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Toxicity Assessment of Compost Prepared From Plastic And Vegetable Waste On Sorghum And Earthworms

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ABSTRACT

The solid waste recycling is essential for environmental safety, economic stability and ecological sustainability. In the present study,pot culture experiments were conducted to assess the effect of compost prepared using plastic and vegetable waste on germination percentage, root length and shoot length of sorghum and weight and length of earthworms. There were 5 treatments, (0%, 1%, 5%, 10% and 20%)and 10 Sorghum seedswere sown into each pot, and 10 earthworms were introduced into each pot. The observationwere made on 15 days after sowing of sorghum and 30 days after introduction of earthworms. Results showed that as the percentage of compost is increased up to 10%, there was increase in root length, shoot length and seed germination percentage (positive effect) of Sorghum and increase in weight and length of earthworms. The study encourages the degradation of plastic wastealong with vegetable waste by composting method and use of compost for plants.

KEY WORDS: Compost, Plastic, Vegetable waste, Sorghum, Earthworm

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INTRODUCTION

Sustainable agriculture employs organic wastes and animal manuresfor improving soil nutrients and modify physico-chemical and biological characters of soil. Inappropriate solid waste management contributes the emissions of ammonia (NH_3) and greenhouse gases (GHG), including nitrous oxide (N_2O), methane (CH_4), and carbon dioxide (CO_2), which are responsible for global warming.

The organic waste is transformed into stabilized products by proper waste management practice called composting, products of which are very beneficial for agriculture and land reclamation activities. To protect the environment there is an increasing number of compost operations due to increasing landfill tipping fees and legislation. Thus, to increase composting efficiency, reduce processing time, and achieve better quality products which are key aspects to compost marketing,there is a need to pay attention on this method.

Vermicompost or organic matter amendments are helpful in improving soil physical properties which may be helpful in contribution to sustainable agro-ecosystems. The contaminated soil could be improved for plant growth substrates by bringing to below toxicity level as vermicomposting helps in the removal or reduction of heavy metals. Vermicompost help in improving soil fertility by providing phyto hormones, rhizobacteria, vitamins, antibiotics, soil enzymes, and immobilized microflora, which are readily soluble in water, Required for plant growth; increasing the bioavailability of mineral nutrients; and at the same time minimizing the dependence on the chemical fertilizers, which is not affordable among developing countries.

The conversion of organic waste into organic fertilizers through vermicomposting is very cost effective[14], in which a number of interactions between earthworms and microorganisms occur in the worm gut[15]. Earthworms generally can eat all types of organic waste and the consume organic waste almost equal to their body weight per day. The prepared compost have good quantity of nitrates, phosphorus, potassium, calcium and magnesium.

There are millions of tons of solid waste like human based, live stock based and plant derived waste produced every year which cause safe disposal problem and many other problems to the environment.If processed through the proper ratio and combination the vermicomposting is most useful, cost-effective and eco-friendly technique to convert the widely available solid waste in to compost. To approach a successful soil rehabilitation and fertility there are many materials which have been used till now like vegetable solid waste, cow dung, wheat straw, biogas slurry, kitchen paper waste, kitchen yard waste, cattle manure yard waste, and rice waste.*Eiseniafoetida* and *Eisenia Andrei* aremost commonly used earthworms for preparation of vermicompost. *E. foetida* is considered as the most eurythermal species of eugenic earthworms.

The amount of waste produced increased day by day as city dwellers become richer. Richer societies tend to curb their waste. The global solid-waste generation will peak as living standards around the world rise and urban populations stabilize. Just when is difficult to predict. But by extending current socio-economic trends to 2100, we project that 'peak waste' will not occur this century. The planet will have to bear an increasing waste burden, unless we reduce population growth and material consumption rates.

Considering the above facts, the present study was undertaken to assess the toxicity of compostprepared from plastic and vegetable waste using microbes from Pirana site, Ahmedabad on Sorghum and earthworms.

