EFFECTS OF BORON AND VERMICOMPOST ON GROWTH, YIELD AND NUTRIENT CONTENT OF CHILLI (*Capsicum annum* L.)

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Abstract

The effects of boron (B) and vermicompost (VC) on growth and yield of Chilli (*Capsicum annum* L.) and nutrient accumulation in its fruits was examined. The highest plant height (22 cm), leaf number per plant (73), leaf area (502.53 cm^2/plant), dry weight (22.27g/plant), fruit length (8.97cm), fruit number per plant (6), fruit yield (11.76 g/plant) were recorded in $B_{0.5}$ kg/ha + VC_5 ton/ha at harvest. The results of growth and yield of Chilli varied significantly ($p<0.05$) and increased with time. The total nutrient concentrations in the fruits were measured and varied significantly ($p<0.05$). The highest concentration of total P (0.028 %), K (2.50%), S (0.20 %), Cu (8.0 mg/kg), Fe (410 mg/kg) and Mn (0.80 mg/kg) in the fruit were observed in $B_{0.5}$ kg/ha +VC_5 ton/ha treatment and total N (0.41 %) and Zn (3.50 mg/kg) were found in $B_{1.5}$ kg/ha + VC_5 ton/ha treatment. The overall best growth, yield and nutrient accumulation in the fruits of Chilli was achieved in $B_{0.5}$ kg/ha + VC_5 t/ha treatment.

***Key words*:** Boron; Chilli; Growth; Nutrient accumulation; Vermicompost.

INTRODUCTION

Vermicompost is the excreta of earthworms, which are rich in humus, macronutrients, and micronutrients that can improve and enhance crop production (Adhikary, 2012; Azarmi *et al*. 2008). Vermicompost to the soil is very beneficial, in increasing nutrient availability (Roy *et al*. 2006) and improve the growth and fruit yield (Theunissen *et al*. 2010). Chilli is a rich source of vitamins A, C and E where 100 gram of edible portion contains 24k cal of energy, 1.3 g of protein, 4.3 g of carbohydrate and 0.3 g of fat (Vijayalakshmi and Gayathri, 2017). Considering the above nutritional value, an experiment was undertaken to investigate the effect of vermicompost and boron on growth, yield and nutrient contents of fruit of Chilli (*Capsicum annum* L.).

METERIAL AND METHODS

Soil sample collection and some physical and chemical properties

Soil sample (0-15cm depth) was collected from Dhamrai Upazila following composite sampling method. The sample was air dried and ground and sieved through 2 mm sieve. The soil had a pH of 7.54 (Jackson, 1965), electrical conductivity 49.9 ds/m (Jackson, 1965), organic carbon 0.16 % (Walkley and Black, 1934), organic matter 0.27%, available nitrogen 0.016% (Kjeldahl extraction; Jackson, 1965), available phosphorus 0.042% (blue color method using ascorbic acid, Olsen *et al*. 1954), exchangeable potassium 0.030% (Pratt, 1965), available sulphur 0.0048% (Turbidimetric method, Bardsley and Lancaster, 1965). The concentrations of total iron was 2310 mg/kg, manganese 421 mg/kg, zinc 75 mg/kg and copper 26 mg/kg were determined using an atomic absorption spectrophotometer followed by Mordtvedt *et al*. (1991).

Preparation and properties of vermicompost

Vermicompost was prepared and collected from the crop field of Soil Resource Development Institute (SRDI). In this process, the digestive tracts of certain earthworm species (e.g. *Eisenia fetida*) were used to stabilize cow dung. The final product is an odourless peat like substance. Some chemical properties of vermicompost were mentioned in Table 1.

Table 1. Chemical properties of the processed vermicompost.

