IOSR Journal of Agriculture and Veterinary Science (IOSR-JAVS)
e-ISSN: 2319-2380, p-ISSN: 2319-2372. Volume 9, Issue 1 Ver. I (Jan. 2016), PP 06-16
www.iosrjournals.org

Yield Response of Tomato under Different Combination of Manures and Fertilizers

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Abstract: *An experiment wascarriedouton yield response of tomato (Lycopersiconesculentum Mill.) under different combination of manures and fertilizers at Hogladanga village under the Batiaghataupazila of Khulna district during November, 2013 to March, 2014. Theexperiment was set up in a Randomized CompleteBlock Design(RCBD) with threereplications.Theexperimentconsistedof seventreatments.Thetreatmentswere T_1 = Recommended doses of NPK (Urea @ 350 kg ha^{-1}, TSP @ 250 kg ha^{-1} , MoP 300 kg ha^{-1} , respectively), T_2 = cowdung @10 t ha^{-1}, T_3 = vermicompost @ 10 t ha^{-1}, T_4 = Trichoderma compost @10 t ha^{-1}, T_5 = 50 % cowdung + 50 % recommended doses of fertilizer, T_6 = 50 % vermicompost + 50 % recommended doses of fertilizer and T_7 = 50 % Trichoderma compost + 50 % recommended doses of fertilizer. The response on growth and physio-morphological characteristics, yieldattributesandyield of tomatowerepositivelyandsignificantlyinfluencedbytheapplication ofvermicompostwithrecommended dose ofNPK and also Trichoderma compost with the recommended dose of NPK.Inmostcases T_6 (50 % vermicompost + 50 % recommended doses of fertilizer) treatmentperformed better.However,themaximumyield of tomato(78.02t ha^{-1})was obtainedfromthe treatmentreceiving50 % vermicompost + 50 % recommended doses of fertilizer and the lowest yield of tomato (42.36 t ha^{-1}) was obtained from treatment T_2 (cowdung @10 t ha^{-1}). The highest benefit cost ratio (BCR) of tomato (3.15) was obtained from application of 50 % vermicompost + 50% recommended doses of fertilizer due to higher yield and market value. So, 50 % vermicompost + 50% recommended doses of fertilizer treatment (T_6) was proved more profitable and sustainable for cultivation of tomato obtaining better yield.*

***Key words**: Morphological, Cowdung, Vermicompost, Tricoderma compost, Tomato*

I. Introduction

Tomato (*LycopersicumesculentumM*ill.),a member of the family Solanaceae, is the most popular vegetable in the world for its taste, colour and high nutritive value and also for its diversified use (Bose and Som, 1986). Tomato is one of the important vegetable crops grown throughout the world and ranks next to potato in terms of the area but ranks first as a processing crop(Mehdizadeh*et al.*, 2013). In Bangladesh tomato is mainly cultivated in winter season, although some recommended summer variety are cultivated during summer season. Popularity of tomato is increasing day by day due to its flavor, food and medicinal value. It is widely using in cannery and made into soups, conserves, pickles, ketchup, sauces, juices etc. In Bangladesh, tomato is growing in about 13,066 ha of land with the total production of 74,000 metric tons (BBS, 2012). So, this research is designed to identify the way of improving yield capacity of tomato arranged with cowdung, vermicompost, *Trichoderma* compost and NPK fertilizer.

Cowdung is highly familiar manure and used in our agricultural aspect. Vermicompost and *Trichoderma* compost are not much familiar, but use of these two are increasing day by day because of higher nutrient content as alternate of inorganic fertilizer. Vermicompost and *Trichoderma* compost are highly using worldwide as source of organic manure. Agoodagriculturalsoilshould havearound5%organicmatterbutin Bangladesh,thesoilsofmostregionshave1.5-2%,some soilsevenhavelessthan1%organicmatter(Fertilizer Recommendation Guide,2012). Organicmanuresuchascowdung,*Trichoderma*compost andvermicomposimprovetexture,structure,color,water holdingcapacity,microbialactivity,anionand cationexchangecapacity,organicmatterandcarbon-contentofsoiland, italsopromotesthevegetative growth,flowering,fruitset,yieldandqualityoftomatoinwayssimilartoinorganicfertilizers(Tonfack*etal*.,2009).
Manure and biofertilizers prepared from animal and plant origin are most commonly used for sustainable production (Premsekhar and Rajashree, 2009) due to their beneficial effects on nutrient uptake and retention, pest control and productivity (Barrios-Masias*et al.*, 2011). Among such preparations, vermicompost has been recognized as having considerable potential for soil amendments (Wei *et al.*, 2012).

Cowdung is the most cheap and available qualified manure. The use of available and cheap cowdung can ensure sustainability of production and balanced nutrition. The long term use of cow dung increased aggregate stability, macro pores and lowered bulk density (Olayinka *et al*., 2006). A great part of the benefit of animal manure lies in slow mineralization and the addition of organic matter to the soil which offers a definite advantage over inorganic fertilizers (Lakshmikathan, 1983).

Vermicompost is a finely divided manure peat like material with high porosity, aeration, drainage and water holding capacity and microbial activity and is stabilized by interaction between earthworms and micro-organisms in a nonthermophilic process (Edwards and Burrows, 1988). Vermicompost contains a high proportion of humic substances (humic acids, fulvic acids and humin) which provide numerous sites for chemical reaction; microbial components known to enhance plant growth and disease suppression through the activities of bacteria (*Bacillus*), yeast (*Sporobolomyces* and *Cryptococcus*) and fungi (*Trichoderma*), as well as chemical antagonists such as phenols and amino acids (Theunissen*et al*., 2010). With the process of conversion of various organic wastes by earthworms, many of the nutrients are changed to their available forms in order to make them easily utilizable by plants.

Efficient use of *Trichoderma*-enriched biofertilizer may increase yield, reduce the uses of N fertilizers, reduce soil borne pathogens and improve soil health. *Trichoderma* compost is used to produce quality tomato seedlings, capable of withstanding adverse abiotic and biotic stresses after transplanting and improve mineral nutrient uptake, inspire producers to consider a combined pre sowing inoculation of seedling with *Trichoderma harzianum*.

The yield of tomato is not satisfactory in Bangladesh. Several factors such as deficiency of soil nutrients, cultural factors, spacing etc., are considered as the major constraints to successful tomato production. The farmer of our country use excess amount of inorganic fertilizer to gain better yield without considering adverse effect of it. High application of chemical fertilizers has negative effects on physical, chemical and biological properties of soil and may cause soil erosion (Davarinejad*et al*., 2004). Now-a-days there is more attention to replace chemical fertilizers with biological fertilizers (Kader *et al*., 2002). Excessive use of inorganic fertilizers creates environment related problems and situation can be improved through the use of bio-fertilizer (Saadatnia and Riahi, 2009). One of the possible options to reduce the use of chemical fertilizers could be recycling of organic wastes. Compost as the organic waste can be a valuable and inexpensive fertilizer and source of plant nutrients. Organic waste have Positive effects on soil structure, aggregate stability and water-holding capacity (Odlare*etal*., 2008).

