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EVALUATION OF E-VERMICOMPOST FOR TOMATO PRODUCTION

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Abstract

Vermicompost has a plethora of benefits that restores nutrient, stabilizes soil, and enhances soil fertility. The experiment was conducted at farmers' field of Mymensingh and Jamalpur to evaluate the effect of e-vermicompost on tomato production during October 2019 to March 2020. There were five fertilizer treatments combination (T_1: RCF-Recommended fertilizer (N_{120} P_{35} K_{70} S_{15} Zn_2 $B_{0.5}$), T_2: 85 % RCF+3 t ha^{-1} vermicompost, T_3: 85% RCF+1 t ha^{-1} e-vermicompost, T_4: 70% RCF+3 t ha^{-1} e-vermicompost and T_5: 70% RCF+1 t ha^{-1} e-vermicompost). The experiment was laid out in a Randomized Complete Block Design with three replications. The fresh tomato fruits were harvested in three times. The fresh weight of tomato at Mymensingh ranged from 53.3 to 68.5 t ha^{-1} with the highest yield of 68.5 t ha^{-1} from the treatment T_2 (85% RCF + 3 t ha^{-1} e-vermicompost). At Jamalpur, the yield ranged from 50.4 to 65.3 t ha^{-1} and the highest yield of 65.3 t ha^{-1} was recorded also from the treatment T_2 (85% RCF+3 t ha^{-1} e-vermicompost). The lowest yield was obtained from the treatment T_5 in both locations. The percent fresh yield increased over control (T_1), was 24.5 and 18.3% in Mymensingh and Jamalpur, respectively. The highest gross margin was Tk. 762,225/-, which was obtained from the treatment T_2 (85% RCF+3 t ha^{-1} e-vermicompost). The highest MBCR 2.80 (average of two locations) was obtained from the same treatment T_2 (85% RCF+1 t ha^{-1} e-vermicompost). The results indicates that the application of e-vermicompost along with 85% recommended dose of chemical fertilizer is more profitable than the application of chemical fertilizer alone.

Key wards: e-vermicompost, yield, tomato, fertilizer

Introduction

The yield per unit area of a wide range of crops in Bangladesh is either in a state of stagnating or declining. It is due to the cumulative effects of less use of organic matter to the soil, intensive cropping, nutrient depletion, imbalanced fertilization and improper management practices. It is true that sustainable production of crops cannot be maintained by using only chemical fertilizer and similarly it is not possible to obtain higher crop yield by using organic manure alone. The application of organic manures improves the soil fertility by supplying essential plant nutrients, especially micronutrients, which boosts the crop growth (Bhanwaria *et al*., 2022; Sharma *et al*., 2014). Manures can substitute mineral fertilizer for increasing crop productivity, carbon sequestration, soil structure, as well as reducing environmental pollution (Akhtar *et al*., 2019; Khan *et al*., 2019).

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Previously, it was well-reported that manure fertilization significantly improved the physicochemical and biological properties of the soil, such as pH, bulk density, enzymatic activity, soil aggregation, soil organic carbon, and both macro- and micro-nutrients (Morone *et al*., 2019).

Sustainable crop production could be possible through the integrated use of organic and chemical fertilizers. A suitable combination of organic and inorganic sources of nutrients is necessary for sustainable agriculture that will provide food with good quality. Organic matter plays an important role in maintaining soil fertility and productivity. Organic matter acts as a reservoir of plant nutrient and prevents leaching of the nutrients. The organic matter content as well as the nutrient status of Bangladesh soils is low and declining day by day. The application of organic manure increases crop production significantly (Saleque *et al*. 2004). Incorporation of organic manure into soil has been shown to increase organic carbon, total nitrogen and crop yield (Chakraboty *et al*. 2001).

Manure fertilization can improve the soil's structure, allowing it to store more water and nutrients, and thus increase crop productivity (Ibrahim *et al*., 2020; Du *et al*., 2020) and have residual effect on succeeding crop (Dhaliwal *et. al*., 2019; Peralta-Antonio *et al*., 2019). Moreover, partial substitution of organic manures with inorganic fertilizers will lower the production cost to a greater extent (Srivastava *et al*., 2020). Previous studies have reported that substitution of chemical fertilizers with organic manure have beneficial effects on crop yield (Bolinder *et al*., 2020; Raza *et al*., 2021).

