

Original Research Article**Yield and yield component of chickpea as affected by boron****ABSTRACT**

The present research work was carried out at the Agronomy Field Laboratory, Department of Agronomy and Agricultural Extension., to study the yield of chickpea as affected by boron. 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_____ (Remove it) and four boron levels. viz. 0, 1, 2 and 3 kg B ha⁻¹. A Randomized Complete Block Design was used for the experiment with three applications. Variety and application of boron had significant effects on the all yield components and yield. The highest plant height (75.28 cm), number of primary branches plant⁻¹ (5.10), number of secondary branches plant⁻¹ (28.41), number of pods plant⁻¹ (48.25), pod length (1.97cm), number of seed pod⁻¹ (1.91), seed yield (1.74), stover yield (2.28), biological yield (4.03), 1000-seed weight (175.45) were obtained from BARI Chola-8 variety. The highest plant height (72.33cm), number of primary branches plant⁻¹ (4.93), number of secondary branches plant⁻¹ (27.53), number of pod plant⁻¹ (49.22), effective pod plant⁻¹ (44.94), pod length (1.94 cm), number of seed pod⁻¹ (1.9), seed yield (1.7 t ha⁻¹), stover yield (2.27 t ha⁻¹), biological yield (3.77 t ha⁻¹). All the yield components and yield

Key words: Variety, chick pea, boron, yield

INTRODUCTION

Pulse is one of the most important legume crops in Bangladesh and it occupies the important place in the daily diet of the human consumption. Most of the people in our country are

24 poor. They eat pulses as a source of protein. Pulse is one of cheapest source of protein
 Remove it from text
 25 which is called “Poor mans meat”. Chickpea (*Cicer arietinum*) is an ancient cultivated
 26 plant, domesticated during early age of civilization and being cultivated throughout the
 27 world (Add reference). It is an edible legumes belonging to the family “Fabaceae” with slightly round,
 28 irregular shape and are slightly longer in size than the normal peas. Its nomenclature in
 29 different countries is well documented as gram, chickpea, hommos, chana, chiating
 30 vetch, nakhud, nakhut, kicher, pois chice, garbarzo etc.[1] (follow the format of
 31 journal). In respect of area and
 32 production the total yield of chickpea was produced 8250 ha in 6488 MT in Bangladesh
 33 [2] (follow the format of journal). It is the third most important pulse crop in Bangladesh in respect
 of area and
 34 production with an average yield of 765 kg ha⁻¹ (Add reference) It is used for human consumption as
 35 well as for feeding green leaves is used as green vegetables. Its flour is used in the
 36 preparation of various types of sweet. It is the cheap source of high quality protein in the
 37 diet of millions of people in developing countries, who cannot afford animal protein for
 38 balanced nutrition [3]. On chemical analysis of chickpea seed with and without seed
 39 coat contain (%) water, protein, fat, minerals, ash, carbohydrate, energy (Cal.) at (9.9),
 40 (20.8), (5.6), (2.7), (1.2), (61.5), and (372) respectively. It is also rich in Ca and Fe.
 41 Now a day’s different HYV release for the increase of yield. Improved variety also
 42 increases the seed yield. Yield of chickpea is affected by variety because different
 43 variety shows different performance. Yield depends on the number of effective pod, pod
 44 length, seed pod⁻¹, 1000-seed weight etc. (Rewrite or clear it)
 45 Boron (B) is a micronutrient plays an important role in increasing yield of pulse
 46 legumes. It is very important in cell division and in pod and seed formation. Boron
 47 ranks third places among micronutrients in its concentration in seed and stem as well as
 its total amount after zinc (Shil et.al., 2007) (follow the format of journal). Boron significantly affected
 the seed yield

of chickpea [4] (follow the format of journal). On station (which station and were) studies of BARI indicated that chickpea yield of more than 1 t ha⁻¹ can be obtained by applying 3 kg ha⁻¹ of boron. Chickpea being an important crop has done little work for the improvement of this crop in this country (lot of work has been done on this study) how u know little work has done). Therefore, the present study was undertaken to study the yield and yield components of chick pea as affected by boron fertilization.(Give clear justification of work)

Materials and Methods

The present research work was carried out at the Agronomy Field and 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. 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 for three times. The total number of unit plots in the entire experimental plot was 5×4×3=60. The size of the each plot was 2m×2m. 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 (Application has been done before sowing or land preparation plz clear it). 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 of 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 apart from 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

71 technique and the mean differences among the treatments were adjudged by new
72 Duncan's Multiple Range Test (DMRT) (Add reference if any) with the help of MSTAT software [5].

