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NUTRITIONAL AND AGRONOMIC RESPONSE OF EGGPLANT (*SOLANUM MELONGENA* L.) TO THE APPLICATION OF VERMICOMPOST, POTASSIUM AND BORON

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Abstract

A pot experiment was conducted to study the effect of vermicompost (VC), potassium (K) and boron (B) on the growth, yield and mineral nutrient accumulation of eggplant (*Solanum melongena* L.). Eight treatments were arranged in a completely randomized design (CRD) with three replications including control. Application of VC_8K_{60} (T_5) resulted in the highest plant height (60 cm). However, $VC_8K_{60}B_{0.4}$ (T_8) recorded the maximum leaf number (17 plant^{-1}), leaf area (264 cm^2), fruit petiole (4.15 plant^{-1}), fruit number (3.50 plant^{-1}), total fresh (143.15 g plant^{-1}) and dry weight (16.4 g plant^{-1}). Application of $VC_8K_{60}B_{0.4}$ (T_8) helped the improvement of the N, P, K, S, Fe and Zn concentrations of the roots, leaves and fruits. Result of growth, yield attributes and nutrient content varied significantly ($p \leq 0.05$). Hence, to achieve higher fruit yield with higher nutrient concentration the soil should be supplied with vermicompost, muriate of potash (50% K) and boric acid (17% B) at a required rate. However, for a good recommendation field trials are needed in major agroecosystems of the country.

Introduction

Eggplant (*Solanum melongena* L.), belonging to Solanaceae, is a widely cultivated vegetable crop. It has high nutritional and medicinal value. It is also known as ‘Aubergine,’ ‘Brinjal,’ or ‘Guinea Squash.’ With a total production of 409,001 metric tons on 84,537 hectares, eggplant is the second-most significant crop farmed in Bangladesh (BBS 2022). Eggplant is grown in almost all agro-climatic zones, with over 100 varieties under cultivation, offering fruits of different colors, sizes, shapes, and tastes. Tender fruits of eggplant contain protein, minerals, vitamins (A and B) and iron (Gurbuz *et al.* 2018). Its extract reduces live cholesterol and blood pressure in humans, and white-type eggplant fruit is suitable for diabetic patients. It is used to treat many ailments, which include asthma, arthritis, bronchitis and diabetes (Magioli and Mansur 2005). Like many other crops, soil nutrient deficiencies often affect eggplant, resulting in reduced yield and quality. Researchers have explored various soil fertility management strategies to overcome this challenge, including using organic and inorganic fertilizers.

The organic farming technique plays a good role in cultivating high-value vegetable crops (Mishra *et al.* 2018). Vermicompost is a good source of different macro and micronutrients, particularly NPK. It increases the absorbability and retention of nutrients for a longer period (Mamta *et al.* 2012). Contrarily the use of synthetic fertilizers might have a negative impact on the environment. In addition, organic farming would help to reduce the additional burden of environmental pollution.

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Potassium (K) has been found to improve plant tolerance to various abiotic stresses, including drought and salinity. This is because potassium plays a crucial role in maintaining cell turgor pressure, regulating stomatal opening, and enhancing the activity of antioxidant enzymes, thereby reducing oxidative stress and enhancing plant defense mechanisms (Niu *et al.* 2020). Studies have shown that this element can improve the quality and yield of various crops, including eggplant. Boron (B) is another essential nutrient (which is a micronutrient) for the normal growth and development of a plant. It is required in small amounts, but its deficiency can result in reduced root and shoot growth, poor fruit development, and low-quality fruit (Reid 2007). In Italy Proietti *et al.* (2013) reported that boron application increased the total yield of eggplants by up to 47%, indicating the critical role of boron in crop productivity. These observations indicate that farmers should manage soil fertility levels for eggplant cultivation in an integrated way by using organic and inorganic fertilizers. Thus, the present study was undertaken to monitor the effects of vermicompost, potassium, and boron on the performance of eggplant production and to suggest the best combination of compost and fertilizers (MoP and boric acid) for eggplant cultivation.

Materials and Methods

A pot experiment was laid out at the net house of the Department of Soil, Water and Environment under University of Dhaka. The investigation was undertaken during the summer, from April to June 2020. An amount of 7 kg of soil was taken in a 10- kg plastic pot (24.5 × 23 cm). Vermicompost (8 t ha^{-1}), potassium (60 kg ha^{-1}) as MoP, and boron (0.4 kg ha^{-1}) as H_3BO_3 were applied. Eight treatments with three replications were arranged following a Completely Randomized Design. A hybrid eggplant variety F1 of 1-month old eggplant were collected from the Horticulture Centre, Asadgate, Dhaka and planted one plant in each pot. After 75 days, eggplants with fruits were harvested for the first time. Vegetative growth parameters, *viz.* plant height, leaf number, leaf area, fruit petiole, fruit number, and fresh and dry weight of fruits were measured.

