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International Journal of Recent Scientific Research
Vol. 3, Issue, 2, pp.75 -79, February, 2012

International Journal of Recent Scientific Research

ISSN: 0976-3031

Growth and yield of *lycopersicum esculentum* mill. grown in municipal solid waste (viz. kitchen waste) compost amended soils

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ARTICLE INFO

Article History:

Received 15th January, 2012
Received in revised form 25 th, January, 2012
Accepted 20th February, 2012
Published online 28th February, 2012

Key words:

Lycopersicum esculentum Mill,
Compost, Kitchen waste

ABSTRACT

Municipal Solid waste (Viz. Kitchen Waste) compost amendments caused significant improvement in soil quality and growth and yield of *Lycopersicum esculentum* Mill with the increase in Municipal Solid waste (Viz. Kitchen Waste) compost amendments at following levels i.e. Control, 60, 120, 180 and 240 tons ha $^{-1}$. Edible part of *Lycopersicum esculentum* Mill grown in Municipal Solid waste (Viz. Kitchen Waste) compost amended soils accumulated Cr, Cu, Zn, Fe, Pb and Cd. Based on the data obtained we found that soil amended at 180 tons ha^{-1} Municipal Solid waste (Viz. Kitchen Waste) compost not only improved the physical properties of the soil but also contributed to better growth and yield of *Lycopersicum esculentum* Mill in red soil of bundelkhnad region.

INTRODUCTION

Composting is defined as the biological decomposition and stabilization of organic substrates under conditions that allow development of thermophilic temperatures as a results of biologically produced heat, to produce a final product that is stable, free of pathogens and plant seeds, and can be beneficially applied to land (Haug, 1993). In other words, composting is a controlled bio-oxidative process that:

1. Requires a heterogenous organic substrate in the solid state;
2. Evolves by passing through a thermophilic phase; and
3. Leads to production of Carbon Di oxides, water , minerals and stabilized organic matter (compost) (Zucconi et al., 1985)

The basic composting process is depicted in Figure 1.1. The major factors that affect the decomposition of organic matter by microorganism are oxygen and moisture (Epstein, 1997). Temperature is the results of microbial activity and plays a very important role in the composting process. Other important factor that could limit the composting process are nutrients and pH. Carbon and Nitrogen are essential for microbial growth and activity and their presence in the composting process is of utmost importance. Carbon is the principal source of energy and nitrogen is required for cell synthesis. Most of the self-heating of organic matter is the result of microbial respiration (Finstein and Morris, 1975) raising the temperature of the Mass. During the composting process, provided enough oxygen is available, the organic materials are converted to more sTable products such as humic acid and carbon oxide and water is evolved. In general terms, the composting process can be represented by the following equation (Finstein et al., 1986b).

$$\text{Fresh organic waste} + O_2 \longrightarrow \text{Stabilized organic residue} + CO_2 + H_2O + \text{Heat}$$

The composting is therefore simply a means of converting raw organic matter in to usable humas (Gray et al., 1971).

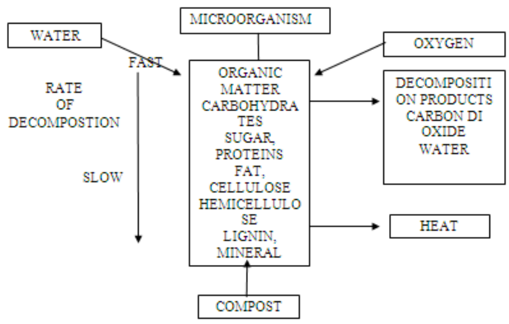

Figure 1.1 The composting Process (Epstein, 1997)

As a consequence, the main aim of all composting systems is to avoid anaerobic reactions through adequate aeration

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(i.e. oxygen supply) (Finstein et al., 1987a and 1987c). The composting process passes through four characteristics stages distinguished by temperature. These stages are:

1. Mesophilic Phase with temperature up to 40°C,
2. Thermophilic Phase (45 to 65 °C)
3. Cooling, and
4. Maturing (Gray et al., 1971).

