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Study on Composting of Agricultural and Forest Wastes

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Abstract

The effective recycling of agricultural waste (rice straw) and forest waste (saw dust) were carried out to produce organic fertilizer, compost, by using traditional method. During the decomposition process of composting, changes occurred for temperature and height of bedding were studied and the characteristics of raw materials and compost samples were analyzed. The results showed that compost produced from saw dust gave higher yield (46%) than that produced from rice straw (33%). It was also found that 3 fold reductions in volume of organic matter was achieved by using rice straw and 2 fold reductions in volume was achieved by using saw dust. The analysis of compost samples indicated that the products contain sufficient amount of both primary and secondary macronutrients but all the values obtained were near the lower limit of literature value due to the low C:N value in raw materials and also the absence of microorganisms used in traditional method.

Keywords: agricultural waste, forest waste, organic fertilizer, compost, macronutrients

Introduction

Environment degradation is a major threat confronting the world, and the use of chemical fertilizers contribute largely to the deterioration of the environment through depletion of fossil fuels, generation of carbon dioxide and contamination of water resources. It leads to loss of soil fertility due to imbalanced use of fertilizers that has adversely impacted agricultural productivity and causes soil degradation. Now there is a growing realization that the substitution of organic fertilizers in the placed of chemical fertilizers can reverse the declining trend in the global productivity and environment protection (Aveyard, J. 1988 ; Wani, S.P. and K.K. Lee 1992; Wani, S.P. et al. 1995).

In Myanmar, large quantities of plant nutrients contained in agricultural and forest byproducts are wasted. Composting is a viable process of treating solid waste for beneficial use and destroying pathogens, diseases and

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undesirable weed seed. By properly managing air, moisture and nutrients, the composting process can transform large quantities of organic material into compost in a relatively short time (Cochran, B. J. and W. A. Carney 1996).

The potential of composting to turn waste materials into a farm resource makes an attractive proposition. Compositing offers benefits such as enhanced soil fertility and soil health that increased agricultural productivity, improved soil biodiversity, reduce ecological risks and provided better environment. Thus, composting could be one of the valuable options for farmers to restore or enhance their agricultural soil physical, chemical and biological properties (Hailu, K.A. 2009).

However, many farmers especially those in developing countries, like Myanmar, fail to make the best use of organic recycling opportunities. This work attempted to contribute to this lack of knowledge about the composting of agricultural and forest wastes.

The objectives of the study are (1) to produce compost from agricultural waste (rice straw) and forest waste (saw dust) by traditional method; and (2) to analyze the characteristics of compost samples such as nitrogen content, phosphorus content, potassium content, calcium, magnesium and sulphur contents, organic matter content, moisture content, pH, and carbon and nitrogen ratio.

Materials and Methods

Experiment Site and Set Up

The experiments were conducted at the Laboratory of Department of Industrial Chemistry, West Yangon University, during the year 2012, taking 4 months (from August 1 to November 30). There were two experiments in the study: Experiment 1 was composting of rice straw, and Experiment 2 was composting of saw dust.

Preparation of Compost Bed

For rice straw composting, a cement tank, having diameter of 3 feet and height of 3 feet, was placed at the shaded area of the laboratory. The rice straw was soaked for 2 hours in water and it was chopped with knife to get easy decomposition. The bottom of the cement tank was filled with chopped rice straw to get 6 inches thickness. Then, cow dung was placed as the second layer to obtain 3 inches thickness. Finally, a thin third layer of soil was added to get 1 inch thickness. This formed the first pile. The purpose of using soil is to introduce microorganisms needed to break down the organic matter in the pile. The ratio of the materials for piling the heap was rice straw: cow dung: soil = 6: 3: 1.

A hollow PVC pipe having a length of 3 feet and diameter of 3.5 inches was placed in the center of the pile for aeration after first pile forming. Then, two additional piles were made by adding the layers of rice straw, cow dung and soil. One liter of water was sprinkled in order to keep the pile moist. The surface of the compost bed was covered with plastic sheet to prevent drying the contents and to increase the temperature.

For the saw dust composting, the whole procedure was repeated with saw dust, cow dung and soil.

Decomposition Process

The compost beds were left for four months for the complete decomposition of the contents. The compost beds were turned by every two weeks. The purpose of turning was to improve aeration, speed up microorganism activity and ensure uniform decomposition. The material previously on the top and sides of the bed were moved to the center. During the decomposition process, 1liter of water was sprinkled twice a week to maintain conditions conducive for the composting process. The temperature and height of compost beds were recorded every two weeks.

Harvesting the Compost

The composts were harvested after four months. The processed compost was black, light in weight and free from bad odor. When the compost was ready to harvest, it was kept without watering for 3 days to make the compost easy for shifting. The harvested composts were spread on the plastic sheets for two days to reduce the moisture content for drying. The weight and volume of compost obtained from each experiment were measured and recorded. The compost was packed in plastic bags and stored them in a cool place.

Analysis of Raw Materials and Compost Samples

The physical characteristics of compost samples such as moisture content and pH were determined at the Laboratory of Department of Industrial Chemistry, West Yangon University.

