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Yield and Yield Components of Winter Chilli (*Capsicum annum* L.) as Affected by Different Levels of Nitrogen and Boron

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Abstract : The effects of different levels of nitrogen and boron fertilizer were determined on the yield and yield components of winter Chilli (*Capsicum annum* L) using different levels of nitrogen viz., 0, 20, 40, 60, 80, 100, 120 and 140 kg ha^{-1} and three levels of boron viz., 0, 1.5, 2.5 kg ha^{-1}. The highest chilli yield (dry) was obtained from 120 kg N ha^{-1} (2.41 ton ha^{-1} in 1997-98 and 2.77 ton ha^{-1} in 1998-99) which differed significantly from other nitrogen levels. The yield was progressively increased with the increased levels of nitrogen up to 120 kg N ha^{-1} and there after it was declined. Among different levels of boron, the highest yield was obtained from 2.5 kg B ha^{-1} which was identical to 1.5 kg B ha^{-1}. Interaction effects between nitrogen and boron on the chilli yield were found significant. In both the years, the highest chilli yield was recorded from 120 kg N ha^{-1} when applied with 2.5 kg B ha^{-1} which was identical to 120 kg N ha^{-1} when applied with 1.5 kg B ha^{-1}.

Key words: Winter chilli, nitrogen, boron, *Capsicum annum* L.

Introduction

Chilli (*Capsicum annum* L.) is a widely grown winter spice and cash crop in Bangladesh. The national average yield of this crop is only 0.64 t ha^{-1}, which is very low compared to other countries of the world. The low yield of this crop is mainly due to poor fertility management (Nasreen and Islam, 1989) particularly in case of nitrogen fertilization. Poor plant establishment on the other hand further aggravated the situation. Optimum nitrogen fertilization is very much essential for good plant establishment and expected growth. Nitrogen affects leaf development and retention, the retention of the largest possible leaf area for as long as possible, has shown to increase yield by maintaining the flow of assimilates to flower and young pods (Weiss, 1983). In capsicum, significant response of nitrogen for up to 150 kg ha^{-1} was reported by Caravelle (1976).

Recently, micronutrient particularly scarcity of boron is known to cause sterility in pod or grain development (Shahidullah and Ali, 1994). They reported that maximum numbers of plant in chickpea failed to produce any pod due want of boron. They further added that conspicuous response of boron was observed from 1.5 to 2.5 kg B ha^{-1} in pod development and higher yields. Most farmers either neglected or reluctant to use boron fertilizer in capsicum.

It is therefore, required that these two factors should be carefully correlated in such a way so that higher yield can be obtained through the rational use of these fertilizers. Therefore, the present study was undertaken to find out the effects of different levels of nitrogen and boron fertilizer on the yield and yield contributing characters of winter chilli.

Materials and Methods

A field experiment was conducted at Gabtali Multi-location trial site, Agricultural Research Station, Bangladesh Agricultural Research Institute, Bogra, Bangladesh during rabi (winter) season from 1997-98 to 1998-99. The site belongs to "Karatoya-Bangali flood-plain Agro-ecological zone (No. 4) of Bangladesh. The land was medium high and the soil was silty loam in texture. The mean annual rainfall was 1565 mm. The mean maximum and minimum temperature during the growing period were 25.1 and 11.2°C, respectively. The experiment was laid out in split-plot design following three replications. The eight different nitrogen levels viz., 0, 20, 40, 60, 80, 100, 120 and 140 kg N ha^{-1} were assigned in the main-plot and three different levels of boron viz., 0.0, 1.5 and 2.5 kg ha^{-1} were assigned in the sub-plot. The crop was broadcast sown on 25 and 29 September in 1997-98 and 1998-99, respectively and was harvested on 155 days after sowing (DAS). Fertilizer dose was maintained as per treatment mentioned above. In addition, 100, 70 and 10 kg ha^{-1} of P, K and S were used as blanket dose. The entire amount of P, K, S, B and ¼ N were applied during final land preparation. The rest of the nitrogen was applied with three equal splits at 30, 45 and 60 DAS in each year. The crop was irrigated thrice at 28, 43 and 58 DAS in each year. First weeding and thinning were done on 20 DAS. The second weeding was done on 36 DAS. To control Anthracnose disease, Tilt 250 EC at the rate of 5 ml/10 litre of water was sprayed on 45 and 60 DAS. Ripe fruits were collected by two picking at 135 and 155 DAS. The fruits were sun dried and weighed. Data on yield and yield contributing characters were collected and mean values were adjusted by DMRT following Gomez and Gomez (1976).

