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Vermicomposting of Agricultural Wastes

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Abstract

In the present work, the effective recycling of agricultural wastes like rice straw and cow dung was carried out to produce organic fertilizer – vermicompost. The locally available earthworm Red Wigglers *Eisenia Fetida* and Indian Blue earthworm *Preionyx Excavatus* were used for the purpose. Changes occurred for temperature, height of bedding, moisture content, weight and multiplication of earthworms during the vermcomposting process were studied. The characteristics of vermicompost such as nitrogen content, phosphorus content, potassium content, calcium, magnesium and sulphur contents, organic matter content, pH and carbon and nitrogen ratio were analyzed. The vermicompost products were applied in Japan-ne-gya (*Melampodium Paludosum* H. B. and K.) and Mo-hmyaw-ngayok (*Capsicum minimum* Roxb.) and its effect on plant growth characteristics were studied. The vermicomposting process took 3 months to produce black, light and odourless products. The results showed that vermicompost produced by the combination of local and Indian earthworm species gave higher yield than those produced by single earthworm species. The analysis of vermicompost indicated that the products contained primary macronutrients – nitrogen (1.356%), phosphorus (0.345%), potassium (0.148%), and secondary macronutrients – calcium (1.202%), magnesium (0.243%) and sulphur (3.836%). It was also found that Japan-ne-gya (*Melampodium Paludosum* H. B. and K.) and Mo-hmyaw-ngayok (*Capsicum minimum* Roxb.) with the application of vermicompost had better growth characteristics – in terms of plant height, number of leaves per plant, number of flowers and fruits per plant - than those plants without application of vermicompost.

Keywords: organic fertilizer, vermicompost, nitrogen content, phosphorous content, potassium content, organic matter content, carbon and nitrogen ratio

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 (CO_2) and contamination of water resources. It leads to loss of soil fertility due to imbalanced use of fertilizers that has adversely impacted agricultural

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productivity and causes soil degradation. Now there is a growing realization that the substitution of organic fertilizers in the place 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).

On the one hand tropical soils are deficient in plant nutrients and large quantities of plant nutrients contained in agricultural byproducts are wasted. On the other hand, there are number of earthworms that have the ability to convert these agricultural wastes into valuable resources containing plant nutrients and organic matter. The concept of vermicomposting started from the knowledge that certain species of earthworms consume a wide range of organic residues very rapidly and converting them into vermicompost, a humus-like soil building substance, in short time (Wani, S.P., 2002 ; Hailu, K.A., 2009).

Vermicompositing 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, vermicomposting 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 using earthworm. This work attempted to contribute to this lack of knowledge about the vermicomposting of agricultural wasted by using earthworms.

The objectives of the study are (1) to produce vermicompost from agricultural wastes (rice straw and cow dung) by using different worm species *Eisenia Fetida* and *Preionyx Excavatus* (2) to analyze the characteristics of vermicompost such as nitrogen content, phosphorus content , potassium content, calcium , magnesium and sulphur contents, organic matter content, moisture content, pH and carbon and nitrogen ratio and (3) to apply the vermicompost in Japan-ne-gya (*Melampodium paludosom* H. B and K.) and Mo- hmyaw-ngayok (*Capsicum minimum* Roxb.) and study its effect on plant growth characteristics.

Materials and Methods

Experimental Site and Set Up

The vermicomposting experiments were conducted at the Laboratory of Department of Industrial Chemistry, West Yangon University during the year 2010, and taking 3 months and 20 days (from August 18 to December 6). There were three experiments in the study:

Experiment 1 - Vermicomposting by 400 numbers of locally available Red Wigglers *Eisenia Fetida*.

Experiment 2 - Vermicomposting by 400 numbers of Indian Blue earthworm *Preionyx Excavatus*.

Experiment 3 - Vermicomposting by combination of 200 numbers of each of Red Wigglers and Indian Blue earthworms.

Collection of Worm Samples

600 numbers of locally available Red Wiggler (*Eisenia Fetida*) and 600 numbers of Indian Blue earthworms (*Preionyx Excavatus*) were obtained from Myanmar International Crop Development Enterprise (MICDE), Ministry of Agriculture and Irrigation, 9 mile, Pyay Road, Yangon.

