Journal of Aquatic Biology and Fisheries Vol. 2/2014/ pp. 476 to 483

WASTE MANAGEMENT BY COMPOSTING AND IT'S EFFECT ON GROWTH OF *TRIGONELLA*

Pratap V. Naikwade
Department of Botany, Aathalye Sapre Pitre College, Devrukh-415804
Email: naikwade.pratap@gmail.com

Received on: 10 October 2013, accepted on: 12 December 2013

Abstract: Waste management is a global issue; worsen by population and economic growth. It is an increasingly serious problem in developing countries like India. Globally, 140 billion tones of agricultural biomass waste is produced annually most of it either left to rot in the field or burnt. The landfilling of biodegradable waste is proven to contribute to environmental degradation. In addition to causing environmental damage through greenhouse gas emissions, this also represents the loss of a valuable resource that could used as nutrient resource for conservation of environment and sustainable development. Agricultural waste is any substance or object from premises used for agriculture or horticulture, which the holder discards, intends to discard or is required to discard. It is waste specifically generated by agricultural activities. Vegetable waste includes damaged, rotten parts of vegetables which are generally thrown. In India, about 320 million tones of agricultural waste are generated annually. *Composting* is the decomposition of plant remains and other once-living materials to make an earthy, dark, crumbly substance that is excellent for soil and crop growth. Use of compost in agriculture is increasing as both an alternative to land filling for the management of biodegradable waste, as well as means of increasing or preserving soil organic matter and nutrients. This research aimed to contribute to the identification of a system of *waste management by two types of composting. A field* experiment was carried out in the research farm located at Shibala, Maharashtra for use of vegetable and agricultural waste for preparation of compost and then used for growth of fenugreek (*Trigonella foenum-graecum* L.). Vegetable waste and agricultural waste was collected and converted into good quality compost by two types of composting such as aerobic (NADEP) and anaerobic (Bangalore pit) composting. After formation, chemical analysis of dried compost samples was carried out for dry matter, N, P, K, Ca, ash content and C:N ratio. It was used later for growth of fenugreek in earthen pots (h=30.5 cm and d=26.0 cm). The six treatments were vegetable waste Aerobic compost (VWNC), vegetable waste Anaerobic compost (VWBC), agricultural waste Aerobic compost (AWNC), agricultural waste Anaerobic compost (AWBC), chemical fertilizer (NPK) and control (CON) with four replicates each. Fenugreek was harvested after 50 days of sowing and fresh yield, dry matter was calculated. Fresh fenugreek was analyzed for chlorophyll (a, b and total), β carotene, vitamin C content. The results show that composting can be successively used for waste management of vegetable and agricultural waste and result into nutrient rich composts. Out of two methods of composting aerobic composting method was found effective than anaerobic composting. Compost prepared from vegetable waste was more nutrient rich than compost prepared from agricultural waste. When fenugreek was grown on these composts, yield and nutrient quality of fenugreek was enhanced as compared to chemical fertilizer and control treatments. The yield of fenugreek grown on VWNC showed highest yield than other treatments. Composts prepared from waste not only increase the yield of crop but also enhance quality of crop as reflected from increase in chlorophyll, β carotene, ascorbic acid content. Management of waste by composting and use of these composts in agriculture is a sustainable practice because of the increasing mineral fertilizer prices and the resulting improvement in crop quality, organic waste diversion. This waste management system must be promoted to maximize agronomic benefit, whilst ensuring the protection of environmental quality.

Key words: Agricultural waste, Aerobic, Anaerobic, Environment, Nutrients, Vegetable waste.