Results and Discussion

Effects of Nitrogen: Plant population per unit area did not differ significantly due to different levels of nitrogen, however, the highest population was counted from 120 and 140 kg N ha^{-1} while the lowest population was counted from control ('0' kg N ha^{-1}) (Table 1). Significant positive response of nitrogen was observed on the plant height of chilli. In 1997-98, the tallest plant was recorded from 140 kg N ha^{-1} (67.35 cm) which was identical to 120 kg N ha^{-1} (65.83 cm). Similarly, in 1998-99 the tallest plant was recorded from 140 kg N ha^{-1} (70.95 cm) which was identical to 120 kg N ha^{-1} (68.84 cm) but differed significantly from other nitrogen levels. Data indicated that plant height increased progressively with the increased levels of nitrogen. The shortest plant was recorded from '0' kg N ha^{-1} (52.54 cm in 1997-98 and 53.95 cm in 1998-99). Similar to plant height, number of secondary branches per plant also increased progressively with the increased levels of nitrogen (Table 1). These two parameters clearly indicated the impact of nitrogen in the development of vegetative growth in the chilli plant. Number of fruits per plant also varied significantly due to different levels of nitrogen. The highest number of fruits per plant was obtained from 120 kg N ha^{-1} (50.52 in 1997-98 and 52.44 in 1998-99) which was identical to 140, 100 and 80 kg N ha^{-1} in 1997-98 and only to 140 kg N ha^{-1} in 1998-99. The results indicated that the number of fruits per plant increased progressively with the increased levels of nitrogen up to 120 kg N ha^{-1} and it was declined thereafter. The dry fruit weight per plant was also significantly affected by different levels of nitrogen. The highest dry fruit weight per plant (21.52 g in 1997-99 and 28.28 g in 1998-99) was obtained from 120 kg N ha^{-1}, while the lowest fruit weight was recorded from control. The dry fruit weight per plant followed nearly similar trend of result as of number of fruits per plant that increased with the increased levels of nitrogen up to 120 kg N ha^{-1} and thereafter it was declined with 140 kg N ha^{-1}. In both the years, it was observed that the yield increased progressively with the increased levels of nitrogen up to 120 kg N ha^{-1}. The highest chilli yield with 120 kg N ha^{-1} might be due to the cumulative effects of highest number of fruits per plant and dry fruit weight per plant. The regression analysis of the effects of different levels of nitrogen on chilli yield further showed a linear (R^2 = 0.93 in 1997-98 and 0.94 in 1998-99) trend up to 120 kg N ha^{-1} with a significant R-squared value (Fig. 1 and 2). The lowest chilli yield was recorded from '0' kg N ha^{-1} (0.96 ton ha^{-1} in 1997-98 and 1.30 ton ha^{-1} in 1998-99).Nasreen and Islam (1989) also found linear response of nitrogen to chilli yield up to 120 kg N ha^{-1}. Similarly, Khan and Suryana (1978) reported that chilli responded significantly to 90 kg P_2O_5 when applied with 120 kg N ha^{-1} and 90 kg K_2O. Srinivas and Pravakar (1982) have reported linear response up to 150 kg N ha^{-1}.

