Studies on integrated use of tannery wastewater, municipal solid waste and fly ash amended compost on vegetable growth

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Abstract- The present study is an attempt carried out to explore the possibility of finding the solution to environmental problem by eco-friendly technique. Utilization of bacteria, earthworms and its compost for growing crops having much more importance in recent years, under concept of sustainable agriculture. In the present investigation tannery waste water, municipal solid waste and cow dung is being used with the help of bacteria and earthworm for manure preparation. Three different methods are used i.e. pit composting, bacterial composting and vermicomposting for manure preparation, which for vermicomposting *Eisenia foetida* species and for bacterial composting *Azatobactor sp*. were used. For preparation of compost 2:2:1 proportion of cow dung, municipal solid waste and saw dust is used respectively, followed by spraying tannery waste water. During the present study waste material were analyzed for its chemical characteristics before and after composting. The compost produced from these three different methods was mixed with fly ash generated in coal based thermal power plant and used for selected vegetable plants i.e., *Trigonella fenugrecum* (Methi) and *Pisum sativum* (Watana) to study the growth rate. The polyphenol and chlorophyll content of selected vegetable plants were studied with comprising the chemical characteristics of soil.

Keywords- Composting, *Trigonella fenugercur, Pisum sativam*, Earthworms, *Azotobacter sp*. Fly ash

Introduction

In the modern age of development the increasing quantity of solid waste is one of the growing environmental problem in both developed and developing countries. Due to rapid growth in industrialization the most of the rural population are shifted toward the urban area in the search of employment. According to 2001 census population of urban India was 285 million which produces approximately 1, 20,000 tones of solid waste every day. By the 2025 it is expected that urban population shall reach 50% of total populations therefore waste generation will become an unavoidable problem. Solid waste composition and characteristics is diversifies in nature and it is depend upon the area from where waste is collected, season, living standard of population and human activities [1-3]. The solid waste characterization study carried out by NEERI (1996) reveals that municipal solid waste contains large organic fraction (30-40%), ash & fine earth (30-40%), paper (3-6%), along with plastic and metal (each less than 1%), calorific value of refuse of ranges between 800-1000 Kcal/Kg and C/N ratio ranges between 20-30. The quantity of solid waste generation varies between 0.2 – 0.4 Kg/Capita/day in the urban area. The waste quantities are estimated to increase from 46 million tones in 2001 to 65 million tones in 2010.The average collection efficiency for MSW in Indian cities is about 72.5% and around 70% of the cities lack adequate waste transport capacities [4-6]. It is has been estimated that around 8 % of Indian landmass has become wasteland due to open garbage dumps. The organic and inorganic waste accounts for 8-15 %. These wastes are often rich in plant nutrient. As a result, our cities, towns and their surroundings are facing the threat of being overrun by garbage and pilled up waste is threatening our health, environment and well being [7-9]. Composts are widely used to improve the physical characteristics of soil and are also valuable source of organic matter. Nitrogen provided by the compost and poultry manure influenced plant growth and flowering [10-12]. Composting controls aerobic biological decomposition of moist organic solid matter to produce a soil conditioner. It has been traditionally proved that organic matter can be converted in the compost within thirty days [13, 14]. Organic material contains minerals, other chemicals and nutrients.

However, applying raw organic materials directly to the soil is not the best way to use organic matter and its nutrients. The C/N ratio is narrowed down substantially and nitrogen retention is more in compost prepared with earthworms than with out earthworms. Millions of tons of solid wastes like food scrap and domestic wastes are buried or burned annually. Instead of this, if solid waste is being recycled with the help of earthworms, it would not only solve the pollution problem but generate quality manure for agriculture use. Vermicomposting turns many types of solid wastes into nutritious soil for plants. When vermicompost is added to soil, it boosts the nutrients available to plants and enhances the soil fertility. Vermicomposting is considered as an eco-friendly way of solving organic waste problem. This technology has been defined as "Method of converting organic wastes into a useful product through action of earthworms". Vermicomposting can be called as enhancing the degradation of organic waste by action of earthworms [15]. Bacterial composting process is done by using nitrogen fixing bacteria's like *Azotobactor*.