An agricultural soil should have 3-5% organic matter but the organic matter content of most of the soils is below 1.5% and in many cases it is less that 1% in Bangladesh (BARC, 2018) which is alarmingly low for total agricultural production. Since ancient time farmers used to increase their crop yield by adding various organic sources of organic matter to soil, viz. cowdung, crop residues, vegetable wastes, etc. Use of different manures (press mud, poultry manure and farmyard manure) in crop production has evidenced to increase the crop yield and DTPA-extractable micronutrients (Zn, Cu, Fe and Mn) concentrations in soil of north-western India (Randhawa *et al*., 2021; Raza *et al*., 2022). In long-term field experiment of 40 years under soybean-maize rotation, the application of organic manures on brown soil improved the crop yields along with soil properties (Hua *et al*., 2020).

But now-a-days these materials are not easily available to farmers. Moreover, unconscious and unjustified use of chemical fertilizers is gradually reducing the organic matter in the soil. Now it is essential to apply balanced fertilizer and organic matter to soil on the basis of soil analysis. E-vermicompost is completely an organic fertilizer which is produced through the activities of suitable earthworms on different organic materials. It is widely acknowledged that using compost and vermicompost as amendments, rather than industrialized fertilizer and raw manure, could improve soil nutrients and promote soil health (Jack and Thies, 2006). Manure compost?? has been widely applied at farmers level as it is highly accessible at low price Ramirez-Guerrero and Meza-Figueroa, 2014), and greatly improved most of the characteristics of crop plants compared with mineral fertilizer (Da Silva *et al*., 2011).

Application of compost and vermicompost can also increases soil organic carbon, nitrates, phosphates, exchangeable calcium and some other nutrients for plants (Jindo *et al*., 2016). Hence, an improvement and maintenance of a good supply of organic matter is essential for sustenance of soil fertility and crop productivity. Recently private companies are formulating different organic fertilizers like e-vermicompost. These initiatives will help to supply proportionately the deficient nutrients in the soils. Therefore, this study was undertaken to investigate the effect of e-vermicompost (a private company developed) on the growth and yield of tomato.

Materials and Methods

Field experiment was conducted at farmers' field of Mymensingh and Jamalpur to see the effect of e-vernicompost supplied by a private company on tomato production during November 2019 to March 2020. The initial soil status of the experimental sites has been given in the Table 1.

The initial soil analysis were done following standard methods (Jackson 1962; Olsen *et al*., 1954; Page 1982) The experimentcomprised with five treatments which were as T_1: RCF –Recommended fertilizer ($N_{120}P_{35}K_{70}S_{15}Zn_2B_{0.5}$), T_2: 85% RCF+3 t ha^{-1} vermicompost, T_3: 85% RCF+1 t ha^{-1} e-vermicompost, T_4: 70% RCF+3 t ha^{-1} e-vermicompost and T_5: 70% RCF 1 t ha^{-1} e-vermicompost and the experiment was conducted in a Randomized Complete Block Design with three replications. E-vermicompost was applied to the field during final land preparation.

One-third urea and all TSP, MoP, Gypsum, Zn and B were applied at final land preparation. Remaining urea was applied in two equal splits. The fruits were harvested three times throughout the growing period depending on the maturity.

Table 1. Initial soil status of the experimental field

Locations	pH	OM (%)	Nitrogen (%)	Available P (ppm)	Available K (me%)	Available S (ppm)
Mymensingh	6.8	1.13	0.11	14.4	0.18	15.0
Jamalpur	6.7	1.20	0.12	13.8	0.22	14.5

Statistical analysis

Plant parameters (growth, yield and yield components) data were analyzed using computer based program ensuring basic principle (Gomez and Gomez, 1984). Analysis of variance (ANOVA) and significance were done accordingly at 5% by Duncan's Multiple Range Test (DMRT).

Results and discussion

Plant Growth

Plant height, number of branches plant^{-1}, the number of fruit plant^{-1} and average fruit weight were significantly influenced by the different treatment combinations of e-vermicompost. Plant height increased insignificantly due to the e-vermicompost application and the tallest plant was found in the treatment T_2 where e-vermicompost was applied 3 t ha^{-1}. Considering the number of branches plant^{-1}, the highest branches plant^{-1} were produced in the treatment T_2 and other parameters like total number of fruit plant^{-1} and fruit weight were found highest in the treatment T_2 as well (Table 2 & Table 3).

There were significant effects of e-vermicompost treatment found on tomato yield (Table 2 & 3). In both locations, yield was increased significantly due to the treatments combinations with the e-vermicompost comapred to 100% CF. All the e-vermicompost treated plots produced higher yield over the chemical fertilizer treated plot except T_5 (70% RCF+1 t ha^{-1} e-vermicompost) because 1 t-ha^{-1} e-vermicompost could not supports nutrients that of 30% chemical fertilizer. The yield of tomato at Mymensingh ranged from 53.3 to 68.5 t ha^{-1} with the highest yield of 68.5 t ha^{-1} from the treatment T_2 (85% RCF+3 t ha^{-1} e-vermicompost) followed by the treatment T_3 (85% RCF + 1 t ha^{-1} e-vermicompost) which produced 60.2 t ha^{-1}. The lowest yield (53.3 t ha^{-1}) was obtained from the treatment T_5 (70% RCF + 1 t ha^{-1} e-vermicompost). The highest percent increase of fresh yield over T_1 was 24.5 at Mymensingh.