Parameters	Chemical properties	Analytical methods used
pH	6.54	Jackson, 1965
Organic carbon (%)	9.87	-
Organic matter (%)	17.01	Walkley and Black, 1934
C:N ratio	8.54	-
Total nitrogen (%)	1.25	Kjeldahl extraction (Jackson, 1965)
Total phosphorus (%)	0.059	Blue color method using ascorbic acid, (Olsen et al. 1954)
Total potassium (%)	0.242	(Pratt, 1965)
Available Fe (mg/kg)	0.11	(Jackson, 1965)
Available Mn ″	0.69	″
Available Zn ″	2.17	″
Available Cu ″	0.01	″
Available B ″	0.601	″

Pot experiment

A pot experiment was carried out in the net house of the Department of Soil, Water and Environment, University of Dhaka. Eight kilograms of air dried soil were placed in 10 kg capacity pot providing a drainage hole at the bottom. Eight treatments with three replications were as follows: control (-B and VC), VC_5 ton/ha, $B_{0.5}$ kg/ha, $B_{1.0}$ kg/ha, $B_{1.5}$ kg/ha, $B_{0.5}$ kg/ha+VC_5 ton/ha, $B_{1.0}$ kg/ha+VC_5 ton/ha, and $B_{1.5}$ kg/ha + VC_5 ton/ha. Pots were arranged in a completely randomized design (CRD). Urea, TSP and MP fertilizers were applied in quantities of 20 kg/ha, 15 kg/ha and 30 kg/ha, respectively in each pot as basal dose. Boron was used as boric acid. Certified seeds of Chilli, (*Capsicum annum* L.) were collected from 'quality seed company', Siddique Bazar, Dhaka. Three healthy seeds were sown to each pot and water was applied up to field capacity. One healthy seedling was kept in each pot. The pots were watered thrice a week in the morning. Plant height, the number of leaf and leaf area per plant were recorded at 60 and 120 days.

Harvesting

The plants were harvested as root, stem, leaf and fruit. The roots were washed with tap water and finally with distilled water to remove any adhering particles on the root surface. Samples were air dried in room temperature and finally oven-dried at 65^0 C for 48 hours in the laboratory. The dry weight of the samples was recorded and the samples were ground with a mechanical grinder and stored in plastic containers for further chemical analysis. For nitrogen, 0.5 g of yield (fruit) sample was digested in a Kjeldhal digestion flask (Jackson, 1965), for P and K 0.5 g yield (fruit) was digested (Jackson, 1965). Phosphorus of the digest was determined by vanadomolybdophophoric yellow color method at 430 nm using spectrophotometer (model DR 5000). Potassium in the digest was determined by using JENWAY flame photometer (model PFP 7). For sulfur 0.5 g yield (fruit) sample was digested with HNO_3-$HClO_4$ acid. After digestion, the extract was used to determine the total sulfur content by turbidimetric method (Bardsley and Lancaster, 1965). For total Cu, Fe, Zn and Mn were determined by the atomic absorption spectrophotometer (VARIAN AA240). LSD tests of the result were performed using IBM SPSS, version 25.

RESULTS AND DISCUSSION

Plant growth, yield and nutrient accumulation in the fruits were assessed in terms of plant height, leaf number, leaf area and yield attributes (Table 2), and macro and micro nutrients concentration in the fruits of chili plants (Table 3). Height, leaf number and leaf area of chilli plant increased with time and varied significantly ($p<0.05$) (Table 2). However, the highest plant height (22 cm) was observed in $B_{0.5}$

kg/ha + VC_5 ton/ha treatment. Singh *et al*. (2008) reported that vermicompost application potentially increases plant spread, leaf area, dry matter and fruit yield in strawberry plants.

