J. Sylhet Agril. Univ. 4(2):213-220, 2017 **ISSN: 2308-1597**

EFFECTS OF ORGANIC AND INORGANIC FERTILIZERS ON TOMATO PRODUCTION IN SALINE SOIL OF BANGLADESH

D Saha*[1], O A Fakir[2], S Mondal[2], and R C Ghosh[3]

[1]*Sylhet Agricultural University Research System, Sylhet Agricultural University, Sylhet-3100, Bangladesh*
[2]*Bangladesh Agricultural Research Institute, Agricultural Research Station, Satkhira, Bangladesh*
[3]*Department of Agriculture Extension, Kushtia, Bangladesh*

(Available online at: www.jsau.com.bd)

Abstract

Organic fertilizer is a major limiting factor in crop production, especially for vegetables during the winter season in Bangladesh. Recently, an experiment was conducted at ARS, BARI, Satkhira on three types of organic fertilizer (OF) like OF from Co-compost (Faecal Sludge and Municipal Solid Waste), OF from earthworm compost (Vermicompost) and OF from cowdung whereas chemical fertilizer were applied as control treatment. Now a day's farmers are cultivating tomato in saline areas and normally they do not use any compost fertilizers at their field as an organic fertilizer, therefore, it is urgent to find out the suitable combining dose of different types of compost and chemical fertilizers for maximizing the yield or know the best combination of chemical and organic fertilizer as well as the economic benefit from best treatment considering soil health. For this reason, this experiment was conducted in RCBD design with three dispersed replications in the winter season 2016-17 at ARS, Satkhira. Four fertilizer doses viz., T_1 = 100% Chemical Fertilizer (Soil Test Based, FRG, 2012), T_2 = Co-compost @ 2 t ha^{-1} with 50% recommended dose of chemical fertilizer (RDF), T_3 = Vermicompost @ 2 t ha^{-1} with 50% RDF, T_4= Cowdung @ 5 t ha^{-1}; were set as the treatments. Tomato (BARI Tomato-14) was planted on 15 November 2016; during final land preparation following proper methodology. Only four irrigations were applied after 10, 25 and 35 and 45 days after plantation. It was found that treatment T_2 gave the highest yield (45.94 t ha^{-1}) followed by T_3 (42.16 t ha^{-1}), T_1 (32.50 t ha^{-1}) and T_4 (32.50 t ha^{-1}). From the economic study, it was found that higher income obtained from using co-compost along with chemical fertilizer (198825 Tk. ha^{-1}) followed by T_3 (155025 Tk. ha^{-1}), T_1 (118025 Tk. ha^{-1}) and T_4 (190575 Tk. ha^{-1}). Now, it is clear that 2 ton co-compost with 50% inorganic fertilizer from Recommended Dose of Fertilizer (RDF) gave the highest yield with economic benefit. Also soil salinity was recorded minimum in co-compost treated plot.

Keywords: Vermicompost, co-compost, cowdung, tomato, saline soil.

Introduction

Salinity is one of the most detrimental factors which are limiting the productivity of agricultural crops, with adverse effects on germination, plant vigour and crop yield (Munns and Tester, 2008). In Bangladesh, salinization is one of the major natural hazards hampering crop production. Coastal area in Bangladesh constitutes about 20% of the country of which about 53% are affected by different degrees of salinity (Haque, 2006). Tomato is one of the most important vegetable crops in the world. Tomatoes play a vital role in human diet and are a good source of vitamins and minerals. Tomato crops require nutrients such as N, P, K, Mg, Ca, Na and S for good production. These nutrients are specific in function and must be supplied to the plant at the right time and in the right quantity for proper growth and reproduction (Adekiya and Ojeniyi, 2002). However, there is renewed interest in proper and effective use of organic manure to maintain soil fertility (Olatunji and Oboh, 2012). Organic manure helps to increase the population of soil microorganisms which have some influence in protecting plant against pathogens like nematodes and soil born insects and also provides plant growth hormones like auxins (Sanchez and Miller, 1986; Agbede and Ojeniyi, 2009).