73 RESULTS AND DISCUSSION

74 Plant height

75 Significant variation was observed in respect of plant height due to different varieties.
76 BARI Chola-8 produced the tallest plant (75.28 cm) whereas BARI Chola-5 produced
77 shortest plant (67.67 cm) are both values are at par). There was no significant difference among
78 the varieties in
79 respect of plant height. (it means u have no difference between varieties but 75.28 and 67.67 are
80 different significantly plz clear it or rewrite) Plant height did not influence significantly to the
81 boron
82 applications. The highest plant height (72.33 cm) was observed at 3 kg B ha⁻¹ and the
83 lowest one (68.24 cm) at 0 kg B ha⁻¹(Table 1).The interaction between variety and
84 boron level on plant height was not statistically significant. The tallest plant (76.88cm)
85 was obtained from BARI Chola-8 with 3 kg B ha⁻¹ and the shortest one (66.73cm) from
86 BARI Chola-5 at 0 kg B ha⁻¹ (Table 2).

85 Primary branches plant⁻¹

86 Variety had significant effect on the number of primary branches plant⁻¹.The highest
87 number of primary branches plant⁻¹ (5.10) was produced by BARI chola-8 and lowest
88 number of primary branches plant⁻¹ variety (4.21) was produced by BARI Chola-5. The
89 number of primary branches plant⁻¹ was significantly influenced by boron level. The
90 highest number of primary branches plant⁻¹ (4.93) was observed at 3 kg Bha⁻¹ and the
91 lowest one (4.24) was observed at control treatment (0 kg Bha⁻¹) (Table 1). Variety and
92 boron level interacted significantly on the number of primary branches plant. The
maximum number of primary branches plant⁻¹ (37.00) was obtained from BARI Chola-8

at the highest level of boron (3 kg Bha⁻¹) and lowest one (13.36) from BARI Chola-5 at control treatment (0 kg Bha⁻¹) (Table 2). (Rewrite it were is dicussion are your work is agreed with any findings you have write on results)

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 number of secondary branches plant⁻¹ (17.39) was produced by BARI Chola-5. Different boron levels showed significant variation in respect of number of secondary branches plant⁻¹. The maximum number of secondary branches plant⁻¹ (27.57) was obtained from BARI Chola-8 with 3 kg Bha⁻¹ and the minimum one (16.69) was obtained from control treatment (Table 1). Variety and boron level interacted significantly on the number of secondary branches plan. The maximum number of secondary branches plant⁻¹ (37.00) was obtained from BARI chola-8 at 3 kg Bha⁻¹ and lowest one was obtained from BARI Chola-5 at control treatment (0 kg Bha⁻¹) (Table 2).

were is dicussion are your work is agreed with any findings you have write on results)

Nodule plant⁻¹

Variety had significant effect on the number of nodule plant⁻¹. The maximum number of nodule plant⁻¹ (25.15) was produced by BARI Chola-8. Number of nodule plant⁻¹ was significant by boron level. The maximum number of nodule plant⁻¹(26.46) was obtained from BARI Chola-8 with 3 kg Bha⁻¹. The minimum number of nodule plant⁻¹(18.52) was obtained from control treatment (Table 1). The interaction between variety and boron level produce significant variation in case of number of effective pod plant. Numerically the highest number of nodule plant⁻¹ (30.77) was obtained from BARI Chola-8 at the highest level of boron (3 kg Bha⁻¹) and the lowest one(16.30) was obtained from BARI Chola-5 at control treatment (Table 2). were is dicussion are your work is agreed with any findings you have write on results)