The chemical characteristics of raw materials such as carbon to nitrogen ratio; and that of compost samples such as nitrogen content, phosphorus content, potassium content, calcium, magnesium and sulphur contents, organic matter content and carbon to nitrogen ratio were measured at the Laboratory of Department of Land Use Division, Myanmar Agriculture Service (MAS), Yangon Region.

Results and Discussion

Characteristics of Raw Materials

According to Dalzell, H.W. (1987), for efficient compost production the compost piles should have a carbon to nitrogen ratio (C/N ratio) in the range of 25-35. If it is higher, the composting process will take a long time and if it is lower, the final compost will be given off as ammonia. The simplest method of adjusting the C/N ratio is to mix together different materials of high and low carbon and nitrogen contents. Therefore rice straw and saw dust which had a high C/N ratio mixed with cow dung which had low C/N ratio. The C/N ratios of rice straw saw dust and cow dung are indicated in Table 1. It was found that the raw materials had low C/N ratios in comparing with literature values.

Table 1 Carbon to Nitrogen Ratio of Raw Materials

Raw Materials	Carbon to Nitrogen Ratio	
	Measured Values*	Literature Values**
Rice Straw	38.70	30-100
Saw Dust	51.71	50-150
Cow Dung	12.13	11-30
Soil	2.38	2-10

* The data were measured at the Laboratory of Department of Land Use Division, Myanmar Agriculture Service (MAS), Yangon Region.

** Aveyard, J. (1988) and Steinegger, D.H.and D.E.Janssen (1993)

Volume of Compost Samples

With an input of 30.6 thousand cubic inch of agricultural or forest waste, 10.2 thousand cubic inch of compost in rice straw composting and 14.3 thousand cubic inch in saw dust composting were produced as shown in Table 2. The results showed that the saw dust compost gave higher yield (46%) than rice straw compost (33%). It was found that 3 fold reductions in volume of organic matter was achieved by using rice straw and 2 fold reductions in volume was achieved by using saw dust.

Table 2 Volume of Raw Materials and Compost Samples

Sample	Volume of Raw Materials (thousand cubic inch)				Volume of Compost (thousand cubic inch)	Weight of Compost (kg)	Yield Percent (%)
	Rice Straw/ Saw Dust	Cow Dung	Soil	Total			
Rice Straw Compost	18.3	9.2	3.1	30.6	10.2	87	33
Saw Dust Compost	18.3	9.2	3.1	30.6	14.3	122	46

Changes in Height of Compost Bed

Changes in height of bed during the composting process (from 0 to 121 days) were recorded every two weeks. At the beginning of the process, the changes in height of bed (reduction in volume) were not significant. The reduction volume became significant during the third month of composting process, especially in rice straw composting. The height of bed reached a minimum of 10.5 inches in rice straw composting and 14.0 inches in saw dust composting. The changes in height of bed during the composting process are indicated in Figure 1.

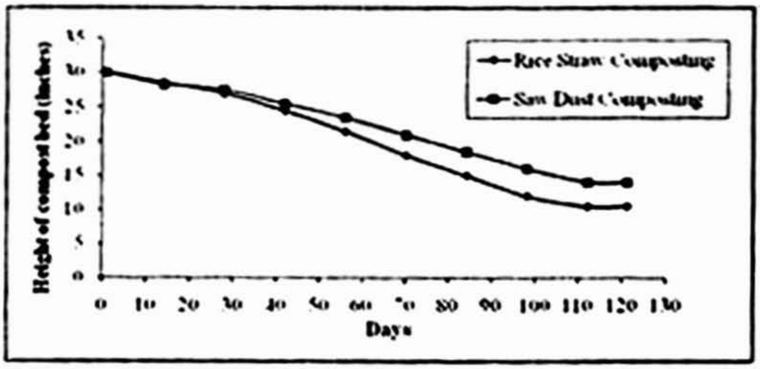

Figure 1 Changes in Height of Compost Bed

Temperature Changes during the Composting Process

Temperature changes were observed during the process of composting. At the beginning of the process, the temperature of bed was high (34°C) when compared to ambient temperature (29°C). Later, there was a gradual decrease in temperature, which reached a minimum of about 27°C during the whole period of digestion process. The temperature lower than ambient temperature means that all the organic wastes have completely changed to compost. The temperature changes during the composting process are shown in Figure 2.

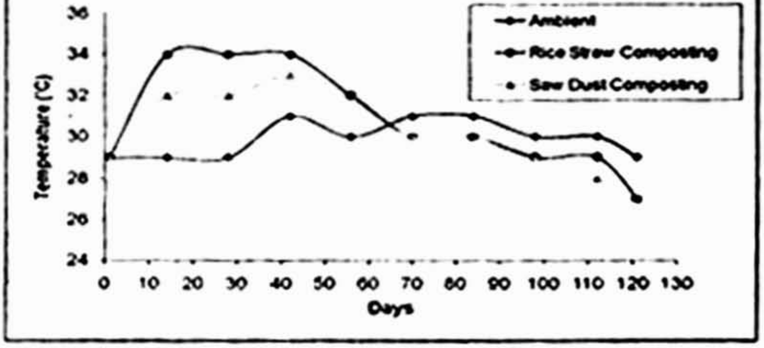

Figure 2 Temperature Changes during the Composting Process