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APPLICATION OF NITROGEN AND BORON ON GROWTH AND NUTRIENT CONTENTS OF OKRA (*Abelmoschus esculentus* L.) GROWN ON SOIL

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Abstract

A pot experiment was conducted in the net house of the Department of Soil, Water and Environment, University of Dhaka to find out the interactive effects of nitrogen (0, 30, 60 and 120 kg/ha) and boron (0, 0.5, 1 and 2 kg/ha) fertilizers on the growth and nutrient contents of okra (*Abelmoschus esculentus* L.). The increase in height of okra was significant ($p<0.05$) due to combined application of nitrogen and boron fertilizers. Maximum height, shoot and root dry matter yield and uptake of nutrients in root and shoot of okra were observed in treatment 30 kg N/ha with 1 kg B/ha ($N_{30}B_1$). But, higher doses of fertilizer combinations (60 and 120 kg of N/ ha with B) responded differently. Higher doses of fertilizer combinations significantly ($p<0.05$) reduced shoot and root growth as well as the concentration and uptake of nitrogen, phosphorus potassium in okra. It could be concluded that the treatment combination of 30 kg N/ha with 1 kg B/ha can be used for better growth of okra.

Key words: Okra, N and B fertilizers, Growth, Dry matter yield and uptake, Concentration of nutrients

Introduction

Okra (*Abelmoschus esculentus* L.) is a tall-growing, summer season, annual vegetable. It is mainly cultivated in kharif season in Bangladesh. Its tender green fruits are popular as vegetable among all classes of people in Bangladesh and elsewhere in the world. Though it is popular in our country, its production is mainly confined during summer. The total vegetable production around 30% is produced during kharif season and 70% is produced in Rabi season in Bangladesh. The production of okra was 39000 metric tons during the year 2007-2008 having about 4% share in the total summer vegetable production (BBS 2008). In spite of all our efforts to increase okra yield in the country, its yield is much lower (3.1 tha^{-1}) than that of other agriculturally developed countries (7.12 tha^{-1}) (FAO 2007).

The low yield of okra in Bangladesh may be due to improper use of fertilizers and poor management practices. Fertilizing should be planned, so that nutrition dose not become a limiting factor on the way of achieving good returns from crops which are expensive to grow. Significant increase in the growth and yield of okra plants was observed after the

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application N and or NPK (Katung *et al.* 1996). Similar trends were also reported by many scientists (Hooda *et al.* 1980, Mani and Ramnathan 1980, Majanbu *et al.* 1985, Philip *et al.* 2010 and Rahman and Akter 2012). They concluded that the higher yield of okra plants was observed due to application of NPK. Tariq and Mott (2006) and Riaz and Irshad (2011) had reported that boron significantly effective in yield matter of various crops. Boron deficiency have been reported to result considerable yield reduction in annual, cereal and oil seed crops (Zia *et al.* 2006).

Few reports on the effect of N and B fertilizers on the height, dry matter yield and nutrient contents of okra plants are available in Bangladesh. Thus the present study was undertaken to evaluate the impacts of various levels of nitrogen and boron and their interaction on height, dry matter yield and nutrient contents of okra plants grown on soil.

Materials and Methods

Soil sample collected from the bank of the river Turag (Near Baliarpur, Savar) at a depth of 0-15 cm was air-dried, ground, sieved and stored in polyethylene bags for physical and chemical analysis. The physicochemical properties of soil are presented in Table 1.

Table 1. Physicochemical characteristics of the soil used in the pot experiment.

Characteristics	Values
pH (1:2.5 W/V H_2O)	6.5
Organic C[a] (%)	1.1
Available N[b] (%)	0.002
Available P[c] (mg/kg)	15
Available K[c] (mg/kg)	150
Available B[d] (mg/kg)	0.40
Available Fe[e] (mg/kg)	20
Available Cu[e] (mg/kg)	0.10
Moisture percentage (%)	2.58
Water holding capacity (%)	33
Particle size analysis[f]	
Sand (%)	25
Silt (%)	64
Clay (%)	11
Texture	Silt loam

[a] Wet oxidation method (Walkley and Black 1934), [b]Kjeldahl's distillation method (Jackson 1973), [c]Troug's extraction reagent (Imamul Huq and Alam 2005), [c]1N ammonium acetate at p^H 7 (Imamul Huq and Alam 2005), [d]Hot water method (Berger and Truog 1939), [e]DTPA extracting solution (Sarkar and Haldar 2010), [f]Hydrometer method (Bouyoucos 1962).

