COMPOSTING OF MSW IN JAMSHEDPUR AND ITS EFFECT ON AGRICULTURE

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ABSTRACT:

Composting is one of the most favored options for municipal solid waste recycling for waste streams with high content of biodegradable materials. Compost has many uses including its use in agriculture for soil structure and fertility improvement. Composting is a reliable technology for production of stabilized organic matter that is suitable for agriculture, but this process should be carefully monitored with appropriate indices. Quality of compost is important from maturity and stability viewpoint, but in most compost factories proper attention is not paid to it.

Determining appropriate parameters for evaluation of compost stability, depending on the raw waste is important. There are different results from different studies that may be controversial. The quality of compost is generally judged by its odor, color, particle size, pH, soluble salts, organic matter content, carbon to nitrogen ratio, and the presence of undesirables such as weed seeds, heavy metals and phytotoxic compounds (toxic to plants).

The germination test is a simple and reliable indicator of compost maturity. For seed germination test on field, prepared 16 beds of 4 square feet. The ratio of compost in each 4 replicates was 0kg, 6kg, 8kg and 10kg. 200seeds of Fenugreek (trigonella foenumgraecum), 200seeds of red chilli (capsicum annuum), 12seeds of bottle gourd(lagenaria siceraria) and 16seeds of lady's finger (abelmoschus esculentus) sowed on the compost treated field. The effect of the compost on the bottle gourd(lagenaria siceraria) was the highest at the bed of 8 and 10 kg.

However, heavy metals (HMs) such as Cd, Cu, Pb and Zn are found in all MSW compost, and there are obvious concerns about such toxic elements entering the food chain through food crops to which composts have been applied as fertilizer.

Key words:- MSWM, MSWC, germination, windrow platform and leachate

Introduction:-

Composting urban waste in India has a long history. Sir Albert Howard developed the Indore process nearly 75 years ago by systemizing the traditional process that was carried out in India (Howard, 1940). Government intervention to promote this practice can be traced to the 1940s and the early 1970s, when the national government initiated a scheme to revive urban composting (Selvam, 1996). However, centralized large-scale composting plants in urban areas promoted in the 1970s proved to be uneconomical (Dulac, 2001). Only a few installations are currently still operational (UNDP, 1991). Due to high operating and transport costs and the poorly developed

market for compost, the expected profits could not be realized as planned. Composting of mixed waste also had a negative effect on compost quality and, thus, on its acceptance by farmers.

From 1990's decentralized composting schemes have been implemented by NGO's with the help of international funding. The decentralized composting schemes became very popular and widespread in a short span of time. Various types of composting have been adopted by these schemes e.g. Bin-composting, Shallow windrow, Pit composting and vermi-composting. However, the maintenance of such schemes proved to be difficult because the household involvement was sporadic, as many people believe that it is the municipal corporation's responsibility to collect waste and do not want to make additional payments. This study states that though decentralized composting has more advantages than centralized composting, the market for MSW compost is limited and is rarely financially competitive to heavily subsidized chemical fertilizers and traditional cow dung or poultry manure (Zurbrügg, et al 2002).

The organic content of Municipal Solid Waste (MSW) tends to decompose leading to various smell and odor problems. It also leads to pollution of the environment. To ensure a safe disposal of the MSW it is desirable to reduce its pollution potential and several processing methods are proposed for this purpose. Composting process is quite commonly used and results in production of a stable product - compost which depending upon its quality can be used as a low grade manure and soil conditioner. The process results in conservation of natural resources and is an important processing method, especially in agricultural and horticultural areas.

Composting is the biological transformation of the organic fraction of MSW to reduce the volume and weight of the material and produce compost, HUMUS like material that can be used as soil conditioner. Almost all organic components can be converted although the rate at which these degrade varies.The organic fraction of MSW varies food waste, papers, cardboards, grass, textiles, rubber, wood, leather and yard waste.

Composting is a process involving bio-chemical conversion of organic matter into humus (Lignoproteins) by mesophillic and thermophillic organisms. There are two process by which composting is done; Aerobic Composting where the organic matter is converted into humus in the presence of air, and Anaerobic Composting where the process is carried in the absence of air.