Bulk soil (0-15 cm depth) were collected from an agricultural field of Duptara, Araihazar, Narayanganj. Then soil was air-dried, grounded, and sieved through a 2-mm sieve. Soil physico-chemical attributes, *viz.* soil pH 7.39 (Jackson 1973), soil EC 128.80 µS/m (Richards 1954), soil organic matter content 1.04% (Walkley and Black 1934), available N 28 mg kg^{-1} (Marr and Cresser 1983), available P 92 mg kg^{-1} (Murphy and Riley 1962), exchangeable K 0.795 cmol kg^{-1} (Pratt 1965), available S 9 mg kg^{-1} (Morgan 1941), field capacity 32.3% (Black 1965) and textural class silt loam (sand 11.4%, silt 65.7%, and clay 22.9%) (Bouyoucos 1962) were measured. Total N (0.84%), P (0.86%), K (0.06%), S (0.69%), Fe (0.26%) and Zn (0.01%) concentrations of vermicompost were determined following standard method (Huq and Alam 2005). The treatment variables were T_1 (control), T_2 (vermicompost 8 t ha^{-1}), T_3 (potassium 60 kg ha^{-1}), T_4 (boron 0.4 kg ha^{-1}), T_5 (vermicompost 8 t ha^{-1} + potassium 60 kg ha^{-1}), T_6 (vermicompost 8 t ha^{-1} + boron 0.4 kg ha^{-1}), T_7 (potassium 60 kg ha^{-1} + boron 0.4 kg ha^{-1}), and T_8 (vermicompost 8 t ha^{-1} + potassium 60 kg ha^{-1} + boron 0.4 kg ha^{-1}).

After 75 days, plants for the first time were harvested as roots, leaves and fruits, washed with tap water and then distilled water, and wrapped with soft tissue papers. Immediately after harvest, fresh weights of roots, leaves and fruits were taken and then air dried on the rooftop for three days, and then oven dried at 65°C in an oven for 72 hrs. The dry weight of the sample was recorded, ground with a mechanical grinder, and stored. For total N, 0.2g of the powdered root, leaf and fruit samples were digested (Shelton and Harper 1941). For P, K, S, Fe, and Zn, the same 0.2 g of root, leaf and fruit samples were digested with nitric-perchloric acid (HNO_3:$HClO_4$ = 2:1), and the methods described by Huq and Alam (2005) were followed. The statistical analysis (ANOVA, LSD at 5% probability level) of data was carried out using Minitab 20, and Microsoft Excel 2016 was used for the calculation and arrangement of the collected data.

Results and Discussion

Plant growth was assessed in terms of plant height, leaf number, leaf area, fruit petiole, fruit number, and fresh and dry weight of the fruit (Table 1). Before transplanting into pots, the plant's height was 13.5 cm. After the incorporation of fertilizers of organic and inorganic, some of the vegetative growth parameters varied significantly ($p \leq 0.05$) at harvest over (T_1), but the other values did not vary significantly. The highest plant height (60 cm) was observed in the pot treated in T_5, followed by 58 cm in T_8 treatment. Syed *et al.* (2022) reported increased vegetative growth and yield attributes in spinach following the application of vermicompost in combination with inorganic fertilizers. Leaf number (17 $plant^{-1}$) and leaf area (264 cm^2) in different treatments increased up to harvest and obtained their maximum in T_8. The maximum fruit petiole (4.2 $plant^{-1}$) and fruit number (3.5 $plant^{-1}$) were recorded in the T_8 treatment, followed by 3.6 $plant^{-1}$ and 3 $plant^{-1}$, respectively in the T_5 treatment. The values of fresh (75 g) and dry (3.2 g) weight of fruits were recorded highest in T_8. The lowest values were noted in control treatment T_1 for all plant parameters. The findings are also in agreement with the findings of Yadav *et al.* (2019) in eggplant.

Table 1. Effects of vermicompost, potassium and boron fertilizer on the growth and yield attributes of eggplant.