There are many problems in agriculture of Bangladesh among these degradation of soil health is one of the major problems. This problem creates due to higher use of agrochemicals such as fertilizers, pesticides, herbicides etc. in crops fields as well as for intensive cropping to produce more foods for the fast and vast growing populations without considering the negative impact of chemicals on soil. It is hypothesis that organic agricultural practices might be a potential alternative to mitigate the soil health degradation problem and may be gave higher yield and BCR. However, concept of organic farming is very preliminary in Bangladesh. This practice maintains crops yield at optimum level by assuring soil health.

From the above discussion it is revealed that cowdung, vermicompost and *Trichoderma* compost are highly beneficial with various properties influencing soil fertility, growth and yield of products. So this research was conducted with following objective:

- To assess the effect of different combination of manures and fertilizers on growth and yield of tomato

II. Materials and Methods

2.1 Plant material and growth condition

The field experiment was conducted at Hogladanga village under the Batiaghataupazila of Khulna district during November, 2013 to March, 2014. Climate wassub-tropicalwhich wascharacterizedby heavy rainfall, high humidity, high temperature and relatively long day during the Kharifseason(ApriltoSeptember)andscantyrainfall,associatedwithmoderately low temperature and short day period during the Rabi season (October to March). Plentyofsunshineandmoderatelylowtemperatureissuitablefor growingtomato, which prevails during Rabi season in Bangladesh.

The soil of experiment area was medium high in topography and clay loam to sandy loam in texture belonging to the Ganges Tidal Floodplain Tract under the Agro Ecological Zone-13 (FAO, 1988).The tomato cultivar used in the experiment was “Suraksha”, which was a high yielding determinate and bacterial wilt resistant variety ("Namdharimalik Company", India). Vermicompost was collected from Plant Breeding and Biotechnology laboratory under Agrotechnology discipline, Khulna University, Khulna. *Trichoderma* compost was collected from GrameenKrishokSohayakSangstha (GKSS), Gabtali, Bogra.Tomato seedlings were raised on one seedbed with special care (Hogladanga, Khulna). Twenty five days old healthy and uniform size seedlings were transplanted in the experimental plots on 6 December, 2013. In total, there were 21 unit plots in the experiment. The unit plot was 2.4 m × 1.6 m in size. Thus each unit plot arranged with 16 plants where plant to plant and row to row distance were 40 cm and 60 cm, respectively. Furrow irrigation methods was followed for irrigation of tomato crops. Chemical analysis of soil sample was done after fertilization and after harvesting (SRDI, Daulatpur, Khulna). Different intercultural was done such as gap filling, staking, weeding, and crop protection (Malathion 57 EC @ 2 ml litre^{-1}, Dithane M-45@ 2g litre^{-1}, Furadan5G,Sundomil 72 WP was used) etc. Harvesting was started from 13th March and completed by 9th April. Fruits were harvested at four days interval during early ripe stage when they attainedred color. During harvesting marketable and unmarketable fruits were divided.

2.2 Treatments and design

The single factor experiment was laid out in the Randomized Complete Block Design (RCBD) with three replications which consisted of seven treatments such as T_1 = Recommended doses of NPK (Urea 350 kg ha^{-1}, TSP 250 kg ha^{-1},MoP 300 kg ha^{-1}, respectively.),T_2 = Cowdung @10 t ha^{-1},T_3 = Vermicompost @ 10 t ha^{-1}, T_4 = *Trichoderma* compost @10 t ha^{-1}, T_5= 50 % Cowdung + 50 % Recommended doses of fertilizer, T_6= 50 % Vermicompost + 50 % Recommended doses of fertilizer, T_7= 50 % *Trichoderma* compost + 50 % Recommended doses of fertilizer.

2.3 Data collection

Ten plants were selected randomly from each unit plot for data collection. Data were recorded from sample plants during the period of the experiment.

2.3.1 Plant height

Plant height was measured from the sample plants in centimeter from the ground level to the tip of the longest stem and mean value was calculated. Plant height was recorded from 10 days of planting up to 70 days to observe the growth rate of plants. Mean value of the ten selected plants were calculated for each unit plot as expressed in centimeter (cm).

2.3.2 Plant spread

Plant spread was measured from the sample plants in centimeter from the tip of the longest leaf one side to another and mean value was calculated. Plant spread was recorded from 10 days of planting up to 70 days to observe the spread rate ofplants at 10, 20, 30, 40, 50, 60, 70 Days after Transplanting (DAT) and mean value was calculated for each unit plot and expressed in centimeter (cm).

2.3.3 Number of leaves plant^{-1}

The total number of leaves plant^{-1} was counted from 10 sample plants from 20 days of planting up to 80 days to observe leaf no. ofplants. Mean value of the ten selected plants were calculated for each unit plot as expressed in centimeter (cm).

2.3.4 Days to first flowering

Date of first flowering for each treatment was recorded during pre-flowering season and the number of days required for first flowering was calculated.

2.3.5 Number of flower clusters plant^{-1}

The number of flower clusters was counted from the sample plants periodically during flowering season, and average number of flower clusters plant^{-1} was recorded.

2.3.6 Number of flowers cluster^{-1}

The number of flowers cluster^{-1} was calculated as follows:

$$\text{Number flowers cluster}^{-1} = \frac{\text{Total number of flowers from ten plants}}{\text{Total number of flower cluster from ten plants}}$$

2.3.7 Number of fruit clusters plant^{-1}

The number of fruit clusters was recorded from the ten sample plants, and the average number of fruit clusters produced plant^{-1} was recorded.

2.3.8 Number of fruits cluster^{-1}

The number of fruits cluster^{-1} was calculated as follows:

$$\text{Number of fruits cluster}^{-1} = \frac{\text{Total number of fruits from ten plants}}{\text{Total number of fruit cluster from ten plant}}$$

2.3.9 Number of fruits plant^{-1}

The number of fruits plant^{-1} was recorded from the ten sample plants and the average number of fruits produced per plant was recorded.

2.3.10 Fruit length

The length of fruit was measured with a slide calipers from the neck of the fruit to bottom of 30 selected marketable fruits from each plot and their average was calculated in centimeter (cm).

2.3.11 Fruit diameter

Diameter of fruit was measured at the middle portion of 30 selected marketable fruits from each plot with a slide calipers and their average was calculated in centimeter (cm).