In today's era, heavy doses of chemical fertilizers and pesticides are being used by the farmers to get better yield of various field crops. These chemical fertilizers and pesticides decreased soil fertility and caused health problems to the consumers. Due to adverse effects of chemical fertilizers, interest has been stimulated for the use of organic manure. Porosity, drainage, water holding capacity and microbial activity are high in vermicompost. Vermicompost is produced by biodegradation of organic material through interactions between earthworms and microorganisms. The presence of

***Corresponding author: D Saha**, *Sylhet Agricultural University Research System, Sylhet Agricultural University, Sylhet-3100, Bangladesh, E-mail: dabasishsau@yahoo.com*

nutrients such as nitrates, phosphates and exchangeable calcium and soluble potassium remained in vermicompost. Vermicompost contains plant growth influencing materials produced by microorganisms.

As a result of increased popularity of organic vegetable production, more information is needed comparing the growth and yield of vegetable crops produced organically or using inorganic fertilizer. Co-composting means composting of two or more raw materials together and in this case, Faecal Sludge (FS) and MSW are common materials. Other organic materials, which can be used or subjected to co-compost, comprise animal manure, sawdust, wood chips, bark, slaughterhouse waste, sludge's or solid residues from food and beverage industries. Co-composting for its good quality plant nutrient value can be used successfully for wheat production. But its effectiveness depends on cropping systems, crop variety to be used, soil types and agroecological regions. Neither co-compost nor inorganic fertilizer alone is enough to meet demand of soil-crop systems. Now every year different institutions, NGOs, company are producing huge amount of co-compost fertilizers using faecal sludge and municipal waste in Bangladesh with the concern of the Government. It is clear that such kind of co-compost could be the solution for mitigating the current solution. Faecal sludge and municipal solid waste are used in co-composting, so plant nutrient value of co-compost come out of these materials expectedly will vary which need to be determined. With varied nutrient value these co-compost will affect crop production variedly in different local environment. The extension activities of co-compost and utilization could be strengthening with appropriate evidence based research information. The research on co-compost can generate more information on effective utilization of co-compost in crop production and there by more economic and profitable use of co-compost which will encourage more farmers to use it. It is also illustrious that Bangladesh Agricultural Research Institute has analysed the current co-compost in different dimensions, i.e., diseases and heavy metal content but the report showed there were no hazardous issues that could be created a problem in human health. Neither compost nor inorganic fertilizer alone is enough to meet demand of soil-crop systems. Judicious use of chemical fertilizers along with organic fertilizer may not only help to maintain soil fertility but may also increase crop productivity. Since comparative information on the effect of different compost on the yield of tomato as well as soil status is not available. Therefore, the present study was undertaken to evaluate the effects of three different organic fertilizers on the growth performance and yield potentials of tomato grown in South-western part of Bangladesh.

Materials and Methods

Experimental site and design

The experiment was conducted at the Agricultural Research Station (ARS), BARI, Benarpota, Satkhira during the rabi (winter) season of 2016-2017 to observe the effect of different organic and inorganic fertilizers on tomato production in saline condition. The soil belonged to the AEZ-11 and AEZ-13. There were four treatments *viz.* T_1 = 100% Chemical Fertilizer (Soil Test Based, FRG, 2012), T_2 = Co-compost @ 2 t ha^{-1}+ RDF, T_3 = Vermi-compost @ 2 t ha^{-1}+ RDF, T_4 = Cowdung @ 5 t ha^{-1}. The crop variety was BARI Tomato-14. The experiment was laid out in a RCBD design with three replications. The dimensions of individual plots were 2.4 m $\times$ 2.4 m.

Physical properties of soil

The land topography was medium low. The soil of the field, ARS, Satkhira was clay loam in texture having bulk density and particle density of 1.42 and 2.37 g cm^3, respectively (Table 1) while porosity was 40.02%.