Table 1 : Yield and yield component of winter chilli as affected by different nitrogen and boron levels

	Plant population/m^2 (No.)		Plant height (cm)		Number of secondary branches/plant		Number of fruits/plant		Dry fruit weight per plant (g)		Chilli yield (dry) (ton ha^{-1})	
Treatments	1997-98	1998-99	1997-98	1998-99	1997-98	1998-99	1997-98	1998-99	1997-98	1998-99	1997-98	1998-99
Effects of nitrogen												
0	8.72a	7.23a	52.54f	53.95f	3.54e	3.72e	33.31d	33.84g	13.30d	19.65g	0.96g	1.30f
20	8.80a	7.40a	55.08e	56.67ef	3.80e	3.95e	37.07c	37.62f	13.85d	20.50fg	1.02g	1.36f
40	8.77a	7.90a	57.53d	58.83de	4.46d	4.58d	42.14b	42.70e	14.40d	21.07ef	1.20f	1.51e
60	9.72a	8.04a	59.57cd	61.47cd	4.73d	4.85d	44.76b	45.46d	17.06cd	24.23de	1.57e	1.92e
80	9.76a	8.87a	61.55c	63.72c	5.12c	5.32c	47.95a	48.83c	18.68b	25.91cd	1.71d	2.12d
100	10.15a	8.89a	64.48b	67.13b	5.78b	6.02b	49.04a	49.85bc	19.10b	26.35bc	2.00c	2.33c
120	10.46a	9.67a	65.83ab	68.84ab	6.11b	6.20ab	50.52a	52.44a	21.52a	28.28a	2.41a	2.77a
140	10.20a	8.99a	67.35a	70.95a	6.51a	6.48a	49.50a	50.91ab	20.80a	28.00ab	2.13b	2.56b
Effects of boron												
0	9.35a	8.23a	55.50c	57.68c	4.92a	5.02a	42.31b	43.93b	15.91c	22.84b	1.49b	1.84b
1.5	9.36a	8.32a	60.88b	62.67b	5.04a	5.22a	44.58ab	45.23ab	16.84b	24.87a	1.66a	2.03a
2.5	9.72a	8.50a	65.10a	68.24a	5.05a	5.19a	45.97a	46.45a	19.13a	25.43a	1.73a	2.05a

In a column, means followed by the same letter(s) did not differ significantly at 5 % levels of probability