The highest leaf number was recorded 73 in $B_{0.5}$ kg/ha+VC_5 ton/ha treatment at harvest. It was found that the number of leaf significantly increased with the combined application of organic and inorganic fertilizer. Pettter *et al*. (2012) confirmed that integrated application of organic and inorganic fertilizers significantly increased plant growth and crop productivity. Khadir *et al*. (2002) also observed that combined application of different inorganic and organic fertilizers increased both vegetative and leaf number in cabbage. Leaf area was maximum (502.53 cm^2/plant) in $B_{0.5}$ kg/ha +VC_5 ton/ha treatment. The application of vermicompost in combination with chemical fertilizer resulted in higher leaf area index. Similar result was recorded by Jeyabal and Kuppuswamy (2001), reported that with a higher leaf area index, plants become photosynthetically more active, which would contribute to the improvement in yield attributes. Vermicompost contained numerous humic acids, which enhances the number of leaf, leaf area index, plant height and ultimately increased the growth rate (Atarzadeh *et al*. 2013).

Table 2. Effects of Boron and Vermicompost on the height (cm), leaf number (number/plant), leaf area (cm^2/plant) and yield attributes of Chilli plants.

Treatments	Plant height at 120 days	Leaf number at 120 days	Leaf area at 120 days	Dry weight of root (g/ plant)	Dry weight of shoot (g/ plant)	Dry weight of leaf (g/ plant)	Total (g/ plant)	Fruit length (cm)	Fruit number	Fruit yield (g/ plant)
Control (-B and VC	11.51	53.01	295.79	3.17	6.66	8.14	17.97	5.62	2	6.93
VC_5 ton/ha	17.50	69.23	346.05	3.63	8.63	7.18	19.44	8.85	5	11.63
$B_{0.5}$ kg/ha	14.00	55.87	357.51	2.36	8.05	10.63	21.04	6.68	4	10.76
B_1 kg/ha	17.00	62.33	324.71	3.27	6.78	11.5	21.55	6.64	5	11.22
$B_{1.5}$ kg/ha	13.50	67.46	305.68	3.80	7.93	9.50	21.23	8.29	5	10.58
$B_{0.5}$kg/ha+VC_5 ton/ha	22.00	73.00	502.53	4.25	8.88	9.14	22.27	8.97	6	11.76
$B_{1.0}$kg/ha+VC_5 ton/ha	14.00	72.82	448.79	2.67	6.24	8.84	17.75	7.33	5	10.95
$B_{1.5}$kg/ha+VC_5 ton/ha	13.50	58.94	337.20	1.62	6.64	7.39	15.65	7.33	4	10.95
LSD at 5%	0.750	1.048	0.987	0.727	1.036	2.953	-	0.89	0.84	1.33

Dry matter yield

Dry weights of root, stem and leaf are presented in Table 2 varied significantly ($p<0.05$). The highest yields of root, stem and leaf were achieved due to the combined application of inorganic and organic fertilizer in $B_{0.5}$ kg/ha + VC_5 ton/ha treatment. The highest dry weight was found (22.27 g/plant), in $B_{0.5}$ kg/ha + VC_5 ton/ha treatment. Results of the fruit length and fruit number per plant of chilli during harvest, (Table 2) varied significantly ($p<0.05$). The maximum fruit length (8.97 cm) of chilli was observed in $B_{0.5}$ kg/ha +VC_5 ton/ha treatment. The second highest fruit length (8.85 cm) was found in VC_5 ton/ha treatment. The lowest fruit length (5.62 cm) was observed in control. The maximum number of fruit per plant was six, observed in $B_{0.5}$ kg/ha + VC_5 ton/ha treatment. The second highest number of fruit per plant was five, recorded in VC_5 ton/ha, B_1 kg/ha, $B_{1.5}$ kg/ha and B_1 kg/ha + VC_5 ton/ha treatments, respectively. The minimum number of fruit per plant was two, found in control. This increase in yield attributes might be due to the high levels of organic nutrients of vermicompost that could boost up the vegetative growth of chilli plants to accelerate the photosynthetic rate. Treatments that received vermicompost significantly increased yield compared to control. However, the maximum fruit yield (11.76 g/plant) obtained in combination of B and vermicompost; in $B_{0.5}$ kg/ha +VC_5 ton/ha treatment. Hossain *et al*. (2012) noted that vermicompost potentially enhances higher yields in tomato plants rather than other fertilizers.