Preparation of Bedding

The three cement rings having diameter of 3 feet and height of 1.5 feet were placed at the shaded area in the laboratory. The cement ring was filled with 25 kilograms of rice straw. Then, 5 kilograms of cow dung slurry was sprinkled on the rice straw. Finally, the cement ring was completely filled with 25 kilograms rice straw and the top of cement ring was pasted with 10 kilograms of cow dung. The rice straw was allowed to decompose for 20 days.

Vermicomposting

When the heat evolved during the decomposition of the materials has subsided (after heaping for 20 days), 400 numbers of earthworm were released through the cracks developed. The worms disappeared from the surface of bedding within a few minutes. The small amount of water was sprinkled to the bedding material in the cement ring. 1.5 L of water was sprinkled everyday in order to maintain adequate moisture and body temperature of the earthworms. The ring contents were kept moist but not soaked because the earthworms could be killed either by the stagnant water or by the lack of moisture in the ring.

Harvesting the Vermicompost and Worms

The vermicompost was harvested 3 months after the earthworms had released into the bed. The processed vermicompost was black, light in weight and free from bad odor. When the vermicompost was ready to harvest, it was kept without watering for 3 days to make vermicompost easy for shifting. The vermicompost was piled in small heaps and left under ambient condition for a couple of hours when all the worms move down the heap. The upper portion of the pile was separated and the lower portion was sieved to separate the earthworms from the vermicompost. The vermicompost was packed in plastic bags and stored them in a cool place. After completion of the process, the whole procedure was repeated for the next batch of vermicomposting.

Analysis of Vermicompost

The physical characteristics of vermicompost samples such as moisture content and pH, were measured at the Laboratory of Department of Industrial Chemistry, West Yangon University. The chemical characteristics of vermicompost samples such as nitrogen, phosphorus, potassium, calcium, magnesium, sulphur and organic matter content, and carbon and nitrogen ratio were analyzed at the Laboratory of Department of Land Use Division, Myanmar Agriculture Service (MAS), Ministry of Agriculture and Irrigation, West Gyogone, Bayint Naung Road, Yangon.

Application of Vermicompost to Japan-ne-gya (*Melampodium Paludosum* H. B. and K.) and Mo-hmyaw-ngayok (*Capsicum minimum* Roxb.)

The pot experiments for the effect of vermicompost on the growth and development of Japan-ne-gya and Mo-hmyaw-ngayok were conducted by comparing with the plants without application of vermicompost, at the Laboratory of Department of Industrial Chemistry, West Yangon University, during the year 2010-2011 taking three months (from December 15 to March 15). The experiments contained four pots. The seedlings of Japan-ne-gya and Mo-hmyaw-ngayok (6^{th} week condition) were planted in two pots with the application of vermicompost and the other two seedlings of the same age were planted in another two pots without application of vermicompost. Plant height and number of leaves, flowers and fruits were measured and recorded monthly.

Results and Discussion

Vermicomposting Process

It was found that the complete conversion of all the agricultural wastes into vermicompost took 110 days (from 18 August 2010 to 6 December 2010). The processed vermicompost was black, light in weight and free from bad odor. At the beginning of the process, the earthworms digested the agricultural wastes starting near the wall of cement ring. As the decomposition process progressed, the area of vermicompost product became wider and wider towards the center of the bed. Finally the whole cement ring was filled with vermicompost products.

Amount of Vermicompost Product

As indicated in Table (1), the weight of vermicompost product in experiment 1 (using 400 numbers of Red Wigglers) was 57 kg, that in experiment 2 (using 400 numbers of Indian Blue worms) was 53 kg, and that in experiment 3 (using combination of 200 numbers of Red Wigglers and Indian Blue worms) was 60 kg. The yield percent in experiment 3 was the highest with 92.31 %.

Table (1) Weight of Raw Materials and Vermicompost Products

Experiment	Weight of Raw Materials (kg)			Weight of Vermicompost (kg)	Yield Percent (%)
	Rice Straw	Cow Dung	Earth-worm		
Experiment 1	50	15	0.28	57	87.69
Experiment 2	50	15	0.25	53	81.54
Experiment 3	50	15	0.27	60	92.31

Multiplication of Earthworms

There was an increase in earthworm population during the vermicomposting process. The result showed that mixed culture of Red Wigglers and Indian Blue worms in the experiment 3 multiplied 3.03 times as shown in Table (2).