Tomatoes belong to the plant family Solanaceae, the nightshade family, which includes potatoes, capsicums and eggplant, as well as the nightshade weed. The tomato (*Lycopersicum esculentum* Mill.) is native to the Andes region of South America. Tomatoes are divided into two types. Determinate tomatoes, also called bush or dwarf tomatoes, grow to a certain height, then flower and set all their fruit within a short time. Each shoot on the determinate plant ends in a cluster, and consequently a fruit cluster. The harvest period for determinate tomatoes is generally short, making them good choices for canning (Moraru et al., 2004).

MATERIAL AND METHODS

Study area

The study site is located in Jhansi city of Bundelkhand district Uttar Pradesh. The municipal solid wastes (Kitchen waste) were collected from the dumping site. The district is situated in the South West corner of the region at 24º11' - 25º57' N latitude and 78º10' - 79º23' E longitudes.

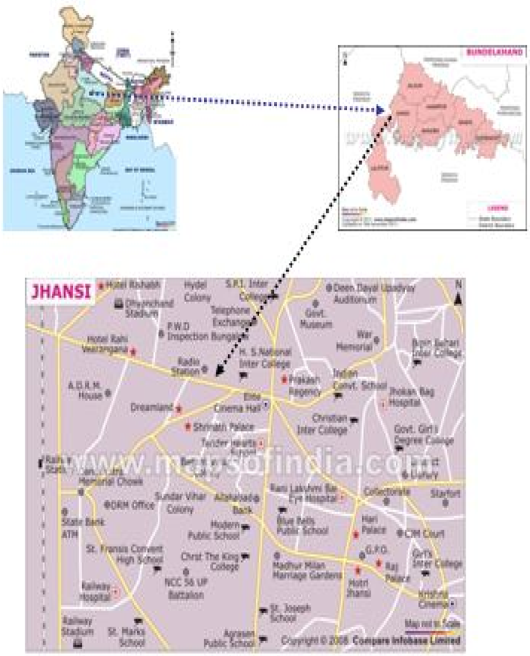

Figure 1.2 Location of study area (Map not in scale)

Physico-chemical analysis of different amendment and soil

Municipal Solid waste (Viz. Kitchen Waste) and soil samples were collected randomly from different locations in Jhansi city (UP). The Municipal Solid waste (Viz. Kitchen Waste) compost and soil were dried 5 days and passed through 2 mm sieve before making various amendments i.e. 0, 60,120, 180 and 240 t/ha respectively were taken. Physico-chemical analysis was carried out in triplicate on soil and their different amendments with Municipal Solid waste (Viz. Kitchen Waste) compost before the growth of *Lycopersicum esculentum* Mill The pH of the different amendment was measured in 1 : 2.5 soil water suspension using pH meter (Consort C831), electrical conductivity (EC) expressed in µs/cm of soil and amendments samples was determined following 30 min equilibrium in mechanical shaker a digital conductivity meter (Consort C831).

Organic carbon values of soil and amended samples were determined by oxidation with potassium dichromate in acid medium (Walkley and Black 1934). Total concentrations of trace elements were determined with Hydrogen fluoride, Nitric acid and Perchloric acid (7:3:1) using through with AAS (Perkin Elmer 200).

Experimental design:

Lycopersicum esculentum Mill were obtained from Jhansi City (UP) India. All the seed were sterilized with 0.1 % mercuric chloride for 5 min to avoid fungal contamination and washed with distilled water for three times and soaked in water 5 h. The soaked seed were evenly shown in pot (10 in diameter), which were filled with different amendments (60,120, 180, and 240 t/ha of 7 kg, along with one set of control (soil) each in pot to a depth of 0.5 cm and watered daily till seed germination. The plants were irrigated with tap water at regular (300 ml) avoiding leakage of water from the pots and measured root and shoot length respectively.

Leaves of plants 45 and 90 days after germination were used for biochemical analysis (Chlorophyll a, Chlorophyll b, Total Chlorophyll and Carotenoid using with Arnon 1949) .1 gm of (fresh weight) of leaves (Three replicates) samples were crushed with 10 ml of 80 % acetone v/v. After centrifugation at 10000 rpm for 10 min, optical densities of acetone soluble pigments were determined at 643 and 645, 480 and 510 nm. Total concentrations of metal in plant parts were determined with nitric perchloric acid (3:1) using through with AAS (Perkin Elmer 200). All the experiments were conducted in triplicate and repeated twice, SE mean value and two way ANOVA analyses were performed to compare between treated and untreated samples of each of the data sets. Analysis was performed on ERRISTAT for window version 4.0.2.0.