Table 1. The physical properties of initial soil at ARS, Satkhira at research farm

Soil depth	Bulk density (g cm^{-3})	Particle density (g cm^{-3})	Porosity (%)	Initial Moisture content (%)	Field Capacity (%)	Textural class
0 - 15 cm	1.42	2.37	40.02	21.54	21.31	Clay Loam

Chemical Properties of Soil

The chemical properties of the initial soil were taken from 0 to 15 cm depth of the soil. The soil pH was 6.91 whereas OC and total N were 0.95% and 0.08% and it's seems to be very low in soil. On the other hand exchangeable K, Ca and Mg were 0.13, 5.78 and 10.62 meq/100 g in soil. It was also found that available P was 16.70 ppm; S was 8.33 ppm; Zn was 0.68ppm; B was 0.31ppm; Cu was 1.25 ppm and finally Mn was 0.88ppm. The chemical proprieties of the soil (0-15 cm depth) which were considered for the determination of fertilizer dozes in the experiment presented in Table 2.

Table 2. Chemical properties of initial soil at Tomato field

Soil characteristics	Analytical value			Critical levels
	Initial soil	Soil after harvest		
	Value	Value	Interpretation	
Soil p^H	6.91	7.11	Neutral	-
Organic matter (%)	1.61	1.65	Medium	C:N= 10:1
Organic C (%)	0.95	0.81	low	C:N= 10:1
Total N (%)	0.08	0.11	Low	0.12
Available P (ppm)	16.70	22.01	Optimum	10.0
Exchangeable K (meq100g $soil^{-1}$)	0.13	0.21	Medium	0.12
Available S (ppm)	8.33	7.27	Low	10.0
Available Zn (ppm)	0.68	0.90	Medium	0.6
Available Boron (ppm)	0.31	0.30	Medium	0.2
Available Cu (ppm)	1.25	1.14	Very high	0.2
Available Fe (ppm)	20.72	19.15	Very high	4.0
Available Mn (ppm)	0.88	0.76	Very low	1.0
Exchangeable Ca (meq100g $soil^{-1}$)	5.78	4.81	Optimum	2.0
Exchangeable Mg (meq100g $soil^{-1}$)	10.62	8.44	Very high	0.5

Chemical properties of different compost

Vermi-compost was high in organic materials (11.90) than Co-compost and Cowdung (Table 3). Co-compost was comparatively rich in essential plant macronutrients which contained about 2.26 percent nitrogen, 1.80 percent phosphorus, and 1.36 percent potassium. In addition to nitrogen and phosphorous of special importance was the micronutrients more found in co-compost such as manganese and iron.

Table 3. Chemical properties of different types of compost

Specification	Co-compost	Vermicompost	Cowdung
Physical condition	Dust	Dust	Dust
Color	Black	Black	Black
Moisture (%)	30.38	40.65	55.36
pH	6.80	7.9	8.0
OC (%)	6.700	11.90	11.83
Ca (%)	1.49	1.44	2.11
N (%)	2.26	2.04	1.88
P (%)	1.80	0.77	0.67
K (%)	1.36	1.70	1.34
S (%)	0.84	0.42	0.40
Cu (%)	0.004	0.007	0.004
Fe (%)	1.09	0.79	0.51
Mn (%)	0.34	0.26	0.32
Zn (%)	85.62	87.81	92.28
Pb (ppm)	6.8	5.0	4.8
Cd (ppm)	1.01	1.01	1.2
Cr (ppm)	21.17	23.10	22.43
Ni (ppm)	13.5	12.2	10.5

Estimated actual Fertilizer dozes

The actual dozes after calculation the fertilizer requirements considering initial soil nutrients and compost were - T_1 = 124 N + 11 kg P + 51.16 kg K + 0.62 kg S + 0.21 kg Zn + 0.84 kg B, T_2 = 142.5 kg N + 2.3 kg P + 64.52 kg K + 0.635 kg S + 1.21 kg Zn + 1.03 kg B, T_3 = 98.5 kg N + 8 kg P + 43.64 kg K + 0.53 kg S + 0.65 kg Zn + 0.63 kg B + 2190 kg

FYM compost, T_4 = 100.5 kg N + 9 kg P + 44.74 kg K + 0.50 kg S + 0.75 kg Zn + 2052 kg Vermi-compost. The dozes were estimated for 1 ha of land.