MATERIALS AND METHODS

Isolation of Microbes

Isolation and enumeration of bacteria were performed by serial dilution plate technique using nutrient agar media. 1 g of dried soil sample was dissolved in 9 ml of distilled water and agitated vigorously. Different dilutions such as 10^{-1}, 10^{-2}, 10^{-3}, 10^{-4}, 10^{-5}, and 10^{-6} of the suspension were applied on the nutrient agar media plates. After that plates `were incubated at 37° C for 24 hrs. Enumeration of different isolates were carried out. Selected colonies of bacteria were transferred from mixed culture of the plate to respective agar plates and incubated at 37°C for 24 hours. The developed colonies were counted and the average number of colonies per three plates was determined. The number of total bacteria (CFU) per gram dry weight soil was determined using the formula-

CFU/ml of original sample = No. Of colonies / Inoculum size (ml) × Dilution factor

Isolated Bacteria were identified by Gram Staining and biochemical Characterization**(***Halomonassp, Bordetellapetrii*, *Luteimonas marina* and *Bacillus megaterium* **)**

Compost preparation analysis

The compost was prepared in aerobic composting bioreactor. The aerobic reactor consists of rectangular plastic boxes having dimensions of [1.5(l) x 1 (w) x 1 (h)] ft. The working volume of reactor was 15 kg. The materials which decomposed slowly with aeration as high lignin content were used for composting. The container of the composting reactor was filled with a layer of coconut fibres, palm tree leaves up to a 1.5 inch height and the 3 inch layer of dried leaves. Similarly two more layers of above mentioned materials were made and the moisture content was maintained up to 55 to 65% by watering. Vegetables waste (200 to 300g) was chopped to 2-5 mm size and spread over the composting material. During the composting process, the microorganisms from ambient phase turn into mesophilic conditions started immediately after a day. Mesophilic conditions lasted for about one week at the temperature of about 40^0C. After this the phase changes to thermophilic conditions above 40 to 60 ^{0}C.

Plastic samples were degraded in active compost at this phase. A 10 gm plastic sample was well mixed in the activated compost with sea sand (ca. 400 g). The mix bacterial culture from acclimatized collected plastic samples (from the site) was introduced in the composting reactor**.** After this stage the Aerobic bioreactor was shifted into incubator and maintained at temperature 56 $\underline{+}2^0$C for a period of 8 weeks. The composting materials were manually turned every alternate day to maintained aerobic conditions. Every week the composting reactor was fed 200 gm of vegetable waste (> 2mm size). During the aerobic composting, the temperature, C/N ratio and moisture were maintained. At the end of 8 weeks, reactor was removed from the incubator and allowed composting material to stabilize and mature for a period of one week. Standard procedures from APHA (1993) were followed for the various parameters analyzed.

Toxicity assessment of prepared compost on selected plan and earthworms

To test the toxicity of prepared compost animals (earthworms) and plants (Sorghum) were selected. The experiment was designed with different treatments in triplicates (Plate 1).

Table 1 Different treatments of compost with soil

Treatments (T_s)	Concentration of compost with soil (%)
T_0	0 (control)
T_1	1
T_2	5
T_3	10
T_4	20