RESULTS AND DISCUSSION

Effect on *Lycopersicon esculentum* Mill.

Effect on Shoot length (cm) of *Lycopersicon esculentum Mill*. After amendment with MSW (Viz.KW) compost at two seasons in red soil are depicted in Table 1 to 3. Max Shoot length (cm) of *Lycopersicon esculentum Mill.* in red soil recorded as 29.76 in 2011. It is significantly affect as compare to control environment. It is found that all were significantly increased with increasing soil/ MSW (Viz.KW) compost amendment ratio as compared the control set. The plant growth was better in 60 t/ha, 120 t/ha 180 t/ha and 240 t/ha combinations in comparison of control. Effect on Root length (cm) of *Lycopersicon esculentum Mill.* after amendment with MSW (Viz.KW) compost at four seasons in red soil are depicted in Table 4 and 5. Max Root length (cm) of *Lycopersicon esculentum Mill.* in red soil recorded as 12.04 in 2011 . It is significantly affect as compare to control environment.

Table 1 Effect of Different Treatment of MSW (Viz. KW) compost on shoot length of *Lycopersicon esculentum Mill.* (inch) at different durations in 2010 in red soil.

Treatment (T/Ha)	Days					
	15	30	45	60	75	90
Control	2.46±0.03	3.79±0.35	5.04±0.24	9.62±0.06	24.90±0.61	28.18±0.64
60t/ha	2.76±0.03	3.73±0.02	6.36±0.63	11.47±0.20	25.50±0.35	27.73±0.34
120 t/ha	3.22±0.06	4.16±0.14	5.94±0.02	12.59±0.09	27.53±0.28	29.27±0.27
180 t/ha	3.22±0.06	4.26±0.03	5.94±0.04	12.73±0.26	26.03±0.37	28.20±0.52
240 t/ha	3.15±0.08	4.42±0.25	5.91±0.29	8.96±3.65	23.57±0.90	26.77±1.12

Values are Mean ± SE (n=3), Significant at $p < 0.05$,

Table 2 Effect of Different Treatment of MSW (Viz. KW) compost on shoot length of *Lycopersicon esculentum Mill.* (inch) at different durations in 2011 in red soil.

Treatment (T/Ha)	Days					
	15	30	45	60	75	90
Control	2.47±0.02	3.79±0.35	5.40±0.46	9.68±0.11	24.90±0.61	26.37±0.37
60t/ha	2.77±0.02	3.73±0.02	6.48±0.59	11.43±0.02	25.50±0.35	27.90±0.70
120 t/ha	3.17±0.06	4.19±0.18	5.87±0.02	12.52±0.16	27.53±0.28	29.76±0.88
180 t/ha	3.12±0.01	4.14±0.04	5.90±0.01	12.79±0.12	25.41±0.61	29.09±1.00
240 t/ha	3.15±0.08	4.16±0.03	5.91±0.29	12.61±0.02	22.57±0.38	25.05±0.55

Values are Mean ± SE (n=3), Significant at $p < 0.05$,

Table 3 Comparison between different amendments of Solid Waste (viz. Kitchen Waste) compost on shoot length of *Lycopersicon esculentum Mill.* (inch) at different years indifferent soil after harvesting.

Parameter	Red Soil			
	Year	Treatment	Year*Treatment	Days
SE (d)	0.105	0.117	0.235	0.129
C. D. (P=0.05)	0.207	0.232	0.464	0.254

Table 4 Effect of Different Treatment of MSW (Viz. KW) compost on root length of *Lycopersicon esculentum Mill.* (inch) at different years in Red soil after 45 and 90 days of hervesting.

Treatment (T/Ha)	2010		2011	
	45 days	90 days	45 days	90 days
Control	6.56±0.221	9.51±0.169	6.22±0.114	9.44±0.224
60t/ha	6.59±0.338	10.09±0.280	6.62±0.302	10.35±0.921
120 t/ha	7.52±0.288	11.31±0.834	7.68±0.255	12.04±0.351
180 t/ha	7.43±0.150	10.87±0.497	7.53±0.364	11.69±0.267
240 t/ha	6.80±0.780	9.31±0.301	6.77±0.737	9.48±0.164

Values are Mean ± SE (n=3), Significant at $p < 0.05$,

Table 5 Comparison between different amendment of MSW (Viz. KW) compost on root length of *vegeTable crops* at different years indifferent soil after harvesting.

