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Evaluation of Municipal sewage sludge vermicompost on two Cultivars of Tomato (Lycopersicon esculentum) plants

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Abstract: 20% concentration of Municipal Sewage sludge mixed with Eichhornia crassipes was prepared using Eisenia foetida worms. The usefulness of compost was carried for pot experiment to investigate the effect of the municipal waste vermicompost on the growth and distribution of heavy metals in the different organs of two cultivars of tomato (Arka Saurabh and pusa Ruby), and their fruit yields. Treatments were 10, 20 and 30 tons/ha of MSSVC. The heavy metals concentration was decreasing in soil with cultivation, heavy metal contents in all organs of two varieties under different treatments are below normal levels and toxicity level. Also they are more than accepted as safe for human consumption. The high total yield was recorded with Araka Saurabh cultivar in all treatment, but the best treatment was 20 tons/ha of MSSVC. Observations were recorder the on plant height, number of branches, fruits/plant, days to first harvest and average fruit weight.
Key words: Lycopersicon esculentum; Sewage sludge vermicompost; heavy metals.

Introduction

Municipal waste management is an integral part any urban environment and planning of the urban infrastructure to ensure a safe and healthy human environment while considering the promotion of sustainable economic growth. Rapid economic growth by industrialization of the developing countries in Asia has created serious problems of waste disposal due to uncontrolled and unmonitored urbanization. The problem is further aggravated by the lack of financial as well human resources trained in the management of these practices in the sphere of collection, transportation, processing and final disposal. Whereas aspects like recycle, reuse and recovery of the solid waste is grossly demand and supply driven or disorganized in most cases. Sewage sludge is a necessary result of wastewater treatment - one of the most important advances in protecting public health and the environment. Landfill disposal and gasification are unlikely to produce net energy and are likely the sources of significant greenhouse gases. Using biosolids on soils is often better; it takes advantage of nutrients and organic matter in biosolids. The sludge used in this study was obtained from from Vidyaranyapuram decentralised effluent treatment plant, Mysore. Fresh plants of *Eichhornia crassipes* was collected from Kukarahalli lake Mysore, rinsed with water and chopped into pieces. The vermicompost experiments were performed in five plastic Bins provided with tight-fitting lid, drainage holes in bottom and air vents on top and sides, the dimention of the bins were 20cm x 30cm x 10cm (length ×width ×depth). Moist drained bedding to worm bin is provided with strips of Newspaper[1].

Tomato is the world's largest vegetable crop and known as protective food both because of its special nutritive value and also because of its wide spread

production. Tomato is one of the most important vegetable crops cultivated for its fleshy fruits. Tomato is considered as important commercial and dietary vegetable crop. Botanical name of tomato is *Lycopersicon esculentum* and belongs to family Lycopersicae. Many hybrids and varieties are developed in the country with biotic and abiotic resistant characters. The main varieties are Pusa Ruby, Pusa Early Dwarf, Arka Abha, Araka Alok, PlantBahar, Pusa hybrid-1, Pusa hybrid-2, MTH-6, Araka Vardan etc., Hybrid seed production has become easier with the development of male sterile line in tomato. Development of tomato varieties resistant to bacterial wilt has made their cultivation successful in non-traditional areas. Drip irriagation technology is economical for tomato crop. The aim of this work is to investigate the effect of Municipal sewage sludge vermicompost on the growth and heavy metals concentration in soil and tomato plants[2].

Experimental

Sewage sludge (20 %) with 65 % moisture was mixed with *Eichhornia crassipes* to provide a suitable C/N ratio. The mixture was composted for 30 days at 75°C to kill pathogenic microorganisms and decompose phytotoxic substances, and then sieved (<20-mm mesh) to remove large bark pieces and stored in swathes[1]. The swathes were mixed with *Eisenia fetida (Lumbricidae)* earthworms[3-5]. 12 numbers of adult healthy *Eisenia fetida* earthworms with approximate weight of 0.9-1.1 g, were placed in all vermicompost plastic bins. Moisture content in the plastic bins was maintained between 60-70 % during the study. The duration of study was 60 days. Appropriate weight of the municipal sewage sludge vermin were weighed and properly incorporated to the soil in the 5 litre pot. Tomato plants were grown on red soil. The pH of the soil was 7.5. The bed is treated with 10 % formaldehyde, and the pot bed was drenched with 0.2 % Dithan M-45. The seeds were treated with Bavistin. The bed was covered by paddy straw and irrigated every morning. Before transplanting the seedling were treated with insecticide (0.1 % Dithane M- 45). Tomato seedlings were raised for 4 weeks before transplanting. The seedlings were transplanted at the rate three /pot. During the plants growth, training and pruning was done for the quality of fruit. Mature old leaves were removed to avoid the disease in plants Parameters determined included plant height and number of leaves. The plants were harvested at 75 days after transplanting. The above-ground portion of the plant were cut and washed in distilled water dried in an oven at 65 ^{o} C until samples attained a constant weight. The dried samples were weighed and then powdered using mortar and pestle. The ground samples were stored in polyethylene bags. Aqua Regia was used to digest soil samples for total contents of the investigated heavy metals. 2 gram of the ground plant materials from the field trials was wet digested with a mixture of (20 ml HNO_3 and 4 ml $HClO_4$). Heavy metals in the digests were determined by the use of AAS[6-8]. This study was conducted during the period from January 2010 to March 2010.

