QUALITY COMPARISON OF DIFFERENT COMPOSTS REGISTERED BY GOVERNMENT OF PUNJAB UNDER FCO 1973

Amir Khattak*, Nasir Ahmed, Muhammad Akram Qazi, , Nawaz Chaudhary, Urooj Naseem**, Saira Lateef, Muhammad Salik Ali Khan, Naveed Iqbal** and Shazia Ilyas******

ABSTRACT

Composts are mostly prepared from mixed municipal solid waste and due to probable chance of heavy metals contamination these can pose a great threat to environment by polluting our soils and subsequent insertion into food chain to cause severe ill effects on health. The present study was designed to assess quality of 13 licenced composts/organic amendments regarding plant nutrients and heavy metals contents manufactured by different companies. These products were collected randomly. Chemical analysis for basic nutrients i.e. nitrogen (N), phosphorus (P_2O_5), potassium (K_2O), organic matter (OM), heavy metals namely cadmium (Cd), chromium (Cr) and lead (Pb) was carried out in the year 2012. The results were compared with national standard to determine product status. Organic matter values in all samples ranged from 11.9 to 70.9 percent. Three products with trade names of Taqatwar, Zameen Dost and Agrolizer manufactured by Green Force Fertilizers (Pvt). Ltd, National Fertilizer Marketing and Kanzo AG Multan, respectively were substandard with respect to standard value of 25 percent organic matter as established by Agriculture Department. Among macronutrients, total nitrogen contents ranged from 0.8 to 4.3 percent in all these samples which contained nitrogen above the minimum required value of 0.6 percent. Regarding phosphorus and potassium concentrations, one sample of Lahore Compost local (Zameen Dost) and one of Agro Partner (Simba) was found deficient having 0.4% P_2O_5 and 0.07% K_2O against standard values of 0.5% and 0.08%, respectively. Considering heavy metals Cd and Cr as contaminants, all samples were found within permissible limit of 1.0 and 300 mg/kg, respectively whereas three samples of Elegant Agro, Bioman Chemical & Fertilizer and Agri Com Int. with trade names of Orgevit Plus, FertePlus and Biocom Super, respectively were found contaminated with lead having values higher than permissible limit of 1.00 mg/kg. This situation demands sound management/policy for manufacturing of composts to ensure a safeguard to the environment.

KEYWORDS: Compost; chromium; cadmium; lead; toxicity; organic matter; nitrogen; phosphorus; potassium; Pakistan

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***Institute of Geology, University of Punjab, Lahore, **Soil and Water Testing Laboratory for Research, Thokar Niaz Baig, Lahore, ***College of Earth and Environmental Sciences, University of Punjab, Lahore.**

INTRODUCTION

In Pakistan, cultivation of high yielding crop varieties augmented with unscrupulous use of fertilizers has led to depletion of soil organic matter (SOM) contents and degradation of soil quality (9). Risks of soil degradation can be managed by increasing soil organic matter to a level needed for sustaining soil quality (10). It has been reported (14) that soil of a vast area of Pakistan is extremely poor in organic matter which has appeared to be the main cause of crop yield stagnation. Chemical fertilizers in combination with organic manures can be effectively used to level off the yield stagnation because efficient use of chemical fertilizers necessitates an optimum level of organic matter in soil that can be achieved by the use of organic manures or biosolids including composts (20).

It has shown that soils should be amended with proper organic sources to maintain soil organic matter content and quality of soil to a level required for a sustainable crop production. Among organic inputs, animal waste, crop residues, green manure and municipal solid waste manure (1) are found to be suitable to enhance organic constituents of surface soil. However, sustainable supply of organic matter to soil through these means, excluding compost, is severely limited due to their other uses. Thus application of waste compost is gaining popularity because of its easy availability, cost-effectiveness, environmentally safe and agronomical importance (19). The use of composts in agricultural fields is also a feasible alternative to open landfill disposal or incineration (4, 14) because application of compost to soil prevents soil compaction by increasing organic constituents of soil that lowers its bulk density and increases porosity. Therefore, waste management is one of the major environmental problems of mega cities of developing countries (19).

