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Study on the Production of Vermicompost from Food Wastes and its Application in Mustard Greens (*Brassica Juncea* var.) Plantation

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Abstract

With the progressive increase in the size of the Myanmar's population, large volumes of organic wastes produced all over the country are creating a serious disposal problem and a major source of environmental pollution. In the study, effective recycling of food wastes was carried out to produce organic fertilizer – vermicompost. The locally available earthworm Red Wigglers *Esenia Fetida*, and Indian Blue earthworm *Preionyx Excavatus* were used for the purpose. The characteristics of vermicompost such as nitrogen content, phosphorous content, potassium content, organic matter content, calcium and magnesium contents, pH, carbon and nitrogen ratio were determined. The vermicompost products were applied in Mustard Greens (*Brassica Juncea* var.) (Mon-hnyin) plantation and its effect on growth characters were investigated. The vermicomposting process took 3 months to produce black, light and odourless products. The results showed that vermicompost produced from mixed earthworm species gave higher yield than those produced by single species. The analysis of vermicompost revealed that it contained sufficient amount of both primary macronutrients – nitrogen (1.32%), phosphorus (0.72%), potassium (0.58%), and secondary macronutrients – calcium (0.79%) and magnesium (0.32%). It was also found that Mustard Greens plants with the application of vermicompost had better growth characters in terms of numbers of leaves per plant, leave length and leave width than those plants without application of vermicompost.

Key words: organic fertilizer, vermicompost, earthworm, macronutrients

Introduction

Rapid growth of population and industrialization in Myanmar has resulted in large volumes of solid wastes which are creating a serious disposal problem. Unscientific and indiscriminate disposal of solid waste is a matter of serious health concern. Immediate actions are therefore warranted for proper management of urban solid waste. Under these circumstances there is an immediate need for improved technologies for reduction in generation of solid

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waste and for recycling and reuse. Further, it is very important to adopt the most economically viable method for solid waste disposal.

Organic waste makes up a major component of solid waste in most municipalities throughout Myanmar. As of the survey conducted at Hlaing Tharyar Township in 2009, organic waste constituted 74% of total solid waste (Seinn Lei Aye, Bo Bo Thet and Nwe Ni Win, 2009). Vermicomposting, or composting with the help of earthworms, is an excellent technique for recycling food waste in the apartment as well as composting yard wastes in the backyard. Certain species of earthworms consume a wide range of food waste very rapidly and converting them into vermicompost which is more effective organic fertilizer than garden compost (Hailu, K.A., 2009). Vermicompost contain higher percentage (nearly twofold) of both macro and micronutrients than the garden compost (ICRISAT, 2006). Vermicompost is an essential material in organic farms and greenhouse bedding plants.

Thus, the present study aims to produce vermicompost at house level from food waste, and assessing its efficacy by applying it to Mustard Greens (*Brassica Juncea* var.) (Mon-hnyin) plantation. The specific objectives of the study are (1) to produce vermicompost from food wastes (outer leaves of banana stem, watermelon peels, and outer leaves of cabbage and cauliflower) 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 and magnesium contents, organic matter content, moisture content, pH and carbon and nitrogen ratio, and (3) to apply the vermicompost in Mustard Greens (*Brassica Juncea* var.) (Mon-hnyin) plantation 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 2011, and taking three months (from January 5 to April 4). There were three experiments in the study:

Experiment 1 - Vermicomposting by 300 numbers of locally available Red Wigglers *Eisenia Fetida.*

Experiment 2 - Vermicomposting by 300 numbers of Indian Blue earthworm *Preionyx Excavatus.*

Experiment 3 - Vermicomposting by combination of 150 numbers each of Red Wigglers and Indian Blue earthworms.

Collection of Earthworms

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

Preparation of Vermibin

The three cement tanks having a diameter of 90 cm and height of 45 cm were placed in the shaded area in the laboratory. Each cement tank was filled with gravel to about 5 cm, then with sand to about 3 cm, and finally with loamy soil to about 12 cm. To this, about 300 earthworms were inoculated. 5 kilograms of cow dung were scattered on top and covered with 5 kilograms of dry leaves. One liter of water was sprinkled daily and maintained for 20 days.

Feeding the Earthworms

Food wastes like vegetable peels, unwanted leaves, fruit skins, egg shells, non-greasy leftovers and coffee grounds can all be used to feed the earthworms. In this experiment, they were fed with outer leaves of banana stem, watermelon peels and outer leaves of cabbage and cauliflower. Food wastes, collected from Da-Nyin-Gown Market, were weighed and introduced into the vermibin on the 20th day of the experiment. Into each vermibin, 5 kilograms of food waste was added once every three days until the 44th day of the experiment.

Watering the Compost Bed

One liter of water was sprinkled every day in order to maintain adequate moisture and body temperature of the earthworms. The vermibin contents were kept moist but not soaked because the earthworms could be killed either by the stagnant water or by the lack of moisture. As the vermicompost was getting ready, the change of refuse into spongy and good smelling dark brown compost was noticeable. Watering was stopped on the 42nd day of last application of food waste.