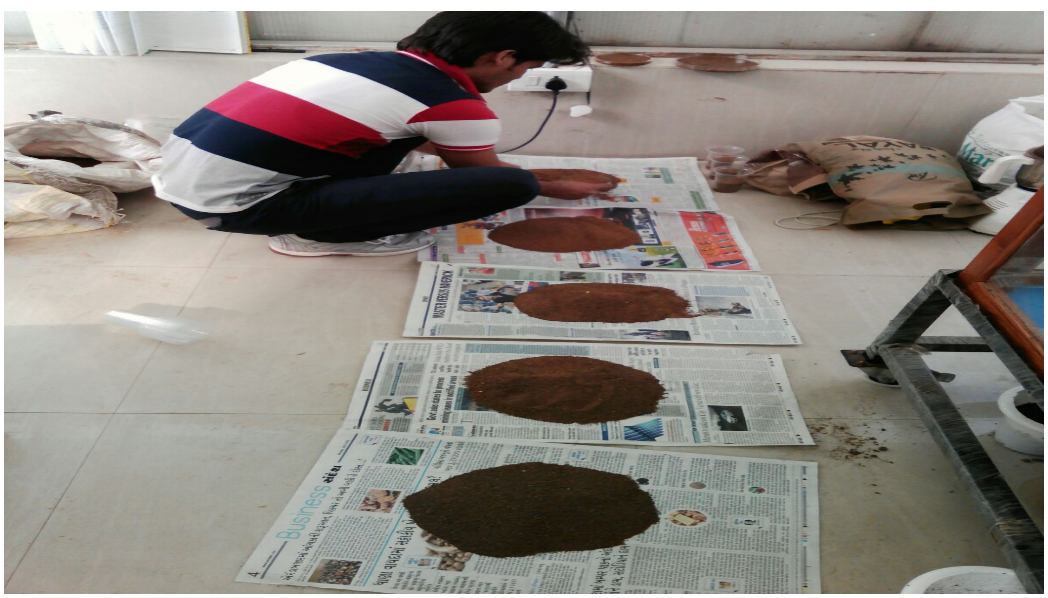

Fig. 1Preparation of soil with different concentration of compost

After preparing the soil as per compost tratment 10 seeds were sown including control pots and for earthworms, 10 selected earthworms were left for surviving in each concentration including control pots.After 15 days following parameters were observed in sorghum-

Seed germination percentage

The seeds germinated after two days of sowing were counted and percentage was calculated using the formula–

$$\text{Germination \%} = \frac{\text{Number of seed germinated}}{\text{Total number of seeds shown}} \times 100$$

Root length

The root length of plants was measured after 15 days of sowing using scale from root tip to root collar point and noted in cm.

Shoot length

The shoot length of plants was measured after 15 days using scale from root collar point to tip of plant noted in cm.

After 30 days we the following parameter were observed in earthworms-

Weight of earthworms

The weight of earthworms was taken using electric weighing balance at 0 days and after 30 days and tabulated in g.

Length of eartworms

The length of earthworms was measured using scale at 0 days and after 30 days and noted in cm.

RESULTS AND DISCUSSION

The experiment of composting lasted for 8 weeks in bioreactor. The composted material was collected, dried in shade and analysed.

compost after 8 weeks | compost after drying | compost after crushing | compost after sieving

Fig.2 Different stages of compost

Physico-chemical Characterization of compost

The compost prepared from plastic and vegetable waste was characterisedand comparedwith FCO standard (Ministry of Agriculture and Rural Development, Govt. of India)andpresented (Plate 2).

The colour of the compost was dark brown andfoul odorous (NEERI 2009). The moisture content of the sample was 19.67 ± 2.36 %. The average pH of the compost was 7.15 ± 0.35 which was varied from almost neutral to slightly alkaline as FCO Standard recommended value of 6.5–7.5.High pH accelerates ammonia gas emission from the compost to the ambient air. The temperature of the compost during the preparation of compost increases due to microbial activity (mesophilic and thermophilic bacteria). Average EC was within the permissible limit of FCO standard. The average concentrations of total nitrogen, total phosphate and total potassium of compost were 1.89 ± 0.02, 1.04 ± 0.12, and 2.07 ± 0.11 mg/kg, respectively. The average concentrations of some selected heavy metal of compost, e.g., Zn, Cu, Cd, Pb, Ni and Cr were 246.50 ± 6.36, 201.50 ± 20.50, 2.19 ± 0.08, 87.50 ± 4.94, 31.50±3.53 and 86.00 ± 4.24 mg/kg, respectively.The average concentrations of the above heavy metals were within the permissible limit of FCO Standard.

Table 2 Characterization of compost in comparison with Fertilizer Control Order (FCO) standard.

S.N.	Parameters	Range	Average	Standard deviation	Standards(FCO)
1	pH	6.9-7.4	7.15	0.35	6.5-7.5
2	Moisture content (%)	18-21.34	19.67	2.36	15-25%
3	Electrical conductivity(ds/m)	1.20-1.33	1.26	0.09	≥4
	Macronutrients				
4	Total Nitrogen (%)	1.87-1.91	1.89	0.02	0.5 (min)
5	Total Phosphorus (%)	0.96-1.13	1.04	0.12	0.5%(min)
6	Total Potassium (%)	1.99-2.15	2.07	0.11	1%(min)
	Micronutrients/Heavy metals				
7	Zn (mg/kg)	242-251	246.50	6.36	1000
8	Cu (mg/kg)	187-216	201.50	20.50	300
9	Cd (mg/kg)	2.13- 2.25	2.19	0.08	5
10	Pb (mg/kg)	84-91	87.50	4.94	100
11	Ni (mg/kg)	29-34	31.50	3.53	50
12	Cr (mg/kg)	83-89	86.00	4.24	50