2.3.12 Weight of individual fruit

The weight of fruit was measured with an electric weighing machine of 30 selected marketable fruits from each plot and their average was calculated in gram (g).

2.3.13 Weight of fruits plant^{-1}

It was recorded from the weight of fruits obtained from the selected plants and their average was calculated in kilogram (kg).

2.3.14 Fruit yield plot^{-1}

Total weight of fruits from five harvests of sample plants was measured. A pan scale balance was used to take the weight of fruits plot^{-1}. It was measured by totaling of fruit yield from each unit plot separately during the period from first to final harvest and was recorded in kilogram (kg).

2.3.15 Fruit yield hectare^{-1}

It was measured by the following formula:

$$\text{Fruit yield (t hectare}^{-1}) = \frac{\text{Fruit yield plot} - 1(\text{kg}) \times 10000}{\text{Area of plot in square meter (m2)} \times 1000}$$

2.4 Benefit cost ratio of tomato

To find out the BCR the following formula was used:

$$\text{Benefit cost ratio (BCR)} = \frac{\text{Gross return}}{\text{Total cost of production}}$$

2.5 Statistical analysis

Recorded data were analyzed statistically with the help of computer package program MSTAT-C and the mean differences were adjusted with Duncan's New Multiple Range Test at 1% and 5 % level of probability (Gomez and Gomez, 1984).

III. Results and Discussion

3.1 Plant height

Plantheightwasrecordedatdifferentdaysaftertransplanting(DAT). Amarkedvariation inplantheightwasobserved duetotheinfluence ofdifferent organicmanuresand fertilizers.Statistically the resultwashighlysignificantatdifferentDAT. Themaximumheight(88.40 cm)at 70 DATwasfoundin theplantsgrownunderT_6treatment which was statistically identical with T_7 (85.87 cm), T_5 (83.13 cm) and T_1 (83.53 cm) treatments,while theshortestplant(78.57cm)wasobservedintheplantstreated with T_4 treatmentwhich was statistically identical with T_2 (78.87 cm) treatment (Table 1).

Plant height is one of the important growth contributing characters for tomato highly related with yield condition. From the result it can be concluded that combined treatment of inorganic fertilizer and organic manure gave better result than whole NPK or whole manure. But whole vermicompost @ 10 tha^{-1} also gave significant result. Najar and Khan (2013) found highest shoot length (76 cm) with application of vermicompost @ 6 tha^{-1}. Abduli*et al.* (2013) observed the highest plant height with vermicompost: soil (1:1) ratio. Rodge and Yadlod (2009) andSenapati*et al.* (2007) found significant plant height from the treatment combination (50% recommended dose of fertilizer + 50% vermicompost). Singh *et al.* (2010) recorded higher plant height of tomato from treatment combination T_4 (50% NPK + 50% vermicompost) than control T_1 (100% NPK) or T_4 (100% vermicompost) treatment. Vermicompost had significant effect on plant height as reported by different authors. Vermicompost and inorganic fertilizer combination gave higher plant height. It is because vermicompost is a reservoir of many nutrients and it facilitates plant growth. It also creates good soil environment and helps to grow plant vigorously. In case of whole manure treatment mineralization is slow process but in combined condition improved mineralization is found. It is because of rapid conversion of inorganic fertilizer into available form of nutrients to plants. As a result plant height increased day by day significantly at this treatment combination.

3.2 Plant spread

Plantspreadwasrecordedatdifferentdaysaftertransplanting(DAT). Asignificant variation inplantspreadwasobserved duetotheinfluence ofdifferent combination of organicmanuresand fertilizer atdifferentDAT. The maximum spread (106.8 cm) at 70 DAT was found in the plants grown under T_6 treatment which was statistically identical with T_7 (103.8) treatment, while the lowest plant spread (88.13 cm) was observed in the plants treated with T_4 treatment which was statistically identical with T_1 (90.53 cm), T_2 (89.47 cm) and T_3 (89.13 cm) treatments (Table 1). Plant spread increases due to progress of time. It is because vermicompost and recommended doses of fertilizers creates healthy and optimum condition on the soil. As a result, plant spread increased vigorously in the open air. According to Islam (2011) higher tomato plant spread was found from vermicompost and *Trichoderma* compost with NPK fertilizer than NPK.

Treatments	Plant height (cm)							Plant spread (cm)						
	10 DAT	20 DAT	30 DAT	40 DAT	50 DAT	60 DAT	70 DAT	10 DAT	20 DAT	30 DAT	40 DAT	50 DAT	60 DAT	70 DAT
T_1	23.07 b	29.00 b	40.27 ab	54.20 ab	65.67 ab	76.07 ab	83.53 ab	21.93	31.73	45.47 ab	58.60 abc	71.67 b	81.13 b	90.53 b
T_2	24.62 ab	29.40 ab	38.93 ab	52.20 b	61.20 b	68.13 c	78.87 b	19.93	29.33	42.07 b	54.67 c	67.40 c	76.80 b	89.47 b
T_3	24.13 ab	29.47 ab	38.40 b	52.60 b	62.73 ab	72.93 bc	81.07 ab	21.33	33.00	45.00 ab	56.93 abc	69.53 bc	79.07 b	89.13 b
T_4	24.33 ab	30.53 ab	41.47 ab	51.07 b	61.07 b	68.00 c	78.57 b	21.07	32.00	43.47 ab	56.27 bc	69.13 bc	78.47 b	88.13 b
T_5	23.67 ab	28.87 b	38.33 b	52.13 b	62.27 ab	74.73 ab	83.13 ab	21.33	32.47	45.60 ab	60.60 abc	71.93 b	82.27 b	93.00 b
T_6	25.53 a	32.07 a	43.20 a	56.80 a	66.40 a	79.47 a	88.40 a	21.93	34.73	47.80 ab	64.00 a	79.33 a	95.87 a	106.8 a
T_7	24.17 ab	29.07 b	40.07 ab	53.73 ab	63.67ab	78.40 ab	85.87 ab	20.80	34.67	50.13 a	63.40 ab	75.13 ab	91.67 a	103.8 a
Level of significance	**	*	**	**	*	**	**	ns	ns	*	**	**	**	**
CV (%)	3.49	5.21	4.60	3.13	4.28	3.27	3.77	6.23	11.87	6.91	5.05	3.69	3.17	5.38

Table 1. Effect of different combinations of manures and fertilizers on plant height and plant spread of tomato at different days after transplanting

T_1 = Recommended doses of NPK (Urea @ 350 kg ha^{-1}, TSP @ 250 kg ha^{-1}, MoP @ 300 kg ha^{-1})
T_2= Cowdung @10 t ha^{-1}, T_3= Vermicompost @ 10 t ha^{-1}
T_4=*Trichoderma* compost @10 t ha^{-1}, T_5= 50 % Cowdung + 50 % Recommended doses of fertilizer
T_6=50 % Vermicompost + 50 % Recommended doses of fertilizer, T_7=50 % *Trichoderma* compost + 50 % Recommended doses of fertilizer