Harvesting the Vermicompost

The vermicompost was harvested 45 days after the last application of the food waste. The processed vermicompost was black, light in weight and

free from bad odor. The compost was carefully taken with spade without disturbing the bed and heaped in 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 weight of vermicompost obtained from each experiment was measured. The vermicompost was packed in polythene bags to retain moisture and stored them in a cool place.

Analysis of Vermicompost

The physical characteristics of vermicompost samples, 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 content, phosphorus content, potassium content, calcium and magnesium contents, 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 Mustard Greens (*Brassica Juncea* var.) (Mon-hnyin) Plantation

The field experiments for the effect of vermicompost on the growth and development of mustard greens was conducted during December 2011 to January 2012 at the organic farm of Central Bank of Myanmar, Yankin Township, Yangon. To test the efficacy of vermicompost upon plant growth, mustard greens was chosen as the candidate plant.

Two plots of dimension 120 inches x 35 inches was measured and selected. Soil tilling was done for proper aeration and water penetration. To avoid seepage and leaching of vermicompost in between the plots a polythene sheet filled with small pieces of bricks was placed to the depth of 6 inches. Plots were then watered uniformly and left undisturbed for a day.

The plots were labeled as I and II. Of these, 700 g of prepared vermicompost was applied to plot I and plot II was left as control for comparison. On the next day, each plot was divided into 7 equal rows. The seedlings of mustard greens were obtained from nursery bed in the organic farm of Central Bank of Myanmar, Yankin Township, Yangon. The seedlings were transplanted to the plots in the late afternoon to minimize transplant shock. The seedlings were inserted in holes so the cotyledons were above the

surface. The soil around the root was pressed firmly. The plant spacing was 5 inches. Then, the bases of plants were watered to settle the soil.

The average number of leaves, average leaf length, and average leaf width were noted based on 6 random samples from each plot, once a week from 30 December 2011 to 26 January 2012 (4 weeks). The collected data were analyzed using IRRISTAT software version 4.0 developed by International Rice Research Institute (IRRI), the Philippines.

Results and Discussion

It was found that the complete conversion of all the food wastes into vermicompost took 3 months (from 5 January 2011 to 4 April 2011). The processed vermicompost was black, light in weight and free from bad odor.

With an input of 45 kg of organic waste, 18.5 kg of vermicompost in experiment 1, 16.3 kg in experiment 2, and 20 kg in experiment 3 were produced as shown in Table 1. The results showed that vermicompost produced from mixed earthworm species in Experiment 3 gave higher yield (44.4%) than those produced by single species in Experiment 1 and 2 (41.1% and 36.2%). In total, 2.5 fold reductions in weight of organic matter were achieved using this method of vermicomposting.

The primary macronutrients in vermicompost are nitrogen (N), phosphorus (P), and potassium (K). Phosphorus and potassium predominantly refer to in their oxide form, i.e., P_2O_5 and K_2O. Nitrogen is important in plant for protein formation and photosynthesis. Phosphorus and potassium play an important role in accumulation and transport of the products of plant metabolism and crop disease resistance. The results in Table 2 show that nitrogen and phosphorus contents in vermicompost sample 1 were the highest at 1.32 % and 0.72 %. It was also found that the potassium content of vermicompost sample 3 was the highest at 0.62 %. All the results fall within the range of literature value. The secondary nutrients, calcium (Ca) and magnesium (Mg), content of vermicompost sample 3 was found to be the highest at 0.71 % and 0.39 %. In general, it can be said that sample 1 had highest primary macronutrients and sample 3 had highest micronutrients.

Organic matter has ability to hold a lot of moisture and can attract up to ten times more plant nutrients than can the clay minerals. To provide proper nutrition for earthworms during vermicomposting, carbon and nitrogen must be present in the substrates in the correct ratio. According to Dalzell, H.W. (1987), for efficient compost production the wastes should have a carbon and

nitrogen ratio (C/N ratio) in the range of 25-35. If it is higher, nitrogen- a valuable plant nutrient - will be lost in the form of ammonia gas. If it is lower, air would fail to penetrate the mass which would quickly go anaerobic and cause bad smell. The simplest method of adjusting the C/N ratio is to mix together different materials of high and low carbon and nitrogen contents. Therefore, dry leaves which had a high C/N ratio (35-40) were mixed with cow dung which had low C/N ratio (20-25). As indicated in Table 3, the organic matter in vermicompost samples were 65.35, 59.33 and 63.43. It was also found that,the vermicompost samples were found to have C/N ratio of 27.38, 27.60 and 26.24 which all indicated that the vermicomposting had progressed with the correct ratios of raw materials.