Toxicity test of compost

Effect of compost on growth of animals (Earthworms)

Weight of earthworms

The different compost concentration affected the growth of earthworms. Table 3 shows initial (0 days) weight of 10 individual earthworms and their average weight (1.13, 1.29, 1.21, 1.09, 1.66 g) in different concentrations of compost. Table 3 also shows the increased weight of 10 individual earthworms after 30days and their average weight (1.39, 1.47, 1.68, 1.97, 1.55 g) in different concentrations of compost which shows that the compost positively affects the growth (weight) of earthworms from control up to the 10% concentration of compost. In 20% concentration of compost the average weight of earthworms were decreased which proves that the higher concentration of compost is toxic (not suited) to the animals.

Table 3 Weight of earthworms (gm)

Treatments (Ts)	**0 days**		**After 30 days**	
	Average	S.D.	Average	S.D.
T_0 (Control)	1.13	0.47	1.39	0.52
T_1 (1%)	1.29	0.54	1.47	0.51
T_2 (5%)	1.21	0.58	1.68	0.39
T_3 (10%)	1.09	0.53	1.97	0.22
T_4 (20%)	1.66	1.42	1.55	0.43

Length of earthworms

Table 4 represents the initial (0 days) length of 10 individual earthworms and their average length (9.55, 9.94, 9.27, 9.65, 9.53 cm) in different concentration of compost. Table 4 also shows the increased length of 10 individual earthworms and their average (10.65, 11.02, 11.15, 11.35, 10.58 cm), in different concentration of compost, which shows the increased length of earthworms from control up to the 10% concentration of compost. In 20% concentration the length is not much increased as compared to 1%, 5%, 10% concentration.

Table 4 Length of earthworms (cm)

Treatments (Ts)	**0 Days**		**After 30 Days**	
	Average	**S.D.**	**Average**	**S.D.**
T_0 (Control)	9.55	2.99	10.65	2.99
T_1 (1%)	9.94	3.00	11.02	2.99
T_2 (5%)	9.27	3.16	11.15	2.82
T_3 (10%)	9.65	3.25	11.35	2.94
T_4 (20%)	9.53	3.32	10.58	2.98

Effect of compost on plants (Sorghum)

The different compost concentration affected the sorghum plant. The effect is observed as seed germination percentage, root length and shoot length.

Seed germination percentage

Table 5 shows the average number of germinated seeds out of 10 seeds in different concentrations (Control, 1%, 5%, 10%, 20%) and their average (8, 9, 9.66, 10, 8.66), and seed germination percentage (80%, 90%, 96.66, 100%, 86.66%), which indicates that the seed germination percentage is increased from control up to 10% and further decreased in 20% concentration of compost, this concentration is not suited to seed germination of plants.

Table 5Seed germination percentage (%)

Treatments (Ts)	Average	Standard deviation	Seed germinationPercentage
T_0 (Control)	8	1	80
T_1 (1%)	9	1	90
T_2 (5%)	9.66	0.57	96.66
T_3 (10%)	10	0	100
T_4 (20%)	8.66	0.57	86.66

Root length and Shoot length of sorghum plant

Table 6 represents the root length of 10 individual plants and their average (11.08, 12.27, 14.59, 17.03,12.42 cm) in different concentration of compost. this indicates that the root length increased compared to control upto10% concentration of compost, whereas in 20% concentration the root length is not much increased as compared to control, 1%, 5%, and 10% concentration. Table 6 also represents the shoot length of 10 individual plants and their average (10.04, 11.09, 12.05, 12.49, 11.29), in different concentration of compost, which indicates that the shoot length is increased from control up to the 10% concentration of compost, in 20% concentration the shoot length is not much increased as compare to control, 1%, 5%, and 10% concentration.

