Effect of bio-slurry on pot planted tomato

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Abstract: pot experiment supported by a laboratory analysis was conducted to evaluate the performance of bio-slurry on tomato production during November 2011 to April 2012. The experiment was laid out in a Complete Randomized Design (CRD) with 3 replications. There were 6 treatments viz., T_0 - Control, T_1 - Recommended fertilizer Dose (RFD), T_2 – 60% RFD + Poultry Manure (PM), T_3 - 60% RFD + Poultry slurry, T_4 - 60% RFD + Cow-dung (CD), T_5 - 60% RFD + Cow-dung slurry. Chemical analysis of cow-dung, cow-dung slurry, poultry manure and poultry manure slurry showed that the Organic matter, Organic carbon, N, P, K and S varied from 32-69.5, 18.6-40.4, 1.51- 2.94, 0.51- 0.81, 0.45- 1.36, 0.39- 0.46%, respectively. Cow-dung and cow-dung slurry had the higher Organic matter and Organic carbon content while poultry manure and poultry manure slurry had the higher nutrient concentration. Nutrient concentration particularly N and K in cow-dung and poultry bio-slurry was found to be lower than the cow-dung and poultry manure. The growth and yield of tomato were significantly influenced by the application of different manure at 1% level of probability. The tallest (58.40cm) plant was observed in T_2 while the shortest plant (17.10cm) was found in T_0 treatment. The highest number of fruits plant^{-1} (16.33) was produced in T_1 and it was lowest (4.33) in T_0. The highest average fruit weight (33.55 g fruit^{-1}) was observed in treatment T_3 and the lowest was in T_0 (19.84 g fruit^{-1}). The highest yield (516.57 g pot^{-1}) was recorded in T_3 followed by T_1 (465.39 g pot^{-1}), T_2 (450.01 g pot^{-1}), T_4 (410.80 g pot^{-1}), T_5 (376.27 g pot^{-1}) and the lowest (85.4 g pot-^{1}) in T_0. The yield of tomato was increased by 445, 427, 505, 381 and 340 % over control in T_1, T_2, T_3, T_4 and T_5 respectively. Application of poultry bio-slurry in combination with chemical fertilizer showed the best performance on tomato yield. The use of poultry bio-slurry not only gives higher yield but also improves soil health which is necessary for sustainable crop production by maintaining soil fertility and productivity.
Key words: Bio-Slurry, tomato, organic matter, yield.

Introduction

Soil organic matter is both a source and sink of plant nutrients (Noor *et al.*, 2005), it is an ion exchange material, it promote the formation of soil aggregates and thereby influences soil physical properties and soil moisture, and it is an energy substrate for soil microbes and macrofauna (Page *et al.,* 1982). Soil organic matter is consider as the most important indicator of soil quality and agronomic sustainability because of its impact on other physical, chemical and biological indicators of soil quality (Rosenberg, 1952). A good soil in Bangladesh should have an organic matter content of at least 2.5% (BARC, 2005). But in Bangladesh, most soils have less than 1.7%, and some soils have even less than 1% organic matter. Declining in soil fertility is a common scenario in Bangladesh though magnitudes vary in different Agro-Ecological Zones (AEZ). Decline in soil fertility occurs through a combination of lowering of soil organic matter and loss of nutrients. In Bangladesh, depletion of soil fertility is mainly due to exploitation of land without proper replenishment of plant nutrients in soils. According to an appraisal report of Bangladesh soil resources, soils of about 6.10 m ha contain very low (less than 1%) organic matter, 2.15 m ha contain low (1-2%) organic matter and the remaining 0.90 m ha contain more than 2 % organic matter (Mondal, 2000). The average organic matter content of top soils has decline by 20-46% over past 20 years due to intensive cropping without inclusion of legume crops, imbalance use of fertilizer, use of modern varieties and scanty use of organic manure. It is agreed that decreases in soil fertility is a major constraint for higher crop production in Bangladesh. The beneficial effect of organic manure in crop production has been demonstrated by many workers (Joshi *et. al*., 1994; Batsai *et. al.,* 1979; Singh *et al.,* 1970 and Subhan, 1991). Maintenance of soil fertility is a prerequisite for long term sustainable crop production and it is certain that organic manure (cow-dung, poultry manure and their slurry) can play a vital role in the sustainability of soil fertility and crop production. So, the maintenance of soil organic matter is a burning issue both for the farmers and agricultural scientists. Application of bi-product of the recently popularized biogas technology named 'bio-slurry' in soil could be one of the options to maintain declining soil fertility of Bangladesh.