Management

Tomato seedlings were planted in a line maintaining a spacing 40 cm × 60 cm and planted on 15 November 2016. All the co-compost, phosphorus, sulpher, zinc and boron were applied as a basal during final land preparation. Nitrogen and potasium were applied in three equal splits at 15 and 35 and 45 days after transplanting as ring method under moist soil condition and mixed throughly with the soil as soon as possible for better utilization. The crop was harvested on April 2017. Yield and yield contributing characters like plant highet, branches plant^{-1}, fruits length, fruit diameter, yield t ha^{-1} were measured. The data were analyzed statistically by MSTAT-C software.

Results and Discussion

Plant height (cm)

Significant variations on plant height were found among different treatments (Fig. 1). The rate of plant height increment was rapid when applied co-composed. At final harvest, the highest plant height was found in Co-compost (77.79 cm). The lowest height was found in Vermicompost (65.03 cm) followed by Cowdung (65.72 cm). The result obtained from the present study was consistent with the result of researcher Brown *et al*. (1995).

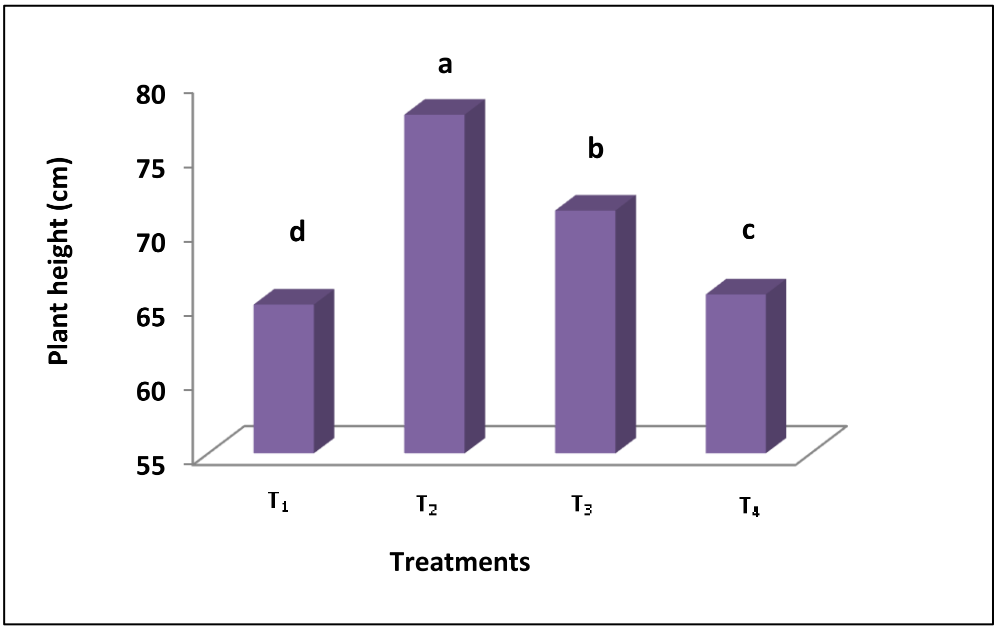

Fig. 1 Plant height (cm) of different treatments

Number of branches plant^{-1}

The number of branches plant^{-1} varied significantly among different treatments (Table 4) of tomato. The Co-compost produced maximum branches plant^{-1} (7.67). Chemical fertilizer had lowest number of branches plant^{-1} (6.07) which were statistically similar to the treatment Vermicomposed (6.47) and cowdung (6.67). The result indicates that Co-compost treatment had vigorous growth habit than other treatment. The similar number of branches plant^{-1} was also reported by Tsado (2014) and Singh *et al*. (2007).

Table 4. Effect of different treatments on yield contributing parameters of tomato

Treatments	Plant height (cm)	Branches $plant^{-1}$	Fruits length (cm)	Fruits diameter (cm)	Fruits $plant^{-1}$
T_1	65.03c	6.07c	3.00b	3.20b	21.20c
T_2	77.79a	7.67a	3.41a	3.67a	36.33a
T_3	71.35b	6.67b	2.95b	3.09b	29.20b
T_4	65.72c	6.47b	2.81b	3.25b	25.27b
CV (%)	3.59	3.54	6.91	6.51	7.98

In a Colum, T_1 = 124 N + 11 kg P + 51.16 kg K + 0.62 kg S + 0.21 kg Zn + 0.84 kg B, T_2 = 142.5 kg N + 2.3 kg P + 64.52 kg K + 0.635 kg S + 1.21 kg Zn + 1.03 kg B, T_3 = 98.5 kg N + 8 kg P + 43.64 kg K + 0.53 kg S + 0.65 kg Zn + 0.63 kg B + 2190 kg FYM compost, T_4 = 100.5 kg N + 9 kg P + 44.74 kg K + 0.50 kg S + 0.75 kg Zn + 2052 kg Vermicompost. The dozes were estimated for 1 ha of land.