** Significant at 1 % level of probability
*Significant at 5 % level of probability
ns – Non significant, Different letters indicate significant variation among treatments ass per DMRT

3.3 Number of leaves plant^{-1}

Number of leaves plant^{-1}wasrecordedatdifferentdaysaftertransplanting(DAT).Up to 40 DAT, there was no significant variation, but at 60 DAT and 80 DAT noticeable variation had been observed. Themaximumnumber of leaves plant^{-1}(116.2)at 80 DATwasfoundin theplantsgrownunderT_6treatment which was statistically identical to T_7 (112.7) and T_5 (110.12) treatments,while the lowest number of leaves plant^{-1} (97.07)wasobservedintheplantstreated with T_2 treatmentwhich was statistically identical to T_1 and T_2 treatments (Table 2).Organic manure mainly vermicompost creates good soil environment. It facilitated proper vegetative growth of tomato plants. On the other hand, plant absorbed more sunlight and produced more food for plant growth, that's why the leaves plant^{-1} increased day by day. Joshi and Vig (2010) found higher no. of leaves from 30% vermicompost and soil mixture.

3.4 Days to 1^{st} flowering

Days required to 1^{st} flowering of tomato varied significantly due to the application of different levels of organic manures and fertilizers. Earlier flowering (28.67 days) was found in case of T_3 treatment which was statistically similar to T_6 (29.67) and T_4 (30.33) treatments, on the other hand, T_1 treatment produced flowers later than that all other treatments (32.33 days) though it was statistically similar to T_5 (31.67) and T_7 (31.00) treatments (Table 2).Vermicompost helps to initiate flowering earlier and was more effective than other treatments. This might be due to vermicompost undergoes mineralization and releases adequate quantities of N, P, K and smaller amount of micronutrients than other organic sources and helps to vigorous plant growth and flowering. Prodhan*et al.* (2014) and Nizam*et al.* (2014) both found earlier flowering with vermicompost @ 5 tha^{-1} and vermicompost @ 10 tha^{-1} with different spacing, respectively than other manure based treatments

3.5 Number of flower clusters $plant^{-1}$

Number of flower clusters $plant^{-1}$ showed significant variation due to the application of different organic sources of nutrients. The highest number of flower cluster (14.40) was observed in T_3 treatment which was statistically identical with T_6 treatment (14.03) and the lowest number of flower cluster (12.27) was found from T_4 treatment which was statistically identical with T_2 treatment (12.57) and T_7 treatment (12.53) (Table 2). Vermicompost increased the number of flower clusters $plant^{-1}$ than other treatments. Thismightbeoccured becauseof vermicompostactsasanutritive'organicfertilizer'richinNPKandmicronutrients,beneficial soilmicrobeslikenitrogen-fixingbacteriaandmycorrhizalfungi whichpromotesthegrowthand floweringof plant. This resultisinagreementwiththe findingsofNizam*et al.* (2014) and Prodhan*et al.* (2014) where they reported that, vermicompoststimulates flowering, increasing the number and biomass of theflowers producedin tomato.

3.6 Number of flowers $cluster^{-1}$

Number of flowers $cluster^{-1}$ showed significant variation due to the application of different organic and inorganic sources of nutrients. Vermicompost increased the number of flowers $cluster^{-1}$ than other treatments. The highest number of flowers $cluster^{-1}$ (7.41) was observed from T_6 treatment which was statistically identical to T_3 treatment (7.34) and the lowest number of flowers $cluster^{-1}$ (6.30) was found from T_4 treatment which was statistically identical to T_1 treatment (Table 2). Findings of Nizam*et al.* (2014) also obtained higher number of flower $cluster^{-1}$ with vermicompost and recommended doses of fertilizer.

Number of flowers $cluster^{-1}$ increased in vermicompost and recommended doses of fertilizers. It is due to vermicompost undergoes mineralization and return adequate quantities of macro and micro nutrients than other sources and helps to vigorous plant growth and increases flower number.

3.7 Number of fruit clusters $plant^{-1}$

No significant variation was found in respect of numbers of fruits $cluster^{-1}$ due to the application of different organic and inorganic source of nutrients. The highest number of fruits $cluster^{-1}$ (9.73) was recorded from T_6 treatment while the lowest number (8.40) derived from T_2 treatment (Table 3). Vermicompost helps in vegetative growth and could be attributed to physiological changes within the plant and translocation of sugar at development of the flowering and fruiting stages. Nizam*et al.* (2014) reported that higher number of fruit cluster $plant^{-1}$ was observed in vermicompost @ 10 t ha^{-1} treatment comparing with other organic sources (cowdung, leaf rottern compost).

3.8 Number of fruits $cluster^{-1}$

Thenumberoffruits$cluster^{-1}$oftomato was not significantduetotheapplicationof different organic manure and inorganic fertilizer. The highest number of fruits $cluster^{-1}$ (4.06) was found in case of treatment T_6 while the lowest number was obtained from T_2 treatment (3.62) (Table 3). Vermicompost facilitated proper vegetative growth of tomato plant and could be attributed to physiological changes within the plant and helped to develop number of fruit $cluster^{-1}$.

3.9 Number of fruits $plant^{-1}$

Number of fruits $plant^{-1}$ of tomato showed significant differences for the application of organic manure and inorganic fertilizers. The highest number of fruits $plant^{-1}$ was recorded from T_6 treatment (37.61) followed by T_7 treatment (33.49) and T_5 treatment (30.15), respectively. On the other hand, the lowest number (27.30) was observed from T_4 treatment (Table 3). This result is in agreement with the findings of (Nizam*et al.* 2014, Prodhan*et al.* 2014) where they reported that, vermicompost produces the higher number of fruits $plant^{-1}$ than other manure. Chanda *et al.* (2010) suggested higher number of fruits $plant^{-1}$ from vermicompost supplemented with NPK treated plots. Rodge and Yadlod (2009) found higher number of fruits $plant^{-1}$ from the treatment combination 50% RDF (Recommended dose of fertilizer) and 50% vermicompost. Vermicompost and other recommended doses of fertilizers helps to proper growth of plants. It also supports to physiological changes within the plant. As a result, number of fruits plant^{-1} increased in this combination. Trichoderma with NPK also gave good results. Here it should be concluded that higher number of fruit causes the fruit size in combined treatment was lower than whole organic treatment.

