^{a}	2.27^{a}
LS	NS	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	NS	0.01	0.01
CV (%)	5.93	6.03	5.29	4.68	11.94	12.77	7.10	4.98	8.09	17.22	6.41	5.11

In a column the figures bearing similar letter (s) or without letter (s) are identical and those having dissimilar letter (s) differed significantly as per DMRT

Table 3. Interaction effect of variety and boron level on the yield and yield components of chickpea

Variety× Boron	Plant height (cm)	Primary branches plant^{-1} (No.)	Secondary branches plant^{-1} (No.)	Nodules 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 wt (g)	Seed yield (t ha^{-1})	Stover yield (t ha^{-1})
V_1B_1	66.73	3.86	13.36^{l}	16.30^{k}	29.46	34.00	8.53	1.51	1.20	120.66	1.233	1.660
V_1B_2	67.40	4.13	15.53^{jk}	18.40^{i}	32.83	38.00	7.23	1.60	1.40	126.66	1.333	1.857
V_1B_3	68.50	4.33	18.80^{gh}	20.15^{g}	34.13	42.66	7.13	1.77	1.60	133.33	1.433	1.967
V_1B_4	69.33	4.06	21.86^{e}	21.50^{f}	37.26	45.20	7.00	1.83	1.80	139.00	1.550	2.020
V_2B_1	68.31	4.33	15.36^{jk}	17.18^{j}	44.33	25.66	7.26	1.63	1.40	127.33	1.317	1.723
V_2B_2	70.69	4.53	17.96^{hi}	19.30^{h}	45.23	28.40	6.20	1.78	1.60	133.33	1.433	1.893
V_2B_3	71.59	4.73	20.06^{fg}	22.61^{e}	42.33	31.26	6.00	1.85	1.80	141.66	1.533	2.067
V_2B_4	68.50	4.20	22.73^{e}	25.24^{c}	49.76	39.30	5.03	1.91	1.93	146.66	1.633	2.183
V_3B_1	59.80	4.53	14.06^{kl}	18.36^{i}	33.80	22.63	6.80	1.73	1.60	132.66	1.417	1.900
V_3B_2	70.69	4.73	16.60^{ij}	21.58^{f}	34.73	28.53	6.20	1.85	1.73	139.00	1.533	2.067
V_3B_3	71.78	5.00	19.60^{g}	24.63^{cd}	42.63	37.20	5.43	1.90	1.86	146.00	1.630	2.223
V_3B_4	73.69	5.20	24.46^{d}	27.33^{b}	47.80	42.20	5.60	1.95	1.86	149.66	1.717	2.330
V_4B_1	73.69	4.73	21.40^{ef}	21.37^{f}	38.06	32.66	5.40	1.92	1.86	1.77.66	1.533	2.070
V_4B_2	74.67	5.00	24.73^{d}	24.32^{d}	42.80	37.80	5.00	1.96	1.86	189.66	1.727	2.253
V_4B_3	75.87	5.20	30.53^{b}	27.46^{b}	52.60	48.20	4.40	1.99	1.93	130.00	1.817	2.363
V_4B_4	76.88	5.46	37.00^{a}	30.77^{a}	55.26	51.26	4.00	2.02	2.00	204.50	1.900	2.457
V_5B_1	68.74	4.33	19.26^{gh}	19.33^{gh}	39.66	32.66	7.00	1.84	1.73	158.66	1.483	1.933
V_5B_2	69.86	4.53	22.86^{e}	21.57^{f}	44.16	37.33	6.83	1.89	1.86	160.00	1.583	2.067
V_5B_3	70.93	4.73	26.66^{c}	24.76^{cd}	47.53	41.33	6.20	1.95	1.86	166.33	1.690	2.233
V_5B_4	72.06	4.93	31.80^{b}	27.47^{b}	50.36	44.66	5.73	1.97	1.93	168.66	1.743	2.360
LS	NS	NS	0.01	0.01	NS	NS	NS	NS	NS	NS	NS	NS
CV (%)	5.93	6.03	5.29	4.68	11.94	12.77	7.10	4.98	8.09	17.22	6.41	5.11

In a column the figures bearing similar letter (s) or without letter (s) are identical and those having dissimilar letter (s) differed significantly as per DMRT.
V_1= BARI Chola-5; V_2= BARI Chola-6; V_3= BARI Chola-7; V_4= BARI Chola-8; V_5= BARI Chola-9
B_1= 0 kg B ha^{-1} (Control); B_2= 1 kg B ha^{-1}; B_3= 2 kg B ha^{-1}; B_4= 3 kg B
LS= Level of Significance; CV= Co-efficient of Variation; NS= Non Significant

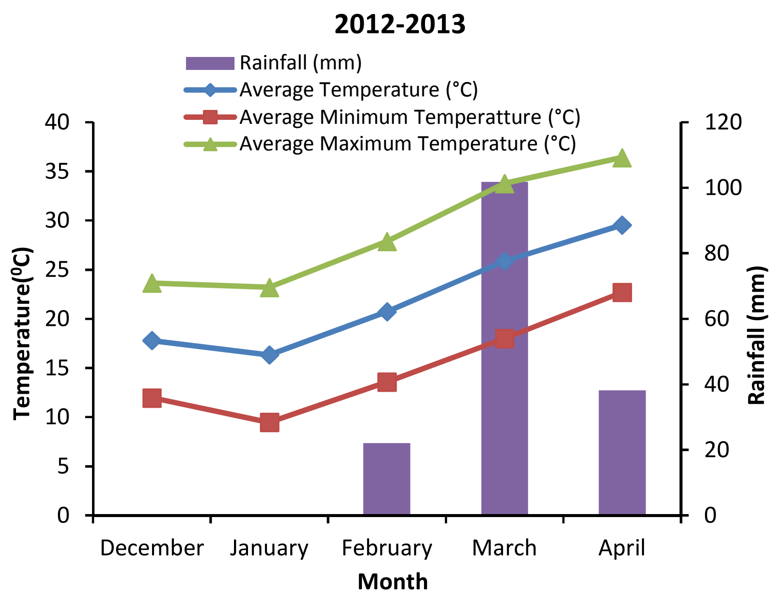

Fig. 1. Monthly temperature and rainfall during the study period (December, 2012 to April, 2013)