Bio-slurry obtained from the biogas plant may be considered as a good source of organic fertilizer as it contains considerable amounts of both macro and micronutrients. Bio-slurry can be utilized as a potential bio-manure in crop production. Bio-slurry can improve the physical and biological quality of soil by adding organic matter to the soil. It also provides both macro and micro-nutrients to crops. These improve in water holding capacity, cation exchange capacity, lesser soil erosion and provision of nutrients to plants and soil micro-flora including N fixing and phosphorous solubilizing organisms. Apart from the nutrient supply, bio-slurry can inhibit pest attack e.g. nematode attack on tomato also can inhibit weed seed germination. Fertilizer value of cow-dung or poultry manure is slightly increased after gas production. The fermentation process reduces C/N ratio by removing some of the carbon thus increases nutrient concentration. Bio-slurry organic fertilizer is environmental friendly, has no toxic or harmful effects and can easily reduce the use of chemical fertilizers up to 50%. Nutrients from organic sources are more efficient than those from chemical sources. Bio-slurry is a 100% organic fertilizer most suitable for organic farming for some high value field and horticultural crops. Bio-slurry contains appreciable amounts of organic matter (20 to 30%) very much needed for our hungry soils. Bio-slurry is alkaline in reaction and has liming effects. It is very useful for reducing harmful effects of aluminum in acid soils. Thus, it can be easily seen that the use of bio-slurry has multiple benefits.

In Bangladesh, first biogas plant was constructed in 1972 at the premises of Bangladesh Agricultural University (BAU), Mymensingh, Bangladesh. After that through several projects under different organizations constructed about 24 thousands biogas plants in different parts of the country. Research work on the quality of bio-slurry and its performance on crop production in different soils and environment is lacking in Bangladesh. Therefore, it is important to evaluate the quality of bio-slurry and its effect on different crop performance particularly vegetables where manuring is better for its quality than chemical fertilization. Under such circumstance, this piece of research work was conducted to achieve the objectives to study the nutrient concentration in different manure and bio slurry and to observe the effect of different manure and bio slurry on tomato production.

Materials and Methods

The pot experiment was conducted in the open net house of the Soil Science department, Bangladesh Agricultural University, Mymensingh during the period from November, 2011 to April, 2012 to evaluate the effects of bio-slurry on tomato (cv. Ruma VF) production. There were 6 treatments viz., T_0 - Control, T_1 - Recommended fertilizer Dose (RFD), T_2 – 60% RFD + Poultry Manure (PM), T_3 - 60% RFD + Poultry slurry, T_4 - 60% RFD + Cow-dung (CD), T_5 - 60% RFD + Cow-dung slurry. The experiment was laid out in a Complete Randomized Design (CRD) with 3 replications. There were 18 (6×3) unit plastic pots having the diameter of 35cm and depth of 30 cm. The soil used in this experiment was collected from a selected area of Soil Science field of Bangladesh Agricultural University, Mymensingh. Poultry manure and poultry slurry were collected from Krishibid Poultry Farm, Valuka, Mymensingh and cow-dung and cow-dung slurry were collected from dairy farm of Bangladesh Agricultural University. chemical composition (e.g organic matter, organic carbon, N, P, K and S) of samples were analyzed in the laboratory to study their manural value before application to soil. The doses of cow-dung, poultry manure, slurry and chemical fertilizers were applied as per the treatments. Cow-dung, poultry manure, slurry and recommended doses of TSP and MOP were mixed thoroughly with soil. Urea was applied in three installments, one third at the final land preparation and the rest two thirds were applied at 30 days intervals after transplanting. Intercultural operations were performed as and when necessary throughout the growing period of the crop. Fruits were harvested at full maturity at several times. Data on Plant height, number of fruits per plant, weight of fruit and yield were collected. Data were analyzed for ANOVA with the help of a computer package program of MSTAT-. A one way ANOVA was made by F variance test. The pair comparisons were performed by Least Significant Difference (LSD) test at 1% level of probability (Gomez and Gomez, 1984).