Table 6Root length and Shoot length of plants after 15 days of germination (cm)

Treatments (Ts)	Root length		Shoot length	
	Average	S.D.	Average	S.D.
T_0 (Control)	11.08	4.15	10.04	2.76
T_1 (1%)	12.27	3.87	11.09	2.51
T_2 (5%)	14.59	3.73	12.05	2.66
T_3 (10%)	17.03	4.02	12.49	1.78
T_4 (20%)	12.42	3.63	11.29	2.03

It have been reported that Suaedacompost in combination with farmyard manure (FYM) and phosphate solubilizing bacteria significantly increased the growth and yield characteristics of *V. Radiate*. It was also documented that maize growth was improved by application of MSW compost. Compost supplies nutrients at a slower rate but for a longer period. It helps to improve the soil organic matter and subsequent plant growth.It have been also reported the significant increase in the growth of tomato seedlings by the application of pig manure vermicompost as a component of a horticultural bedding plant medium.It was also documented that organic fertilizer prepared from the composting of banana waste improves the growth, development, morphology and productivity of Sorghum bicolour ‘cv (Tabat)’. It was also reported that the compost prepared from MSW enhance the growth and production of vegetable crops (Potato,Corn and Squash), due to the providing Nitrogen and phosphorous required to the crop plants.

It was also documented that compost prepared from MSW and sewage sludge is helpful in enhancing the growth and nutrition value of the native shrub *Pistialentiscus* due to the enhancement of P uptake by the plants.Application of MSW compost in agriculturalland usually poses positive effect on the productivityof a wide variety of croplandvegetables andalso in hydroponic system.It was alsoevaluated theeffectof MSWC on potatoes and sweet corn and found thatthis compost was a good source of P for bothvegetables. Recently, conductedan experiment to assess the ability of MSWC toimprove the growth of tomato under hydroponicsystem.

Besides improving soil’s physicochemical propertiesMSWC also adds nutritive value to differentvegetable crops and fruits.MSW compost amendment provides sustainability tothe agroecosystems and soil ecology. Its incorporationin land aids in maintaining long term productivity,ameliorating soil physico-chemical and biologicalproperties. It also helps in protecting the soil fromover cropping, changes in climatic conditions and poormanagement.

MSW compost provides a good source of nutrients inplant available form, so could be used as organicfertilizer which have many advantages over inorganicfertilizers. Besides this, agricultural utilization of MSWcompost has potential to solve two main burningproblems of present viz. soil fertility management andMSWM[37].When agriculture is integratedwith vermiculture then one product (vermicompost)is recycled into the system for soil fertilization, but within this integrated ‘vermi-pisciculture’ approach twovermiculture products (vermicompost as a manure andearthworm as a fish feed) are recycling within the systemwhich is more economical, and income generating. Moreresearch and information is needed in this area.

CONCLUSION

The findings provide opportunities to explore the potential of plastic in MSW composting along withother organic wastes and efficiently recycling the nutrients. MSW composting can be used as a simple and efficient method for sustainable land restoration programmes with a low input basis. Composting and vermicomposting are procedures to detoxify and stabilize organic waste. The decomposition of organic material improves its quality in terms of micro ad macro nutrients and compounds essential for plant growth. Improved growth results in better yield and quality of plant products.

1. The present study brings us an initiative to utilise bioreactor for MSW composting.
2. The compost is not toxic to soil fauna (earthworms).
3. The prepared compost can be used for crops.
4. Further studies could be carried out with different organic constituents.

REFERENCES

1. Diacono M, and Montemurro F. Long-term effects of organic amendments on soil fertility. A Review. Agro. Sustai. Develop. 2010; 30:401–22.
2. Wang J, Hu Z, XU X, Jiang X, Zheng B, Liu X, Pan X, and Kardol P. Emissions of ammonia and greenhouse gases during combined pre-composting and vermicomposting of duck manure. Waste Manage. 2014; 34:1546–52.
3. Zucconi F, and Bertoldi DM. Compost specifications for the production and characterization of compost from municipal solid waste", In: de Bertoldi M, Ferranti MP, L'Hermite P, Zucconi F (eds) Compost: production, quality and use. *Elsevier, Essex, UK;* 1987: 30–50
4. He X, Logan TJ, and Traina SJ. Physical and chemical characteristics of selected U.S. municipal solid waste composts. J Environ Qua.1995;24:543–552
5. Bertoldi DM, Ferrero G, Hermite LP, and Zucconi F. Conclusions of the symposium. In: de Bertoldi M, Ferranti MP, L'Hermite P, Zucconi F (eds) Compost: production, quality and use. Elsevier, Essex, *UK*; 1987; 746–749
6. Funke U. Compost marketing. In: de Bertoldi M, Ferranti MP, L'Hermite P, Zucconi F (eds) Compost: production, quality and use. *Elsevier, Essex, UK;* 1987;703–709
7. Ngo PT, Rumpel C, Ngo QA, Alexis M,Velasquez VG, Mora L, Gil M, Dang DK and Jouquet P. Biological and chemical reactivity and phosphorus forms of buffalo manure compost, vermicompost and their mixture with biochar. Biore. Technol. 2013; 148:401–07