The agricultural use of this waste in order to improve soil quality could be considered as an appropriate and adequate approach for waste management. Over the last few years, the private sector of Pakistan has taken initiative to establish composting facilities for agricultural use (17) because of its inherent advantages such as its ability to improve SOM and nutrient status (13), soil chemical properties (16), physical properties (2) and biological characteristics (12). Besides many positive aspects of compost applications, there is justified concern regarding potential accumulation of compost-borne heavy metals in surface soils (21) which poses ultimately risk to human being through food chain (11). Composts specifications (national standard) laid down by the Agriculture Department, Government of Punjab, provide guideline to companies to manufacture good quality organic amendments.

The present study was designed to assess the quality of composts being offered for sale or use on agricultural fields by a number of manufacturers in Punjab province. This study is first of its kind in Pakistan and will provide information for future research work and guidelines for policy makers/environmentalists.

MATERIALS AND METHODS

This study was conducted in Soil and Water Testing Laboratory for Research, Thokar Niaz Baig, Lahore, Pakistan during the year 2012. Thirteen compost manufacturers / companies registered under Fertilizer Control Order (FCO) -1973, Government of Punjab were selected (Table 1). Samples were

Table 1. Detail of samples alongwith their manufacturing company name.

Sr. No.	Sample/Lab code	Company name	Product name	License No.
1	1-F	Green Force Fertilizer (Pvt). Ltd	Taqatwar	-
2	2-F	Elegant Agro	Orgevit Plus	4955
3	3-F	Agri Life Fertilizer	Bioboom	4663
4	4-F	R.B Avari Enterprises (Pvt). Ltd	Bio max Plus	5731
5	5-F	Warden Farming	Garshell	4323
6	6-F	Lahore Compost	Zameen Dost	1140
7	7-F	Starlet Chemicals & Fertilizers	Orgenolet	4243
8	8-F	Kanzo AG Multan	Agrolizer	4321
9	9-F	Agro Partners	Simba	4494
10	10-F	National Fertilizer Marketing Ltd	Zameen Dost	-
11	11-F	Bioman Chemical and Fertilizer	Ferte Plus	4315
12	12-F	Agri Farm Services	Ormat	4303
13	13-F	Agri Com Int.	Biocom super	5014

Source: Agriculture Department, Government of the Punjab, No. SO A (EXT) 1-70/2006 (FCO) dated: 26 -01- 2008.

collected from market and coded as 1-F to 13-F and analysed following established standard test methods. For studying heavy metals contents, oven dried ground material (0.50g) was digested using 15mL of tri-acid mixture of HNO_3, $HClO_4$ and H_2SO_4 in 2:1:1 ratio on temperature controlled hot plate. Final volume was made upto 50mL when digested material became clear. The solution was filtered and stored in plastic bottles for analysis by atomic absorption spectrophotometer (AAS). Certified reference materials (CRM) having traceability to National Institute of Standards and Technology (NIST) were used for calibration of instruments. Pyrex class- A glassware was used during analytical procedures. Organic matter was calculated by following formula of Tandon (12).

$$\text{Organic matter (\%)} = 100 - \text{Ash (\%)}$$

$$\text{Ash(\%)} = \frac{W3-W1}{W2-W1} \times 100$$

Nutrients and contaminants (toxic metals) concentration in fertilizer products play an important role in its acceptance as an environment friendly product and it should be under limits of national as well as international standards. Soil Fertility Research Institute, Lahore (SFRI) is authorized by Government of Punjab to set the standard values for toxic metals (Table 2) and also monitor the quality of fertilizers and composts being marketed.

Table 2. National standards set by Soil Fertility Research Institute, Punjab, Lahore.

