Global Advanced Research Journal of Agricultural Science (ISSN: 2315-5094) Vol. 2(2) pp. 059-064, February, 2013
Available online http://garj.org/garjas/index.htm

Full Length Research Paper

Manurial value of different vermicomposts and conventional composts

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Accepted 11 February, 2013

The aim of this study was to evaluate the manurial value and maturity indices in different composting methods with different organic residues. Studies were conducted on normal composting with chemical additives and vermicomposting with *Eisenia foetida* in different organic residues i.e sugarcane trash, weeds, vegetable market waste and paddy straw mixed with cattle dung. Vermicomposting resulted in significant reduction in C:N ratio and increase in total N,P, K, Zn, Fe, Mn and Cu content after 65 days of composting over normal composting uninoculated with earthworms after 110 days. The enzyme activities i.e. phosphatase, dehydrogenase and cellulase were decreased with increasing the composting period in all the organic residues. Microbial activity, as measured by dehydrogenase assay, increased initially and declined on further incubation. However higher dehydrogenase activity was recorded in vermicomposting over normal composting of different organic residues and with in the organic residues, vegetable market waste recorded higher enzyme activities except cellulase, it was higher in paddy straw compost. There was more total N in the compost prepared by earthworm inoculation. Total P, K and Cu contents did not differ in compost prepared with earthworm inoculation from the uninoculated treatments.

Keywords: Vermicomposting; organic residues; manorial value

INTRODUCTION

India produces around 3000 million tonnes of organic wastes annually (Alok Bhardwaj, 2010). The disposal of ever increasing amounts of organic wastes is becoming a serious problem in India. The hygienic disposal of organic wastes by composting is an environmentally sound and economically viable technology resulting in the production of organic fertilizer which is a basic and valuable input in organic farming. In India, about 350 million tonns of agricultural wastes are generated annually, of which vegetable waste alone is in major portion (Jadia and Fulekar, 2006). The biological treatment of these wastes appears to be most cost effective and carry a less negative environmental impact (Paraskeva and Diamadopoulus, 2006). Weeds are the rich source of nutrients, which could be effectively utilized in the organic recycling process. Paddy straw and cane straw are produced in largest quantity in the country. In many countries the traditional management practice of post harvest residues is the elimination by open air burning leads to release of green house gases and the production of particulate matter are obvious. Therefore as an alternative to burning of cane trash and paddy straw, the incorporation into the soil stands to reason, which has been widely accepted. However, the materials like rice straw and sugar cane trash

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take a long time for decomposition under normal conditions, application of vermiculture technology for recycling of these organic residues gives a valuable manure with in short period. Vermicomposting is an eco-biotechnological process that transforms energy rich and complex organic substances into stabilized humus like product vermicompost, hence the research work is formulated to study the possibilities of adopting vermiculture technology for recycling of organic residues and its comparative evaluation with normal composting.

MATERIALS AND METHODS

The present investigation entitled "**Vermicomposting for effective waste management**" involved preparation of vermicomposts and normal composts from different organic residues and evaluation of its manurial value was carried out at Regional Agricultural Research Station, Anakapalle, Visakhapatnam district of Andhra Pradesh, India during 2010. The basic raw materials used for vermicomposting and normal composting were: 1) Sugarcane trash 2) Weeds 3) Vegetable market waste and 4) Paddy straw. Earthworm species used for vermicomposting was *Eisenia foetida*. Whereas in normal composting 1 % N as urea and 2 % SSP was used as chemical additives. As a accelerator 5 % dung slurry was used in both methods of composting. Pit method of composting was done with the dimensions of 6.0 x 1.0 x 0.6 m.

