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Effects of organic fertilizer on growth and yield of tomato

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Abstract

The experiment was conducted during rabi season 2019-2020 at Agricultural Research Station, On Farm Research Division, Alamnagar, Rangpur to find out the useful effects of organic fertilizer on growth and yield of tomato. The experiment was arranged in a randomized complete block design (RCBD) with five treatments in three (03) compacted replicate blocks. The treatments included T_1: 100% Recommended Chemical Fertilizer (RCF), T_2: 85% CF + 3 tha^{-1} organic Fertilizer (OF), T_3: 85% CF + 1 tha^{-1} OF, T_4: 70% CF + 3 tha^{-1} OF and T_5: 70% CF + 1 tha^{-1} OF. The highest yield was observed in T_2 (50.59 t ha^{-1}) due to more number of fruit $plant^{-1}$& weight of fruit $plant^{-1}$ and the lowest was in T_5 (35.32 t ha^{-1}). These results may be due the parameters of growth components increased with increasing amount of organic and inorganic fertilizers applied. Combination of organic and inorganic fertilizer treated plots produced higher yield than plots without combination of organic and inorganic fertilizer. The highest gross return (BDT. 607080) was found in T_2 treatment and the lowest gross return (BDT. 423840) was recorded from T_5. The highest gross margin (BDT. 328520 ha^{-1}) was obtained from T_2. The lowest gross margin (Tk. 145280 ha^{-1}) was obtained from T_5. Integrated nutrient management (combination of organic and inorganic fertilizer) is the best option for higher tomato production in Bangladesh.

Key words: Organic fertilizer, soil fertility, chemical fertilizer, tomato

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Introduction

The term **"**Organic fertilizer"comprises material from animal or plant origin. It covers all soil amendments that add to the pool of soil organic matter, namely organic compounds and carbon (C). Soil organic matter improves the physical properties of the soil by improving its structure and water holding capacity and by preventing nutrient leaching.

Since high temperatures promote the decomposition of organic matter in soils (FAO, 2006), the addition of organic matter to soils is particularly important for maintaining long-term soil fertility. Organic fertilizers usually also provide some measure of N, P and K, as well as varying amounts of micronutrients. Poor soil fertility resulting from low organic matter content is a major production constraint in Bangladesh. In this aspect, farmers were used frequently huge inorganic fertilizers and pesticides in their crop fields, resulting harmful for sound environment (Islam et al., 2015a). Better soil fertility with higher organic matter content is a prerequisite for sustainable crop production, and organic manure can play a role in increasing soil fertility and crop production. Application of organic manures has been reported to increase crop yield and improve soil quality, especially soil organic matter content (Garg et al., 2005; Islam et al., 2010). Although synthetic fertilizer contains higher quantities of plant nutrients than organic fertilizer, the presence of growth-promoting agents in organic fertilizer makes them important for enhancement of soil fertility and productivity (Sanwal et al., 2007; Yadav and Garg, 2016). Soil productivity is affected by cropping systems and crop management practices including tillage, synthetic fertilizer, and organic manure management as well as enhance the causes of pesticide residues in the products (Anwar et al., 2017; Bhushan and Sharma, 2002; Islam et al., 2015b,c; Yeasmin et al., 2019). It has been reported that continuous and unbalanced use of synthetic fertilizer degrades physicochemical and biological soil environment (Mahajan et al., 2007). Balanced fertilization is a prerequisite for exploiting optimum crop yield potential and beneficial effects of organic manure in crop production have been demonstrated (Ferdous et al., 2011; Mahamood et al., 2016; Moyin-Jesu, 2015). Combined application of organic fertilizer along with synthetic fertilizer could be a promising soil management practice to improve crop productivity, soil fertility, and sustainability (Hernandez et al., 2016; Moyin-Jesu, 2015).