S. No.	Parameters	Standard value	
		Percent	Mg/kg (ppm)
1	Organic matter (minimum)	25	250000
2	Nitrogen as N (minimum)	0.6	6000
3	Phosphrous as P_2O_5 (minimum)	0.5	5000
4	Potassium as K_2O (minimum)	0.084	840
5	Lead (Pb) (maximum)	0.0001	1
6	Cadmium (Cd) (maximum)	0.0001	1
7	Chromium (Cr) (maximum)	0.030	300

Total nitrogen was determined by Kjeldahl's procedure which involves digestion and distillation. In first step organic-N is converted to ammonium-N by heating in presence of H_2SO_4 and digestion catalyst. Ammonium-N calculated in second step by steam distillation, using excess NaOH to raise the pH. The distillate was collected in H_3BO_3 and then titrated with standardized H_2SO_4 (18). Phosphorus was determined by spectrophotometer at 410-nm wavelength and potassium by flame photometry (18).

RESULTS AND DISCUSSION

Organic matter concentration in samples ranged from 11.9 percent to 70.9 percent (Table 3). Nine samples were found fit regarding organic matter contents as per standard value set by Agriculture Department while remaining four samples of companies namely Green Force, Lahore Compost, Kanzo AG and National Fertilizer Marketing Ltd. were declared as substandard due to organic matter less than 25 percent (Table 3). Maximum organic matter (70.9%) was found in product of Elegant Agro (Orgevit Plus) while minimum (11.9 %) in Zameen Dost marketed by National Fertilizer Marketing Ltd.

Comparing macronutrient nitrogen, all samples had nitrogen more than minimum standard value of 0.6 percent (Table 4). Nitrogen values ranged from 0.8 to 4.3 percent. Maximum N was found in Orgevit Plus, product of Elegant Agro which also had the highest organic matter concentration.

Analytical results revealed direct correlation between organic matter and total nitrogen contents within a sample.

Table 3. Comparison of organic matter values (%) with national and international standards.

Company name	Organic matter (%)	SFRI standard value	Italian standards (17)	Status
Green Force Fertilizer (Pvt). Ltd	18.8	25	40	Substandard
Elegant Agro	70.9	25	40	Fit
Agri Life Fertilizer	57.5	25	40	Fit
R.B. Avari Enterprises (Pvt). Ltd	47.4	25	40	Fit
Warden Farming	29.1	25	40	Fit
Lahore Compost	17.2	25	40	Substandard
Starlet Chemicals & Fertilizers	29.1	25	40	Fit
Kanzo AG Multan	22.3	25	40	Substandard
Agro Partners	55.3	25	40	Fit
National Fertilizer Marketing Ltd	11.9	25	40	Substandard
Bioman Chemical and Fertilizer	29.1	25	40	Fit
Agri Farm Services	52.8	25	40	Fit
Agri Com Int.	57.6	25	40	Fit

Table 4. Macronutrients (NPK) values and their comparison with national and international standards.

Sample/ Lab code	Nitrogen (N) contents (%)			Phosphorus (P_2O_5) contents (%)			Potassium (K_2O) contents (%)		
	Sample	SFRI*	AAPFCO**	Sample	SFRI*	AAPFCO**	Sample	SFRI*	AAPFC**
1-F	0.8	0.6	2.3	2.8	0.5	1.8	0.70	0.084	1.6
2-F	4.3	0.6	2.3	1.8	0.5	1.8	2.79	0.084	1.6
3-F	2.8	0.6	2.3	2.7	0.5	1.8	0.53	0.084	1.6
4-F	1.2	0.6	2.3	1.2	0.5	1.8	0.48	0.084	1.6
5-F	2.2	0.6	2.3	1.2	0.5	1.8	0.31	0.084	1.6
6-F	1.2	0.6	2.3	0.4	0.5	1.8	0.55	0.084	1.6
7-F	2.2	0.6	2.3	1.4	0.5	1.8	0.35	0.084	1.6
8-F	1.8	0.6	2.3	1.2	0.5	1.8	0.58	0.084	1.6
9-F	1.1	0.6	2.3	0.6	0.5	1.8	0.07	0.084	1.6
10-F	0.8	0.6	2.3	0.8	0.5	1.8	0.19	0.084	1.6
11-F	3.9	0.6	2.3	1.2	0.5	1.8	1.22	0.084	1.6
12-F	3.7	0.6	2.3	1.3	0.5	1.8	0.55	0.084	1.6
13-F	1.8	0.6	2.3	2.6	0.5	1.8	1.13	0.084	1.6