116 **Total pod plant⁻¹**

117 BARI Chola-8 produced the highest number of total pod plant⁻¹ (48.18) whereas BARI
 118 Chola-5 produced the lowest number (39.00) for this yield component of chickpea. The
 119 number of total pod plant⁻¹ was significantly influenced by boron level. The highest
 120 number of total pod plant⁻¹ (49.52) was observed at 3 kg B ha⁻¹ and the lowest one
 121 (36.52) was observed at control treatment (Table 1). The interaction effect between
 122 variety and boron level on the number of total pod plant⁻¹ was not significant. The
 123 maximum number of total pod (55.26) was obtained from BARI Chola-8 with 3 kg B
 124 ha⁻¹. This result supported by Valenciano *et. al.* The minimum number of total pod
 125 plant⁻¹ (29.16) was obtained from BARI Chola-5 at control treatment (Table 2).
 126 were is discussion are your work is agreed with any findings you have write on results)

127 **Effective pod plant⁻¹**

128 Variety had significant effect on the number of effective pod plant⁻¹. The maximum
 129 number of effective pod plant⁻¹ (48.18) was produced by BARI Chola-8. Number of
 130 effective pod plant⁻¹ was significant by boron level. The maximum number of effective
 131 pod plant⁻¹ (44.94) was obtained from BARI Chola-8 with 3 kg B ha⁻¹. The minimum
 132 number of effective pod plant⁻¹ (29.52) was obtained from control treatment (Table 1).
 133 The interaction between variety and boron level failed to produce significant variation
 134 in case of number of effective pod plant⁻¹. Numerically the highest number of effective
 135 pod plant⁻¹ (55.26) was obtained from BARI Chola-8 at the highest level of boron (3 kg
 136 B ha⁻¹) and the lowest one (34.00) was obtained from BARI Chola-5 at control
 137 treatment (Table 2). were is discussion are your work is agreed with any findings you have write on results)

Non-effective pod plant⁻¹

Number of non-effective pod plant⁻¹ was significant due to 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 on BARI Chola-5 and the minimum one (5.57) was found in BARI Chola-8 (Table 1). 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 2).

were is dicussion are your work is agreed with any findings you have write on results)

Pod length

Variety had significant effect on pod length. The highest pod length (1.97cm) was produced by BARI Chola-8. The lowest pod length (1.64cm) was given by BARI Chola-5. Pod length was significantly influenced by boron level. Numerically the highest length of pod (1.94cm) was recorded at 3 kg B ha⁻¹ and the lowest pod length (1.72cm) was observed at control treatment (Table 1). The interaction between variety and boron level failed to produce significant variation in case of pod length. Numerically the highest pod length (2.02cm) 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 2).

were is dicussion are your work is agreed with any findings you have write on results)

Seed pod⁻¹

The number of seeds pod⁻¹ was significantly influenced by different varieties. The highest number of seeds pod⁻¹ (1.91) was produced by BARI Chola-8 and the lowest number of seed pod⁻¹ (1.50) was produced by BARI Chola-5. Significant variation was observed in respect of number of seed pod⁻¹ due to different boron level. The highest number of seed pod⁻¹ (1.90) was given by BARI Chola-8 with 3 kg B ha⁻¹. The lowest number of seed pod⁻¹ (1.56) was given by BARI Chola-5 at control treatment (Table 1). The number of seed pod⁻¹ was not statistically significant due to interaction of variety and boron level (Appendix VI). Numerically the highest number of seed pod⁻¹ (2.00) was produced by BARI Chola-8 at 3 kg B ha⁻¹. The lowest number of seed pod⁻¹ (1.20) was produced by BARI Chola-5 at control treatment (Table 2). **were is dicussion are your work is agreed with any findings you have write on results)**

1000-seed weight

Variety had significant effect on 1000 seed weight of chickpea. The weight of 1000-seed was highest in BARI Chola-8 (175.45g) and lowest of 1000-seed weight (129.91g) 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 (161.70g) was obtained from 3 kg B ha⁻¹ and the lowest one (143.40g) was obtained from control treatment (Table 1). 1000-seed weight was not significantly influenced by the interaction of variety and boron levels. Numerically the highest weight of 1000-seed (204.50g) was obtained from BARI Chola-8 at 3 kg B ha⁻¹. The lowest weight of 1000 seed (120.66g) was recorded from BARI Chola-5 at control treatment (Table 2). **were is dicussion are your work is agreed with any findings you have write on results)**