Table 2. Effect of e-vermicompost on tomato yield and yield component at Mymensingh

Treatments	Plant height (cm)	Branches plant^{-1}	Fruit plant^{-1}	Ave. fruit weight (g)	Fruit yield (t ha^{-1})	% yield increase over T_1
T_1 : RCF	90.2	8.1	45b	90.3c	55.0 bc	-
T_2 : 85% RCF + 3 t ha^{-1} VC	96.6	10.3a	51a	102.2a	68.5a	24.5
T_3: 85% RCF + 1 t ha^{-1} VC	95.3	9.8	46b	98.6ab	60.2b	9.5
T_4: 70% RCF + 3 t ha^{-1} VC	91.2	8.6	41bc	95.6b	59.3bc	7.8
T_5: 70% RCF + 1 t ha^{-1} VC	92.4	8.9	39c	94.5b	53.3c	-3.1
CV (%)	7.26	9.48	10.68	12.48	9.28	

Recommended Chemical Fertilizer (N_{120} P_{35} K_{70} S_{16} Zn_2 $B_{0.5}$)

Table 3. Effect of e-vermicompost on tomato yield and yield component at Jamalpur

Treatments	Plant height (cm)	Branches plant^{-1}	Fruit plant^{-1}	Ave. fruit weight (g)	Fruit yield (t ha^{-1})	% yield increase over T1
T_1: RCF	92.2	8.3	46b	92.2c	55.2 bc	-
T_2: 85% RCF + 3 t ha^{-1} VC	95.3	10.6	50.3	101.4a	65.3a	18.3
T_3: 85% RCF + 1 t ha^{-1} VC	95.1	9.1	48b	96.6ab	58.0b	5.0
T_4: 70% RCF + 3 t ha^{-1} VC	90.3	8.9	38bc	92.2b	58.1bc	5.2
T_5: 70% RCF + 1 t ha^{-1} VC	90.2	8.2	37c	90.1b	50.4c	8.6
CV (%)	8.28	10.88	10.68	11.53	9.28	

RCF (N_{120} P_{35} K_{70} S_{16} Zn_2 $B_{0.5}$)

At Jamalpur, the yield of tomato ranged from 50.4 to 65.3 t ha^{-1} and the highest yield of 65.3 t ha^{-1} was recorded in the treatment T_2 (85% RCF+3 t ha^{-1} e-vermicompost) followed by the treatment T_3 (85% RCF +1 t ha^{-1} e-vermicompost) which produced 62.4 t ha^{-1}. The lowest yield (50.4 t ha^{-1}) was obtained by the treatment T_5 (70% RCF + 1 t ha^{-1} e-vermicompost). The highest percent increase of tomato yield over T_1, was 18.3. From the different treatments of e-vermicompost with recommended chemical fertilizer packages, the results demonstrated that the highest tomato yield was obtained from the treatment T_2 (85% RCF + 3 t ha^{-1} e-vermicompost).

Economic Analysis

The estimated gross return, variable cost, gross margin and marginal benefit cost ratio (MBCR) are presented in the Table 3. The integrated use of chemical fertilizer and e-vermicompost increased the gross margin in all the treatments. The highest gross margin was Tk. 762,225/-, which was obtained from the treatment T_2 (85% RCF + 3 t ha^{-1} e-vermicompost) followed by the treatment T_3 (85% RCF + 1 t ha^{-1} e-vermicompost). The highest MBCR 2.80 (average of two locations) was obtained from the treatment T_2 and the second highest MBCR 1.94 was found from the treatment T_3 (85% RCF + 1 t ha^{-1} e-vermicompost). The result indicates that application of e-vermicompost along with 85% recommended dose of chemical fertilizer is more profitable than application of chemical fertilizer alone.

