Development of Compost using EM Technology for Organic Farming from Cotton Dust Waste

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Abstract

Increase in awareness on hazardous of soil pollution, nowadays organic farming has become popular to maintain the soil health. Using compost as manure helps in improving the water-holding capacity of soil, nutrient build-up and avoid soil erosion. This paper mainly focuses on composting of cotton microdust waste which is considered as a solid waste of textile industry, to high-value compost using a consortium of effective microorganism. This compost is rich in minerals and nitrate nitrogen content which is an absolute form of nitrogen for plants to uptake for their metabolic activity. The result of seed germination study denotes that length of roots directly indicates porosity of the compost is good. Thus this property helps in growth and yield and not only leads a way for organic farming but also a remedy for solid waste management of textile industry

Keywords - *Pollution, Soil health, Nutrient, Erosion, Cotton microdust, seed germination, waste management*

I. INTRODUCTION

Cotton is one of the important cash crops of India. India is the 3rd largest cotton producing country in the world with large number of cotton mills. Coimbatore, the Manchester of South India has emerged as a major industrial center of the South India and has over 50,000 small, medium and large industries and textile mills (Sangeetha 2013) In India, the total cotton fiber consumption is estimated to be 26 lakh tons per year, (Aishwariya, 2012) of which approximately 2, 10, 000 tones of cotton waste is generated, of which 40% are fibrous waste and 60 % of waste are dust waste (micro dust, a non-saleable waste). Cotton yarns can be recycled from pre-consumer (post-industrial) and post-consumer cotton fibrous waste. Recycled cotton is often combined with recycled plastic bottles to make clothing and textiles, creating very sustainable, earth-conscious products. But these industries are facing a lot of problems in disposal of cotton dust waste and are thrown directly to waste land. The problems associated with microdust from textile factories, have now assumed serious consideration (Meenakshi et al., 2004), and since it has impact on many environmental as well as health issues (Farooque et al., 2008). *Byssinosis*, also called "brown lung disease" or "Monday fever", is an occupational lung disease caused by exposure to cotton dust in inadequately ventilated working environments. Due to lack of landfill sites and waste related problems, we need to reduce our landfill waste drastically. Composting is one such remedy for organic waste dumping, and with the help of Effective microorganism (EM) (Edwards *et al.*, 2015), the decomposition is complete without foul odour. These waste are rich in minerals, tricarboxyalic acids, proteins and thus good quality compost can be prepared from it.

Compost is a key ingredient in organic farming. The compost soil contains all essential micro and macronutrients for the plant growth. However most of the chemical fertilizer do not contain micronutrients and also they do not support the microbiological life in the soil. Synthetic fertilizer does not add any organic content to the soil. There are many possibilities of creating toxic concentration of salts in the agricultural lands. The chemical fertilizer release the nutrients faster than plants use them. Organic farming is the only solution to rectify all the problems. Organic farming is a form of agriculture that developed from a desire to improve soil quality and the environment, and from a strong rejection to use of synthetic chemicals and fertilizers in agriculture.The current study involves the development of compost from cotton waste with the help of EM. Through Microbial decomposition of the organic waste matter which can be stabilized, matured and deodorized in to a product rich in humic substances that can be used as organic soil conditioner which is easy to store and distribute (Sahu *et al.*, 2015). This paper elaborates on converting the cotton microdust waste which is considerd as solid waste of textile industry, with the help of effective microorganism in an optimized condition. The resulted compost is rich in minerals, C/N ratio and nitrate nitrogen content which is an absolute form for plants to uptake for their metabolic activity. Optimization of composting days with and percentage of EM were detected for reducing the days for complete degradation. When these wastes are developed in to high value compost for agriculture, the growth and yield of crops were increased with increase in the soil fertility. The efficacy of prepared compost was studied through seed germination study. This mineral rich compost can be used as biofertilizer instead of chemical fertilizer.