3.10 Weight of individual fruit

Significant variation was observed in respect of weight of individual fruit. The highest weight of individual fruit (75.14 g) was found from T_6 treatment followed by T5 and T_1 (73.63 g and 73.43 g) treatments, respectively. The lowest weight (70.97 g) was observed in T_7 treatment (Table 3). Prodhan*et al* (2014) found higher individual fruit weight of tomato in case of vermicompost @ 5 tha^{-1} (50.14 g) comparing with cowdung @ 10 tha^{-1} (45.25 g) and leaf rotten compost @ 10 tha^{-1} (46.23 g). Vermicompost and recommended dose of fertilizers creates healthy environment in soil. So plant grows vigorously in that environment. Finally, these vigorous plant produced larger fruit. As a result, individual fruit weight increases at that combinations.

3.11 Length of fruit

Applicationofdifferent combination oforganicmanure and inorganic fertilizersshowed significantvariationonlengthoffruitoftomato.Thehighestlengthoffruit(4.84cm)wasrecordedfrom T_6treatmentwhich was statistically identical with all other treatments except T_1 treatment having lowest length of fruit (4.06 cm) (Table 3). Optimum doses of organic manure namely vermicompost and other NPK fertilizers facilitates proper growth of the fruit to plant and could be attributed to physiological changes within the plant and helps to increase fruit length. Higher length of fruit in case of T6 treatment gave unique shape to attain consumer appeal.

3.12 Diameter of fruit

Diameteroftomato fruit varied significantly due to the application of different sources of organic and inorganic fertilizer.Thehighestdiameteroffruit(5.33cm)wasrecordedfromT_5treatment whichwasstatisticallysimilartoall other treatments except T_6 (4.29 cm) treatment (Table 3). In case of T_5treatment there was comparatively lower no. of fruits that gave more space to grow up that's why fruit diameter was found higher. In case of T6, treatment fruit number was highest which gave elongated shaped fruit with comparatively lower diameter than other treatments.

Table 2. Effect of different combinations of manures and fertilizers on leaves number and flower characters of tomato

Treatments	Number of leaves plant^{-1}				Flower characters		
	20 DAT	40 DAT	60DAT	80DAT	Days to 1st flowering	No. of flower cluster plant^{-1}	No.of flower cluster^{-1}
T_1	7.86	14.53	55.13 bc	102.0 cd	32.33 a	13.67 ab	6.38 c
T_2	7.26	13.80	50.60 c	97.07 d	30.67 ab	12.57 ab	6.89 ab
T_3	8.06	14.13	57.33 abc	104.5 bcd	28.67 b	14.40 a	7.34 ab
T_4	8.14	14.13	54.33 bc	101.2 cd	30.33 ab	12.27 b	6.30 b
T_5	7.54	14.20	58.73 abc	110.4 abc	31.67 a	13.80 ab	6.73 ab
T_6	7.60	14.20	63.33 a	116.2 a	29.67 ab	14.03 ab	7.41 a
T_7	8.00	14.20	61.53 ab	112.7 ab	31.00 ab	12.93 ab	6.57 ab
Level of significance	ns	ns	**	**	**	**	**
CV (%)	7.51	3.73	4.39	3.04	5.67	5.55	6.24

T_1 = Recommended doses of NPK (Urea @ 350 kg ha^{-1}, TSP @ 250 kg ha^{-1}, MoP @ 300 kg ha^{-1})
T_2= Cowdung @10 t ha^{-1}, T_3= Vermicompost @ 10 t ha^{-1}
T_4=*Trichoderma* compost @10 t ha^{-1}, T_5= 50 % Cowdung + 50 % Recommended doses of fertilizer
T_6=50 % Vermicompost + 50 % Recommended doses of fertilizer, T_7=50 % *Trichoderma* compost + 50 % Recommended doses of fertilizer
** Significant at 1 % level of probability
* Significant at 5 % level of probability
ns- Non significant, Different letters indicate significant variation among treatments ass per DMRT

3.13Fruit weight plant^{-1}

There was significant variation in weight of fruits plant^{-1} in respect of different organic manures and fertilizers. The highest weight of fruit yield plant^{-1} (2.55 kg) was observed from T_6 treatment which was statistically identical with T_7 (2.30 kg), T_5 (2.02 kg), T_1 (2.07 kg) treatments and the lowest fruit weight plant^{-1} (1.20 kg) was found from T_2 treatment which was statistically identical with T_4 (1.20 kg) and T_3 (1.92) treatments (Fig. 1). Vermicompost enriched treatment showed higher fruit weight plant^{-1} although other combined treatment could have shown good result. This result is in agreement with the findings of Singh *et al.* 2010, Najar and Khan, 2013, where they confirmed that, the increased yield potential of vegetables achieved through application of vermicompost. Prodhan*et al.* (2014) found higher fruit weight plant^{-1} with vermicompost. Vermicompot undergoes mineralization and release available plant nutrients which facilitated proper plant growth. As a result vigorous plant produced larger quantities of fruits.

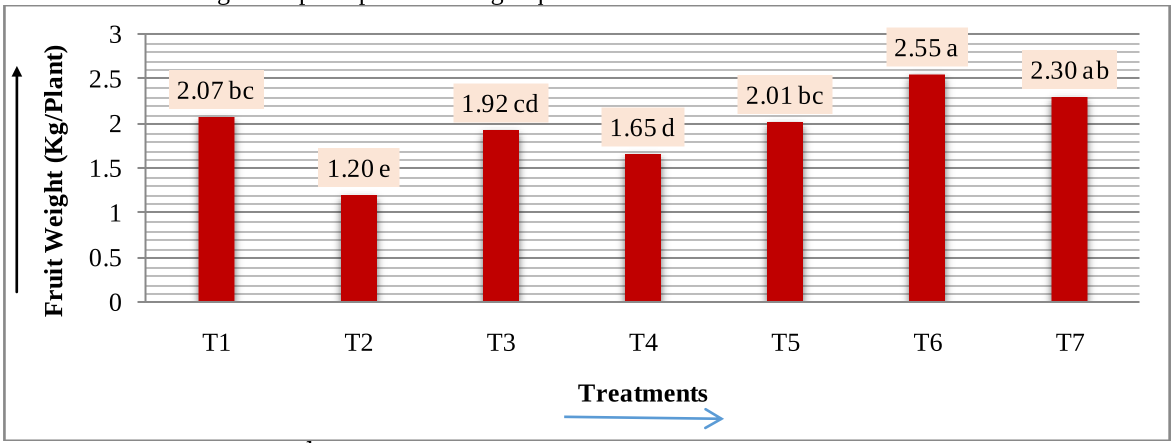

Fig. 1. Fruit weight plant^{-1} as influenced by cowdung, vermicompost, *Trichoderma* compost and NPK fertilizers.