Material and Method

In the present study tannery waste water, municipal solid waster and saw dust are sekected as raw material. The raw materials were mixed in the ratio 2:2:1. In addition the tannery waste water is spread on this mixture every day for maintaining the moisture level. The 2 x 3 feet wooden boxes are made for the composting. Equal amount of bedding material is added in these boxes, earthworm species *Eisenia foetida* is inoculated in one box and in other box *Azotobactor* species is inoculated as bacterial culture. The third box is used as pit for composting. The bedding material is kept for 45 days for compost making. At the interval of 15 days the compost were analyzed for their N, P, K content. After completion of compost the compost is amended with fresh fly ash generated in coal based thermal power plant were used, for evaluation of impacts Pisum sativum and *Trigonella fenugrecum* plants were used. The soil in which these plants are planted were analyzed for different physico-chemical parameters.

Result and Discussion

During the analysis of the soil and bedding material the following results are obtained. Table no.1 summarizes the initial physico-chemical parameters of soil and bedding material used for composting and plantation. The results show the pH value of soil and bedding material varies between 6.8 ±0.29 and 7.5 ± 0.32 respectively. The soil contains significant amount of organic carbon (1.48 ±0.04), Nitrogen (0.01 ±0.004), Phosphorous (1.61 ± 0.06), Potassium (1.81 ± 0.05), Calcium (0.74 ± 0.03) and Magnesium (0.1 ± 0.03) respectively. The bedding material is partially degraded for about 8 days. The soil taken for the potting is from the garden. The pH value of the soil is slight alkaline [16, 17]. The fly ash collected form coal based thermal power plants was used for compost amendment, the some characteristics of fly ash was summarized in Table no.2. Table no.3 and 4 shows chlorophyll and polyphenol content in *Pisum sativaum* and Trigonella Fenugrecum. In *Pisum sativaum* chlorophyll a in control pot is 48.9 mg/100 mg. chlorophyll -b is 50.75 mg/100mg and total chlorophyll is 99.65 mg/100mg, while polyphenol is reported as 572 mg/100 mg. *Pisum sativaum* is potted in all three types of composts as well as in soil as in control pot. In *Pisum sativaum*, pit compost pot having total chlorophyll is 100.96 mg/100mg, vermicompost pot having 100.55 mg/100mg and bacterial compost pot having total chlorophyll is 98.38 mg/100mg while Polyphenol in these 3 pots is 580 mg/100mg, 577 mg/100mg and 593 mg/100mg respectively. In case of *Trigonella fenugrecum* control pot having chlorophyll a 50.24 mg/100mg, chlorophyll b is 45.83 mg/100mg, while total chlorophyll is 96.07 mg/100mg. Polyphenol is 525 mg/100mg, vermicomposting pot having chlorophyll a 53.75 mg/100mg, chlorophyll b is 49.03 mg/100mg, total chlorophyll is 102.78 mg/100mg. while Polyphenol is 521 mg/100mg. bacterial composting pot is having chlorophyll a 50.30 mg/100mg, 45.88 mg/100mg and total chlorophyll is 96.18 mg/100mg and polyphenol is 524 mg/100mg. Chlorophyll and Polyphenol content in both the species of plants is in the rang of control plants.

Conclusion

After completion of composting percentage of nitrogen, phosphorous, potassium as well as calcium and magnesium were increased in each type of compost. The nitrogen percentage is more in bacterial compost than vermicompost and pit compost, because of the use of *Azotobactor* culture which are the nitrogen fixing bacteria's.The earthworm species *Eisenia foetida* can tolerate the tannery waste water. Bio-management of tannery wastewater and domestic waste by using earthworm species *Eisenia foetida* and *Azotobactor* culture has been successfully achieved and compost is used for plants. Vegetable crop species *Pisum sativaum* and *Trigonella fenugrecum* shows normal growth with the use of all three types of composts.