Tomato (*Solanum lycopersicum L.*) is a very important vegetable crop and consumed in most parts of the world, from home gardens and greenhouses to large commercial farms due to its wider adaptability to various agro-climatic conditions. It is one of the most fashionable salad vegetables and is taken with great relish. It is also one of the organically produced vegetables crops in the world. The continuous use of chemical fertilization leads to deterioration of soil characteristics and fertility, and may lead to the accumulation of heavy metals in plant tissues which compromises fruit nutrition value and edible quality (Shimbo et al., 2001; Islam et al., 2020a,b; Uddin et al., 2015). Chemical fertilizer also reduces the protein content of crops, and the carbohydrate quality of such crops also gets degraded (Marzouk & Kassem, 2011). The main sources of the organic fertilizers are composted livestock manures, plant residues (Mondol et al., 2020) and industrial wastes. The organic fertilizers provide the nutritional requirements of plants and also suppress the plant pest populations. Additionally, they increase the microbial activity in soil, anion and cation exchange capacity, organic matter and carbon-content of soil. Organic fertilizers increase the yield and quality of agricultural crops in ways similar to inorganic fertilizers rather than problems (like- pesticide residues) create during crop production and quality maintenance (Liu et al., 2007; Tonfack et al., 2009; Islam et al., 2015b,c). Agomoniis a newly introduce organic fertilizer that can improve the yield of crops. Therefore, the study was taken to find out the useful effects of organic fertilizer on growth and yield of tomato.

Materials and Methods

***Site description and experimental design*:** The experiment was conducted during 2019-2020 cropping seasons at the Agricultural Research Station, On farm Research Division, Alamanagar, Rangpur, Bangladesh located at $25^0$43.251' N latitude and $089^0$15.735' E longitude with an elevation of 29 m above mean sea level. The area mostly falls under high- and medium-high land of the Tista Meander Floodplain (Anowar et al., 2015; Ferdous et al., 2016). Water holding capacity of the soil is good. The area receives an average annual rainfall of around 2,160 mm with an average temperature of about 25°C (Ferdous et al., 2016).

The experiment was arranged in a randomized complete block design (RCBD) with five treatments in three (03) compacted replicate blocks. The treatments included T_1: 100% Recommended Chemical Fertilizer (RCF), T_2: 85% CF + 3 tha^{-1} organic Fertilizer (OF) T_3: 85% CF + 1 tha^{-1} OF, T_4: 70% CF + 3 tha^{-1} OF, and T_5: 70% CF + 1 tha^{-1} OF. The crop variety was BARI tomato-17. Each plot measured 4m×5m. Thirty days old seedlings were transplanted on 17 November, 2019.

***Crop management*:** The crop was fertilized with recommended doses of fertilizers at the rate of 207-50-130-20-3 kg/ha of NPKSZn along with organic fertilizer as par treatments. All the fertilizers were applied at the time of final land preparation except urea and MoP. N and K were applied in three equal installments 10 days after transplanting (DAT), 22 DAT and 36DAT. Bavistin, marshal, tafgor, secure and acrobat were applied against late blight disease. The crop was irrigated three times at 20 DAT,37 DAT and 75 DAT. Other intercultural operations were done as and when necessary. The harvest was done from 18 February 2020 to 22 March 2020.

***Data analysis*:** Data on yield and yield contributing characters were taken and statistically analyzed using 'Statistics10' software package. Production of tomato included costs of field preparation, seed, planting, irrigation, organic manure and synthetic fertilizer, plant protection chemicals, and harvesting. Gross return under a treatment was calculated by multiplying the gross amount of crop produced by the farm-gate price. The gross margin was calculated by subtracting cost of production from the gross return (Ferdous et al., 2017a).

Results and Discussion

The most important parameter i.e. yield which was affected significantly with different dozes of organic fertilizer on tomato production. The results presented in Table 1 revealed that there was significant difference among the treatments in respect of number of fruit plant^{-1}, weight of fruit plant^{-1} and yield. The highest number of fruit plant^{-1} (56) and weight of fruit plant^{-1} was obtained from T_2 (1.45 kg) and the lowest from T_5. The highest yield was observed in T_2 (50.59 t ha^{-1}) due to more number of fruit plant^{-1}& weight of fruit plant^{-1} and the lowest was in T_5 (35.32 t ha^{-1}). These results may be due the parameters of growth components increased with increasing amount of organic and inorganic fertilizers applied. This can be due to the role of organic fertilization in plant physiology and improving the quantity and quality growth characterization and can provide plants with essential elements required (Sun *et al*. 2003; Lin *et al*. 2010; Ferdous *et al*. 2014). Combination of organic and inorganic fertilizer treated plots produced higher yield than plots without combination of organic and inorganic fertilizer (Anwar *et al*. 2012; Ferdous *et al*. 2017).

Table 1. Yield and yield attributes of tomato as influenced by Organic fertilizer (Agomoni Jaibo Sar) at Agricultural Research Station, OFRD, BARI, Rangpur during 2019-2020.