II. MATERIALS AND METHODS

A. Selection of waste as substrate and preparation of compost (Zervakis et al, 2013)

Blow room cotton microdust waste was directly procured from textile mills in and around Coimbatore and Erode districts. Sugarcane bagasse and saw dust were also collected in and around Coimbatore for the present study for better composting. The liquid culture of the EM used in the study was supplied by Environ Biotech and contained a mixture of lactic acid bacteria, Lactobacillus plantarum (1.0 X10^4 CFU/ml) yeast, Candida utilis (1.0X10^5 CFU/ml), actinomycetes, Streptomyces albus (3.0X10^3 CFU/ml), fermenting fungi, Aspergillus oryzae (1.1X10^5 spores/ml).

B. Optimization of EM % for better composting

One liter of 'instant solution' is made by mixing 10 ml of EM, 40 ml of molasses and 950 ml of water and leaving it for seven days, on room temperature in a glass container. This solution is then added to 1 liter of molasses with 98 liters of water to obtain 100 liters of ready-to-use EM solution. This solution is been added to the raw materials while preparing the compost. Three different compost piles was prepared with three different percentage of EM solution. The substrates were mixed in ratio 3:1:1, (cotton waste saw dust, sugarcane bagasse) and left till 40 days for better composting Each ten days the compst pile was turned over. The temperature of the compost was monitoredat regular intervels.

C. Physicochemical study of prepared compost (Shyamala et al, 2012)

Physico-chemical analyses of compost samples such as Moisture content, Particle size, pH, Electrical conductivity, Organic Matter, C: N Ratio, Nitrogen, Phosphorus, Potassium, Sodium, Magnesium and Nitrate Nitrogen were studied. The pH was determined on a suspension of sample in water (10 g/25 ml), the total nitrogen (Kjeldahl method). Phosphorus availability was determined by titration method using quinoline and HCl. Phenolphthalein act as indicator. Organic matter present in the composite also determined by titration method.

D. Isolation of microorganism from compost pile (Djeugap et al, 2014)

Persistence of EM was studied each 10 days for best compost. Five random samples were collected from each compost, About 1g of the compost soil sample from respective compost pile taken from depth of 3cm and serially diluted with sterile phosphate buffer and 0.1 ml of the aliquot was spread plated on trypticase soy agar plates (Bacteria), Starch casein agar (actinomycetes) and sabouraud dextrose agar (mold and yeast). After incubation the number of colony forming units (CFU) per gram was determined to estimate number of viable microbial cells. This cycle was repeated for each ten days until 40 days of completion.

E. Pot study for nutrient efficacy of compost (Hamdi, 2002)

Pot study was performed for selected compost and normal soil as control. *Trigonella foenum-graecum* seeds were selected for the study as it belong to medicinal as well as cash crop of India. The life cycle of the plant is too short that it can be harvested on 30 days. The seeds were germinated on pots containing 350 g of compost soil with triplicates. All pots were kept in room temperature (28±2 °C) near the sunlight for the period of 30 days. Germination % of seeds was daily recorded. At the end of the germination experiment, germination %, length of root, shoot length, number of leaves, number of flowers/plant, number of pods/ plant, number of seeds/pod and weight of seeds/pods were recorded and compared with plants grown on control soil.

III. RESULTS AND DISCUSSION

. The collected waste were cleaned for non decomposable matter and soaked for 3 hours. Later was drained and made into different pile for composting with different percentage of EM solution. Compost piles were turned each 10 days to maintain temperature evenly around the compost and water was sprayed to moisture when it becomes dry. The EM solution functioning as accelerator reduces the composting period from three months to one month. Compost with 3% EM solution showed only 35 days for complete composting whereas others took up to 45 days. Complete composting of raw material with 3% EM solution took 35 days for complete composting. A gradual increase in temperature of the compost to 60±2 °C was observed in the compost pile during the initial 15 - 30 days. After 30 days, a gradual decrease to 25 ±2 °C was observed. This increment in temperature is a good indicator of microbial activity in the compost pile, (Savoie 1996, Miller 1992). This might be because of the chemical breakdown of the molecules triggered by the action of enzymes produced by effective microorganisms, (Girvan, 2003). The decreases in temperature after 30 days in indicate the complete decomposition of organic matter (Wollum, 1982). Pictorial representation of results was given in Fig -1 and Fig -2.