Pot experiment: Eight kg air dried soil was taken in the plastic pot. Nitrogen at the rate of 0, 30, 60, 120 and boron at the rate of 0, 0.5, 1, 2 kg /ha were added according to treatment combinations. Treatments combinations ($kgha^{-1}$) were as follows: N_0B_0, $N_0B_{0.5}$, N_0B_1, N_0B_2, $N_{30}B_0$, $N_{30}B_{0.5}$, N_0B_1, $N_{30}B_2$, $N_{60}B_0$, $N_{60}B_{0.5}$, $N_{60}B_1$, $N_{60}B_2$, $N_{120}B_0$, $N_{120}B_{0.5}$, $N_{120}B_1$ and $N_{120}B_2$. Urea and boric acid were used as a source of N and B, respectively. A basal dose of phosphorus and potassium at the rate of 50 kg/ha and 30 kg/ha was applied as triple super phosphate (TSP) and muriate of potash (MP), respectively (BARC 2005). The fertilizers were mixed thoroughly with the soil as per treatment combinations in the form of solution. There were 16 treatment combinations with 3 replications. Pots were arranged in a Randomized Complete Block Design (RCBD) design.

Five seeds of okra (variety: okra green finger F1) were sown per pot in pre-kharif season. After germination three seeds were kept in each pot. The pots were kept moist by adding distilled water, whenever required. Weeds were removed as they appeared. The uprooted roots of weeds were washed with small amount of water into the respective pot so that no nutrient loss could occurred by the roots. Insecticide was sprayed once at the last stage of growing period. Plant height was recorded at 10 days interval.

Harvesting and analysis: Eight week old plants were harvested as shoots and roots. Roots were washed with water. Shoots and roots were air-dried, oven-dried (65°C), weighed, ground (<1 mm) in a mechanical grinder and stored in air-tight polyethylene bags. For total N analysis, 0.1 g ground shoots and 0.01g ground roots was digested (360°C) with 5 ml concentrated H_2SO_4 and 2 ml 4% (V/V) solution of perchloric acid (62%) in concentrated H_2SO_4 (Cresser and Parsons 1979). The concentration of N in shoots or roots was determined using microkjeldahl's distillation apparatus in the presence of excess 40% NaOH. The concentration of P in shoots and roots was determined after developing yellow color with venado-molybdate at 470 nm wave length of spectrophotometer. The concentration of K in shoots and roots was determined by feeding the extract into a flame photometer. The uptake of N, P and K in shoots and roots was determined through multiplying concentration with total amount of shoot and root yields.

Data analysis: All growth and nutrient concentration and uptake data are subjected to statistical analysis. ANOVA were done to observe any significant interactions between N and B (SPSS software ver. 20 and cropstat softwer ver. 7.2). LSD test was carried out to separate means (Zaman *et al.* 1982)

Results and Discussion

The height of okra plants at different days interval presented in Table 2 shows that height of okra plants increased significantly ($P<0.05$) with time (10, 20, 30, 40 and 50 days) at different treatments. However, the increase in height was significant ($p<0.05$) due to

combined application of nitrogen and boron fertilizers with time, but differences were observed among the treatments, especially higher doses of combined application of nitrogen and boron fertilizers reduced the height of plants. Among the fertilizer doses, the response of 30 kg N/ha combined with 1 kg B/ha showed higher plants height at different days interval. Firoz (2009) reported that the height of okra plants increased due to combined application of nitrogen and phosphorus.

Table 2. Effects of N and B on the height (cm) of okra plants (*Abelmoscus esculentus* L.) at 10 days interval grown on soil.

Treatments (kg/ha)	Height (cm) of okra plants				
	Days after sowing				
	10d	20d	30d	40d	50d
N_0B_0	19.00ab	20.83a	23.33a	27.27a	30.67a
$N_0B_{0.5}$	22.33a	27.67c	33.23bcd	36.83bc	40.67bcd
N_0B_1	19.50ac	22.83ab	26.33ab	31.00ab	32.67abc
N_0B_2	19.90ab	22.67ab	25.17ab	29.57ab	33.00abc
$N_{30}B_0$	19.00abc	20.83a	23.00a	27.27a	30.67a
$N_{30}B_{0.5}$	20.33a,b	27.83c	32.03bcd	35.17bc	39.83bcd
$N_{30}B_1$	22.67a,b	29.00d	33.33bcd	37.17bc	44.17bcd
$N_{30}B_2$	16.33c	21.83ab	25.00a	28.00a	31.00a
$N_{60}B_0$	20.83a,b	24.50abc	27.50abc	29.17ab	30.83a
$N_{60}B_{0.5}$	21.23a,b	27.83c	33.00bcd	37.17bc	41.00bcd
$N_{60}B_1$	22.33a	25.67bc	30.50bcd	34.93bc	38.83abc
$N_{60}B_2$	16.00c	20.67a	25.67ab	28.17a	31.83ab
$N_{120}B_0$	20.50a,b	23.33ab	26.50ab	28.4a	31.67ab
$N_{120}B_{0.5}$	19.00bc	25.00bc	30.05bcd	31.25ab	34.83abc
$N_{120}B_1$	19.83abc	21.17a	25.27ab	26.67a	29.33a
$N_{120}B_2$	18.16bc	20.33a	23.00a	26.00a	28.00a
P value	0.036	0.00	0.00	0.002	0.007
LSD at 5%	3.85	4.11	5.45	6.45	8.51
CV(%)	17.08	13.63	11.99	11.74	16.04