Treatments (VC ton ha^{-1} and KB kg ha^{-1})	Plant height (cm)	Leaf number $plant^{-1}$	Leaf area (cm^2)	Fruit petiole $plant^{-1}$	Number of fruits $plant^{-1}$	Fresh weight of fruit (g)	Dry weight of fruit (g)
T_1: $VC_0K_0B_0$	50.2^c	11^b	157.0^c	2.5^b	1.0^c	31.7^b	1.6^b
T_2:VC_8	54.0^b	15^a	209.5^b	3.0^{ab}	1.5^c	47.5^{ab}	1.6^{ab}
T_3: K_{60}	53.0^b	14^{ab}	224.0^{ab}	3.4^{ab}	1.0^c	59.4^{ab}	2.6^{ab}
T_4: $B_{0.4}$	51.0^b	13^b	227.0^{ab}	3.2^{ab}	1.0^c	60.4^a	2.7^a
T_5: VC_8K_{60}	60.0^a	17^a	234.8^{ab}	3.6^{ab}	3.0^{ab}	55.5^{ab}	2.7^a
T_6: $VC_8B_{0.4}$	54.0^b	15^a	225.0^{ab}	3.3^{ab}	2.5^b	59.4^a	2.9^a
T_7: $K_{60}B_{0.4}$	50.3^c	12^b	211.0^b	2.3^b	2.0^{abc}	40.6^{ab}	1.9^{ab}
T_8: $VC_8K_{60}B_{0.4}$	58.0^a	17^a	264.0^a	4.2^a	3.5^a	75.0^a	3.2^a

Means that do not share a letter are significantly different at 5% level by Tukey's Range Test.

The concentration of K (0.12 - 0.21%), S (0.02 - 0.08%), Fe (380 - 1888 ppm) and Zn (93.2 - 138.2 ppm) in the roots of eggplant varied significantly ($p \leq 0.05$), as seen in Table 2. The N (0.08 - 0.10%), and P (0.08 - 0.11%) accumulation in the roots did not show a statistically significant difference. The overall NPK accumulation was maximum in the treatment T_8 while Fe (1888.3 ppm) and Zn (138.2 ppm) concentrations were maximum in the treatment T_4 and T_5, respectively.

The concentration and uptake range of N (0.12 - 0.20%), P (0.46 - 0.66%), K (0.12 - 0.21%), S (1.2 - 1.7%), Fe (549 - 1022 ppm) and Zn (75.7 - 117.9 ppm) in the leaves of eggplant varied significantly ($p \leq 0.05$) (Table 3). The concentrations of N (0.20%), K (0.21%), and S (1.7%) were observed the maximum in T_5 treatment while P (0.66%) in T_8 treatment. Fe (1022 ppm) and Zn (118 ppm) concentrations were observed to be the highest in T_5. Application of vermicompost along with K and B improved the nutritional value of eggplant (fruit). Zaman *et al.* (2018) reported that vermicompost with different chemical fertilizers exerted a significant influence on stevia growth, and leaf biomass yield.

Table 2. Effects of vermicompost, potassium and boron fertilizer on macro (NPKS) and micronutrient (Fe and Zn) concentrations of eggplant roots.

Treatments (VC ton ha^{-1} and KB kg ha^{-1})	N (%)	P (%)	K (%)	S (%)	Fe (ppm)	Zn (ppm)
T_1: $VC_0K_0B_0$	0.10^{a}	0.10^{a}	0.12^{b}	0.04^{ab}	943.0^{bc}	93.2^{b}
T_2:VC_8	0.10^{a}	0.09^{a}	0.13^{b}	0.08^{a}	1396.2^{ab}	95.1^{b}
T_3: K_{60}	0.10^{a}	0.09^{a}	0.18^{ab}	0.05^{ab}	10154.6^{b}	95.7^{b}
T_4: $B_{0.4}$	0.09^{a}	0.09^{a}	0.14^{ab}	0.04^{ab}	1888.3^{a}	126.2^{ab}
T_5: VC_8K_{60}	0.08^{a}	0.08^{a}	0.13^{b}	0.02^{b}	380.0^{c}	138.2^{a}
T_6: $VC_8B_{0.4}$	0.10^{a}	0.11^{a}	0.13^{b}	0.02^{b}	796.1^{bc}	132.1^{a}
T_7: $K_{60}B_{0.4}$	0.08^{a}	0.08^{a}	0.18^{ab}	0.04^{ab}	1120.2^{b}	115.3^{ab}
T_8: $VC_8K_{60}B_{0.4}$	0.10^{a}	0.10^{a}	0.21^{a}	0.05^{a}	17087.8^{ab}	111.2^{ab}

Means that do not share a letter are significantly different at 5% level by Tukey's Range Test.