Results and discussion

The pH values indicate that the soil is mildly basic (Table-1). The O.C. and total N of the soil are low and fall within the range of low fertility class. The available P is 10 mg/kg which is within the range of medium fertility characteristics. The pH of the MSSVC is 7.5 which is neutral (Table-1) the value of OC., total N, available P and exchangeable cations for the MSSVC are in high range. This shows the high fertility status of the MSSVC. The heavy metals (Cu, Zn, Pb and Cd) values are within the permissible values of Indian standards[9].

Table -1 Nutrient characteristics of soil and municipal sewage sludge vermicompost

Characteristics	Soil before experiment	Vermi compost
pH -H_2O	7.9	7.5
organic carbon	1.4	20
Total nitrogen	0.6	0.9
Available P	10	35.4
Available K	12.2	27.6
Ca mg/kg	1.00	4.9
Mg mg/kg	0.12	2.0
Na mg/kg	4.40	8.8
K mg/kg	0.31	11.3
Cu mg/kg	2	32
Zn mg/kg	2.8	45.9
Pb mg/kg	-	45.9
Cd mg/kg	-	5.2

Application of compost level to the pots was done as per data given in the table-2. Performance of MSSVC at 20 t/ha increased the fruit yield of tomato (14 t /ha) significantly over 10 tons compost per ha (7.3 t/ha) but was on par with 30 tons compost per ha. Similarly plant height, number of fruits per plant and fruit weight significantly increased by 20 tons of compost and not by the highest dose of 30 tons of compost (Table-2).

Table- 2. Mean performance of two tomato genotypes to Sewage sludge vermicompost

Compost level Tons/ha	plant Height (cm)	No. of branches /plant	Days to first harvest	No. of fruits /plant	Average fruit wt.(g)	plant Height (cm)	No. of branches /plant	Days to first harvest	No. of fruits /plant	Average fruit wt.(g)
	Arka Saurabh					Pusa Ruby				
10	49.5	8.00	75	52.00	40.50	46.5	10.0	72	59	44
20	51.0	7.9	70	65.00	42.00	47.0	11.0	70	60	51
30	43.2	7.0	90	49.00	35.5	36.5	7.8	95	45	37