Mean values of total macro and micro nutrient concentrations in the fruits of Chilli as affected by boron and vermicompost are presented in Table 3. The results varied significantly ($p<0.05$) at 5% level. The N concentration in the fruits ranged from 0.13 to 0.41% among the treatments. The highest N concentration (0.41 %) was recorded in $B_{1.5}$ kg/ha + VC_5 ton/ha treatment. The lowest concentration of N was observed in control treatment. P concentration ranged from 0.019 to 0.028% among the treatments. The highest P concentration (0.028 %) was recorded in the fruits was obtained in $B_{0.5}$ kg /ha + VC_5 ton/ha treatment. The highest total K concentration (2.50 %) in the fruits was obtained in $B_{0.5}$ kg/ha + VC_5 ton/ha treatment. The second highest K concentration (2.40 %) was found in $B_{1.5}$ kg/ha treatment. The highest total S concentration (0.20 %) in the fruits was obtained in $B_{0.5}$ kg/ha+VC_5 ton/ha treatment. The lowest total N (0.13 %), P (0.019 %), K (1 %), and S (0.03 %) were observed in control. The highest total Cu (8.0 mg/kg) in the fruits was obtained in $B_{0.5}$ kg/ha + VC_5 ton/ha treatment. The highest total Zn (3.5 mg/kg) in the fruits was obtained in $B_{1.5}$ kg/ha + VC_5 ton/ha treatment. The highest total Fe (210 mg/kg) and Mn (0.8 mg/kg) in fruits were obtained in $B_{0.5}$ kg/ha + VC_5 ton/ha treatment. The lowest total Cu (4.0 mg/kg), Zn (1.6 mg/kg), Fe (120 mg/kg), and Mn (0.1 mg/kg) were recorded in control. The maximum amount of total macro and micro nutrient concentrations in the fruits of Chilli was possibly due to proper doses of organic and inorganic fertilizers in $B_{0.5}$ kg/ha + VC_5 ton/ha and $B_{1.5}$ kg/ha + VC ton/ha treatments. Zaman *et al.* (2018) reported that vermicompost along with different rates of chemical fertilzers exerted significant influence on the growth, leaf biomass yield and stevioside content of stevia.

Table 3. Effects of Boron and Vermicompost on macro and micro nutrients concentration in the fruits of Chilli plants.

Treatments	N (%)	P (%)	K (%)	S (%)	Cu (mg/kg)	Zn (mg/kg)	Fe (mg/kg)	Mn (mg/kg)
Control (-B and VC	0.13	0.019	1.00	0.03	4	1.6	120	0.1
VC_5 ton/ha	0.34	0.024	2.40	0.19	5	1.9	210	0.7
$B_{0.5}$ kg/ha	0.31	0.027	1.90	0.19	4	1.9	150	0.7
B_1 kg/ha	0.33	0.026	1.40	0.06	5	2.8	210	0.2
$B_{1.5}$ kg/ha	0.34	0.020	2.40	0.10	6	1.8	160	0.4
$B_{0.5}$kg/ha+VC_5 ton/ha	0.40	0.028	2.50	0.20	8	2.2	210	0.8
$B_{1.0}$kg/ha+VC_5 ton/ha	0.31	0.025	1.53	0.19	5	2.8	130	0.7
$B_{1.5}$kg/ha+VC_5 ton/ha	0.41	0.026	1.40	0.10	5	3.5	140	0.7
LSD at 5%	.007	0.041	.342	.005	.051	.002	.001	.008

The results revealed that B and vermicompost shared better effects on growth and yield attribute significantly of Chilli (*Capsicum annum* L.). Better growth and yield were achieved in $B_{0.5}$ kg/ha + VC_5 ton/ha treatment and nutrient accumulation in the fruits was found in $B_{0.5}$ kg/ha + VC_5 ton/ha and $B_{1.5}$ kg/ha + VC_5 ton/ha treatments respectively.

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