Most of the treatments increased dry matter yield significantly ($p<0.05$) of okra plants (Table 3). The highest yield of shoots and roots were 1.15 and 0.5 g/plant, respectively in $N_{30}B_1$ treatment combination. Hussain *et al.* (2012) showed that the interactive effects of nitrogen and boron on yield and quality of broccoli was significant. Shaghdish *et al.* (2013) also suggested that application of nitrogen and spraying the elemental boron increased yield of corns.

Concentration and uptake of N, P and K in the shoots of okra plants harvested at 55 days after sowing are presented in Table 4. The N concentration and uptake in the shoot of

okra plants varied significantly ($p<0.05$). The highest N concentration was found in $N_{120}B_{0.5}$ but the highest N uptake was observed in $N_{30}B_1$ treatment which is similar to effects on height and dry matter yield. Concentration and uptake of P and K were also significant ($P<0.05$) due to combined application of N and B. Similar effect was found on concentration and uptake of P and K where highest uptake of P and both uptake and concentration of K in the treatment $N_{30}B_1$. Similar results were also reported by Chouliaras *et al.* (2009). Who concluded that application of N, B and seaweeds increased productivity and improved nutrition status of olive. Gupta *et al.* (1976) also reported that application of N and B influenced nitrogen and boron concentrations on barley and wheat.

Table 3. Effects of N and B on dry matter yield (g/plant) of okra plants (*Abelmoscus esculentus* L.) harvested at 55 days after sowing.

Treatments (kg/ha)	Shoot dry matter (g/plant)	Root dry matter (g/plant)
N_0B_0	0.18 a	0.07a
$N_0B_{0.5}$	0.50bcd	0.22b
N_0B_1	0.27ab	0.10a
N_0B_2	0.13a	0.05a
$N_{30}B_0$	0.34abc	0.13a
$N_{30}B_{0.5}$	0.63cd	0.27b
$N_{30}B_1$	1.15e	0.50c
$N_{30}B_2$	0.37abc	0.15d
$N_{60}B_0$	0.30ab	0.12ad
$N_{60}B_{0.5}$	0.60cd	0.30e
$N_{60}B_1$	0.72d	0.35e
$N_{60}B_2$	0.38abc	0.17d
$N_{120}B_0$	0.27ab	0.10a
$N_{120}B_{0.5}$	0.41abc	0.19d
$N_{120}B_1$	0.22ab	0.09a
$N_{120}B_2$	0.20ab	0.07a
P value	0.00	0.00
LSD at 5 %	0.304	0.053

The NPK concentration and uptake in the roots of okra plants varied significantly ($p<0.05$) (Table 5). The N concentration of root varied accordingly to treatment combination but the highest N uptake was observed in $N_{30}B_1$ treatment. On the other hand, highest concentration and uptake of P and K were also observed in $N_{30}B_1$

Table 4. Effects of N and B on the concentration and uptake of N, P, K and B in the shoot of okra (*Abelmoscus esculentus* L.) harvested at 55 days after sowing.