8. Di GP, Moreno B, Annoni E, Garcia RG, and Benitez E. Dynamic changes in bacterial community structure and in naphthalene dioxygenase expression in vermicompost-amended PAH-contaminated soils. J of Haza. Mate. 2009; 172:1464–69
9. Jordao CP, Fialho LL, Neves JC, Cecon PR, Mendonca ES, and Fontes RL. Reduction of heavy metal contents in liquid effluents by vermicomposts and the use of the metal-enriched vermicomposts in lettuce cultivation. Bioresou. Technol. 2007;98:2800–13.
10. Zhang H, Tan SN, Teo CH, Yew YR, Ge L, Chen X, and Yong JW. Analysis of phytohormones in vermicompost using a novel combinative sample preparation strategy of ultrasound-assisted extraction and solidphase extraction coupled with liquid chromatography-tandem mass spectrometry. Talanta. 2015; 139:189–97.
11. Sahni S, Sarma B, Singh D, Singh H, and Singh K. Vermicompost enhances performance of plant growthpromotingrhizobacteria in Cicerarietinumrhizosphere against Sclerotiumrolfsii. Crop Prote. 2008; 27:369–76
12. Lim SL, Wu TY, Lim PN, and Shak KPY. The use of vermicompost in organic farming: Overview, effects on soil and economics. J. of Food Scie. and Agri.2015; 95:1143–56
13. Doan T, Bouvier C, Bettarel Y, Bouvier T, Henrydes TT, Janeau JL, Lamballe P, Nguyen BV, and Jouquet P. Influence of buffalo manure, compost, vermicompost and biochar amendments on bacterial and viral communities in soil and adjacent aquatic systems. Appli. Soil Ecolo. 2014; 73:78–86
14. AranconNQ, Edwards CA, Bierman P, Welch C, and Metzger JD. Influences of vermicomposts on field strawberries-1. Effects on growth and yields, Bioresour. Technol. 2004; 93 (2): 145–153.
15. Edwards CA. The use of earthworms in the breakdown and management of organic wastes. In: Edwards, C.A. (Ed.), Earthworm Ecology. CRC Press, Boca Raton, FL, USA; 1998: 327–354.
16. Misra RV, Roy RN, and Hiraoka H. On-farm Composting Methods. *Food* and Agriculture Organization of the United Nations (FAO), Rome; 2003: 1–35.
17. Suthar S. Vermicomposting of vegetable-market solid waste using Eiseniafetida: Impact of bulking material on earthworm growth and decomposition rate. Ecolo. Engi. 2009;35:914–20
18. Warman PR, and Anglopez MJ. Vermicompost derived from different feedstocks as a plant growth mediu. Bioresou Technol. 2010;101:4479–83
19. Manh VH, and Wang CH. Vermicompost as an important component in substrate: Effects on seedling quality and growth of muskmelon (Cucumis Melo L.). APCBEE Procedia. 2014; 8:32–40