Table 4. Cost benefit ratio of e-vermicompost on tomato (average of two locations)

Treatments	Yield (t/ha)	Gross return (Tk./ha/yr.)	Variable cost (Tk./ha/yr.)	Gross Margin (Tk./ha/yr.)	MBCR
T_1: RCF (N_{120} P_{35} K_{70} S_{15} Zn_2 $B_{0.5}$)	55.1	661,200/-	12,442/-	648,758/-	-
T_2: 85% RCF + 3 t ha^{-1} VC	66.9	802,800/-	40,575/-	762,225/-	2.80
T_3: 85% RCF + 1 t ha^{-1} VC	59.1	709,200/-	20,575/-	688,625/-	1.94
T_4: 70% RCF + 3 t ha^{-1} VC	58.7	704,400/-	38,709/-	673,691/-	0.81
T_5: 70% RCF + 1 t ha^{-1} VC	51.9	622,200/-	18,709/-	648,758/-	-

* Chemical fertilizer @ (N_{120} P_{35} K_{70} S_{15} Zn_2 $B_{0.5}$ kg ha^{-1} at Mymensingh & Jamalpur. Tomato = Tk 12 kg^{-1}, Urea = Tk 16 kg^{-1}, TSP = Tk 22 kg^{-1}, MP = Tk 15 kg^{-1}, Gypsum = Tk 10 kg^{-1}, Zn & B, E-vermicompost Jaibo Sar = Tk 10 kg^{-1}.

Effects on post harvest soil properties

The application of chemical fertilizer and e-vermicompost had positive influence but not significant effect on the soil chemical properties (Table 5).The nitrogen, phosphorus, potassium and sulphur content do not have changes due to one cropping. Continuous application of e-vermicompost might have positive change in all chemical parameters. An appropriate combination of organic and inorganic fertilizer is very crucial and important for crop production as well as sustained soil fertility.

Table 5. Initial and postharvest soil analysis at Mymensingh and Jamalpur

Treatments	pH	OM (%)	Total Nitrogen (%)	Available Phosphorus (ppm)	Available Potassium (me%)	Available Sulphur (ppm)
			Mymensingh			
Initial soil	6.8	1.13	0.11	14.4	0.18	15.0
			Post harvest soil			
T_1	6.7	1.11	0.10	14.2	0.18	14.8
T_2	6.8	1.20	0.13	14.1	0.20	14.9
T_3	6.8	1.19	0.12	14.5	0.20	15.0
T_4	6.7	1.19	0.12	14.0	0.21	14.6
T_5	6.7	1.15	0.12	14.1	0.20	15.0
			Jamalpur			
Initial soil	6.7	1.20	0.12	13.8	0.22	14.2
			Post harvest soil			
T_1	6.6	1.17	0.10	13.7	0.20	14.1
T_2	6.8	1.22	0.12	13.8	0.24	13.6
T_3	6.8	1.22	0.12	13.5	0.24	15.2
T_4	6.7	1.21	0.11	13.6	0.23	14.5
T_5	6.8	1.20	0.12	13.1	0.21	14.3

Discussion

Taller plants was found after the treatments in this experiment with e-vermicompost, which is consistent with previous research showing that maize plants had increased height after application of vermicompost (Kmet'ova and Kovacik, 2013). Arancon *et al.* (2003) indicated the improvements in crop growth and increase in fruit yields of tomato could also be due to partially to large increase in soil microbial biomass after application of vermicompost, leading to the more hormones or humate content in the vermicompost treatment.

The application of vermicompost promoted the germination of seeds, plant height, and number of leaves of each plant, branches and yield of different vegetable (Singh and Chauhan 2009). The application of organic fertilizer produced an improvement in plants even at the beginning of the growth cycle. The e-vermicompost application increases the microbial population in cultivated soil. The diversity of the soil microbial community increases with the vermicompost addition but may decrease with the continuous cropping years (Fu *et al*., 2017).

The results of this study showed that tomato yield was significantly influenced with the treatment combination and locations, regardless in the vermicompost treated plants produce higher than other chemical treated plots (Yang *et al*., 2015). Vermicompost is rich in potassium (Hanc and Vasak, 2015; Mondal *et al*., 2015) and Colpan *et al*., (2013) found that potassium improved the yield and fruit quality of tomato. Thus, the tomato quality improvement reflects the yield in the vermicompost treated plot. Some studies reported that tomato fruit quality can be improved from increased soil organic carbon (Jindo *et al*., 2016). There are different types of phytohormones have been found in vermicompost (Zhang *et al*., 2014; Scaglia *et al*., 2016) and these phytohormones may significantly improve fruit quality and yield. The use of organic fertilizer like vermicompost was shown to increase soil organic carbon and soil fertility, consequently resulting in a larger yield trend compared to a balanced chemical fertilizer (Gong *et al*., 2011) which is similar with the present study.

Conclusion

From the results, it can be concluded that 85% recommended chemical fertilizer with 3 t ha^{-1} e-vermicompost is the best for tomato production and there is ample scope of increasing tomato yield by the application of e-vermicompost.

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