Parameter	Red Soil		
	Year	Treatment	Days
SE (d)	0.092	0.0656	0.103
C. D. (P=0.05)	0.184	0.13	0.206

Table **6** Effect of Different Treatment of MSW (Viz. KW) compost on edible part of *lycopersicum esculentum L.* (gm/pot) at different years in red soil.

Treatment (T/Ha)	2010		2011	
	F weight	D Weight	F weight	D Weight
Control	116.23±3.953	20.83±1.484	109.77±8.170	19.90±1.929
60t/ha	125.13±6.001	24.57±2.026	123.56±4.824	24.90±3.569
120 t/ha	171.57±11.971	16.03±4.100	165.70±3.081	16.80±4.071
180 t/ha	207.70±5.973	17.97±4.236	202.00±7.192	18.20±4.616
240 t/ha	267.70±9.192	22.80±6.223	193.55±6.293	16.25±2.758

Values are Mean ± SE (n=3), Significant at $p < 0.05$,

Table 7 Comparison between deferent amendments of MSW (Viz. KW) compost with edible part of vegetable crops in different year in different soil

Red Soil				
Parameter	Fresh Weight		Dry Weight	
	Year	Treatment	Year	Treatment
SE (d)	1.269	1.419	1.11	1.241
C. D. (P=0.05)	2.566	2.869	2.245	2.51

Table 8 Effect of Different Treatment of MSW (Viz. KW) compost on photosynthetic pigments of *Lycopersicum esculentum Mill.* (gm/pot) at 45 days in different years in red soil.

Treatment (T/Ha)	**2010**				**2011**			
	Ch. a	**Ch. b**	**Total ch.**	**Carotenoid**	**Ch. a**	**Ch. b**	**Total ch.**	**Carotenoid**
Control	0.95±0.055	0.54±0.040	1.48±0.015	0.32±0.012	0.93±0.056	0.53±0.033	1.45±0.023	0.33±0.006
60t/ha	1.06±0.079	0.73±0.136	1.79±0.214	0.32±0.023	1.06±0.043	0.71±0.115	1.77±0.110	0.32±0.023
120 t/ha	1.07±0.038	0.71±0.038	1.78±0.010	0.48±0.061	1.05±0.062	0.69±0.044	1.74±0.050	0.46±0.026
180 t/ha	0.94±0.162	0.62±0.061	1.56±0.218	0.54±0.101	0.91±0.211	0.63±0.126	1.54±0.332	0.48±0.021
240 t/ha	1.01±0.112	0.55±0.182	1.56±0.190	0.46±0.266	1.02±0.151	0.59±0.161	1.61±0.119	0.34±0.047

Values are Mean ± SE (n=3), Significant at $p < 0.05$,

Table 9 Effect of Different Treatment of MSW (Viz. KW) compost on photosynthetic pigments of *Lycopersicum esculoentum Mill.* (gm/pot) at 90 days in different years in red soil.

	2010				**2011**			
Treatment (T/Ha)	**Ch.a**	**Ch. b**	**Total ch.**	**Caretenoid**	**Ch.a**	**Ch. b**	**Total ch.**	**Caretenoid**
Control	1.03±0.140	0.69±0.087	1.72±0.227	0.5967±0.038	1.0033±0.058	0.65333±0.092	1.6567±0.150	0.6233±0.085
60t/ha	1.41±0.427	0.77667±0.021	2.1867±0.419	0.6933±0.067	1.0933±0.058	0.76±0.026	1.8533±0.055	0.7167±0.124
120 t/ha	1.3233±0.090	0.86667±0.035	2.19±0.125	0.7767±0.081	1.1567±0.115	0.85667±0.035	2.0133±0.146	0.805±0.134
180 t/ha	1.4±0.217	0.95333±0.032	2.3533±0.248	0.9±0.072	1.2633±0.058	0.97167±0.032	2.235±0.079	0.9033±0.071
240 t/ha	0.8633±0.731	0.78667±0.106	1.65±0.783	0.75±0.165	1.0433±0.058	0.8±0.144	1.8433±0.200	0.6267±0.035

Values are Mean ± SE (n=3), Significant at $p < 0.05$,

Table 10 Concentration of trace elements in Edible Part of *lycopersicum esculentum L.* in different years in red soil.