Treatment	Plant height (cm)	Number of fruit plant^{-1}	Weight of Fruit plant^{-1} (kg)	Yield (t ha^{-1})
T_1: 100% Recommended Chemical Fertilizer (RCF)	122.20a	4.7333ab	1.1067b	38.613b
T_2: 85% RCF + 3 tha^{-1} OF	122.40a	5.6667a	1.4500a	50.597a
T_3: 85% RCF + 1 tha^{-1} OF	115.47a	5.1333a	1.2967ab	45.360ab
T_4: 70% RCF + 3 tha^{-1} OF	115.73a	4.7333ab	1.1433b	39.933b
T_5: 70% RCF + 1 tha^{-1} OF	116.20a	3.8667 b	1.0100b	35.327b
CV (%)	8.5893	11.50	13.46	13.48
LSD	3.85	1.0449	0.3045	10.655

Similar results are reported by Ahmed *et al.* (2017) and Anil *et al*. (2008) who report increase fruit yield with phosphorus and organic manure application. Anil *et al.* (2008) observed an increase in seed yield with combine application of organic and inorganic fertilizers.

***Economic performance*:** The cost and return analysis of different treatments are presented in Table 2. The highest gross return (BDT. 607080) was found in T_2 treatment and the lowest gross return (BDT. 423840) was recorded from T_5. The highest gross margin (BDT. 328520 ha^{-1}) was obtained from T_2. The lowest gross margin (Tk. 145280 ha^{-1}) was obtained from T_5. Similar result was reported by Ferdous *et al.* (2011a, 2011b) who report highest gross margin with combination of organic and inorganic fertilizer application.

In the present study, the highest fruit yield was obtained from plants treated with chemical fertilizer in combination with organic fertlizer, while yield was the least for control treatment.

Table 2. Cost and return analysis of tomato as influenced by Organic fertilizer (Agomoni Jaibo Sar) at Agricultural Research Station, OFRD, BARI, Rangpur during 2019-2020.

Treatments	**Yield ($t\ ha^{-1}$)**	**Gross return ($Tk.\ ha^{-1}$)**	**Total variable cost ($Tk.\ ha^{-1}$)**	**Gross margin ($Tk.\ ha^{-1}$)**
T_1: 100% Recommended Chemical Fertilizer (RCF)	38.61	463320	278560	184760
T_2: 85% RCF + 3 tha^{-1} OF	50.59	607080	278560	328520
T_3: 85% RCF + 1 tha^{-1} OF	45.36	544320	278560	265760
T_4: 70% RCF + 3 tha^{-1} OF	39.93	479160	278560	200600
T_5: 70% RCF + 1 tha^{-1} OF	35.32	423840	278560	145280

Market price of Tomato @ 12 BDT kg^{-1}, urea @ 16, triple super phosphate @ 25, muriate of potash @15, gypsum @10, zinc sulphate @ 150 and boric acid@ 150 BDT kg^{-1}, Organic manure @ 7 BDT kg^{-1}.

The present results are in line with the findings of Ferdous, Datta, and Anwar (2017, 2018), Ferdous et al. (2011), Rahman et al. (2011), Sarker et al. (2010), Yadav and Garg (2016), and Haque et al. (2018), who also reported better yields of field and vegetable crops with the application of organic fertilizer. The combined application of organic manure and chemical fertilizer help improve N use efficiency through increased nutrient concentrations, soil organic matter content, water-holding capacity, bulk density, and soil temperature (Akanbi et al. 2010). This increase in N use efficiency promotes root and shoot growth resulting in an increase in crop yield (Datta et al. 2015). Katuwal and Bohara (2009) reported an increase in vegetable crop yields and profits with the application of organic manure. The highest economic profitability from spinach and chili production has been observed with the combined application of chemical fertilizer and organic manure (Muhmood et al. 2014). An enhancement in growth, yield, and yield contributing characters of wheat and rice in the wheat-rice cropping systems has also been reported with the integrated use of chemical fertilizer and cow dung or poultry biogas slurry (Haque et al. 2018) due to higher plant uptake of total N, P, K, and S.

Conclusion

Fertilizer application, especially for chemical fertilizer and organic manure applied to tomato field, can be highly profitable with sustainable production increases for smallholder farming in northern region of Bangladesh. Integrated nutrient management (combination of organic and inorganic fertilizer) is the best option for higher tomato production in Bangladesh. From the study it can be concluded that if organic fertilizer usage can be increased then chemical fertilizer application will be decreased and soil health ultimately improved.

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