INTRODUCTION

Waste management is a global issue; worsen by population and economic growth. It is an increasingly serious problem in developing countries like India. Generally agricultural biomass waste either left to rot in the field or burnt. The land filling of biodegradable waste is proven to contribute to environmental degradation (Wanas and Omran, 2006). In addition to causing environmental damage through greenhouse gas emissions, this also represents the loss of a valuable resource that could used as nutrient resource for conservation of environment and sustainable development. Unscientific disposal causes an adverse impact on all components of the environment and human health (Rathi, 2006; Sharholy *et al*., 2005). Organic wastes are considered as a rich source of macro and micronutrients (Shah and Anwar, 2003). Agricultural waste is any substance or object from premises used for agriculture or horticulture, which the holder discards, intends to discard or is required to discard. It is waste specifically generated by agricultural activities. Vegetable waste includes damaged, rotten parts of vegetables which are generally thrown. In India, about 320 million tones of agricultural waste are generated annually (Suthar *et al*., 2005). The waste from the vegetable market is collected and dumped into the municipal landfills, causing a nuisance because of high biodegradability (Bouallagui *et al*., 2004). This result in loss of potentially valuable materials that can be processed as fertilizer, fuel and fodder (Baffi *et al*., 2005).

One of the best methods of this waste management is composting. As a result of the composting process, the waste volume can be reduced to 50–85% (Sharholya *et al*., 2008). Composting is one of the best solutions to reduce the huge piles of organic wastes and convert it in to a value added product. It is one of the major recycling processes by which nutrients present in organic materials are returned back to the soil in plant available form (Coker, 2006). Composting is controlled decomposition and appropriate stabilization of blended organic substrates that allow the development of thermophilic temperature as a result of biologically produced heat. The biological treatment of agricultural wastes must be done which will result into valuable nutrient source (Paraskeva and Diamadopoulos, 2006).

Any organic-based material such as garden waste, food-scraps, manure, sewage effluent, sawmill waste, leaves and cardboard can, and do, go into compost. Composts vary greatly depending on their maturity and the type (aerobic/anaerobic) and length of the composting process (Wilkinson *et al*.,1998). Compost has very high agricultural value. It is used as fertilizer, and it is non odorous and free of pathogens (Ahsan, 1999; Khan, 1994). Finished compost is generally more superior to un composted materials having more concentrated of nutrients, narrower in C: N ratio and also being effectively free from pathogens, weed seeds and other potential contaminants that cause pollution (Zia *et al*., 2003). Compost is of great agricultural interest because of its organic matter content (Tejada and Gonzalez, 2003). There is growing interest in the use of organic amendments for reclamation of degraded soils (Francis *et al*., 2006). Celik *et al*., (2004) reported that the addition of organic materials of various origins to soil has been one of the most common rehabilitation practices to improve soil physical properties. The principal nutritional benefit given to crops from composts usually is the N carried in slow-release form, although composts can carry other nutrients based on the feedstock (Chaney, 1990a, 1990b; Wen *et al.,* 1995). Composts have much to offer as sources of other elements as phosphorus (P), potassium (K), calcium (Ca), magnesium (Mg), iron (Fe), manganese (Mn), copper (Cu), zinc (Zn) and boron (B). Phosphorus concentrations in composts are also high (He *et al.,* 1995; Vogtmann *et al.,* 1993).

Composting can be done by two methods such as aerobic and anaerobic methods. Aerobic composting is done by NADEP method. The NADEP method of making miracle compost was first invented by a farmer named N.D. Pandharipande living in Maharashtra (India). Anaerobic composting can be done by Bangalore Method which is carried out in pits. Research must be carried out to compare the efficiency and nutrient quality.

Limited research has been done to compare beneficial effect of applying compost prepared from agricultural waste and vegetable waste. It is need to evaluate aerobic and anaerobic method of composting also. This research aimed to contribute to the identification of a system of waste management by two types of composting.

MATERIALS AND METHODS

Experimental site

The field experiment was conducted in the research farm located at Shibala, Dist. Yavatmal, Maharashtra during the period from 1 Jan 2008 to 30 June. 2008.

Raw material and composting Process

The vegetable waste and agricultural waste was collected from nearby local market and agricultural farm. It was converted into good quality compost by two types of composting such as aerobic (NADEP) and anaerobic (Bangalore pit) composting.

The NADEP method of making compost is unique in making good large quantity of compost with a minimum of human effort within a specific period of time. The process basically involves placing select layers of different types of compostible materials in a simple, mud-sealed structure designed with brick and mud water. Bangalore method is an anaerobic method conventionally carried out in pits. Formerly the waste was anaerobically stabilized in pits where alternate layers of solid waste and cow dung were laid. The pit is completely filled and a final soil layer is laid to prevent fly breeding, entry of rain water into the pit and for conservation of the released energy. The material is allowed to decompose for 3 to 4 months after which the stabilized material is taken out and used as compost. The process of composting was followed as described by Stoffella and Kahn (2001). Finally, dark brown composts were obtained after 80 days. The uniformly mixed samples (100gm) of composts by different methods were collected immediately from the pits for nutrients analyses.