Fig 1. Days Taken for Composting

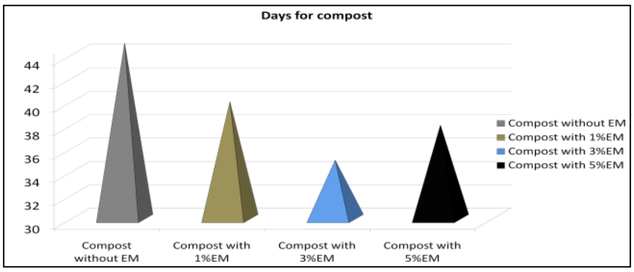
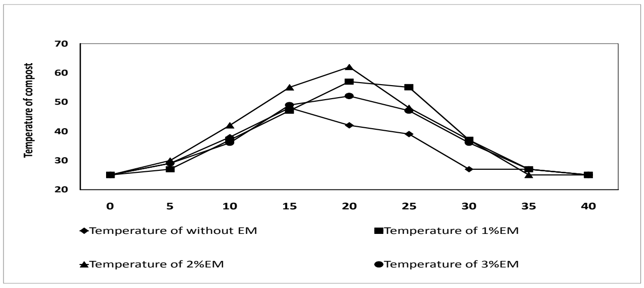


Fig 2. Temperature Change of Compost



The enzyme active phase raises the temperature from 25 °C to 45 °C in control compost was observed, while the compost with 3% EM showed an increase in temperature upto 62 °C. The temperature of compost gradually decreased to 25°C, after 32 days which indicate that complete decomposition of organic compounds. The enzymes catalyze reactions in which sugars; starches, proteins, and other organic compounds are oxidized, producing carbon dioxide, water, energy, and compounds resistant to further decomposition, (Hansen, 2001). In 1941, Lambert proved that the compost temperature ranges within 45 to 55°C in active phase. Once temperature goes beyond 40°C, the mesophilic microbes become less aggressive and are replaced by thermophilic microbes, (Atkinson, 1997). During Thermophilic stage high temperatures accelerate up to 65°C, the breakdown of organic and inorganic compounds like cellulose and hemicelluloses, the major structural molecules (Jeanine, 2002). Curing, or maturation of the remaining organic matter, occurs as these compounds diminished and the temperature gradually decreases with decreases in thermophillic microbes (Harada, 1981).

The physicochemical characteristics of compost with different concentrations of EM solution have been studied and the results are given in Table 1.

Table 1: Physicochemical Analysis of Prepared Compost

Parameters	Recommend standard limit	Compost without EM (Control)	Compost with EM		
			1%	3%	5%
Moisture	45-65 %	68	59	64	61
Particle Size	0.25mg/m3	0.27089	0.236 09	0.2145 6	0.19608
pH at 25 °C (1% Suspension)	-	6.4	5.09	6.68	7.5
Electrical Conductivity (1% Suspension)	2-6 ds/m	4.8	5.0	4.58	4.2
Nitrogen as N	0.4-1.1 %	0.78	0.91	1.02	0.98
Phosphorus as P	mg/kg	436.98	467.9 5	698.84	554.36
Potassium as K	0.6-1.7 mg/kg	0.8	0.76	0.89	0.83
Organic Matter	%	10.22	11.22	17.80	14.35
Magnesium as Mg	mg/kg	27.15	29.52	48.99	32.04
Sodium	%	0.086	0.028	0.038	0.031
C:N Ratio	%	8.722	10.08 7	18.1	13.35
Nitrate Nitrogen	240 mg/l	3.32	3.91	4.58	4.03