Vermicompost preparation

The cane trash and paddy straw obtained during harvest of sugarcane and rice crops were collected. The main weed species available in sugarcane field i.e (*Cyperus rotundus,Cynodon dactylon, Cleome viscosa, Commalina bengalensis* and *Trianthema portulacastrum*) were collected from the field and the vegetable market waste was collected from Anakapalle vegetable market. These organic residues were shade dried for few days and cut into small pieces. The organic residues were spread in the pit (6.0 x 1.0 x 0.6 m) up to 6″ height and 5 % dung slurry was uniformly distributed on the top of the organic residues sufficient to wet the surface. Over this layer another layer of organic residues was spread followed by spraying of dung slurry uniformly. This process was repeated till the spread of the organic residues 6″ above the top of the pit. After partial decomposition of organic residues (attained in 15 days) the earthworms (*Eisenia foetida)* were released @ 1 kg (around 1000 worms) per 1 ton organic residues in to the bed by making holes at the top of the bed on four corners and centre of the pit. Throughout the composting process, sufficient moisture was maintained i.e. at 50 percent of maximum water holding capacity of a material.

After completion of vermicomposting earthworms moved to the top of the bed due to lack of feed inside the bed. At this stage watering was stopped and earthworms again moved to the bottom of the bed. The granular, dark brown coloured vermicompost from different organic residues was collected by leaving thin film of vermicompost material at the bottom of the pit consisting of earthworms, cocoons and eggs. Vermicomposting was completed at 65^{th} day. The vermicompost samples at 15, 30, 45 and 60 days after incubation were collected from each treatment for laboratory analysis by making holes on four corners and centre of the compost pit.

Compost preparation

Similarly normal composting with the same materials was also done in the pits of 6 x 1 x 0.6 m size and the organic residues were spread up to 6″ height and 5 % dung slurry was uniformly distributed on the top of the organic residues sufficient to wet the surface and added chemical additives i.e 1 % N as Urea & 2 % SSP. Over this layer another layer of organic residues were spread along with dung slurry and chemical additives uniformly. This process was repeated till the spread of the organic residues 6″ above the top of the pit. Throughout the composting process, sufficient moisture was maintained i.e. at 50 percent of maximum water holding capacity of a material and proper turnings were given to allow the aeration and rapid decomposition. After completion of composting the material turn to fine, dark coloured compost, which was harvested from different organic residues. Composting was completed with in 110 days.

The compost samples at 15, 30, 45, 60 and 110 days after composting were collected by making holes on four corners and centre of the compost pit with the help of auger.

Characteristics of Organic Materials

The organic residues used for vermicomposting and normal composting and the composts taken from different intervals were analysed for physico-chemical and chemical properties by using standard procedures *p*H and Electrical Conductivity was determined in 1:50 organic material (dried and powdered) : water suspension (Chopra and Kanwar, 1976). Organic carbon content was determined by using dry combustion method (Jackson, 1973).The nitrogen content (%) in the dried compost sample was determined by microkjeldahl distillation method after destroying the organic matter using H_2SO_4 and H_2O_2 (Piper, 1966). The phosphorus content in the diacid digest was determined by developing Vanadomolybdophosphoric yellow colour method with Barton's reagent (Piper, 1966). The potassium content in the di acid digest was

Table 1. Initial chemical composition of organic residues used in the study

Organic waste	pH	EC (dS m^{-1})	TOC (%)	Macronutrients (%)			C/N ratio	Micronutrients (mg kg^{-1})			
				N	P	K		Zn	Fe	Mn	Cu
V1: S.Cane trash	7.50	0.88	36.30	0.63	0.11	1.10	57.62	31	154	16	11
V2: Weeds	7.69	1.11	35.50	1.32	0.65	0.90	26.89	74	295	35	14
V3: Veg. market waste	7.48	0.74	35.22	1.58	0.81	0.93	22.29	65	301	71	25
V4: Paddy straw	7.41	0.95	37.05	0.54	0.10	1.05	68.61	30	160	15	9
Mean	7.52	0.92	36.02	1.02	0.42	1.00	43.85	50	228	34	15

determined by Flame photometer (Piper, 1966). The total micronutrients viz., zinc, iron, copper and manganese were analysed in diacid extract by using an atomic absorption spectrophotometer (Varian AA 240 FS).