Organic amendments and experimental plan

The experiment was conducted in truncated porous earthen pots of approximately 10 liter capacity (h=30.5 cm and d=26.0 cm). The pots were initially filled up to 2.5 cm height with 12.5 mm normal size chips of stone (aggregates), which were then covered with 2.0 cm thick layer of 1 to 5 mm size gravel to ensure proper drainage of excess water. A layer of local soil with 2.0 to 2.5 cm thickness was used above the gravel bed and compost layer. All prepared composts were then top fed (18 to 20 cm thicknesses) into the pots at the rate as (1.0 kg /pot). The six treatments were vegetable waste Aerobic compost (VWNC), vegetable waste Anaerobic compost (VWBC), agricultural waste Aerobic compost (AWNC), agricultural waste Anaerobic compost (AWBC), chemical fertilizer (NPK) and control (CON) with four replicates each. Fenugreek (*Trigonella foenum-graecum* L.) seeds were sown about 1 - 1.5 cm deep in the soil.

Fertilizer application and plant sampling

The fertilizers were applied at the recommended levels of 40N:30P:30 K Kg/ha as urea: single super phosphate: muriate of potash to fertilizer treatment alone. Entire amount of P_2O_5 and K_2O was applied as basal dose for all the pots at the time of cultivation and N was supplied 20 and 35 days after sowing (DAS) in two equal split doses. Fenugreek was harvested after 50 days of sowing and fresh yield, dry matter was calculated. The fresh samples were used for nutrient analysis.

Chemical analyses

The β carotene, Ascorbic acid, total chlorophyll content was estimated in fresh fenugreek. The leaf chlorophyll contents (a, b and total) were estimated following Arnon (1961), using 80 % acetone as a solvent for extraction of pigments. The amount of â-carotene (Pro- vitamin A) was estimated by extracting it in petroleum ether and acetone (2:1) following the method described by Knuckles *et al*. (1972). Ascorbic acid was estimated by titration method given by Sadasivam and Manickam (1992).

Statistical analyses

All the results were statistically analyzed using analysis of variance (ANOVA) test and treatments means were compared using the least significant difference (C.D. p = 0.05) which allowed determination of significance between different applications (Mungikar, 1997).

RESULTS AND DISCUSSION

Analysis of composts prepared from vegetable waste and agricultural waste

Table 1 shows nutrient contents of different composts prepared by two methods used in experiment. Fresh wt. gm/pot was same (1000 gm) in all cases. The dry matter gm/pot was found more in the treatment of AWNC compared to other treatments. Vegetable waste NADEP Compost (VWNC) also shows highest percentage of N, P, K, C as compared to other

Table 1. Chemical analysis of compost samples prepared from waste

Treat ments	Fresh wt. g/pot	Dry matter		N		%				C:N
		%	g/pot	%	g/pot	Ca	P	K	C	
VWNC	1000	70.37	703.7	1.14	8.02	2.58	0.21	0.15	28.65	25.13
VWBC	1000	69.08	690.8	1.03	7.11	2.74	0.17	0.12	27.44	26.64
AWNC	1000	73.21	731.1	0.93	6.80	2.35	0.19	0.14	28.02	30.12
AWBC	1000	72.18	721.8	0.89	6.42	2.86	0.15	0.13	26.96	30.29

Vegetable waste aerobic compost (VWNC), Vegetable waste anaerobic compost (VWBC), Agricultural waste aerobic compost (AWNC), Agricultural waste anaerobic compost (AWBC),

composts. However AWBC gave maximum percentage of Ca. The C:N ratio was more in AWBC and less in VWNC. The range of C:N ratio in compost is in accordance with (Rao and Dakhore, 1993).

The percentage P in the compost would be expected to increase as decomposition proceeds. These effects have indeed been noted (Cooperband and Middleton, 1996) resulting in compost containing 0.2 to 0.7% P (Warman and Termeer, 1996).