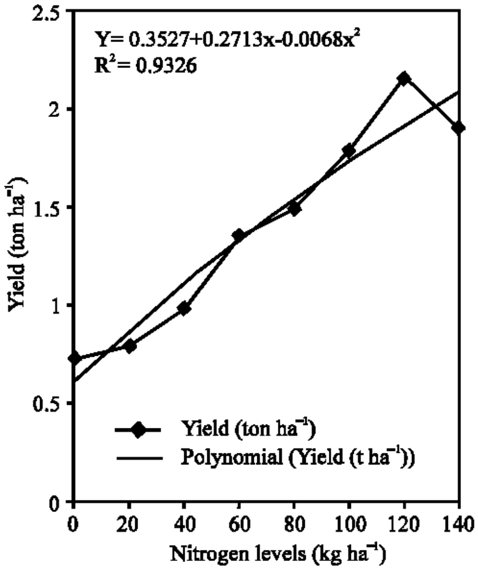

Fig. 1: Yield response to nitrogen during 1997-98

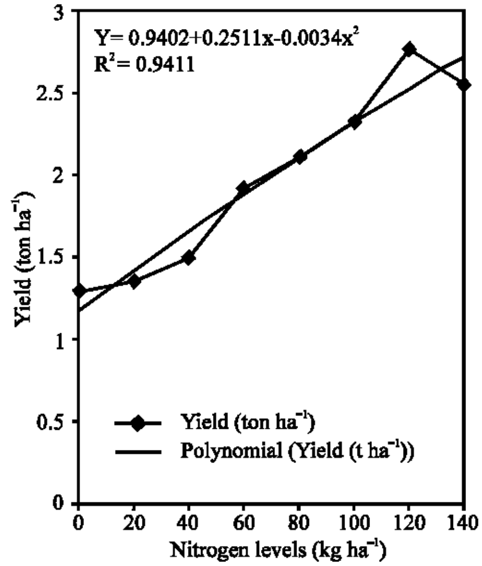

Fig. 2: Yield response to nitrogen during 1998-99

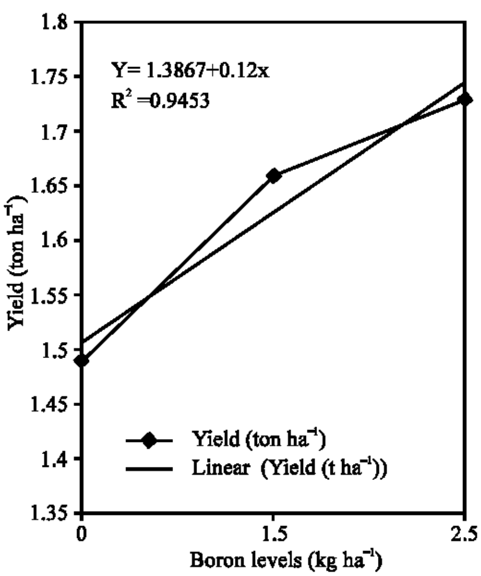

Fig. 3: Yield response to boron during 1997-98

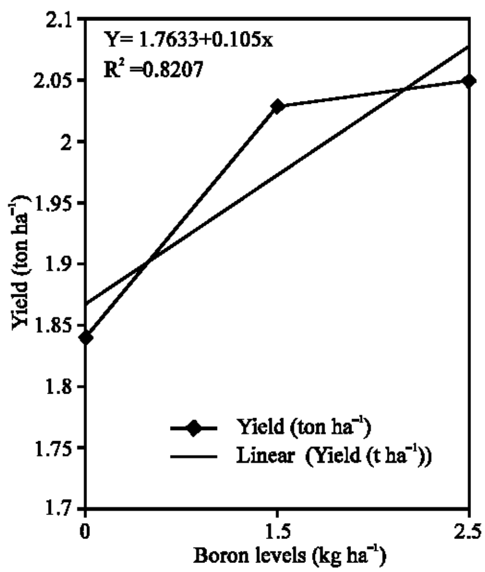

Fig. 4: Response of boron to yield during 1998-99

Effects of Boron: The plant population per unit area did not differ significantly with different levels of boron, however, the highest population (9.72/m^2 in 1997-98 and 8.50/m^2 in 1998-99) was recorded from 2.5 kg B ha^{-1} followed by 1.5 kg B ha^{-1} (Table 1). The lowest population was recorded from '0' kg B ha^{-1}. Different levels of Boron fertilizer had a significant influence on the height of the chilli plant. In both the years, the tallest plants were recorded from 2.5 kg B ha^{-1} (65.10 cm in 1997-98 and 68.24 cm in 1998-99) which differed significantly from other levels. The shortest plant was measured with '0' kg B ha^{-1} (55.50 cm in 1997-98 and 57.68 cm in 1998-99). Like plant population, no significant variation on the number of secondary branches per plant was observed due to different levels of Boron under study, however, the highest number of secondary branches per plant was obtained from 2.5 kg B ha^{-1} (5.05 plant^{-1}) in 1997-98 and in 1998-99 it was the highest with 1.5 kg B ha^{-1} (5.22 plant^{-1}). There was a positive significant influence of boron fertilizer on the number of fruits per plant. The highest number of fruits per plant was obtained from 2.5 kg B ha^{-1} (45.97 in 1997-98 and 46.45 in 1998-99), which was identical to 1.5 kg B ha^{-1} (44.58 in 1998-7-98 and 45.23 in 1998-99) but differed significantly from '0' kg B ha^{-1}. Different levels of Boron had significant effect on the dry fruit weight per plant. In 1997-