Windrow Platform Composting Plant

Composting is a biological process of decomposition carried out under controlled conditions of ventilation, temperature, moisture and organisms in the waste themselves that convert waste into humus-like material by acting on the organic portion of the solid waste. If carried out effectively, the final product is stable, odor-free, does not attract flies and is a good soil conditioner. The final product of composting process is a nutrient rich compost which has high agricultural value and is used as a fertilizer, doesn't have foul smell (rather it smells like soil) and is free of pathogens.

Composting can be done in the presence of air and in the absence of air. There is one more method of by which the degradable waste can be converted into useful compost, called Vermi Composting, which is another type of aerobic composting.

Aerobic composting: In Jamshedpur an effective and eco-friendly technology has been adopted for bio conversion of organic fractions in Municipal Solid Waste into a useful end product, i.e. Bio-Organic Soil-enricher. The composting processes are used mainly for segregated waste but the waste generated in Jamshedpur is very mixed type and difficult to be segregated. So, the technology adopted for composting process here is suitable for segregated as well as non- segregated waste.

MATERIALS AND METHODS

Composting of MSW

Composting is a spontaneous biological decomposition process of organic materials in a predominant -ly aerobic environment. During the process bacteria, fungi and other microorganisms, including micro arthropods, break down organic materials to stable, usable organic substances called compost Bernal et al., (2008). It is also known as a biological reduction of organic wastes to humus or humus-like substances.

The extension or efficiency of the composting process is dependent on various factors balance, pH, particle size, porosity andmoisture, and also on the process management, such as O2 cen tration, temperature and water content. Nutrient balance is basically defined by C quality and C/N ratio. Thus, the presence of readily degradable carbon (C), like carbohydrate in waste, accelerates the .process of decomposition.

Thereafter, decomposition slows on account of the greater resistance to decomposition of remaining C compounds (lignin and cellulose). Generally, the higher the lignin and polyphenolic contentof organic materials, the slower their decomposition Palm and Sanchez (1991). The process of composting occurs into two stages Pereira Neto and Stentiford (1992). The initial stage is known as the thermophilic stage in which an increase in temperature occurs (about 65 ^{o} C). In this stage, there is the decomposition of readily degradable compounds like sugars, fats and proteins. During this stage, the organic compounds are degraded to CO2 and NH3, with the consumption of O2. The pH typically decreases since organic acids are produced (Chen and Inbar 1993).
Additionally, pathogenic microbes and helminthes eggs areeliminated as a result of heat generated during this process. Thus, the organic compost is safer for use by farmers. The second and final stage is known as stabilization stage, where there is decrease in temperature which remains about 25-30^{0} C.

In this step the process of humification of organic compost occurs. At the end of this stage, the organic compost is cured and there are increases in humic matter content and cation exchange capacity (CEC) of

thecompost. Thus, compost can be defined as the stabilized and sanitized end product of composting, which has undergone an initial rapid stage of decomposition. The compost has certain humic characteristics and is beneficial to plant growth thus making the composting of MSW a key issueor sustainable agriculture and resource management Bernal et al., (2008) Arau´jo et al., (2008) Arau´jo and Monteiro (2006) Zucconi and Bertoldi (1987).

Analyzed parameters:- In this study pH, CONDUCTIVITY, TSS, TDS, BOD, COD, CHLORIDE, CADMIUM, CHROMIUM, ARSENIC, NITROGEN, PHOSPHORUS, POTASSIUM, IRON, COPPER, ZINC, LEAD and BORON were selected to assess the compost stability. Moisture and C/N ratio of samples were also measured .

Chemical and Physical Analyses :-Fresh samples were used to determine compost moisture content, pH, Turbidity and EC. Moisture content was determined as weight loss upon drying at 105°C in an oven for 24 h. Electrical conductivity, turbidity and pH were determined from conductivity meter, turbidity meter and pH meter. Both the samples were titrated samples to know the value of DO and chloride .TDS, TSS, BOD and COD of the leachate was also evaluated. N, P, K2O, Mg, Ca, Fe, Cu, Zn, Pb and B were analyzed through Atomic Absorption spectrophotometer(AAS).