T_1 = Recommended doses of NPK (Urea @ 350 kg ha^{-1}, TSP @ 250 kg ha^{-1}, MoP @ 300 kg ha^{-1})
T_2 = Cowdung @10 t ha^{-1}, T_3 = Vermicompost @ 10 t ha^{-1}, T_4 = *Trichoderma* compost @10 t ha^{-1}
T_5 = 50 % Cowdung + 50 % Recommended doses of fertilizer, T_6 = 50 % Vermicompost + 50 % Recommended doses of fertilizer, T_7 = 50 % *Trichoderma* compost + 50 % Recommended doses of fertilizer,Different letters indicate significant variation among treatments ass per DMRT

3.14Fruit yield plot^{-1}

Organic manures and inorganic fertilizers combination exhibited significant effects on the yield of fruits plot^{-1}. The maximum yield plot^{-1} (30.03 kg) was achieved by the application of 50% vermicompost + 50% of recommended dose of NPK (T_6) which was identical with T_7 treatment (27.33 kg), while lowest yield plot^{-1} (16.27) was found from T_2 treatment (Fig. 2). Vermicompost and other recommended doses of fertilizer helps to create good soil environment and facilitates proper plant growth. Finally, plant produced higher number of fruits in each plot.

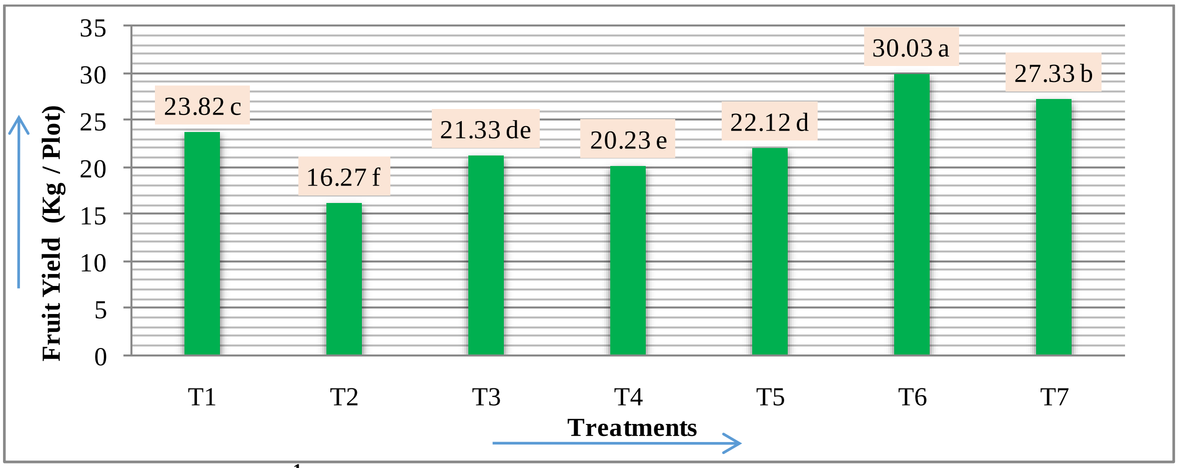

Fig. 2. Fruit yield plot^{-1}as influenced by cowdung, vermicompost, *Trichoderma* compost and NPK fertilizers.

T_1 = Recommended doses of NPK (Urea @ 350 kg ha^{-1}, TSP @ 250 kg ha^{-1}, MoP @ 300 kg ha^{-1})
T_2 = Cowdung @10 t ha^{-1}, T_3 = Vermicompost @ 10 t ha^{-1}, T_4 = *Trichoderma* compost @10 t ha^{-1}
T_5 = 50 % Cowdung + 50 % Recommended doses of fertilizer, T_6 = 50 % Vermicompost + 50 % Recommended doses of fertilizer, T_7 = 50 % *Trichoderma* compost + 50 % Recommended doses of fertilizer, Different letters indicate significant variation among treatments ass per DMRT

3.15Fruit yield hectare^{-1}

Significant variation was recorded on yield hectare^{-1} due to the different levels of organic manures. The highest yield hectare^{-1} (78.20 t) was obtained from T_6 treatment which was followed by (71.18 t) with T_7 treatment, while the lowest yield (42.36 t) from T_2 treatment (Fig.3). Prodhan*et al* (2014), found higher fruit yield hectare^{-1} (58.99 t) from vermicompost @ 5 tha^{-1} comparing with compost @ 10 tha^{-1} (53.94 ton). Thisresultis alsoinagreementwiththefindingsofRodge and Yadlod, 2009, Singh*etal*.2010,Theunissen*et al*.2010, NajarandKhan2013 and Nizam*et al*. 2014, where they confirmedthat, the increased fruit yield per hectare achieved from vermicompost treatment. Organic manure mainly vermicompost goes mineralization and retain available nutrient for proper plant growth and attributed to physiological changes within the plant and helps to increase the number of fruits plot $^{-1}$ and finally the total yield hectare^{-1} increased.

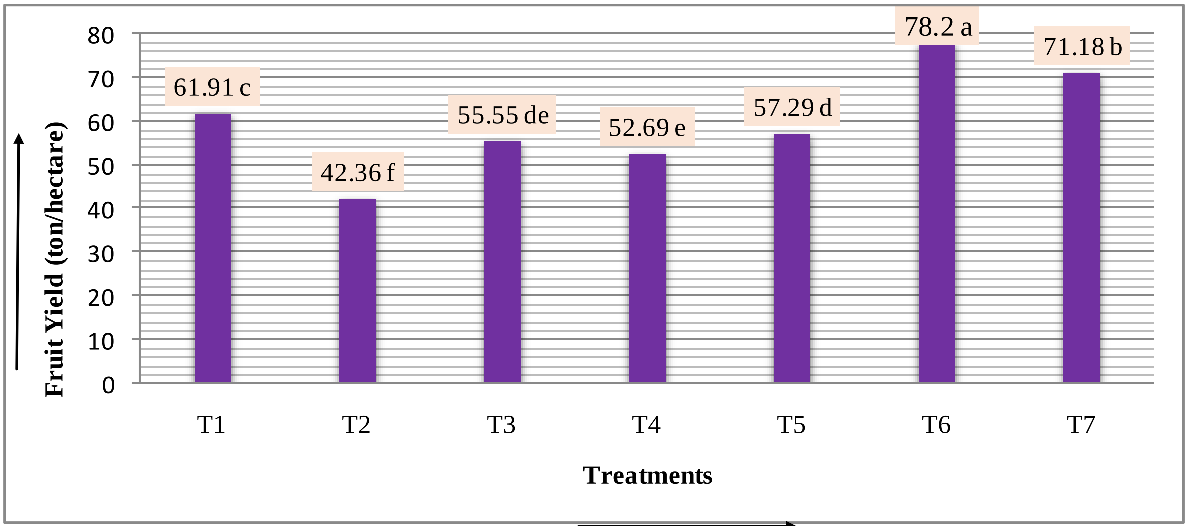

Fig. 3. Fruit yield per hectare as influenced by cowdung, vermicompost, *Trichoderma* compost and NPK fertilizers.