20. Edwards CA, Arancon NQ, and Sherman RL. Vermiculture technology: Earthworms, organic waste and environmental management. In Biology and Ecology of Earthworm Species used for Vermicomposting", eds. J. Domínguez, and C. A. Edwards, Boca Raton, FL: CRC Press; 2010: 27–40.
21. Lalander CH, Komakech AJ, and Vinneras B. Vermicomposting as manure management strategy for urban small-holder animal farms - Kampala case study. Waste Manage. 2015; 39:96–103
22. Reinecke A, Viljoen SA, and Saayman R. The suitability of Eudriluseugeniae, perionyxexcavatus and eiseniafetida (Oligochaeta) for vermicomposting in southern Africa in terms of their temperature requirements. Soil Biol. and Bioche. 1992; 24:1295–307
23. Ayyappan D, Sanjiviraja K, Balakrishnan V, and Ravindran KC. Impact of halophytic compost on growth and yield characteristics of VignaradiataL, Afri. J. of Agri. Resea. 2013; 8 (22): 2663-2672
24. Iqbal T, Jilanil G, Rasheed M, Siddique MT and Hayat A. Enrichment of municipal solid waste compost through rock phosphate and phosphorussolublizing bacteria and effect of its application on soil and maize growth. Soil Environ. 2015; *34(2):119-125*
25. Atiyeh RM, EdwardsCA, SublerS, and MetzgerJD. Pig manure vermicompost as a component of a horticultural bedding plant medium: effects on physicochemical properties and plant growth. Bioresour. Technol.2001; 78 (5): 11-20
26. Mawahib EME, Elfadil AG, Manal FA, and Saeed AEB. Effects of Banana Compost on Growth, Development and Productivity of Sorghum bicolor Cultivar (Tabat). j. of adva. in biolo.2015; 8 (2): 1555-1561
27. Ghaly AE and Alkoaik FN. Effect of Municipal Solid Waste Compost on the Growth and Production of Vegetable Crops. Ameri. J. of Agri. and Biolo. Scie. 2010; 5 (3) 274-281
28. Fagnano M, Adamo P, Zampella M, Fiorentino N. Environmental and agronomic impact of fertilization with composted organic fraction from municipal solid waste: a case study in the region of Naples, Italy.Agr. Ecosyst. Environ.2011; 141(1):100–107
29. Papafilippaki A, Paranychianakis N, and Nikolaidis NP Effects of soil type and municipal solid waste compost as soil amendment on Cichoriumspinosum (spiny chicory) growth. SciHortic-Amst. 2015; 195:195–205
30. Mkhabela MS, Warman PR. The influence of municipal solid waste compost on yield, soil phosphorus availability and uptake by two vegetable crops grown in a Pugwash sandy loam soil in Nova Scotia. AgricEcosyst Environ.2005; 106(1):57–67

31. Chrysargyris A, and Tzortzakis N. Municipal solid wastes and mineral fertilizer as an eggplant transplant me´dium. J. Soil Sci Plant Nutr. 2015; 15(1):11–23
32. Haghighi M, Barzegar MR, and Silva JAT. The effect of municipal solid waste compost, peat, perlite and vermicompost on tomato (Lycopersicumesculentum L.) growth and yield in a hydroponic system. Int J Recycl Org Waste Agricult.2016; doi:10.1007/s40093-016-0133-7
33. Warman PR Soil fertility, yield and nutrient contents of vegetable crops after 12 Years of compost or fertilizer amendments. BiolAgricHortic., 2005; 23(1):85–96
34. Hargreaves JC, Adl M.S, Warman PR, and Rupasinghe HPV. The effects of organic amendments on mineral element uptake and fruit quality of raspberries. Plant Soil. 2008 308(1–2):213–226
35. Hargreaves JC, Adl MS, Warman PR, and Rupasinghe, HPV. The effects of organic and conventional nutrient amendments on strawberry cultivation: fruit yield and quality. J Sci Food Agric. 2008; 88 (15):2669–2675
36. Crecchio C, Curci M, Pizzigallo MD, Ricciuti P, and Ruggiero P. Effects of municipal solid waste compost amendments on soil enzyme activities and bacterial genetic diversity.Soil BiolBiochem. 2004; 36(10):1595–1605
37. Srivastava V, Ademir SFA, Vaish B, Shannon BH, Singh P And Singh RP. Biological response of using municipal solid waste compost in agriculture as fertilizer supplement Rev Environ SciBiotechnol. 2016; 15:677–696
38. Ghosh C. Integrated vermi-pisciculture—an alternative option for recycling of solid municipal waste in rural India. Bioresou.Technol. 2004; 93: 71–75