Fruit length (cm)

Fruit length increased gradually upto few days. Fruit length of tomato differed significantly among the treatments. The longest fruit (3.41 cm) and shortest fruit (2.81 cm) found in Co-compost and Cowdung (Table 4). Fruit length of tomato in Vermicompost found similar to Cowdung in all harvests.

Fruit diameter (cm)

Fruit diameter increased gradually according to the increment of fruit length (Table 4). Significant variation observed among the different fertilizers. The lowest fruit diameter was obtained in Vermicompost treatment (3.09 cm) and the highest fruit diameter was in Compost treatment (3.67 cm). Statistically similar result of fruit diameter of tomato after the treatment Chemical fertilizer and Cow dung were 3.20 and 3.25 cm, respectively. Umara *et al.* (2013) found that the tomato diameter decreased in salt concentration. Dauda (2005) suggested that fruit diameter may increase with increase in compost application.

Number of fruits $plant^{-1}$

There was significant variation among the treatment regarding the number of fruits $plant^{-1}$ (Table 4). The greatest quantity of fruits $plant^{-1}$ (36.33) was obtained by treatment Co-compost. On the other hand, the least number of fruits $plant^{-1}$ (21.20) was found in treatment Chemical fertilizer which was significantly lower than other treatments. Turkmen *et al.* (2004) also reported compost is an important ingredient in increasing the mineral nutrient uptake in tomato cultivated in saline medium.

Fruit yield (t ha^{-1})

The yield is the result of complex interaction of the parameters like number of fruits, fruit setting (%), individual fruit weight etc. Fruit yield (t ha^{-1}) of tomato differed significantly among the treatments (Fig. 2). The highest yield (45.94 t) was obtained by Co-compost and the lowest yield (32.50 t) was recorded by Cow dung which was statistically similar to the treatment Chemical fertilizer (32.86 t ha^{-1}) whereas Vermicompost responded the yield of 42.16 t ha^{-1}. Islam *et al.* (2000) reported analogous variation in fruit yield (t ha^{-1}) ranged from 4.72 to 10.08 tones.

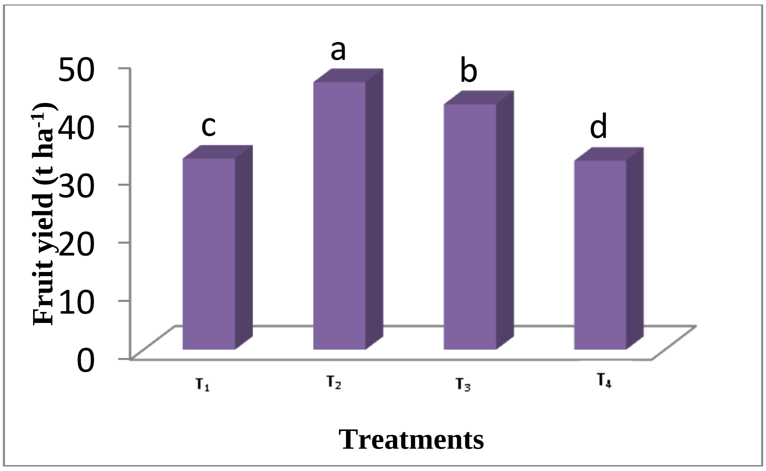

Fig. 2 Fruit yield (t ha^{-1}) of tomato in different treatments

Economic analysis

From the economic study, it was found that higher income obtained from using co-compost and chemical fertilizer (198825 Tk. ha^{-1}) followed by T_3 (155025 Tk. ha^{-1}), T_1 (118,025 Tk. ha^{-1}) and T_4 (190575 Tk. ha^{-1}). Gross return was higher 459400 Tk. ha^{-1} using Co-compost on the opposite site gross return was lower 328600 Tk. ha^{-1} using Chemical fertilizer. The highest variable cost was 266575Tk. ha^{-1} which was statistically similar to Co-Compost 260575 Tk. ha^{-1} and the lowest variable cost was 190575 Tk. ha^{-1} using cowdung. Now, it is clear that 2 ton Co-compost with inorganic fertilizer gave the highest yield with economic benefit.