Chlorophyll contents of fenugreek

The application of compost had significant influence on leaf chlorophyll contents (a, b and total) of fenugreek. Chlorophyll a, chlorophyll b and total chlorophyll contents varied from 0.33-0.56, 0.54-0.71 and 0.87-1.27 mg g^{-1} leaf fresh weight respectively (Fig. 1). Highest amount of total chlorophyll was found in VWNC treated fenugreek followed in order by VWBC, AWNC, AWBC, NPK and lowest in CON.

The greater chlorophyll values in leaves of fenugreek on plots treated with organic manure are of importance because photosynthetic activity and crop yield may increase with increased chlorophyll content of leaves (William *et al.*, 1990; Ramesh *et al.*, 2002). The minimum chlorophyll in control treatment had been observed to diminish carbohydrate production and a restriction in the assimilating power of the plant (Amany *et al.*, 2006). Increase in chlorophyll *a* and *b* contents of the fenugreek may contribute to increased photosynthetic activity.

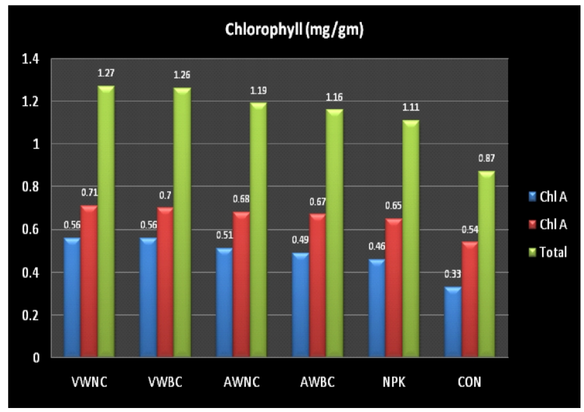

Fig.1. Chlorophyll contents (mg/gm) of fenugreek as influenced by compost at 50 DAS

Ascorbic acid content of fenugreek

The application of compost had important influence on ascorbic acid content of fenugreek. The highest amount was found in VWBC amended fenugreek followed by VWNC, AWNC, AWBC, NPK and lowest in CON (Fig. 2). These results were confirmed as the findings of Lundegardh *et al.* (2008) who showed that organic manures increases ascorbic acid level, compared to chemical fertilizer.

Carotene content of fenugreek

β carotene is a precursor of vitamin A, the most important nutrient for numerous body processes. The application compost of different four types had vital convince on β-carotene content of fenugreek. The highest amount was found in fenugreek receiving VWNC and other composts and less in NPK and CON (Fig. 3). Singh *et al.*, (2003) also indicated that organic manure increased Vitamin A content as compared to chemical fertilizer.

All results are statistically significant over control except chemical fertilizer treatment in some cases.

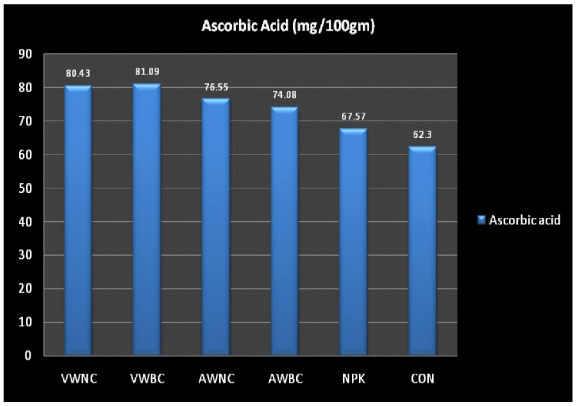

Fig. 2. Ascorbic acid (mg/100gm) contents of fenugreek as influenced by compost at 50 DAS

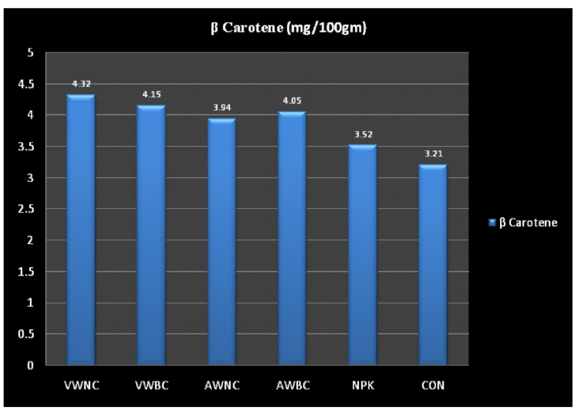

Fig. 3. β Carotene contents (mg/100gm) of fenugreek as influenced by compost at 50 DAS