Results and Discussion

Nutrient composition of manure & bio-slurry

Organic Matter: The organic matter content of different manures and bio-slurry was significantly different at 1% level of probability (Table 1). Organic matter content of the manures was varied from 32.00% to 69.50% (dry basis) among the treatments. The highest organic matter content of 69.50% was observed in cow-dung and the lowest organic matter content of 32.00% was found in poultry manure while in soil it was found only 3.13%. The organic matter content of cow-dung slurry and poultry manure slurry was 43.5% and 32.38% respectively. Organic matter content of cow-dung was statistically superior to cow-dung slurry, however, both the poultry manure and poultry manure slurry were statistically similar. The results were relevant with the findings of ATC (1997) who found 41.46% organic matter content in sun-dried bio-slurry (wet basis).

Table 1. Nutrient content of cow-dung, cow-dung slurry, poultry manure, poultry manure slurry and soil

Particulars	%OM	%OC	%N	%P	%K	%S	Remarks
Cow-dung	69.5±0.20a	40.41±0.41a	2.02±0.22b	0.81±0.01a	1.15±0.00b	0.39±0.04	Dry basis
	49.65±1.27a	28.86±0.74a	1.44±0.23b	0.58±0.01a	0.82±0.00b	0.28±0.04	Wet basis
Cow-dung Slurry	43.5±0.50b	25.29±0.29b	1.51±0.06c	0.51±0.09b	0.45±0.00d	0.43±0.09	Dry basis
	31.08±1.01b	18.07±.59b	1.08±0.06c	0.37±0.09b	0.32±0.00d	0.31±0.09	Wet basis
Poultry manure	32.00±1.00c	18.60±0.30c	2.94±0.20a	0.71±0.01a	1.36±0.01a	0.43±0.04	Dry basis
	22.86±0.25c	13.29±0.14c	2.10±0.2a	0.51±0.01a	0.97±0.01a	0.31±0.04	Wet basis
Poultry manure Slurry	32.38±0.38c	18.82±0.20c	2.13±0.06b	0.79±0.07a	1.05±0.00c	0.46±0.03	Dry basis
	23.13±0.12c	13.45±0.78c	1.52±0.07b	0.56±0.07a	0.75±0.00c	0.33±0.03	Wet basis
SE±	4.6	2.67	0.16	0.04	0.1	0.02	
LSD	0.65	0.34	0.168	0.069	0.015	-	
Level of sig.	**	**	**	**	**	NS	
Soil	3.13±0.18	1.82±0.10	0.05	0.0011	0.002	0.0012	

Nitrogen (N): The nitrogen content of different manures and bio-slurry was significantly different at 1% level of probability. Nitrogen content was varied from 1.51% to 2.94% among the treatments (dry basis) (Table 1). The highest nitrogen content (2.94%) was observed in poultry manure and the lowest (1.51%) in cow-dung slurry while in soil it was only 0.05%. The nitrogen content of poultry manure slurry and cow-dung was statistically similar. Again nitrogen content was recorded from 1.08% to 2.10% among the treatments on wet basis (Table 1). Nitrogen content of cow-dung, cow-dung slurry, poultry manure, and poultry manure slurry was 1.44%, 1.08%, 2.10% and 1.52% respectively on wet basis. This result was in the range of previously reported N content of 1.5-2.0% in fresh cow-dung slurry by Tripati (1993) and Acharya (1961). In all cases N content of cow-dung and poultry bio-slurry was always found lower than the cow-dung and poultry manure. It could be due to the fact that the water soluble N in bio-slurry remains as ammoniacal form accounting 12-18% of total N (Acharya, 1961) was lost through volatilization during the evaporation and drying of the digested paste like slurry due to alkaline pH of the slurry (Acharya, 1961; Chawla, 1984).