Treatments	N		P		K		B	
(kg/ha)	Concentration (%)	Uptake (mg/plant)	Concentration (%)	Uptake (mg/plant)	Concentration (%)	Uptake (mg/plant)	Concentration (ppm)	Uptake (µg/plant)
N_0B_0	1.35a	2.43a	0.52a	0.94a	1.85a	3.33a	53a	9.54a
$N_0B_{0.5}$	1.38a	6.90f	0.45a	2.25f	1.49a	7.45d	78c	39.00g
N_0B_1	1.44ab	3.89c	0.48a	1.29c	1.21a	3.27a	85d	22.95d
N_0B_2	1.40a	1.82b	0.49a	0.64b	1.60a	2.08b	200h	26.00e
$N_{30}B_0$	1.57bc	5.34e	0.48a	1.63d	1.41a	4.79c	55a	18.70c
$N_{30}B_{0.5}$	1.59bc	10.0g	0.53a	3.34h	1.85a	11.5e	95e	59.85j
$N_{30}B_1$	1.67c	19.2i	0.56a	6.44i	2.69b	30.9f	115f	132.2l
$N_{30}B_2$	1.48ab	5.47e	0.45a	1.67d	1.59a	5.88g	230i	85.10k
$N_{60}B_0$	1.60bc	4.80d	0.44a	1.32c	0.61c	1.83h	58a	17.40c
$N_{60}B_{0.5}$	1.80d	10.8g	0.49a	2.94g	2.06a	12.3c	90de	54.00i
$N_{60}B_1$	1.70bcd	12.2h	0.48a	3.46h	1.65a	11.8e	120f	86.40k
$N_{60}B_2$	1.50ab	5.70e	0.59a	2.24f	1.89a	7.18d	160g	60.80j
$N_{120}B_0$	1.73bcd	4.67d	0.48a	1.29c	1.22a	3.29a	55a	14.85b
$N_{120}B_{0.5}$	1.89e	7.75f	0.46a	1.89e	1.24a	5.08i	75bc	30.75f
$N_{120}B_1$	1.53b	3.37c	0.48a	1.06a	1.66a	3.65a	65ab	14.30b
$N_{120}B_2$	1.33a	2.66a	0.55a	1.10a	1.23a	2.46b	250j	50.00h
p value	0	0	0.019	0	0	0	0	0
LSD at 5%	0.159	0.473	0.106	0.167	0.633	0.75	21.66	38.07

Table 5. Effects of N and B on the concentration and uptake N, P, K and B in the roots of okra (*Abelmoscus esculentus* L.) harvested at 55 days after sowing.

Treatments	N		P		K		B	
(kg/ha)	Concentration (%)	Uptake (mg/plant)	Concentration (%)	Uptake (mg/plant)	Concentration (%)	Uptake (mg/plant)	Concentration (ppm)	Uptake (µg/plant
N_0B_0	0.06a	0.04a	0.03a	0.02a	0.11a	0.08a	25a	1.75a
$N_0B_{0.5}$	0.12bcd	0.26c	0.07ab	0.15bc	0.15a	0.33g	39b	8.58c
N_0B_2	0.02a	0.01a	0.02a	0.01a	0.05a	0.03a	86f	4.30ab
N_0B_1	0.13bcd	0.13b	0.05a	0.05a	0.15a	0.15b	60d	6.00bc
$N_{30}B_0$	0.11abcd	0.14b	0.03a	0.04a	0.20b	0.26e	37b	4.81ab
$N_{30}B_{0.5}$	0.17bcde	0.46e	0.06a	0.16bc	0.20b	0.54k	63d	17.01e
$N_{30}B_1$	0.15bcde	0.75g	0.11b	0.55e	0.30c	1.50l	75e	37.50h
$N_{30}B_2$	0.04a	0.06a	0.04a	0.06a	0.20b	0.30f	70e	10.50d
$N_{60}B_0$	0.11abcd	0.13b	0.06a	0.07a	0.19b	0.23d	23a	2.76ab
$N_{60}B_{0.5}$	0.19cde	0.57f	0.07ab	0.21cd	0.20b	0.60i	80f	24.00f
$N_{60}B_1$	0.04a	0.14b	0.04a	0.14bc	0.20b	0.70j	90g	31.5g
$N_{60}B_2$	0.10abcd	0.1b	0.03a	0.05a	0.10a	0.17c	73c	12.41d
$N_{120}B_0$	0.12bcd	0.1b	0.05a	0.05a	0.12a	0.12c	22a	2.20ab
$N_{120}B_{0.5}$	0.20cde	0.38d	0.07ab	0.13bc	0.06a	0.11ab	60d	11.4d
$N_{120}B_1$	0.10abcd	0.09ab	0.03a	0.03a	0.20b	0.18bc	50c	4.50ab
$N_{120}B_2$	0.15bcde	0.11b	0.03a	0.02a	0.20b	014bc	80f	5.60b
p value	0	0	0	0	0	0	0	0
LSD at 5%	0.056	0.055	0.056	0.05	0.075	0.053	17.75	11.38

treatment. Rahman and Akter (2012) showed that application of various levels of NPK influenced the concentration of NPK of okra plants. Higher doses of fertilizer combination (N X B) also reduced the concentration and uptake of NPK in root and shoot as well as height and root and shoot dry matter yield. This may be due to nutrient toxicity because this toxicity occurs when plant growth and yield decrease with increasing plant nutrient (BARC, 2012).

The present study reveals that the application of various doses of nitrogen and boron had significant effect on height, dry matter yield and nutrient contents of okra plants. Among the doses, nitrogen (N) at the rate of 30 kg/ha and boron (B) at the rate of 1 kg/ha gave maximum height, dry matter yield and uptake of NPK. This might be due to combined application of macro and micro nutrients.

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