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Table 1- Values of physico-chemical parameters in soil and bedding material before composting

Sr. No.	Parameter	Soil	Bedding Material
1	pH	6.8 ±0.29	7.5 ± 0.32
2	Electrical conductivity	0.3 ±0.06	3.4 ± 0.15
3	Organic carbon	1.48 ±0.04	2.1 ± 0.20
4	Nitrogen	0.01 ±0.004	0.0034 ± 0.0003
5	Phosphorous	1.61 ± 0.06	2.0 ± 0.99
6	Potassium	1.81 ± 0.05	0.9 ± 0.31
7	Calcium	0.74 ± 0.03	1.15 ± 0.028
8	Magnesium	0.1 ± 0.03	0.15 ± 0.026

All parameters expressed in % except pH & E.C.

Table 2- Composition of fly ash used in this study

Sr. No.	Constituents	Fly ash (%)
1	SiO_2	64.03 ± 0.44
2	Fe_2O_3	6.50 ± 0.23
3	Al_2O_3	15.50 ± 0.22
4	CaO	4.62 ±0.20
5	MgO	3.00 ± 0.23
6	Loss on ignition	4.35 ± 0.13
7	Insoluble residue	2.00 ± 0.15

Table 3- Changed values of composts after 15, 30 and 45 days

Note: All Parameters are in Percentage [%] except pH and Electrical Conductivity

Sr. No	Parameters	Composting type	After 15 days	After 30 days	After 45 days	Average
1	pH	Pit	8	7.9	7.7	7.86 ± 0.15
		Vermin	7.9	7.69	7.5	7.69 ± 0.20
		Bacterial	7.9	7.8	7.77	7.82 ± 0.06
2	Electrical Conductivity	Pit	3.1	3.1	3.51	3.23± 0.23
		Vermin	3.8	4.24	4.3	4.11± 0.27
		Bacterial	4	3.5	3.75	3.75± 0.25
3	Organic Carbon	Pit	1.4	1.5	1.64	1.51 ± 0.12
		Vermin	1.5	1.3	1.35	1.38 ± 0.10
		Bacterial	1.7	1.45	1.64	1.59± 0.13
4	Nitrogen	Pit	0.43	0.53	1.2	0.72 ± 0.41
		Vermin	0.59	0.79	1.87	1.08 ± 0.68
		Bacterial	0.64	0.91	2.7	1.41± 1.11
5	Phosphorous	Pit	1.1	1.3	1.71	1.37 ± 0.31
		Vermin	1.4	1.9	2.4	1.9 ± 0.5
		Bacterial	1.5	1.7	2.1	1.76 ± 0.30
6	Potassium	Pit	0.59	0.67	1.09	0.78 ± 0.26
		Vermin	0.86	0.94	1.5	1.1 ± 0.34
		Bacterial	0.72	0.88	1.36	0.98 ± 0.33
7	Calcium	Pit	0.7	0.8	1.41	0.97 ± 0.38
		Vermin	0.89	0.95	1.55	1.13 ± 0.36
		Bacterial	0.19	0.23	0.52	0.31 ± 0.18
8	Magnesium	Pit	0.04	0.045	0.08	0.05 ± 0.02
		Vermin	0.055	0.053	0.085	0.06 ± 0.01
		Bacterial	0.012	0.013	0.054	0.02 ± 0.02

Table 4- chlorophyll and Polyphenol in Pisum sativum (mg/100mg)

Sr. No.	Parameter	Control pot	Pit composting pot	Vermin	Bacterial composting pot	Average
				composting pot		
1	Chlorophyll a	48.9	49	48.8	47.75	48.6125 ± 0.58
2	Chlorophyll b	50.75	51.96	51.75	50.63	51.2725 ± 0.67
3	Total Chlorophyll	99.65	100.96	100.55	98.38	99.885 ± 1.14
4	Polyphenol	572	580	577	593	580.5 ± 8.9

Table 5- Chlorophyll and Polyphenol in Trigonella fenugrecum (mg/100mg)

Sr. No.	Parameter	Control pot	Pit composting pot	Vermin	Bacterial composting pot	Average
				composting pot		
1	Chlorophyll a	50.24	51.5	53.75	50.3	51.4475 ± 1.64
2	Chlorophyll b	45.83	46.97	49.03	45.88	46.9275 ± 3.13
3	Total Chlorophyll	96.07	98.47	102.78	96.18	98.375 ± 2.5
4	Polyphenol	525	527	521	524	524.25 ± 8.9