Table 5. Economic performance of different treatments on tomato production

Treatments	Total variable cost (Tk. ha^{-1})	Gross Return (Tk. ha^{-1})	Gross margin (Tk. ha^{-1})
T_1	328600	210575	118025
T_2	459400	260575	198825
T_3	421600	266575	155025
T_4	325000	190575	134425

Soil Salinity

Data of the experiment revealed that soil salinity at different dates under application of different organic and inorganic fertilizers remained varying during crop growth. Fig. 3 showed the differences in soil salinity between the treatments over time.

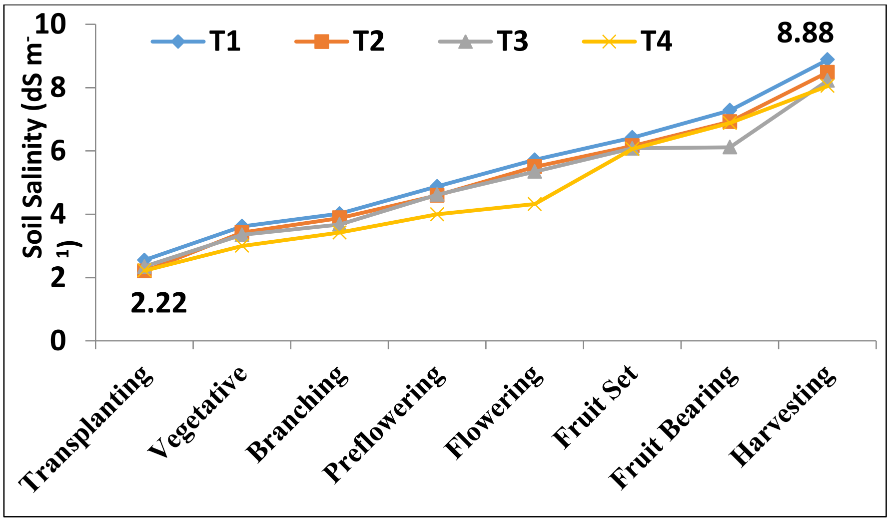

Fig. 3. Different levels of soil salinity (dS m^{-1}) over time at tomato field

The steady monitoring indicated that field values of EC, in general, were increased with time till harvest. The lowest level of soil salinity was recorded in sowing time ranged from 2.22 to 2.55 dS m^{-1} in all treatment plots and the highest level of salinity (8.88 dS m^{-1}) was recorded in T_1 at the harvesting stage. The average maximum and minimum soil salinity also observed the highest in chemical fertilizer treatments (T_1) which went down in case of all other organic fertilizer treated plots (Fig. 4).