Table 2: Effects between different levels of nitrogen and boron on the yield and yield components of winter chilli

Treatments	Plant population/m^2 (No.)		Plant height (cm)		Number of secondary branches plant^{-1}		Number of fruits plant^{-1}		Dry fruit weight per plant (g)		Chilli yield (dry) (ton ha^{-1})	
	1997-98	1998-99	1997-98	1998-99	1997-98	1998-99	1997-98	1998-99	1997-98	1998-99	1997-98	1998-99
0	8.53a	7.06a	48.1i	48.4a	3.6a	3.8a	32.43a	33.60a	12.5a	18.6a	0.89j	1.21lm
20	8.00a	6.60a	49.2i	49.3a	3.8a	4.1a	35.43a	36.63a	12.6a	19.6a	0.91j	1.27 l
40	9.50a	8.67a	50.5ki	51.5a	4.4a	4.5a	40.03a	41.23a	13.4a	20.4a	1.09h-j	1.51ij
60	9.50a	8.27a	52.2ij	55.3a	4.7a	4.9a	42.53a	43.80a	15.9a	22.9a	1.48g	1.85h
80 x 0.0	9.96a	8.60a	55.4hi	58.4a	5.2a	5.4a	46.16a	47.60a	17.2a	24.3a	1.72ef	2.05e-g
100	9.30a	8.30a	60.5gh	61.3a	5.8a	6.1a	46.90a	48.53a	17.5a	24.6a	1.77ef	2.14de
120	10.06a	9.33a	62.6d-g	65.1a	6.1a	6.3a	47.86a	50.50a	18.8a	25.9a	2.15c	2.51c
140	9.93a	9.00a	65.4b-f	68.0a	6.6a	6.5a	47.16a	49.61a	19.1a	26.1a	1.91de	2.45c
0	8.67a	6.73a	53.2h-k	55.2a	3.4a	3.5a	33.30a	33.52a	13.3a	20.0a	0.98j	1.36j-l
20	9.33a	7.60a	55.5h	58.3a	3.6a	3.7a	37.53a	37.70a	13.5a	21.8a	1.04ij	1.40j-
40	8.96a	7.33a	58.6h	59.4a	4.4a	4.6a	42.53a	42.70a	13.8a	22.0a	1.27h	1.58i
60	9.83a	7.93a	61.0gh	61.5a	4.6a	4.6a	45.10a	45.63a	16.7a	24.9a	1.63fg	1.99e-h
80 x 1.50	10.73a	9.33 a	62.5fg	64.2a	5.0a	5.2a	48.10a	48.80a	18.2a	26.4a	1.73ef	2.22d
100	11.20a	9.67a	64.4c-g	66.5a	5.7a	5.9a	49.51a	49.83a	18.5a	26.8a	2.17c	2.45c
120	10.99a	9.67a	65.2b-f	67.0a	6.0a	6.1a	51.03a	52.93a	20.4a	28.3a	2.45ab	2.89ab
140	9.73a	8.33a	66.5a-d	69.1a	6.5a	6.4a	49.56a	50.73a	20.1a	27.6a	2.06cd	2.47c
0	8.96a	8.40a	56.3h	58.2a	3.6a	3.8a	34.20a	34.40a	14.0a	20.3a	1.01j	1.34ld
20	9.20a	7.50a	60.5gh	62.4a	3.9a	4.0a	38.26a	38.50a	15.4a	21.7a	1.12h-j	1.40j-l
40	7.95a	8.00a	63.4c-g	65.5a	4.5a	4.6a	43.86a	44.16a	15.9a	22.2a	1.25hi	1.45i-k
60	9.83a	7.93a	65.5b-f	67.6a	4.8a	5.0a	46.60a	46.96a	18.5a	24.8a	1.59fg	1.92hg
80 x 2.50	8.60a	8.67 a	66.7abc	68.5a	5.1a	5.3a	49.26a	50.10a	20.6a	26.9a	1.69e-g	2.11d-f
100	9.66a	9.00a	68.5ab	73.5a	5.8a	6.0a	50.73a	51.20a	21.2a	27.5a	2.08cd	2.41c
120	10.33a	10.00a	69.7a	74.4a	6.2a	6.1a	52.66a	53.91a	23.8a		2.64a	3.01a
140	10.33a	9.33a	70.1a	75.7a	6.4a	6.5a	51.76a	52.40a	23.4a	29.7a	2.41b	2.78b