T_1 = Recommended doses of NPK (Urea @ 350 kg ha^{-1}, TSP @ 250 kg ha^{-1}, MoP @ 300 kg ha^{-1})
T_2 = Cowdung @10 t ha^{-1}, T_3 = Vermicompost @ 10 t ha^{-1}, T_4 = *Trichoderma* compost @10 t ha^{-1}
T_5 = 50 % Cowdung + 50 % Recommended doses of fertilizer, T_6 = 50 % Vermicompost + 50 % Recommended doses of fertilizer, T_7 = 50 % *Trichoderma* compost + 50 % Recommended doses of fertilizer, Different letters indicate significant variation among treatments ass per DMRT

3.16Benefit cost ratio

The combination of organic manure and fertilizer for benefit cost ratio was different in all treatment combinations. The highest benefit cost ratio (3.15) was observed in T_6 treatment followed by T_7 treatment (2.80) and T_1 treatment (2.79). The lowest benefit cost ratio (1.13) was obtained from T_4 treatment (Fig. 4). Vermicompost with recommended doses of fertilizers (T_6) was focused as more profitable than any other treatment giving highest benefit cost ratio (3.15) which is not only for higher yield but also quality fruit. Unique shape, size and color carried higher market value than other treatments. *Trichoderma* with recommended doses of fertilizers (T_7) also gave better yield with quality fruit, but benefit cost ratio was lower due to high price of compost. So, it is proved that positive effect of vermicompost on growth and yield of tomato easily can compete with inorganic fertilizer having higher benefit cost ratio.

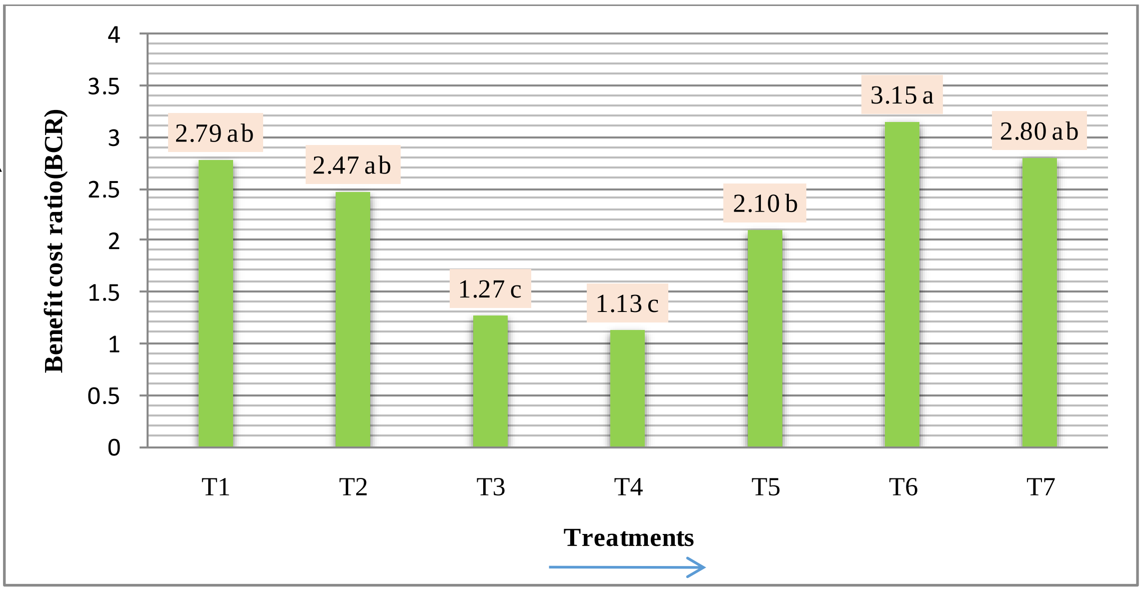

Fig. 4. Benefit cost ratio as influenced by cowdung, vermicompost, *Trichoderma* compost and NPK fertilizers.

T_1 = Recommended doses of NPK (Urea @ 350 kg ha^{-1}, TSP @ 250 kg ha^{-1}, MoP @ 300 kg ha^{-1})
T_2 = Cowdung @10 t ha^{-1}, T_3 = Vermicompost @ 10 t ha^{-1}, T_4 = *Trichoderma* compost @10 t ha^{-1}
T_5 = 50 % Cowdung + 50 % Recommended doses of fertilizer, T_6 = 50 % Vermicompost + 50 % Recommended doses of fertilizer, T_7 = 50 % *Trichoderma* compost + 50 % Recommended doses of fertilizer, Different letters indicate significant variation among treatments ass per DMRT

Table 3. Effect of different combinations of manures and fertilizers on fruit characters of tomato

Treatments	Fruit characters					
	Number of fruit clusters plant^{-1}	Number of fruit cluster^{-1}	Number of fruits plant^{-1}	Weight of individual fruit (g)	Length of fruit (cm)	Diameter of fruit (cm)
T_1	8.93	3.76	28.32 bc	73.43 ab	4.061 b	5.050 a
T_2	8.40	3.62	27.55 c	72.63 b	4.613 ab	5.054 a
T_3	8.93	3.75	29.00 bc	73.18 ab	4.629 ab	5.074 a
T_4	8.64	3.72	27.30 c	72.40 b	4.521 ab	4.987 a
T_5	9.34	3.76	30.50 bc	73.63 ab	4.604 ab	5.332 a
T_6	9.73	4.09	37.61 a	74.62 a	4.845 a	4.295 b
T_7	9.66	3.96	33.49 ab	70.97 c	4.393 ab	5.152 a
Level of significance	ns	ns	**	*	*	**
CV (%)	10.29	12.34	8.75	3.80	8.05	4.44

T_1 = Recommended doses of NPK (Urea @ 350 kg ha^{-1}, TSP @ 250 kg ha^{-1}, MoP @ 300 kg ha^{-1})
T_2= Cowdung @10 t ha^{-1}, T_3= Vermicompost @ 10 t ha^{-1}
T_4=*Trichoderma* compost @10 t ha^{-1}, T_5= 50 % Cowdung + 50 % Recommended doses of fertilizer
T_6=50 % Vermicompost + 50 % Recommended doses of fertilizer, T_7=50 % *Trichoderma* compost + 50 % Recommended doses of fertilizer

** Significant at 1 % level of probability
* Significant at 5 % level of probability
ns- Non significant, Different letters indicate significant variation among treatments ass per DMRT

IV. Conclusion

The present study revealed that vermicompost combined with NPK fertilizers increased the tomato growth and yield. Based on the findings of the experiment, treatment T_6 (50% Vermicompost + 50% recommended dose of NPK) was most profitable than rest of the treatment combinations. So vermicompost can be suggested as organic source to minimize inorganic fertilizer obtaining higher yield of tomato (Suraksha variety).However, the present research work was carried out at Hogladanga village under the Batiaghataupazila of Khulna district under the Agrotechnology Discipline of Khulna University in one season only. Further trial of this research work in different locations of the country is needed before final recommendation in applied level.