Biomass yield of fenugreek

Biomass yield of fenugreek after harvesting is tabulated in Table 2. The maximum fresh weight of spinach was found in VWNC treatment followed in order by VWBC, AWNC, AWBC, NPK and lowest in CON. Dry matter yield per pot was also showed the same pattern. These results are also supported by Fujiwara (1987), who reported that totally decomposed compost increased fresh weight of spinach by 11% and dry weight by 5%. Composts prepared from agricultural waste and vegetable waste increased the yield of crop significantly as compared to control. Application of composts prepared by NADEP method and Bangalore method showed better results than chemical fertilizer. However NADEP method of composting is more effective in increasing yield than Bangalore method as reflected by results. Vegetable waste is more suitable for compost making as compared to agricultural waste, reason may be more water and nutrient content in vegetable itself.

These findings are supported by many researchers; Satyanarayana *et al.* (2002) found maximum grain yield of rice with application of organic manure and inorganic fertilizer. Application of compost increased plant growth, total chlorophyll as well as fresh and dry weight of cucumber (Sanafawi, *et al.*, 2006). Loecke *et al.* (2004) also reported that composted manure increased corn grain yield more than fresh manure.

Table 2. Yield of fenugreek as influenced by composts prepared from waste

Sr. No.	Treatment	Fresh wt. g/pot	Dry Matter	
			%	Yield (g)
1	VWNC	72.31 ±5.80	11.28	8.15 ±0.58
2	VWBC	69.64±6.53	10.70	7.45±0.65
3	AWNC	69.08±6.15	11.06	7.64±0.61
4	AWBC	67.82±7.02	10.31	6.99±0.70
5	NPK	64.33±5.67	10.48	6.74±0.56
6	CON	50.63 ±5.83	11.62	5.88 ±0.58
	S.E.	3.18		0.32
	C.D.	8.18		0.83

Composting is economical and safe mean of organic wastes management than other approaches being used like land filling, burning etc. The technology is, therefore cost effective economically which result in reduction in the use of chemical (Rizwan *et al*., 2006). There is an urgent need for adopting integrated nutrient supply system for promoting the efficient and balance use of macro and micronutrients for plants. The NADEP method of composting actually enables the farmer to get around the difficulty of generation of mass and to increase the quantity of compost rapidly within a given frame of time and without any significant additional expense.

CONCLUSIONS

From the study it get cleared that vegetable waste as well as agricultural waste can be successively managed by composting used as nutrient source for making compost. The compost prepared from vegetable waste gives better results as compared to compost prepared from agriculture waste, but both were superior than chemical fertilizer and control. Compost not only increase the yield of crop but also enhancing quality of crop as reflected from increase in chlorophyll, â carotene, ascorbic acid content. The recycling of organic wastes and its development into a value added product through blending/ enriching with certain nutrients and plant growth regulators could not only help in achieving high productivity in agriculture but also in maintaining sustainable environment. NADEP method of composting is better than Bangalore composting. Agriculture departments can cooperate with rural development departments and organizations to organize production of NADEP compost on a large scale as the system makes available to the farmer a fairly large amount of compost on a sustainable basis without requiring continuous financial inputs. The NADEP method of compost manufacture can also provide the basis of a rural development scheme which will not only employ idle labour in the manufacture of a socially useful product but would also enhance incomes as the compost produced has a ready demand among farmers.

REFERENCES

Ahsan, N. 1999. Solid waste management plan for Indian megacities. *Indian Journal of Environmental Protection,* 19(2): 90–95.

Amany, A.B., Zeidan, M.S. and Hozayn, M. 2006. Yield and Quality of Maize (*Zea mays* L.) as affected by slow release nitrogen in newly reclaimed sandy soil. *Am. Eurasian J. Agric. Environ. Sci.,* 1(3): 239- 242.