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),

183 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).
 184 This is due to varieties differences as a result BARI Chola-8 produced the highest seed
 185 yield. Boron doses exerted significant influence on seed yield of chickpea. From the
 186 results of the experiment we can see that the highest seed yield (1.70 t ha⁻¹) was
 187 obtained with the application of highest level of boron (3 kg B ha⁻¹). Similar results
 188 were also found by [6]. The lowest seed yield (1.39 t ha⁻¹) was obtained from control
 189 treatment (Table 1). The effect of variety and boron level on seed yield was not
 190 statistically significant. Numerically the highest seed yield (1.90 t ha⁻¹) was recorded
 191 from BARI Chola-8 at 3 kg B ha⁻¹ and the lowest one (1.23 t ha⁻¹) was obtained from
 192 the variety BARI Chola-5 at control treatment (Table 2).

were is discussion are your work is agreed with any findings you have write on results)

Stover yield

194 Stover yield was statistically significant due to different varieties. The maximum stover
 195 yield (2.28 t ha⁻¹) was obtained from BARI Chola-8 and the lowest stover yield was
 196 obtained from BARI Chola-5. Boron fertilizer also influenced the production of stover
 197 yield of chickpea. From the results of the experiment we can see that the highest stover
 198 yield (2.27 t ha⁻¹) was produced by the highest boron level (3 kg B ha⁻¹) and the lowest
 199 one (1.85 t ha⁻¹) was produced at the control treatment (Table 1). The effect between
 200 variety and boron level failed to produce significant variation on stover yield.
 201 Numerically the highest stover yield (2.45 t ha⁻¹) was obtained from the combination of
 202 BARI Chola-8 with 3 kg B ha⁻¹ and the lowest stover yield (1.66 t ha⁻¹) was obtained
 203 from BARI Chola-5 at control treatment (Table 2).

were is discussion are your work is agreed with any findings you have write on results)

204 (Before conclusion you should write discussion first)

206 **Conclusion**

207 On the basis of aforesaid findings it is evident that BARI Chola-8 showed better
208 performance for almost all the yield components and yield of chickpea and
209 consequently it produce the highest seed yield. Among the boron level 3 kg b ha⁻¹ was
210 best for better yield. Finally the results suggest that combination of V₄×B₄ (BARI
211 Chola-8 with 3 kg B ha⁻¹) is the best for obtaining highest yield of chickpea. However,
212 further studies are necessary to draw a definite conclusion.

213

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(C. *arti* write full name)

Variety	Plant height (cm)	Primary branches plant ⁻¹ (No.)	Secondary branches plant ⁻¹ (No.)	Nodule plant ⁻¹ (No.)	Total pod plant ⁻¹ (No.)	Effective pod plant ⁻¹ (No.)	Non-effective pod plant ⁻¹ (No.)	Pod length (cm)	Seed pod ⁻¹ (No.)	1000-seed weight (g)	Seed yield (t ha ⁻¹)	Stover yield (t ha ⁻¹)
V ₁	67.67b	4.21c	17.39d	19.08d	39.00c	31.53b	7.47a	1.68b	1.50c	129.91c	1.38d	1.87c
V ₂	68.00b	4.41bc	19.03c	21.08c	39.09c	32.79b	6.25b	1.79a	1.68b	137.25bc	1.47cd	1.96c
V ₃	70.03b	4.61b	18.68c	22.97b	46.53b	40.46a	6.13b	1.86a	1.76ab	141.83bc	1.57bc	2.13b
V ₄	75.28a	5.10a	28.41a	25.98a	48.18a	44.48a	4.70c	1.97ab	1.91a	175.45a	1.74a	2.28a
V ₅	70.40b	4.63b	25.15b	23.28b	46.57a	41.00a	5.57b	1.91a	1.85a	163.41ab	1.62b	2.14b
Boron levels												
B ₁	68.24	4.24c	16.69d	18.51d	36.52c	29.52c	7.00a	1.72c	1.56c	143.40	1.39c	1.85c
B ₂	69.20	4.50bc	19.54c	21.03c	40.30bc	34.01c	6.29b	1.81b	1.69bc	149.73	1.52b	2.02b
B ₃	71.33	4.70ab	23.13b	23.92b	44.65ab	39.73b	5.93bc	1.89ab	1.81ab	143.46	1.62ab	2.17a
B ₄	72.33	4.93a	27.57a	26.46a	49.52a	44.94a	5.57c	1.94a	1.90a	161.70	1.70a	2.27a
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