Phosphorus (P): The phosphorus content of different manures and bio-slurry was significantly different at 1% level of significance. Phosphorus content was varied from 0.51% to 0.81% among the treatments (dry basis) (Table1). The highest 0.81% was observed in cow-dung while the lowest 0.51% was found in cow-dung slurry. The phosphorus content among cow-dung, poultry manure and poultry manure slurry was statistically similar. In soil, phosphorus content was very low and it was found 0.0011%. In wet basis, phosphorus content was varied from 0.37% to 0.58% among the treatments (Table 1). The highest 0.58% was observed in cow-dung and the lowest 0.37% was found in cow-dung slurry. The phosphorus content of poultry manure and poultry manure slurry on a wet basis was 0.51% and 0.56% respectively. This finding is in line with the Phosphorus content of different slurry and manure reported by Demont *et al.* (1999).

Potassium (K): The potassium content of different manures and bio-slurry was significantly different at 1% level of significance. Potassium content was varied from 0.45% to 1.36% among the slurry and manure (dry basis) (Table 1). The highest K content of 1.36% was observed in poultry manure and the lowest potassium content of 0.45% was found in cow-dung slurry. The K content in manures followed the following trends: poultry manure> cow-dung > poultry manure slurry> cow dung slurry. In all cases K content of cow-dung and poultry bio-slurry was always found lower than the cow-dung and poultry manure. It could be due to the fact that the water soluble K in bio-slurry was lost through leaching during the drying of the digested paste like slurry in soil pit.

K content in soil was also very low and it was about 0.002%. Again K content was recorded between 0.32% and 0.97% on wet basis among the treatments (Table 1) while cow dung, cow dung slurry, poultry manure, and poultry manure slurry contain 0.82%, 0.32%, 0.97% and 0.75% of K, respectively. This result is in the range of K content of 0.6-1.5% reported by Demont *et al.* (1991), Tripathi (1993) and Gupta (1991).

Sulphur (S): There was no significant difference in sulphur (S) content among the different manures and bio-slurry. Sulphur content was varied from 0.39% to 0.46% among the treatments (dry basis) (Table 1). The highest 0.46% was observed in poultry manure slurry while the lowest 0.39% was found in cow-dung. In soil, S content was very low and it was found 0.0012%. In the wet basis S content was varied from 0.33% to 0.28% among the treatments (Table 1). The S content of poultry manure and cow-dung slurry was similar and it was 0.31%.

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Plant height: The effect of different treatments on plant height was statistically significant at 1% level of probability (Table 2). All the treatments showed higher plant height over control. Plant height was varied from 17.10 cm to 58.40 cm among the treatments. The tallest (58.40cm) plant was observed in T_2 (60% RFD + Poultry Manure) treatment while the shortest plant (17.10 cm) was found in T_0 (control) treatment. The plant height recorded in T_1 (RFD) and T3 (60% RFD + Poultry manure slurry) and T_4 (60% RFD + Cow-dung) were statistically similar and superior to T0 (control) treatment. The plant height obtained from different treatments ranked in the order of T2 > T1 > T3 > T4 > T5 > T0. The reasons of obtaining higher plant height in T_2 (60% RFD + Poultry Manure) treatment might be due to the higher percent N, P, K and S content in poultry manure. The highest percentage (241.52%) of increased plant eight over control was recorded in the treatment T_2 (60% RFD + Poultry manure). The lowest percentage (141.52%) of increased plant height over control was recorded in the treatment T_5 (60% RFD + Cow-dung slurry).

Table 2. Effect of manure and bio-slurry on the yield contributing characters of pot planted tomato

Treatments	Plant height	No. of Fruits per plant	Wt. of fruits (g)	Yield (g/pot)
T_0 (Control)	17.10c	4.33b	19.84b	85.42f
T_1(100% RFD)	53.67ab	16.33a	28.84a	465.39b
T_2 (60% RFD + poultry manure)	58.40a	14.33a	31.50a	450.01c
T_3 (60% RFD + poultry slurry)	53.27ab	15.67a	33.55a	516.57a
T_4 (60% RFD + cow-dung)	48.80ab	13.33a	31.47a	410.80d
T_5 (60% RFD + cow-dung slurry)	41.30b	14.33a	26.75ab	376.27e
SE±	3.63	1.06	1.35	34.12
LSD	7.49	2.14	4.1	8.26
Level of significance	**	**	**	**