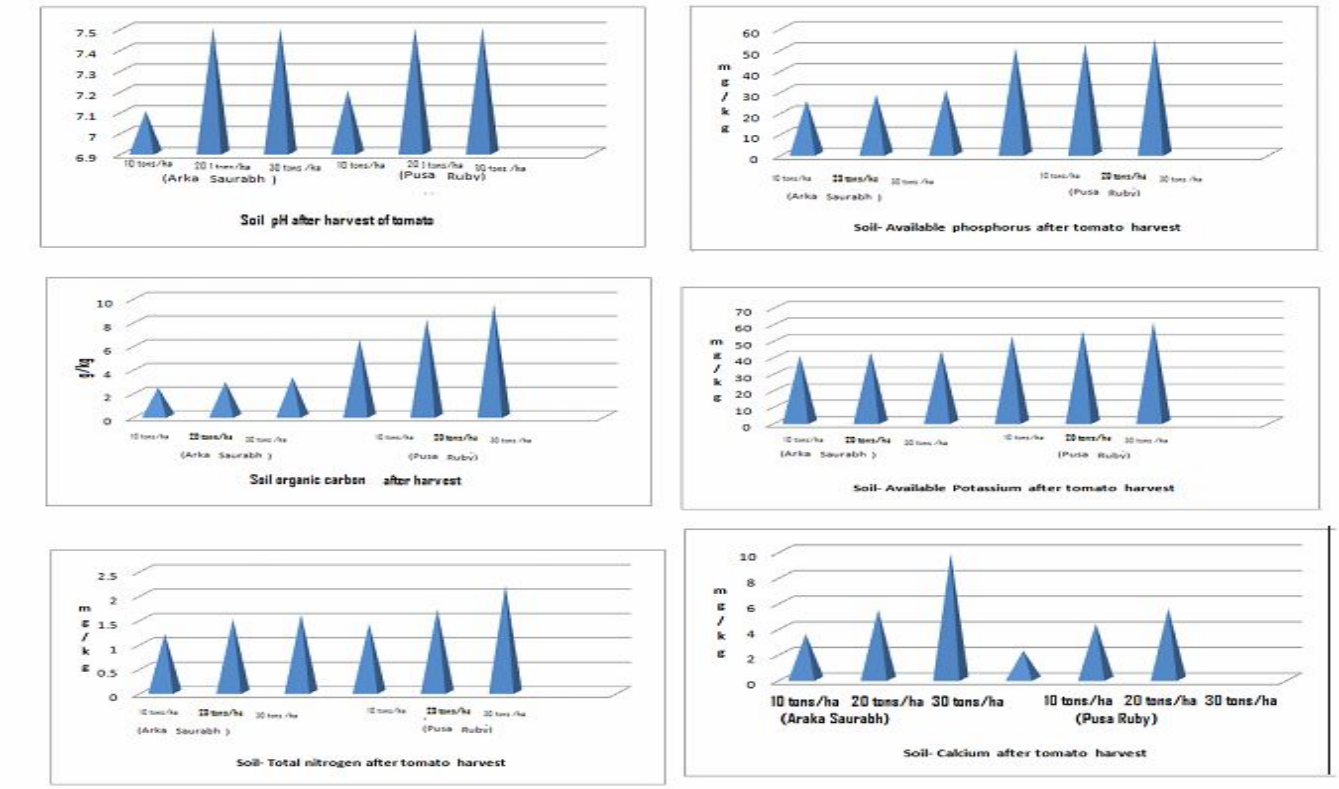
The mean performance of two cultivars of tomato plants shown in the table-2, reveals that 20 ton/ha of the compost was most suitable. In this study the maximum plant height, number of branches, days of first harvest, number of fruits /plant and average fruit weight for Araka Saurabh and Pusa Ruby were evaluated. The shortest plant (36.5 cm) was noticed in Pusa Ruby for 30 tons/ha and the tallest plant (51.5 cm) was noticed for Arka Saurav for 20tons /ha of sewage sludge compost. The variety Pusa ruby took 75 days for 10 tons/ha , 70 days for 20 tons/ha and 90 days for 30 tons /ha of compost level. But for the variety pusa ruby the duration of first harvest was 72 days for 10 tons/ha, the performance was very good in case of Arka Saurabh variety.

Tomato is the second largest vegetable crop in India. With an annual production of 5 million tons, India contributes about 7 % to the world production. Many hybrids ad varieties are developed with biotic and abiotic resistant characters. Table-3 presents the effect of MSSVC on soil parameters. Soil samples were collected before and after harvest of tomatoes. Among the heavy metals investigated (table -3) and (figure-1), concentration of all the nutrients and trace metals increased after harvest.

Table: 3 Chemical analyses of the Soil Before and after harvest of tomato

Characteristics	Soil before experiment	Soil after harvest (Arka Saurabh)			Soil after harvest (Pusa Ruby)		
		Compost, tons/ha			Compost, tons/ha		
		10	20	30	10	20	30
pH -H_2O	7.9	7.1	7.5	7.5	7.2	7.5	7.5
organic carbon g/kg	1.4	2.4	2.9	3.3	6.5	8.2	9.5
Total nitrogen mg/kg	0.6	1.2	1.5	1.6	1.4	1.7	2.2
Available P mg/kg	10	25.4	28.2	30.5	50.4	52.3	54.6
Available K mg/kg	12.2	40.5	42.6	43.6	52.4	55.6	60.6
Ca mg/kg	1.00	3.5	5.4	9.8	2.2	4.3	5.5
Mg mg/kg	0.12	-	-	0.5	-	-	-
Na mg/kg	4.40	6.2	7.9	10.5	5.4	6.2	6.2
K mg/kg	0.31	4.3	5.2	5.4	3.5	4.0	4.5
Cu mg/kg	2	20.5	22.6	30.2	14.5	18.6	20.3
Zn mg/kg	2.8	200.5	205.7	230.8	147.5	189.6	192.5
Pb mg/kg	-	45.5	65.4	78.5	35.4	56.4	77.6
Cd mg/kg	-	4.5	5.5	5.2	3.6	5.2	7.2