Use of MSW compost in agricultural soils :-

Compost represent an important resource to maintain and restore soil fertility and are of great values . particularly in those countries where the organic matter content of the soil is low Castaldi et a l., (2004)Soil organic matter plays a major role in maintaining soil qualityPedra et al., (2007). In addit ionto supplying plant nutrients, the type and amount of soil organic matter influences several soil pro perties Arau´jo et al., (2008). Increasing the soil organic matter improves soil properties, enhances

soil quality, reduces soil erosion, increases plant productivity and soil microbial biomass.
Thus, in the regions where organic matter content of the soil is low, agricultural use of organic compost is recommended forincreasing soil organic matter content and consequently to improve and maintain soil quality. Apart of increasing soil organic matter content, application of organic compost can affect soil quality by:

(a) Decreasing the need of chemical fertilizers and pesticides Zibilske (1987)
(b) Allowing for more rapid growth in plants Bulluck and Ristaino (2002)
(c) Sequestering C in soil that has received compost application
(d) Improving tillage and workability of soil;
(e) Increasing soil microbial biomass and activityBulluck and Ristaino (2002 Arau´jo and Monteiro (2006). Recently, Roca-Perez et al., (2009).

Incorporated MSW compost into soil and reported that the use of compost increased soil qualityof Jamshedpur . The application of MSW compost increased soil organic matter,N,P and stable aggregates from both amended soils. The results also showed a positive response of Plant growth to application of MSW compost in both soils. However, heavy metals (HMs) such as Cd Cu, Pb and Zn are found in all MSW compost, and there are obvious concerns about such toxic elements entering the food chain through food crops to which composts have been applied as fertilizer Gillet (1992). According to Richard (1992), heavy metals are not biodegraded by process of compo sting and can become concentrated due to the loss of carbon and water from the compost due to m icrobial respiration. However, Arau´jo and Monteiro (2006) showed a decreasing in heavy metals (HMs) content in textile sludge as a result of composting. In order to regulate the land

application of heavy metals in MSW compost, various countries from European Union and the USA have regulated the heavy metal content in MSW compost by providing permissible limit. Thus, the application of MSW compost can promote changes in soil microbial biomass and activity, mainly due heavy metals content. There is an important need to evaluate the effect of MSW compost on soil microbial biomass.

The process:

- Fresh garbage is first of all stacked to a certain height on the windrow platform.
- Then few undesirable things are picked out (as much possible) by workmen from the garbage, like big pieces of log, clothes, shoes etc. Rest gets sorted out after the first screening.
- After this Innoculum mixed with water is put on the garbage heap. Innoculation is done in order to fasten the process of decomposition and have proper decomposition of all organic matters.
- Next is moisture, moisture content of the garbage has to be maintained at 40-45%, less than this level will result in the killing of helpful microbes while more moisture would lead to anaerobic kind of decomposition.
- Then the heap is left to be treated and everyday water is sprinkled on it.
- Next is turning of the heap which is done every week. The heap is turned in a way so that the material on the outer layer becomes the inner core while the inner core becomes the outer layer.
- In this way the whole heap is treated in the presence of air and by the end of fourth week the heap decomposes completely leaving the non biodegradable objects or things which take longer time to decompose (molasses, coconut peals, cloths etc). This non degradable waste is separated from the ready compost by a set of screening. First screening is of 35mm where bigger objects are removed, and then the second screening is of 16mm where further stones and other smaller undesirable particle are removed.
- After this the product is again left for about 15 day for further decomposition then again the same is fed into 8mm screen and then the final product is obtained.

The moisture and the temperature are two most important parameters that have to be constantly monitored in order to get perfect compost. The moisture has to be maintained at 40-45% while temperature has to be maintained at 65-70oC which the heap attains in just couple of days and has to be maintained till the end of this process. At this high temperature the pathogens in the garbage are killed that is why foul smell also doesn't come. Proper aeration has also to be ensured.

HOW ORGANIC FERTILISER WORKS IN THE SOIL:

1. It promotes beneficial microorganisms in the root rhizosphere.
2. It improves soil health by:Converts residual organic matter into humified substances.
3. Helps in solubilizing unavailable mineral nutrients into readily available form.
4. Contributes directly by addition of humic components into the soil.
5. Organic Fertiliser is ideal for improvement of soil properties in terms of Porosity for ease of ploughing and crop root expansion.
6. Moderator of bulk density to improve both sandy as well as clay soils.
7. Better transmission ability in the soil for conservation of water & nutrients, for temperature regulation & higher microbial activity.
8. It helps in suppression of plant root disease through pro-biotic effects.
9. Also provide resistance to plant leaves against sucking insects.
10. It absorbs nutrients from chemical fertilizers and releases slowly for long-term feeding

of crops, thereby increasing the fertilizer usage efficiency.