Arnon. 1961. Quoted from Yoshida, S., Forno D.A., Cock J.L and Gomez K.A.1976. Laboratory Manual for Physiological studies of Rice. The International Rice Research Institute. Philippines, 43.

Baffi, C., Dell Abate, M.T., Silva, S., Beneditti, A., Nassisi, A., Genevini, P.L., Adani, F. 2005. A comparison of chemical, thermal and biological approach to evaluate compost stability. By Geophysical Research Abstracts. 7: 09116. European Geosciences Union.

Bouallagui, H., Torrijos, M., Godon, J.J., Moletta, R., Cheikh, R.B., Touhami, Y., Delgenes, J.P., Hamdi, M. 2004. Two-phases anaerobic digestion of fruit and vegetable wastes: bioreactors performance. *Biochem. Eng. J.,* 21: 93-197.

Celik, I., Ortas I. and Kilic, S. 2004. Effects of compost, mycorrhiza, manure and fertilizer on some physical properties of a Chromoxerert soil. *Soil and Tillage Research,* 78: 59-67.

Chaney, R.L. 1990a. Twenty years of land application research. Part I. *BioCycle,* 31(9): 54–59.

Chaney, R.L. 1990b. Twenty years of land application research. Part II. *BioCycle,* 31(10): 68-73.

Coker, C. 2006. Environmental remediation by composting. *Biocycle.* 47: 18-23.

Cooperband, L.R. and Middleton, L.H. 1996. Changes in chemical, physical and biological properties of passively-aerated co-composted poultry litter and municipal solid waste compost. *Compost Science and Utilization* 4(4): 24–34.

Francis, Z.L., Bobbi, H., Francis, J.L., Henry, J., Olalckan,O.A. and Barry, M.O. 2006. Predicting phosphorus availability from soil-applied compost and non-composted Cattle feedlot manure. *J. of Environmental Quality*, 35(3): 928-937.

Fujiwara, S. 1987. Decomposition of Poultry Manure Compost Mixed with Sawdust and Effects of its Application on Crop Growth. In: Dynamics of organic matter in Paddy soil jointly held by IRRI- National Institute of Agricultural Environment, Ministry of Japan.

He, X.T., Logan, T.J. and Traina, S.J. 1995. Physical and chemical characteristics of selected U.S. municipal solid waste composts. *Journal of Environmental Quality,* 3: 543–552.

Khan, R.R. 1994. Environmental management of municipal solid wastes. *Indian Journal of Environmental Protection,* 14 (1), 26–30.

Knuckles, B.E., Bickoff, E.M. and Kohler, G.O. 1972. *J. Agric. Fd. Chem*., 20: 1055.

Loecke, T.D., Liebman, M. Cambardella C.A. and Richard, T.L. 2004. Corn response to composting and time of application of solid swine manure. *Agron. J*., 96: 214–23.

Lundegardh, B., Botek, P., Schulzov, V., Hajslov, J., Stromberg, A., Andersson, H.C. 2008. Impact of different green manures on the content of S-alk(en)yl-L-cysteine sulfoxides and L-ascorbic acid in leek (Allium porrum).*J. Agric. Food Chemistry,* 26, 56(6): 2102-11

Mungikar, A.M. 1997. An Introduction to Biometry. Sarawati Printing Press, Aurangabad.

Paraskeva, P. and Diamadopoulos, E. 2006. Technologies for olive mill waste water (OMW) treatment: a review. *J. Chem. Technol. Biotechnol.,* 81: 1475-1485.

Ramesh, K., Chandrasekaran, B., Balasubramanian, T.N., Bangarusamy, U., Sivasamy, R. and Sankaran, N. 2002. Chlorophyll Dynamics in Rice (*Oryza sativa*) Before and After Flowering Based on SPAD (Chlorophyll) Meter Monitoring and its Relation with Grain Yield. *J. Agron. Crop. Sci.,* 188: 102–105.

Rao, M.S. and Dakhore, R.C. 1993. Effect of long term application of P, K and FYM on micronutrient status of Vertisol of Akola. *J. soils and crops,* 3(1): 52-55.