* Soil Fertility Research Institute, Punjab, Lahore, Pakistan, ** Association of American Plant Food Control Officials (3). Values are average of three replicates.

Phosphorus (P_2O_5) contents ranged from 0.4 to 2.8 percent. Lahore Compost sample having 0.4 percent P_2O_5 was below the national and international standard values of 0.5 percent and 1.8 percent, respectively whereas remaining 12 samples met the national phosphorus criteria (Table 4).

Regarding potassium (K_2O), Simba a product of Agro Partner was low (0.07%) in K_2O as compared to national standard of 0.084 percent (Table 4). Potassium concentrations in samples ranged from 0.07 to 2.79 percent. Maximum potassium was found in Orgevit Plus of Elegant Agro.

Heavy metals contaminants (Cd and Cr) analysis showed that all compost samples of randomly selected companies were within the safe limit of 1.00mg Cd/kg and 300mg Cr/kg. Cadmium values ranged from 0.01 to 0.36 mg/kg while Chromium ranged from 0.29 to 2.87 mg/kg (Table 5). As far as lead (Pb) is concerned, samples of three companies namely Elegant Agro, Bioman Chemical & Fertilizer and Agri Com Int. crossed the permissible limit (1.00mg Pb/kg). Its concentration ranged from 0.07 to 2.79 mg/kg (Table 5).

Table 5. Toxic metals (Cd, Cr and Pb) concentrations.

Sample/Lab code	Cadmium (Cd) (mg/kg)			Chromium (Cr) (mg/kg)			Lead (Pb) (mg/kg)		
	Sample	SFRI*	CDFA**	Sample	SFRI*	CDFA**	Sample	SFRI*	CDFA**
1-F	0.360	1	2.8	1.17	300	42	0.70	1	31
2-F	0.016	1	2.8	0.50	300	42	2.79	1	31
3-F	0.022	1	2.8	0.82	300	42	0.53	1	31
4-F	0.044	1	2.8	2.34	300	42	0.48	1	31
5-F	0.012	1	2.8	0.63	300	42	0.31	1	31
6-F	0.032	1	2.8	2.75	300	42	0.55	1	31
7-F	0.012	1	2.8	0.68	300	42	0.35	1	31
8-F	0.015	1	2.8	0.82	300	42	0.58	1	31
9-F	0.010	1	2.8	2.87	300	42	0.07	1	31
10-F	0.360	1	2.8	2.29	300	42	0.19	1	31
11-F	0.016	1	2.8	2.01	300	42	1.22	1	31
12-F	0.022	1	2.8	0.58	300	42	0.55	1	31
13-F	0.044	1	2.8	0.29	300	42	1.13	1	31

*Soil Fertility Research Institute, Lahore,**California Department of Food and Agriculture (3).

Table 6. Range, mean and standard deviation of quality parameters.

Parameters	Range	Mean	Standard deviation
Organic matter (%)	11.9-70.9	38.38	19.18
Nitrogen (%)	0.8-4.3	2.14	1.20
P_2O_5 (%)	0.4-2.8	1.47	0.78
K_2O (%)	0.07-2.7	0.72	0.70
Cd (mg/kg)	0.01-0.36	0.07	0.12
(Cr) (mg/kg)	0.29-2.87	1.36	0.93
(Pb) (mg/kg)	0.07-2.79	0.72	0.70

Considering the international standards for toxic metals in compost, all samples were found safe from contamination of cadmium, chromium and lead.

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