Table 3. Effects of vermicompost, potassium and boron fertilizer on macro (NPKS) and micronutrient (Fe and Zn) concentrations of eggplant leaves.

Treatments (VC ton ha^{-1} and KB kg ha^{-1})	N (%)	P (%)	K (%)	S (%)	Fe (ppm)	Zn (ppm)
T_1: $VC_0K_0B_0$	0.12^{b}	0.46^{b}	0.12^{b}	1.4^{ab}	549.0^{b}	75.7^{b}
T_2:VC_8	0.20^{a}	0.56^{ab}	0.20^{ab}	1.6^{a}	640.0^{ab}	116.2^{a}
T_3: K_{60}	0.17^{ab}	0.62^{a}	0.15^{ab}	1.5^{ab}	644.0^{ab}	117.5^{a}
T_4: $B_{0.4}$	0.16^{ab}	0.62^{a}	0.14^{ab}	1.6^{ab}	594.0^{b}	95.1^{ab}
T_5: VC_8K_{60}	0.20^{ab}	0.64^{a}	0.21^{a}	1.7^{a}	1022.0^{a}	118.0^{a}
T_6: $VC_8B_{0.4}$	0.20^{a}	0.65^{a}	0.16^{ab}	1.3^{ab}	581.0^{b}	103.7^{ab}
T_7: $K_{60}B_{0.4}$	0.13^{b}	0.55^{ab}	0.17^{ab}	1.2^{b}	591.0^{b}	77.4^{b}
T_8: $VC_8K_{60}B_{0.4}$	0.17^{ab}	0.66^{a}	0.16^{ab}	1.5^{ab}	562.3^{b}	84.1^{ab}

Means that do not share a letter are significantly different at 5% level by Tukey's Range Test.

The concentration ranges of N (0.13 - 0.23%), P (0.54 - 0.89%), K (0.29 - 0.39%), S (0.16 – 0.75%), Fe (37.0 - 319.0 ppm) and Zn (20.2 - 93.7 ppm) in the fruits varied significantly ($p \leq 0.05$), as presented in Table 4. The concentrations of N (0.23%), K (0.39%), and S (0.75%) were recorded to be the highest in T_8 treatment, while P (0.89%) in T_6 treatment. The values of Fe (319 ppm) and Zn (93.7 ppm) were found to be the highest in T_5. More or less similar observation was reported by Agbo *et al.* (2012) on eggplant.

Table 4. Effects of vermicompost, potassium and boron fertilizer on macro (NPKS) and micronutrient (Fe and Zn) concentrations of eggplant fruits.

Treatments (VC ton ha^{-1} and KB kg ha^{-1})	N (%)	P (%)	K (%)	S (%)	Fe (ppm)	Zn (ppm)
T_1: $VC_0K_0B_0$	0.13^{b}	0.54^{b}	0.29^{c}	0.16^{b}	49.5^{c}	39.0^{bc}
T_2:VC_8	0.20^{a}	0.67^{ab}	0.37^{ab}	0.37^{ab}	150.5^{ab}	36.5^{bc}
T_3: K_{60}	0.17^{ab}	0.81^{a}	0.39^{a}	0.23^{ab}	138.0^{b}	46.1^{b}
T_4: $B_{0.4}$	0.15^{ab}	0.72^{a}	0.36^{ab}	0.23^{ab}	64.6^{bc}	26.8^{bc}
T_5: VC_8K_{60}	0.20^{a}	0.63^{ab}	0.38^{ab}	0.33^{ab}	319.0^{a}	93.7^{a}
T_6: $VC_8B_{0.4}$	0.17^{ab}	0.89^{a}	0.32^{bc}	0.43^{ab}	37.0^{d}	29.1^{bc}
T_7: $K_{60}B_{0.4}$	0.14^{ab}	0.66^{ab}	0.29^{c}	0.28^{ab}	66.0^{bc}	21.1^{c}
T_8: $VC_8K_{60}B_{0.4}$	0.23^{a}	0.78^{a}	0.39^{a}	0.75^{a}	77.1^{bc}	20.2^{c}

Means that do not share a letter are significantly different at 5% level by Tukey's Range Test.

From the experimental results it may be concluded that the combined application of vermicompost, potassium, and boron gave significantly better results in terms of growth, yield, and nutrient content than the other treatments. Hence, the application of vermicompost 8 t ha^{-1} + potassium 60 kg ha^{-1} + boron 0.4 kg ha^{-1} is suggested to improve nutrient content, growth and yield attributes of eggplant.

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