RESULTS AND DISCUSSION

Chemical composition of organic residues used in the study

The data on the chemical composition of organic residues used for vermicomposting and composting are presented in the Table 1. The organic residues used in the study were neutral in reaction with normal electrical conductivity. Total organic carbon varied from 35.22 (vegetable market waste) to 37.05 % (paddy straw). The C/N ratio ranged from 22.29:1 (vegetable market waste) to 68.61:1 (paddy straw). These organic residues contained 0.54 % (paddy straw) to 1.58 % (vegetable market waste) of total N, 0.10 % (paddy straw) to 0.81 % (vegetable market waste) of total P and 0.90 % (weeds) to 1.10 % (cane trash) of total K. Total zinc, iron, manganese and copper contents in organic residues varied from 30 (paddy straw) to 74 (weeds), 154 (cane trash) to 301 (vegetable market waste), 15 (paddy straw) to 71 (vegetable market waste) and 9 (paddy straw) to 25 (vegetable market waste) mg kg^{-1}, respectively. Similar nutrient pattern was reported by Patnaik and Reddy (2010) in vegetable wastes, Krishna Murthy *et al.* (2010) in different weed species and Shwetha *et al*. (2010) in sugarcane trash and byproducts of sugarcane. Among different organic residues used in the study vegetable market waste showed high nutrient content followed by weeds, cane trash and paddy.

Chemical Composition of Vermicomposts

The data on the chemical composition of vermicomposts and normal composts used in the present study are presented in Table 2 and 3 and depicted in Fig. 1 and 2.

Vermicompost obtained from cane trash showed a neutral *p*H of 7.20, EC of 0.36 dS m^{-1} and total organic carbon of 24.62 per cent. The contents of total N, P and K were 1.14, 0.46 and 1.61 per cent, respectively and C/N ratio was 21.59. The vermicompost obtained from weeds had a *p*H of 7.35, EC of 0.45 dS m^{-1} and TOC of 23.88 per cent, the content of total N, P and K were 1.88, 1.01 and 1.31 per cent, respectively and the C/N ratio was 12.70. On the other hand vegetable market waste recorded a *p*H of 7.40, EC of 0.34 dS m^{-1} and total organic carbon of 23.92 per cent while contents of total N, P and K were 2.11, 1.22 and 1.45 per cent, respectively and the C/N ratio was 11.33. Vermicompost obtained from paddy straw showed a *p*H of 7.26, EC of 0.41 dS m^{-1} and total organic carbon of 24.16 per cent. The N, P and K contents were 1.12, 0.43 and 1.64 per cent respectively and the C/N ratio was 21.57. Micronutrient status in different vermicomposts varied from 58 to 89 mg kg^{-1} of Zn, 284 to 412 mg kg^{-1} of Fe, 32 to 98 mg kg^{-1} of Mn and 24 to 57 mg kg^{-1} of Cu. Significantly higher micronutrient content was recorded in vegetable market waste compost and lowest content was recorded in cane trash compost. From these results, it was observed that the vermicompost prepared out of vegetable

Table 2. Manurial value of different matured vermicomposts

Treatment	pH	EC(dSm^{-1})	TOC (%)	Total nutrients (%)			C/N ratio	Micronutrients ($mg\ kg^{-1}$)			
				N	P	K		Zn	Fe	Mn	Cu
V_1: S.Cane trash	7.20	0.36	24.62	1.14	0.46	1.61	21.59	61	294	32	28
V_2: Weeds	7.35	0.45	23.88	1.88	1.01	1.31	12.70	81	365	67	36
V_3: Veg. market waste	7.40	0.34	23.92	2.11	1.22	1.45	11.33	89	412	98	57
V_4: Paddy straw	7.26	0.41	24.16	1.12	0.43	1.64	21.57	58	284	36	24
Mean	7.29	0.39	24.14	1.53	0.78	1.50	16.80	72	339	58	36
S.E.m+			0.85	0.07	0.029	0.067	0.89	2.89	13.4	2.11	-
CD (5 %)	NS	NS	2.2	0.17	0.065	0.112	1.87	6.45	28.7	4.59	NS