11. The higher biological activity helps in breakdown of toxic chemical residues.
12. It helps to increase enzymatic activity in plants to detoxify pesticide residues and also increase quality of the produce.
13. It helps in reclamation of salt affected degraded soils through multiple actions in the soil.

COMPOST ANALYSIS REPORT

NO. F/13-14/25 Date: Feb 22, 2014 Page 1 of 1

Issued to : M/s. JAMSHEDPUR UTILITIES & SERVICES COMPANY LTD.,
Sakchi Boulevard Road, Northern Town, Bistupur,
Jamshedpur 831001, Jharkhand

Your Ref. No. : Letter dtd. Nil

Description of sample : City Compost

Mark on Sample : F/13-1/MSW/0001C, Sample collected on : 10/02/2014
Location : Jusco Compost Plant, Jubilee Park, Jamshedpur.

Sample Received on : 10.02.2014

Test Completed on : 22.02.2014

TEST FINDINGS:

Sl. No.	Test Parameters	Unit	Results
01.	Colour	..	Dark brown to black
02.	Odour	..	No foul odour
03.	pH (1 : 2.5 aqueous solution)	..	6.5
04.	C : N Ratio	..	10.7 : 1
05.	Bulk Density	gm/cc	0.65
06.	Conductivity (1 : 2 aqueous solution)	ms/cm	4.0

07.	Moisture content	%	19.20
08.	Nitrogen as N	%	0.91
09.	Phosphorous as P	%	0.44
10.	Total Potash as K_2O	%	0.45
11.	Organic Carbon	%	12.4
12.	Lead as Pb	mg/kg	70.2
13.	Cadmium as Cd	mg/kg	1.66
14.	Chromium as Cr	mg/kg	46.4
15.	Copper as Cu	mg/kg	100.4
16.	Zinc as Zn	mg/kg	334.5
17.	Nickel as Ni	mg/kg	21.4
18.	Arsenic as As	mg/kg	2.05
19.	Mercury as Hg	mg/kg	0.11

(T. NANDI)

Dy. Manager, Technical

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★ Results relate only to the parameters tested.

LEACHATE ANALYSIS REPORT

NO. H/13-14/68 Date: Feb 20, 2014 Page 1 of 1

Issued to : M/s. JAMSHEDPUR UTILITIES & SERVICES COMPANY LTD.,
Sakchi Boulevard Road, Northern Town, Bistupur,
Jamshedpur 831001, Jharkhand

Your Ref. No. : Letter dtd. Nil

Description of sample : City Compost Leachate

Mark on Sample : H/13-1/MSW/0021L, Sample collected on : 10/02/2014

Location : Jusco Compost Plant, Jubilee Park, Jamshedpur.

Sample Received on : 03.02.2014

Test Completed on : 20.02.2014

TEST FINDINGS:

Sl. No.	Test Parameters	Unit	Results
01.	TSS	Mg/l	140
02.	TDS	Mg/l	31980
03.	pH value	..	8.42
04.	Amonical nitrogen	Mg/l..	9.18
05.	Total Kjeldhal nitrogen	Mg/l	1030
06.	BOD	Mg/l	3400
07.	COD	Mg/l	8960
08.	Cyanide	Mg/l	BDL
09.	Choloride	Mg/l	9712
10	Fluoride	Mg/l	1.0
11.	Lead as Pb	mg/kg	0.80
12.	Cadmium as Cd	mg/kg	BDL
13.	Chromium as Cr	mg/kg	0.50
14.	Copper as Cu	mg/kg	0.80
15.	Zinc as Zn	mg/kg	0.50
16.	Nickel as Ni	mg/kg	BDL
17.	Arsenic as As	mg/kg	BDL
18.	Mercury as Hg	mg/kg	0.80

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Seeds Germination test on field

Before starting seed germination test, soil and compost should be analyzed in the laboratory, so that we can understand the requirement of the quantity of the organic fertilizer for the growth of the crops.

Organic fertilizer is used alone or in combination with chemical fertilizers at the time of sowing/transplanting . It can also be applied as side dressing along the rows or encircling around the plants. When used in grown up crops it should be mixed with the top 10 cm soil followed by irrigation. Uniform broadcast application is suggested in nurseries, lawns and other land scaping activity. Since this is a fully digested material it can be applied at any time of the crop feeding stage without the fear of nitrogen robbing effect or creation of heat in root zone as against normal cattle manures.