Parameters (mg/kg)	Treatment (t/ha) 2010					Treatment (t/ha) 2011				
	Control	60 t/ha	120 t/ha	180 t/ha	240 t/ha	Control	60 t/ha	120 t/ha	180 t/ha	240 t/ha
Cr	0.14±0.007	0.21±0.0004	0.23±0.0003	0.26±0.0003	0.29±0.0003	0.17±0.0005	0.19±0.0003	0.23±0.0005	0.29±0.0002	0.36±0.0006
Cu	0.36±0.0022	0.15±0.0003	0.19±0.0005	0.21±0.0005	0.25±0.0006	0.39±0.0005	0.34±0.0004	0.48±0.0006	0.55±0.0003	0.65±0.0007
Zn	0.84±0.0006	0.39±0.0004	0.42±0.0006	0.47±0.0006	0.49±0.0007	0.89±0.0003	0.38±0.0015	0.42±0.0007	0.49±0.0004	0.518±0.0082
Pb	0.66.0006	0.23±0.0005	0.36±0.0017	0.39±0.0006	0.39±0.0018	0.69±0.0007	0.26±0.0026	0.36±0.0018	0.41±0.0005	0.45±0.0015
Fe	0.73±0.0005	0.22±0.0006	0.25±0.0007	0.33±0.0007	0.35±0.0029	0.72±0.0002	0.26±0.0007	0.29±0.0009	0.37±0.0006	0.39±0.0007
Cd	0.016±0.0003	0.03±0.0007	0.04±0.0008	0.05±0.0007	0.06±0.0009	0.018±0.0003	0.04±0.0008	0.05±0.0003	0.06±0.0007	0.07±0.0008

Values are Mean ± SE (n=3), Significant at $p < 0.05$,

Effect on Fresh and Dry weight of Edible part (g/pot) of *Lycopersicon esculentum Mill.* After amendment with MSW (Viz.KW) compost at two seasons in red soil are depicted in Table 6 to 7. Max Fresh weight of Edible part 267.70 in 2010 of fresh weight and Max Dry weight of Edible part (g/pot) of *Lycopersicon esculentum Mill.* in red soil recorded as 24.90 in 2011, it is significantly affect as compare to control environment.

This part of study deals the effect of different amendments of MSW (Viz.KW) compost on chlorophyll and Carotenoid content (mg/kg FW) of *Lycopersicon esculentum Mill.* in two consecutive year 2010 and 2011. The data were depicted in the Tables 3.8 & 3.9 after 45 & 90 days of harvesting in red soil. Decrease chlorophyll content may also be ascribed due to decreases in Carotenoid contents, non-enzymatic antioxidants playing a important role in protection of chlorophyll pigments against a stress (Krupa and Baszynski, 1995).

Accumulation of elements (mg/kg) like Cr, Cu, Zn, Fe, Pb, Cd, has increased with the increase in amendment ratio in edible parts after 90 days. Different amendments of MSW (Viz.KW) compost and there significant values were shown in Table 10. Plants grown in MSW (Viz.KW) compost have accumulated appreciable amounts of these metals than plants grow in control. However general vigour of plant was not affected.

CONCLUSION

Soil application of Municipal Solid waste (Viz. Kitchen Waste) compost at lower levels (120-180 t/ha) were found beneficial for the plant growth and yield of *Lycopersicum Esculentum* Mill in the present study. Thus application of

Municipal Solid waste (Viz. Kitchen Waste) compost is more beneficial to plant growth and yield of *Lycopersicum Esculentum* Mill as compared to control. This studies show that the available nutrients present in Municipal Solid waste (Viz. Kitchen Waste) compost was beneficial for certain levels for utilization of a particular plant species. Thus, Municipal Solid waste (Viz. Kitchen Waste) compost can be used as an eco-friendly nonconventional fertilizer because they will improve the growth and yield of plants. At the same time, the disposal problem of huge amount of Municipal Solid waste (Viz. Kitchen Waste) compost will also be solved.

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