Table 3. Manurial value of different matured normal composts

Treatment	pH	EC (dSm^{-1})	TOC (%)	Total nutrients (%)			C/N ratio	Micronutrients ($mg\ kg^{-1}$)			
				N	P	K		Zn	Fe	Mn	Cu
V_1: S.Cane trash	7.08	0.33	24.22	0.98	0.31	1.52	24.71	36	188	19	18
V_2: Weeds	7.25	0.47	23.12	1.68	0.76	1.20	13.76	52	245	38	22
V_3: Veg. market waste	7.54	0.38	23.05	1.81	0.89	1.23	12.73	61	306	85	31
V_4: Paddy straw	7.18	0.40	23.89	0.96	0.22	1.60	24.89	33	174	22	19
Mean	7.26	0.39	23.57	1.03	0.55	1.38	19.04	46	228	41	23
S.E.m+	-	-	1.20	0.061	0.022	0.039	0.92	1.87	8.4	1.86	-
CD (5 %)	NS	NS	2.45	0.126	0.049	0.081	1.94	3.69	19.8	3.78	NS

market waste recorded significantly higher total NPK content than other organic residues, followed by weeds. Lowest manurial value was recorded in paddy straw. Similar results were reported by Surindra Suthar (2009). However the C/N ratio was significantly high in cane trash vermicompost (21.59) and it was on par with paddy straw vermicompost (21.57). Lower C/N ratio of 11.33 was recorded in vegetable market waste vermicompost. Jadia and Fulekar (2008) reported C/N ratio of 11.47 in vegetable waste vermicompost.

Chemical Composition of Normal Composts

Compost prepared from different organic residues showed a *p*H of 7.08 (cane trash) to 7.54 (vegetable market waste) EC of 0.33 (cane trash) to 0.47 dS m^{-1} (weeds) and total organic carbon of 23.05 (vegetable market waste) to 24.22 per cent (cane trash). Manurial value of different composts varied from 0.96 to 1.81, 0.22 to 0.89 and 1.20 to 1.60 per cent of NPK, respectively. Significantly higher total nitrogen and phosphorus was recorded in vegetable market waste compost and higher total potassium content was recorded in paddy straw compost and the lowest total nitrogen and phosphorus was recorded in paddy straw and total potassium in weed compost. Significantly high C/N ratio was recorded in paddy straw compost (24.89) and it was on par with cane trash compost (24.71) and significantly differed from vegetable market waste compost (12.73) and it was on par with weed compost (13.76). Micronutrient status in different composts varied from 33 to 61 mg kg^{-1} of Zn, 174 to 306 mg kg^{-1} of Fe, 19 to 85 mg kg^{-1} of Mn and 18 to 31 mg kg^{-1} of Cu. Significantly higher micronutrient content was recorded in vegetable market waste compost and lowest content was recorded in cane trash compost.

From these results, it was evident that the per cent increase of total NPK content in vermicompost over compost was 11.85, 27.05 and 2.44 per cent, respectively. It was observed that total NPK and micronutrient content in both the composts was maximum in vegetable market waste compost with narrow C/N ratio and the reverse trend was followed in cane trash and paddy straw.