To know the effect of compost on plants, 200seeds of Fenugreek (trigonella foenumgraecum), 200seeds of red chilli (capsicum annuum), 12seeds of bottle gourd (lagenaria siceraria) and 16seeds of lady's finger (abelmoschus esculentus) sowed on the compost treated field. Ratio of compost in 4replication of 4square feet crop land are 6kg, 8kg and 10kg and other were left to see the growth of plants without compost.

Labeling of the field after sowing the seeds on 12/02/2014

Growth of the plants on compost treated land after 2 months on 14/04/2014

Growth of the plants without compost treated land on 14/04/2014

RESULT:-

The results of seed germination test in the field after 2months for the 4 replicates containing 200seeds of Fenugreek (trigonella foenumgraecum), 200seeds of red chilli (capsicum annuum), 12seeds of lauki(lagenaria siceraria) and 16seeds of bhindi (abelmoschus esculentus) with 0kg, 6kg, 8kg and 10kg of compost are almost same. Approximately all the seeds were germinated much difference is not seen in the growth of the plants of Fenugreek (trigonella foenumgraecum), red chilli (capsicum annuum), and bhindi (abelmoschus esculentus) except lauki (lagenaria siceraria).

LAUKI (LAGENARIA SICERARIA) PLANTS SHOWING THE EFFECT OF COMPOST

Lauki without compost **Lauki with compost**

CONCLUSION:-

Agricultural utilization of municipal solid waste compost cost effective MSW management option over traditional means such as Landfilling or incineration as it enables recycling of potential plants nutrients. Soil microbial use the nutrients in compost.Organic materials amendment in soil, such as municipal solid waste compost (MSWC), promotes microbiological activity, but the presence of potential toxic heavy metals is of much concern.

The final characteristics indicate the stability and usability of the compost in all the reactors with municipal waste. The final GI in composting mixture of reactors 6kg and 8kg was over 80%; however, the GI in the without compost replicate bed was not over 80% during the test. The stability and maturity in the composting mixture of initial mix ratio 10kg was superior to those in composting mixtures of initial C/N ratio of 6kg and 8kg.The results of the current work indicate the necessity to stabilize the compost before its application to agricultural soil in order to avoid environmental problems and phytotoxicity.

The results of the current work indicate the necessity of the mineral requirement of different plants are different. Compost and soil should be analyzed before sowing seeds on agricultural land. So, we can know the exact amount of compost to be used on field. Composted Municipal solid waste is a valuable source of organic matter, nitrogen, phosphorus and other nutrients. By using the compost on plant we can increase the production of fruits and vegetable.

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References:-

1. Journal of environmental quality Volume 29, no.-2, Mar.-Apr. 2000, Comparison of Methods for Evaluating Stability and Maturity of Biosolids Compost L. Wu, L. Q. Ma,* and G. A. Martinez
2. Mokhtari.M , Nikaeen.M, Amin.M.M , Bina.B, and Hasanzadeh.A, EVALUATION OF STABILITY PARAMETERS IN IN-VESSEL COMPOSTING OF MUNICIPAL SOLID WASTE, Iran. J. Environ. Health. Sci. Eng., 2011, Vol. 8, No. 4, pp
3. Manjula Gopinathan1, Meenambal Thirumurthy, Evaluation of Phytotoxicity for Compost from Organic Fraction of Municipal Solid Waste and Paper & Pulp Mill Sludge Environmental Research, Engineering and Management, 2012. No. 1(59), P. 47 - 51
4. GAUTAM S.P., BUNDELA P.S., PANDEY A.K., AWASTHI M.K., and SARSAIYA S., EVOLUTION OF THE MUNICIPAL SOLID WASTE COMPOST PHYTOTOXICITY AND MATURATION FOR ECO-FRIENDLY ORGANIC FARMING SYSTEMS , Journal in applied science in environmental sanctioned (2010)
5. Bundela P.S1 , Gautam S.P. , Pandey A.K. , Awasthi M.K. , Sarsaiya S. 2, Municipal solid waste management in Indian cities A review ,INTERNATIONAL JOURNAL OF ENVIRONMENTAL SCIENCES Volume 1, No 4, 2010