Number of fruits plant^{-1}: The number of fruits plant^{-1} was significantly influenced by different manure and slurry treatment (Table 2). The highest number of fruits plant^{-1} (16.33) was produced in T_1 (RFD) treatment and it was lowest (4.33) in T_0 (Control) treatment. Overall results of number of fruits plant^{-1} indicated that the highest number of fruits plant^{-1} was in T_1 treatment (16.33) followed by the treatment T_3 (15.67), T_2 (14.33) and T_5 (14.33), T_4 (13.33) and the lowest in T_0 (4.33). The number of fruits plant^{-1} was statistically similar in all the treatment except control. The highest percentage (277.13%) of increased number of fruits plant^{-1} over control was recorded in the treatment T_1 (RFD). The lowest percentage (207.85%) of increased number of fruits plant^{-1} over control was recorded in the treatment T4 (60% RFD + Cow-dung). The results indicate that the application of full recommended doses of chemical fertilizer (T_1) had the best effect on the number of fruits plant^{-1} of tomato.

Fruit weight: The data on the average fruit weight of tomato was analyzed and shown in Table 2. The fruit weight of tomato was significantly influenced by different manure and slurry treatment. From the result it was observed that the highest average fruit weight was recorded in T_3 treatment (33.55 g fruit^{-1}) followed by T_2 (31.50 g fruit^{-1}), T_4 (31.47 g fruit^{-1}), T_1 (28.84 g fruit^{-1}), T_5 (26.75 g fruit^{-1}) and the lowest in T_0 (19.84 g fruit^{-1}) treatment. The fruit weight of tomato was statistically similar in all the treatment except control (T_0). The highest percentage (69.10%) of increased fruit weight over control was recorded in the treatment T_3 (60% RFD + Poultry Manure). The lowest percentage (34.83%) of increased fruit weight over control was recorded in the treatment T_5 (60% RFD + Cow-dung). The results indicated that the application of 60% RFD + Poultry Manure (T_3) had the best effect on the average fruit weight of tomato.

Yield: The yield of tomato was significantly influenced by the application of different slurry and manure and chemical fertilizers (Table 2). The yield of tomato varied from 85.42 to 516.57 g pot^{-1} in different treatments combinations. The highest yield (516.57 g pot^{-1}) was recorded in 60% RFD + Poultry bio-slurry (T3) treatment and the lowest yield (85.425 g pot^{-1}) was observed in control (T_0) treatment. Overall results of yield indicated that the highest yield was in T3 treatment (516.57 g pot^{-1}) followed by the treatment T_1 (465.39 g pot^{-1}), T_2 (450.01 g pot^{-1}), T4 (410.80 g pot^{-1}), T_5 (376.27 g pot^{-1}) and the lowest in T_0 (85.42 g pot^{-1}). The yield of tomato were increased by 444.83, 426.82, 504.74, 380.92 and 340.49 % over control in T_1 (RFD), T_2 (60% RFD + Poultry Manure), T_3 (60% RFD + Poultry Bio-slurry), T_4 (60% RFD + Cow-dung), and T_5 (60% RFD + Cow-dung Bio-slurry), respectively. The results indicated that the application of 60% RFD + Poultry Bio-slurry (T3) had the best effect on yield of tomato.

The above results are in line with the finding of Maskey, (1978) who reported that all crops including tomato gave higher yield with biogas slurry. There was a yield increase of 19% in tomato due to application of bioslurry compared with the untreated one. Furthermore, application of organic manures maintained the soil pH near to neutral, besides keeping lower levels of electrical conductivity and bulk density (Steel and Torii,1960).

From the above findings, it may be concluded that application of bio-slurry in combination with chemical fertilizer had better performance on growth and yield attributes tomato cv. Ruma VF. The use of poultry bio-slurry not only gives higher yield but also improves the soil organic matter, maintains soil health and keeps the soil and environment free from pollution. In order to make this work more useful and beneficial for vegetable growers, the following aspects should be considered in future: Similar experiment should be conducted under field condition at different areas of Bangladesh and varietal trials need to be investigated.

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