V₁= BARI Chola-5, V₂= BARI Chola-6, V₃= BARI Chola-7, V₄= BARI Chola-8, V₅= BARI Chola-9,

B₁= 0 kg B ha⁻¹, B₂= 1 kg B ha⁻¹,

B₃= 2 kg B ha⁻¹, B₄= 3 kg B, LS= Level of significance, CV= Co-efficient of variation

effect) of variety and boron level on the yield and yield components of chickpea

Variety× Boron	Plant height (cm)	Primary branches plant ⁻¹	Secondary branches plant ⁻¹	Nodule plant ⁻¹	Total pod plant ⁻¹	Effective pod plant ⁻¹	Non- effective pod plant ⁻¹	Pod length (cm)	Seed pod ⁻¹	1000- seed wt (g)	Seed yield (tonha ⁻¹)	Stover yield (t ha ⁻¹)
V ₁ B ₁	66.73	3.86	13.36 l	16.30k	29.46	34.00	8.53	1.51	1.20	120.66	1.233	1.660
V ₁ B ₂	67.40	4.13	15.53jk	18.40i	32.83	38.00	7.23	1.60	1.40	126.66	1.333	1.857
V ₁ B ₃	68.50	4.33	18.80gh	20.15g	34.13	42.66	7.13	1.77	1.60	133.33	1.433	1.967
V ₁ B ₄	69.33	4.06	21.86e	21.50f	37.26	45.20	7.00	1.83	1.80	139.00	1.550	2.020
V ₂ B ₁	68.31	4.33	15.36jk	17.18j	44.33	25.66	7.26	1.63	1.40	127.33	1.317	1.723
V ₂ B ₂	70.69	4.53	17.96hi	19.30h	45.23	28.40	6.20	1.78	1.60	133.33	1.433	1.893
V ₂ B ₃	71.59	4.73	20.06fg	22.61e	42.33	31.26	6.00	1.85	1.80	141.66	1.533	2.067
V ₂ B ₄	68.50	4.20	22.73e	25.24c	49.76	39.30	5.03	1.91	1.93	146.66	1.633	2.183
V ₃ B ₁	59.80	4.53	14.06kl	18.36i	33.80	22.63	6.80	1.73	1.60	132.66	1.417	1.900
V ₃ B ₂	70.69	4.73	16.60ij	21.58f	34.73	28.53	6.20	1.85	1.73	139.00	1.533	2.067
V ₃ B ₃	71.78	5.00	19.60g	24.63cd	42.63	37.20	5.43	1.90	1.86	146.00	1.630	2.223
V ₃ B ₄	73.69	5.20	24.46d	27.33b	47.80	42.20	5.60	1.95	1.86	149.66	1.717	2.330
V ₄ B ₁	73.69	4.73	21.40ef	21.37f	38.06	32.66	5.40	1.92	1.86	177.66	1.533	2.070
V ₄ B ₂	74.67	5.00	24.73d	24.32d	42.80	37.80	5.00	1.96	1.86	189.66	1.727	2.253
V ₄ B ₃	75.87	5.20	30.53b	27.46b	52.60	48.20	4.40	1.99	1.93	130.00	1.817	2.363
V ₄ B ₄	76.88	5.46	37.00a	30.77a	55.26	51.26	4.00	2.02	2.00	204.50	1.900	2.457
V ₅ B ₁	68.74	4.33	19.26gh	19.33gh	39.66	32.66	7.00	1.84	1.73	158.66	1.483	1.933
V ₅ B ₂	69.86	4.53	22.86e	21.57f	44.16	37.33	6.83	1.89	1.86	160.00	1.583	2.067
V ₅ B ₃	70.93	4.73	26.66c	24.76cd	47.53	41.33	6.20	1.95	1.86	166.33	1.690	2.233
V ₅ B ₄	72.06	4.93	31.80b	27.47b	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 DMR

NS= Non significan