The result clearly indicates that all parameter analyzed lies within standard limit. Moisture of prepared compost lies between 59%-68%. With a hand sprayer water is sprayed to prevent over wetting of the compost heap. pH values ranges from 5.09 to 7.5. In the early stages of composting, organic acids may gather as a result of the digestion of organic substance (Cherif, 2008). The resultant drop in pH encourages the growth of fungi, which actively decompose lignin and cellulose. Usually, the pH rises gradually with the breakdown mechanism of organic acids. This raise is due to decomposition and volatilization of organic acids in the thermophilic phases (Klamer, 1998), and release of ammonia by microbes as they break down proteins and other organic nitrogen sources, (Crecchio, 2001). This ammonia is lost either by evaporation (Savoie, 1995) or used by microbes for its growth leads to neutralize the pH (Zayed, 2005). Particle size of each compost lies between 0.19608 mg/m^3 to 0.2708 mg/m^3. Decrease in particle size, increases the surface area, thus increase microbial activity and the rate of decomposition (Kuhlman, 1990). The availability of carbon and nitrogen is increased as the size of particle is decrease. The electrical conductivity of compost samples varied from 4.2 to 5.0 ds/m. The application of EM in compost increases the macro and micronutrient content, (Jawson, 1986). The total nitrogen of all the compost samples varied from 0.78 to 1.02 %. Ross and Harris in1982 also found that excess ammonia disappeared most rapidly in the range of 40 to 45°C, (Freney, 1983) The C/N ratio of all the compost samples varied from 8.722 to 18.1 %. The nitrate-nitrogen concentration varied from 3.32 to

4.58 mg/L. The total phosphorous concentration varied from 436.98 to 698.84 mg/kg. Potassium concentration varies from 0.76 to 0.89 %, (Khalil, 2001). Organic matter content of the compost samples varied from 10.22 to 17.80 %. Magnesium concentrations varied from 27.15 to 48.99 mg/kg. The sodium concentration varied from 0.028 to 0.086 %. Curing is responsible for stabilizing the products resulting from active composting by lowering the microbial activity. Stabilization promote breakdown of organic acids, nitrate and nitrogen and compounds resistant to decomposition (Watkins, 1987). Thus this nature of compost is suitable for organic farming (Miguel, 2002). The observation of the study indicate that the decomposed organic wasted can be effectively converted to high value manure (Rigby, 2001).

To study the persistence of microbial members of EM, the soil samples were analyzed for the occurrence of individual microbial members by soil dilution technique and tabulated in table 2.

Table 2: Total Viable Count of Microorganism in Different Stage of Compost Soil (3 % Em)

Age of compost (days)	TSA (CFU/ml)	SDA (CFU/ml)	SCA(CFU/ml)
10	13.1X10 ^{4}	1.2X10^{3}	47.3X10^{2}
20	37.8X10^{5}	19.1X10^{4}	67.2X10^{3}
30	45.4X10 ^{5}	24.1X10^{4}	71.2X10^{3}
40	1.1X10^{2}	2.3X 10 ^{3}	15.1X10 ^{2}

Thirty seeds of *Trigonella* were sowed and growth rate was monitored for 3 weeks. Physical parameter such as germination %, length of root, shoot length, number of leaves, number of flowers/plant, number of pods/ plant, number of seeds/pod and weight of seeds/pods are given in table 3(a) and table 3(b)

Table 3(a) - Seed Germination Percentage of Trigonella Plant

Seed type	Trail	Germination %		
		10 days	20 days	30 days
Trigonella foenum-graecum seeds	Compost without EM	28	76	100
	Compost with 3% EM	20	88	88

Table 3 (b) - Parameters of seed germination study

Trails	No of pod/ plant	No of seeds/ pod	Weight of seed/pods	No of leafs / plant	Average shoot length (cm)	Average root length (cm)
Compost without EM	**27**	**9**	2.85 ± 0.01	35	24.3±0.57 7	2.2± 0.26 5
Compo st with 3% EM	**48**	**17**	0.60 ± 0.01	29	17.9±0.35 1	3.5± 0.35 1

IV. CONCLUSION

This study mainly focuses on optimization of decomposting the microdust cotton waste using EM solution in an organic and cheap way to develope bio-manure, which can be used in agriculture which gives improved quality of crops, soil health and a technique that could be adopted by textile industry around the world to manage their cotton microdust waste. Composting of cotton dust waste was done using Effective microorganism under aerobic condition. The physical, chemical and biological parameters of the obtained compost were found to be within the standard limits. Results of Germination study clearly denotes that ithis product can be used as biomanure without any restriction. Thus this study clearly provides a solution for the waste management in textile industry as well as cheap and nutrient rich manure for cultivatation organically.

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