Rathi, S. 2006. Alternative approaches for better municipal solid wastemanagement in Mumbai, India. *Journal of Waste Management,* 26(10): 1192–1200.

Rizwan, A., Abid, N., Zahir, A.Z,, Muhammad, A., Tariq, S. and Muhammad A.U. 2006. Integrated Use of Recycled Organic Waste and Chemical Fertilizers for Improving Maize Yield, *International Journal of Agriculture & Biology*, 08(6): 840–843.

Sadasivam, S. and Manickam, A. 1992. "*Biochemical Methods for Agricultural Sciences*", Wiley Wasten Ltd., New Delhi, 9-11.

Sanafawi, M.E., Salama G.M. and El-Kafrawy A.A. 2006, Effect of different levels of compost on yield, Microorganisms and quality of cucumber grown Under plastic houses conditions, *Egypt. J. Agric. Res*., 84(4): 1173-78.

Satyanarayana, V., Prasad, P.V.V., Murthy, V.R.K. and Boote, K.J. 2002. Influence of integrated use of farmyard manure and inorganic fertilizers on yield and yield components of irrigated lowland rice. *Indian J. Pl. Nutrition*, 25: 2081–90.

Shah, Z. and Anwar, M. 2003. Assessment of solid waste for nutrient elements and heavy toxic metals. *Pakistan J. Soil Sci*., 22: 1–10.

Sharholya, M., Ahmad, K., Mahmood, G. and Trivedi, R.C. 2008. Municipal solid waste management in Indian cities – A review, *Waste Management,* 28: 459–467.

Sharholya, M., Ahmad, K., Mahmood, G. and Trivedi, R.C. 2005. *A*nalysis of municipal solid waste management systems in Delhi a review. In: Book of Proceedings for the second International Congress of Chemistry and Environment, Indore, India, 773–777.

Singh Kirad, K., Barche, S. and Singh, D.B. 2003. Integrated nutrient management in Papaya (*Carica Papaya* L.). II International Symposium on Papaya ISHS *Acta Horticulturae,* 851.

Stoffella, P.J. and Kahn, B.A. 2001. *Compost utilization in horticultural cropping systems*. Lewis publishers, Florida.

Suthar, S.S., Watts, J., Sandhu, M., Rana, S., Kanwal, A., Gupta, D., Meena, M.S. 2005. Vermicomposting of kitchen waste by using *Eisenia foetida* (SAVIGNY). *Asian J. Microbiol. Biotech. Envron. Sci.,* 7: 541-544.

Tejada, M. and Gonzalez, J.L. 2003. Effects of the application of a compost originating from crushed cotton gin residues on wheat yield under dryland conditions. *Europ. J. Agronomy*, 19: 357-368.

Vogtmann, H., Fricke, K. and Turk, T. 1993. Quality, physical characteristics, nutrient content, heavy metals, and organic chemicals in biogeneic waste compost. *Compost Science and Utilization,*1: 69–87.

Wanas, S.A. and Omran, W.M. 2006. Advantages of Applying Various Compost Types to Different Layers of Sandy Soil:1-Hydro-physical Properties. *Journal of Applied Sciences Research*, 2(12): 1298-1303.

Warman, P.R. and Termeer, W.C. 1996. Composting and evaluation of racetrack manure, grass clippings and sewage sludge. *Bioresource Technology,* 55: 95–101.

Wen, G., Bates, T.E. and Voroney, R.P. 1995. Evaluation of nitrogen availability in irradiated sewage sludge, sludge compost and mature compost. *Journal of Environmental Quality,* 24: 527–534.

Wilkinson, K, Tymms, S., Hood, V and Tee, E. 1998. 'Bestpractice composting green organics'. Eco-recycle Vic. Melbourne.

William, W.A., Winter, K., Schreiber, U. and Schramel, P. 1990. Photosynthesis and chlorophyll fluorescence characteristics in relationship to changes in pigment and element composition of leaves of *Platanus occidentalis* L. during autumn leaf senescence. *Plant Physiol.,* 92: 1184-1190.

Zia, M.S., Khalil, S. Aslam, M. and Hussain, F. 2003. Preparation of compost and its use for crop-production. *Sci. Technol. Develop*., 22: 32–44.