Figure-1 Soil nutrient characteristics before and after harvest of tomato plants using MSSVC

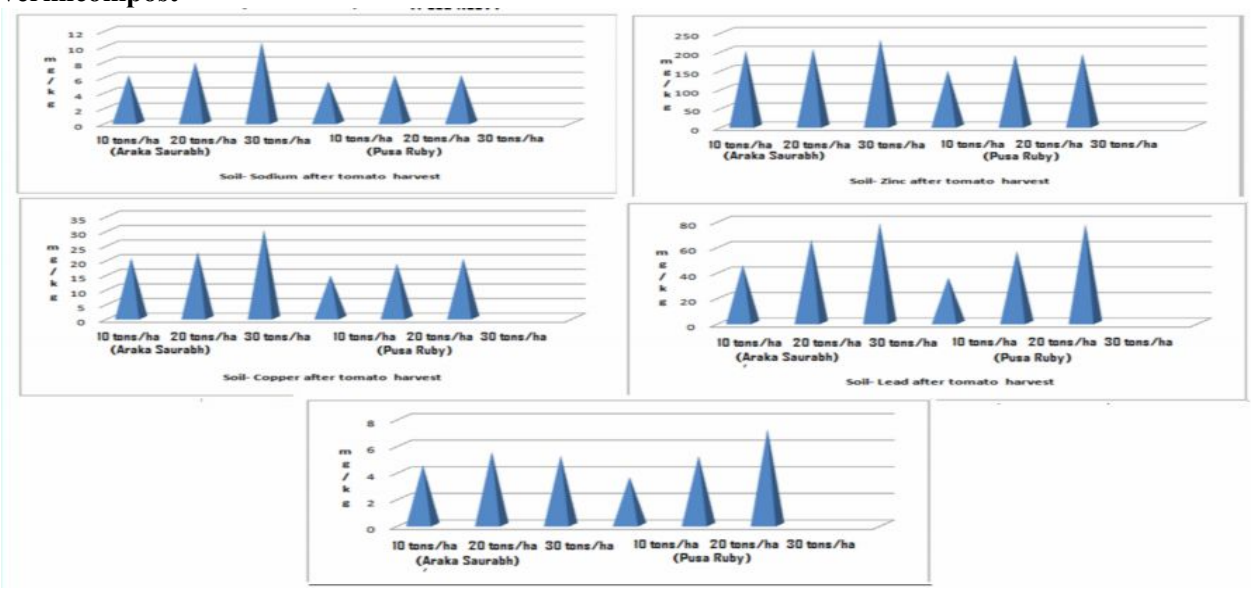


One of the treatment possibilities of Municipal sewage sludges is the agricultural use after composting. However, the heavy metal content of sludges can accumulate in the soil and can get in to the nutritional chain. Analysis of heavy metals in the leaves roots and fruits were high but in permissible limit. No harmful toxic element accumulation was found in the soil and in test plants Table-4 and figure -2. The order of all tested heavy metals in the plants was fruits > leaves > roots.

Table-4 Heavy metal level in two variety of tomatoes harvested using municipal sewage solid sludge vermicompost

Characteristics	Araka Saurabh			Pusa ruby		
	Fruit	Leaves	Roots	Fruit	Leaves	Roots
Cu mg/kg	5.4	7.5	10.5	6.2	8.4	12.4
Zn mg/kg	23.2	30.7	35.7	30.0	26.4	30.4
Pb mg/kg	6.5	13.8	15.9	6.9	14.3	20.3
Cd mg/kg	1.2	1.3	2.5	1.5	1.6	2.2

Figure-3 Heavy metal level in tomatoes harvested using municipal sewage solid sludge vermicompost



Conclusion

Putting the nutrients back into the soil is the best ecological solution to this waste problem this study not only involves devising suitable methods for treatment of solid wastes but also recycling of these wastes as nutrients through their application to the soil. Vermicompost from segregated municipal solid waste provides valuable humus and are bio-fertilizers. Results have shown that highest tomato yeild (14.9 kg/bunch) was obtained at 20 tons /ha MSSVC application. Soil analysis of the treated plots revealed that there was increase in pH, organic carbon, N and P, while potassium content and EC of soil were reduced by the application of MSSVC. Status of phosphorus and potassium in soil was high after the crops were harvested, which means, there is no need to supplement the phosphorus and potassium additionally. The concentrations of Pb and Cu are above the permissible level, while that of Zn and Cd are below. Further there is no statistical difference between the two varieties. This also suggests that there is scope for co-composting municipal sewage sludge for balancing crop nutrition.

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