References

[1] A. B. Olayinka, H. A. Akintoye and B. Olasnmi. Effect of differen sources of nitrogen on growth and yield of Solanum mcrocarpon in derived savanna of Nigeria. Journal of Agronomy, 5(2), 2006: 182-185.
[2] B. M. Rodge and S. S. Yadlod, S. S. Effect of organic and inorganic fertilizers on growth, yield and quality of tomato (*Lycopersiconesculentum* Mill.). Asian Journal of Horticulture, 4(1), 2009: 221-224.
[3] BBS. Yearly Statistical Book. Bangladesh Bureau of Statistics, Dhaka Bangladesh. 2012:144.
[4] C. A. Edwards and I. Burrows. The potential of earthworm composts as plant growth media in Neuhauser, C.A. (Ed.), Earthworms in Environmental and Waste Management. SPB Academic Publishing, The Hague, the Netherlands, 1988: 211-220.
[5] F. H. Barrios-Masias, M. I. Cantwell and L. E. Jackson. Cultivar mixtures of processing tomato in an organic agroecosystem. Organic Agriculture, 1, 2011: 17-30.
[6] FAO. Food and Agriculture Organization of the United Nations, Soil survey project of Bangladesh. Soil resources technical report, 1988:101-159.
[7] FRG. Fertilizer Recommendation Guide, Bangladesh Agricultural Research Council (BARC), Farmgate, Dhaka, 2012: 274
[8] G. Davarinejad, G. Haghnia and A. Lakzian. 2004. Effect of animal fertilizers and enriched compost on wheat yield. Journal of Agricultural Science and Technology, 18, 2004: 101-108.
[9] H. K. Senapati, B. Jena and A. K. Dash. Effect of vermicompost on ragi- tomato cropping systems. Journal of Environment and Ecology, 225(3), 2007: 648-650.
[10] H. Saadatnia and H. Riahi. Cyanobacteria from paddy fields in Iran as biofertilizer in rice plants. Plant Soil and Environment, 55(5), 2009: 207-212.
[11] I. A. Najar and A. B. Khan. Effect of vermicompost on growth and productivity of tomato (*Lycopersiconesculentum*) under field conditions. ActaBiologicaMalaysiana, 2(1), 2013: 12-21.
[12] I. Lakshmikathan, I.Technology of sugarcane growing. Oxford and IBH publishing Co. New Delhi, Mumbai, Calcutta, 1983: 162.
[13] K. A. Gomez and A. A. Gomez. 1984. Statistical Procedure for Agricultural Research. 2nd edition. A Wiley Inter Science Publication, John Wiley and Sons, New York, 1984: 680.
[14] L. B. Tonfack, A. Bernadac, E. Youmbi, V. P. Mbouapouognigni, M. Ngueguim and A. Akoa. Impact of organic and inorganic fertilizers on tomato vigor, yield and fruit composition under tropical soil conditions. Fruits, 64, 2009:167-177.
[15] M. A. A. Prodhan, M. A. Ali, S. A. Zomo, M. D. Sarkar, K. Parvin and F. A. Haque. Organic manure and spacing affecting floral and yield characters of tomato.International Journal of Business, Social and Scientific Research, 2(2), 2014: 90-94.
[16] M. A. Abduli, L. Amiri, E. Madadian, S. Gitipour and S. Sedighian. Efficiency of vermicompost on quantitative and qualitative growth of tomato plants. International Journal Environmental Resource, 7(2), 2013: 467-472.
[17] M. K. Kader, H. Mmian and M. S. Hoyue. Effects of Azotobacter inoculants on the yield and nitrogen uptake by wheat. Journal of Biological Sciences, 2, 2002: 250-265.
[18] M. Mehdizadeh, E. I. Darbandi, H. Naseri and A. Tobeh. Growth and yield of tomato (*Lycopersiconesculentum*Mill.) as influenced by different organic fertilizers. International Journal of Agronomy and Plant Production, 4(4), 2013: 734-738.
[19] M. Odlare, M. Pell and K. Svensson. Changes in soil chemical and microbiological properties during 4 years of application of various organic residues. Waste Management, 28, 2008: 1246-1253.
[20] M. Premsekhar and V. Rajashree. Influence of organic manures on growth, yield and quality of Okra. American-Eurasian Journal of Sustainable Agriculture, 3(1), 2009: 6-8.
[21] M. R. Islam. A study of different organic manures on growth and yield of cabbage and their residual effect on stem amaranth. An M.S. thesis, Department of Horticulture, Bangladesh Agricultural University, Mymensingh, 2011: 1-31.
[22] P. A. Theunissen, R. Ndakidemi and C. P. Laubscher. Potential of vermicompost produced from plant waste on the growth and nutrient status in vegetable production. International Journal of Physical Science, 5(13), 2010: 1964-1973.
[23] R. Joshi and A. P Vig. Effect of vermicompost on growth, yield and quality of tomato (*Lycopersiconesculentum* L). African Journal of Basic and Applied Sciences, 2 (4), 2010: 117-123.
[24] R. Nizam, M. A. Ali, K. Alam, M. D. A. Mollah and M. S. N. Chowdhury. Yield and profitability of tomato (*Lycopersiconesculentum* Mill.) as influenced by organic manure and plant spacing. Applied Science Reports, 3(3), 2014:121-128.DOI: 10.15192/PSCP.ASR.2014.3.3.121128.
[25] R. Singh, R. K. Gupta, R. T. Patil, R. R. Sharma, R. Asrey, A. Kumar and K. K. Jangra. Sequential foliar application of vermicompost leachates improves marketable fruit yield and quality of tomato. Scientia Horticulturae, 124, 2010: 34-39.
[26] T. K. Bose and M. G. Som. Vegetables crops in India.1stEdn. NayaPrikash, Calcutta. 1986: 262-264.
[27] Y. Y. Wei, N. A. A. Aziz, Z. H. Shamsuddin, M. Mustafa, S. A. Aziz and T. S. Kuan. Enhancement of plant nutrient contents in rice straw vermicompost through the addition of rock phosphate. ActaBiologicaMalaysiana, 1(1), 2012: 41-45.