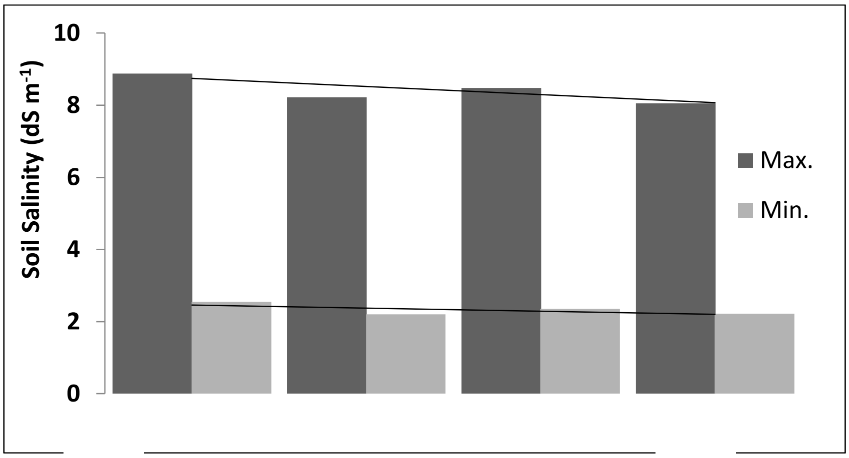

Fig. 4. Maximum and Minimum Soil Salinity (dS m^{-1}) of different treatments

Aziz (2002) and Abdel-Maboud (2004) reported that the soil electrical conductivity was significantly decreased by the application of sludge, cattle manure and chicken manure under irrigation treatment with 75% available moisture depletion. Barzegar *et al*. (1997) found that the application of organic matter to saline soils can accelerate Na^+ leaching, increase the percentage of water-stable aggregates, and decrease the ESP, EC, and soil salinity.

Conclusion

As saline soil is a problematic soil, hence it is difficult to cultivate tomato in coastal zone. From the above findings, it may be concluded that application of two t ha^{-1} of Co-compost in combination with inorganic fertilizer had better performance on growth and yield attributes of Tomato (cv. BARI Tomato-14). The use of Co-compost not only gives higher yield but also improves the soil organic matter, maintains soil health and keeps the soil and environment free from pollution.

Acknowledgement

Authors are very much grateful to authority of Bangladesh Agricultural Research Institute, ARS, Satkhira to allow for conducting this research and the scientists, staffs for their contribution in all related work to complete the manuscript.

References

Adekiya and Ojeniyi. 2002. Evaluation of tomato growth and soil properties under methods of seedling bed preparation in an Alfisol in the rainforest zone of southwest Nigeria. Soil Tillage Res. 64:275-279.

Agbede T M and Ojeniyi S O. 2009. Tillage and poultry manure effects on soil fertility and sorghum yield in southwestern Nigeria. Soil and Tillage Research. 104:74-81.

Brown J E. 1995. Comparison of broiler litter and commercial fertilizer on production of tomato. J. of Vegetable Crop Production. 1:53-60.

Barzegar A R, Nelson P N, Oades J M and Rengasamy P. 1997. Organic matter, sodicity, and clay type: influence on soil aggregation. Soil Science Society of America Journal. 61:1131–1137.

Dauda S N, Aliyu L and Chiezey U F. 2005. Effect of variety, seedling age and poultry manure on growth and yield of garden egg (*Solanum melongena L.).* Nigerian Acad. Forum. 9:88–95.

Haque S A. 2006. Salinity problems and crop production in coastal regions of Bangladesh. Review article. 38(5):1359-1365.

Munns R and Tester M. 2008. Mechanisms of salinity tolerance. Annual Review of Plant Biology. 59:651-681.

Olatunji O and Oboh V U. 2012. Growth and yield of Okra and Tomato as affected by Pig dung and other manure issue for Economic Consideration in Benue state. In: Nigerian Journal of Soil Science. 22(1):103-107.

Sanchez P A and Miller R H. 1986. Organic matter and soil fertility management in acid soils of the tropics. Transactions of the XIII Congress of International Soil Science Society.

Singh R S, Sharma R R and Goyal R K. 2007. Interacting effects of planting time and mulching on "Chandeler" strawberry (*Fragaria* × *ananassa* Duch.). Sci. Hortic. 111:344–351.

Tsado E K. 2014. The best source of compost for tomato production - a study of tomato production in niger state, Nigeria. European J. Agric and Forestry Research. 2: (4): 1p.

Turkmen O, Dursun A, Turan M and Erdinc C. 2004. Calcium and Humic Acid affect Seed germination, growth and nutrient content of Tomato (*Lycopersicon esculentum L.)* Seedlings under Saline soil Conditions. Acta Agric. Scan B-S-P. 54:168-174.

Umara B G, Abdullahi A S, Dibal J M and Ahmad D. 2013. Effects of Salts concentration on emergence and growth of Tomato (*Lycopersicon esculentum*) in Tropical Areas. Inter. J. Engin. and Innov. Techn. (IJEIT). Vol: 289p.