Reduction in *p*H was observed in all matured composts compared to their initial values. This might be due to production of carbon dioxide and organic acids during decomposition of organic residues (Shailaja,2006). The near neutral *p*H of vermicompost may be attributed by the secretion of NH_4^+ ions that reduce the pool of H^+ ions and the activity of calciferous glands in earthworms containing carbonic anhydrase that catalyzes the fixation of CO_2 as $CaCO_3$, there by preventing the fall in *p*H (Pattnaik and Reddy, 2010). According to Sangwan *et al*. (2010), shifting of *p*H to lower levels could be attributed to mineralization of nitrogen and phosphorus and bioconversion of organic materials into intermediate species of organic acids. Electrical conductivity values of matured composts were more in comparison to their respective raw materials. *p*H and electrical conductivity values of vermicomposts obtained from various materials are well with in the range of acceptable limits and can be applied to all types of soils.

Total nitrogen content in all the normal composts and vermicomposts was higher when compared to their respective raw materials. Similar results were reported by Jadia and Fulekar (2008) in different vermicomposts. This was due to high degree of decomposition and release of nitrogenous products through excreta, urine and mucoproteins and loss of mass during composting (Prabha *et al.,* 2008). Sannigrahi (2005) reported that the earthworm tissue contains 50-75 % proteins, 7-10 % fats, calcium, phosphorus and other minerals. These are added to vermicompost after the death of matured earthworm. All these factors help in increasing the nutrient content of vermicompost.

Total nitrogen, phosphorus and potassium was found to be high in vermicomposts than composts and vermicompost prepared from vegetable market waste recorded higher total N, P and K content. This was due to the enhancement of enzyme activity and breakdown of organic rich materials during their passage through the gut of earthworm (Prabha *et al.,* 2008). Chaudhuri *et al*. (2000) reported higher level of transformation of phosphorus from organic to inorganic state, and there by into available forms during vermicomposting compared to composting. Raise in the level of phosphorus content during vermicomposting is probably due to bacterial and faecal phosphatase activity of earthworms.

Vermicomposts recorded higher micronutrient status than composts. Among the organic residues vegetable market waste registered higher micronutrient status than other organic residues. This could be due to nature and composition of the organic residues and substrates used would ultimately influence the level of micronutrients present in the compost. Similar results were reported by Kitturmath *et al.* (2007). Krishna Murthy *et al.* (2010) opined that increased micronutrient status in matured vermicompost than initial values might be due to loss of mass during composting

The present study revealed that the vermicomposts obtained from different organic residues possessed considerably higher values of macro and micro nutrients as compared to their initial substrates. The increase in the nutrient content and decrease in organic carbon, C/N ratio in the vermicompost, are in consistence with the findings of earlier investigators (Haritha Devi *et al.,* 2009). Vermicomposts obtained from decomposition of organic residues possessed significantly higher concentration of nutrients than that of composts obtained from the decomposition of organic residues. Which was probably due to the coupled effect of earthworm activity as well as a shorter thermophilic phase, making the plant availability of most of the nutrients higher in vermicomposting than that of composting process. Further they also suggested that the organic residues ingested by the earthworms undergo physical decomposition and biochemical changes contributed by the enzymatic and enteric microbial activities while passing through the earthworm gut due to the grinding action of the muscular gizzard releasing the nutrients in the form of microbial metabolites enriching the feed residue with plant nutrients and growth promoting substances in an assimilated form, which is excreted in the form of vermicast. More over in both the composting methods vegetable market waste possessed higher nutrient contents probably because it comprised of a mosaic of materials compared to that other organic residues (Patnaik and Reddy, 2010).

CONCLUSIONS

The results of the work showed the simultaneous application of different composting methods provides a more valuable information about the physicochemical and nutritive properties of different organic wastes. The vermicompost developed was found to have high value of nutrients and dehydrogenase activity with narrow C/N ratio than normal compost. Among different organic residues, vegetable market waste yielded significantly higher nutrient content with narrow C/N ratio and followed by weed compost and least performance was observed in paddy straw and cane trash composts. Among different composting methods, vermicomposting is preferred over composting with high nutritive value and less C/N ratio apart from short decomposition period with high dehydrogenase activity.

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