3.11 Seed Yield

Seed yield was influenced significantly by different varieties. The highest seed yield (1.74 t ha^{-1}) was produced by BARI Chola-8 followed by BARI Chola-9 (1.62 t ha^{-1}), BARI Chola-7 (1.57 t ha^{-1}), BARI Chola-6 (1.48 t ha^{-1}) and BARI Chola-5 (1.39 t ha^{-1}). This is due to varietals differences as a result BARI Chola-8 produced the highest seed yield. Boron doses exerted significant influence on seed yield of chickpea. From the results of the experiment we can see that the highest seed yield (1.70 t ha^{-1}) was obtained with the application of highest level of boron (3 kg B ha^{-1}). Similar results were also reported by [3]. The lowest seed yield (1.39 t ha^{-1}) was obtained from control treatment (Table 2). The effect of variety and boron level on seed yield was not statistically significant. Numerically the highest seed yield (1.90 t ha^{-1}) was recorded from BARI Chola-8 at 3 kg B ha^{-1} and the lowest one (1.23 t ha^{-1}) was obtained from the variety BARI Chola-5 at control treatment (Table 3).

3.12 Stover Yield

Stover yield was statistically significant within different varieties. The maximum stover yield (2.28 t ha^{-1}) was obtained from BARI Chola-8 and the minimum one was obtained from BARI Chola-5. Boron fertilizer also influenced the production of stover yield of chickpea. The highest stover yield (2.27 t ha^{-1}) was noticed at the highest level of boron application (3 kg B ha^{-1}) and the lowest one (1.85 t ha^{-1}) was in control treatment (Table 2). The effect between variety and boron level failed to produce significant variation on stover yield. Numerically the highest stover yield (2.45 t ha^{-1}) was obtained from the combination of V_4B_4 (BARI Chola-8 with 3 kg B ha^{-1}) and the lowest stover yield (1.66 t ha^{-1}) was obtained from BARI Chola-5 at 0 kg B ha^{-1} (Table 3).

4. DISCUSSION

Among the five varieties tested, BARI Chola-8 showed better performance in all respect. The maximum number of pods plant^{-1} (48.25), 1000-seed weight (175.45) and seeds pod^{-1} (1.91) were recorded from BARI Chola-8 which was significantly different over rest of the varieties. The highest seed yield (1.74 t ha^{-1}) was produced by BARI Chola-8 followed by BARI Chola-9, BARI Chola-7, BARI Chola-6 and BARI Chola-5. The yield difference was noticed due to varietal potentialities in yield and yield components of the variety. The seed yield and yield components significantly increased with the increment of boron level. The highest seed yield was recorded when 3 kg B ha^{-1} was applied, which was higher over rest of the boron levels. The result indicates that boron had significant influence on grain yield which was associated with the number of pods plant^{-1}, grains pod^{-1} and 1000-grain weight. Boron is very important in cell division and in pod and seed formation. The boron fertilizer increased the production of more grains pod^{-1} which might be the cause of more seed yield. This result is in conformity with the findings of [14]. Boron principally contributed to the yield and the crop performed better with subsequent higher doses up to 2.5 kg B ha^{-1} [8]. Seed yield of chickpea (cv. BARI Chola- 5) increased significantly due to application of 1.5 kg B ha^{-1} [15]. It is observed that under pot conditions with acidic soils at high moisture availability boron applications increased chickpea total dry matter and improved seed yield [9]. The lowest grain yield was recorded from the treatment where boron was not applied (Control). The reason of the lowest yield at control treatment is the boron deficiency in the soil. Due to severe deficiency of boron may restrict the normal flow of hormone. Resulting germination of pollen tube and receptivity of stigma sharply declined. Boron deficiency causes flower drop and, consequently, poor podding in chickpea and poor yields [7]. Soil application of boron did not cause either toxicity or a reduction in yield, perhaps because the doses used were not very high [16] since high rates can cause a reduction in yield, especially in dry conditions [6]. Although [17] did find a significant response, they carried out foliar rather than soil applications. Positive response of different genotypes in terms of seed yield was realized significantly in application of boron @ 3 kg B ha^{-1}. The highest values for seed yield of chick were obtained from V_4B_4 treatment combination and the lowest one from V_1B_1. The application of boron resulted in a more vegetative growth in acidic soils. The dry matter production increase, with increased boron supply, was mostly due to the increase in the number of pods (including seeds) plant^{-1} [18].

5. CONCLUSION

On the basis of aforesaid findings it is evident that BARI Chola-8 showed better performance for almost all the yield components and yield of chickpea and consequently it produced the highest seed yield. Among the boron level 3 kg b ha^{-1} was best for better yield. Finally the results suggest that combination of $V_4 \times B_4$ (BARI Chola-8 with 3 kg B ha^{-1}) is the best for obtaining highest yield of chickpea.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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