In a column, means followed by the same letter(s) did not differ significantly at 5 % levels of probability

99, the highest dry fruit weight per plant was recorded from 2.5 kg B ha^{-1} (19.13 g plant^{-1}) which differed significantly from other Boron levels. In 1998-99, slight variation was observed where both 2.5 kg and 1.5 kg B ha^{-1} gave the identical dry fruit weight plant^{-1}.

The chilli yield (dry fruits) were also significantly influenced by the boron fertilizer. In both the years, the highest chilli yield (dry) was recorded from 2.5 kg B ha^{-1} (1.73 ton ha^{-1} in 1997-98 and 2.05 ton ha^{-1} in 1998-99) which was identical to 1.5 kg B/ ha (1.66 ton ha^{-1} in 1997-98 and 2.03 ton ha^{-1} in 1998-99). The boron response on the chilli yield (R^2 = 0.94 in 1997-98 and 0.82 in 1998-99) was also found linear up to 2.5 kg B ha^{-1} with a significant R^2 value (Fig. 3 and 4). The lowest chilli yield was recorded from ‘0’ kg B ha^{-1} (1.49 ton ha^{-1} in 1997-98 and 1.84 ton ha^{-1} in 1998-99). Rahman *et al.* (1993) have reported that 2 kg B ha^{-1} gave the highest seed yield in mustard. They also reported that the response of boron on yield from 1 to 4 kg ha^{-1} was identical. Similarly, Mehrotra *et al.* (1977) also reported increased yield up to 69% due to boron application.

Interaction effects: Nitrogen and boron together have significant effect on plant height and chilli yield (Table 2). In 1997-98, the taller plant was observed from 140 kg N ha^{-1} when applied with 2.5 kg B ha^{-1} (70.1 cm) which was identical to 120, 100 and 80 kg N ha^{-1} when applied with 2.5 kg B ha^{-1} and with 140 kg N ha^{-1} when applied with 1.5 kg B ha^{-1}. The number of secondary branches per plant, number of fruits per plant and dry fruits weight per plant were found non-significant. In both the years, the highest chilli yield was obtained from 120 kg N ha^{-1} when applied with 2.5 kg B ha^{-1} (2.64 ton ha^{-1} in 1997-98 and 3.01 ton ha^{-1} in 1998-99) which was identical to 120 kg N ha^{-1} when applied with 1.5 kg B ha^{-1} (2.45 ton ha^{-1} in 1997-98 and 2.89 ton ha^{-1} in 1998-99). In both the years, the yield reduced significantly with 140 kg N ha^{-1} when applied either with 2.5 or 1.5 kg B ha^{-1}. This result clearly explained the fact that, whether the boron levels it was, the higher nitrogen levels beyond 120 kg N ha^{-1} badly hampered chilli yield. In both the years, irrespective of boron levels, the lowest chilli yield was obtained from ‘0’ kg N ha^{-1}.

In review of the results of the study, it was observed that for maximizing chilli yield 120 kg N ha^{-1} when applied with 2.5 kg B ha^{-1} gave identical results to 120 kg N ha^{-1} when applied with 1.5 kg B ha^{-1}. Therefore, considering the cost effectness of the applied fertilizer and stability of the crop yield 120 kg N ha^{-1} coupled with 1.5 kg B ha^{-1} may be an alternative.

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