Excessive moisture may damage the granular structure of fertilizers, affect their quality and influence their nutrient content by increasing the weight of fertilizers. Therefore, moisture content is critical to determining the quality of a fertilizer. According to ICRISAT (2006), the moisture content of vermicompost ranges between 32 and 66%. The moisture content of vermicompost samples are shown in Table 3. The results showed that the moisture content of vermicompost were 63.5 %, 64.8 % and 63.1%.

pH has a considerable influence on the availability of nutrients to crops. It also effects earthworm population. ICRISAT (2006) recommended that the pH of vermicompost should be around 7. As shown in Table 3, the pH of vermicompost samples are 6.92, 6.89 and 6.80 which all fell within the range of literature value.

The effect of vermicompost treatments on the growth and development of Mustard Greens (*Brassica Juncea* var.) (Mon-hnyin) were measured every week for four weeks and the statistical results are mentioned in Table 4, Table 5 and Table 6.

The statistical results showed that the number of leaves between treatments were significant at 0.01 % level in week 2, week 3 and week 4. It was significant at 0.05 % level in week 1. There was increase in growth, every week. Between treatments, the number of leaves in vermicompost treatment was higher than that of without vermicompost treatment. At week 1, the number of leaves in vermicompost treatment was 16.25 %; at week 2, it was 33.29 %; at week 3, it was 22.22 %; and at week 4, it was 18.18 % higher number of leaves than without vermicompost treatment (Table 4).

The statistical results showed that leaf length was significant at 0.01 % level in week 1 and week 2; at 0.05 % level in week 3; and non significant in week 4. But their growth increased every week. Between treatments, leaf length of vermicompost treatment was higher than that of without vermicompost treatment. At week 1, the leaf length of vermicompost treatment was 15.23 %; at week 2, it was 9.81 %; at week 3, it was 10.95 %; and at week 4, it was 8.86 % longer leaf length than without vermicompost treatment (Table 5).

Similarly, statistical results of leaf width was significant at 0.05 % level in week 1, but non significant in the later part of growth. The broader leaf width also resulted from the plants with vermicompost treatment. It was also observed that there was also growth in leaf width. At week 1, the leaf width of vermicompost treatment was 19.33 %; at week 2, it was 8.95 %, at week 3, it was 9.73 %, and at week 4, it was 10.87 % higher leaf width than that of without vermicompost treatment (Table 6).

Table 1. Vermicompost Production

Experi-ment	Weight of Raw Materials (kg)			Weight of Food Wastes (kg)	Weight of Vermi-compost (kg)	Yield Percent (%)
	Outer leaves of banana stem	Water-melon peels	Outer leaves of cabbage & cauli-flower			
1	15	15	15	45	18.5	41.1
2	15	15	15	45	16.3	36.2
3	15	15	15	45	20.0	44.4
Average				45	18.3	40.7

Table 2. Macronutrients of Vermicompost

Macro-nutrients	Sample 1*	Sample 2*	Sample 3*	Literature Value**
Primary Macronutrients				
N(%)	1.32	1.05	1.12	0.5-1.6
P_2O_5(%)	0.72	0.61	0.64	0.2-1.0
K_2O(%)	0.58	0.52	0.62	0.2-0.7

Macro-nutrients	Sample 1*	Sample 2*	Sample 3*	Literature Value**
Secondary Macronutrients				
Ca(%)	0.69	0.58	0.71	0.5-1.5
Mg(%)	0.32	0.27	0.39	0.1-0.6

* The experiments were conducted at the Laboratory of Department of Land Use Division, Myanmar Agriculture Service (MAS), Ministry of Agriculture and Irrigation, West Gyogone, Bayint Naung Road, Yangon.

* * ICRISAT (2006)

Table 3. Characteristics of Vermicompost

Characteristics	Sample 1*	Sample 2*	Sample 3*	Literature Value **
Organic Matter (%)	65.35	59.33	63.43	25-80
Moisture Content (%)	63.5	64.8	63.1	32-66
C:N	27.38	27.60	26.24	25-35
pH	6.92	6.89	6.80	~ 7

* The experiments were conducted at the Laboratory of Department of Land Use Division, Myanmar Agriculture Service (MAS), Ministry of Agriculture and Irrigation, West Gyogone, Bayint Naung Road, Yangon.

* * Dalzell, H.W. et al. (1987) and ICRISAT (2006)

Table 4. Effect of Vermicompost Treatments on the Number of Leaves of Mustard Greens (*Brassica Juncea* var.)

Treatment	Number of Leaves			
	Week 1	Week 2	Week 3	Week 4
Without Vermicompost	4.33	4.67	7.00	9.00
With Vermicompost	5.17	7.00	9.00	11.00
F-test	*	**	**	**
5 % LSD	0.7894	1.4327	0.6632	1.1487
cv %	11.2	16.6	5.6	7.7

* 0.05% significant level, ** 0.01% significant level, LSD - lease significantly difference. cv - coefficient variation

Table 5. Effect of Vermicompost Treatments on the Leaf Length of Mustard Greens (*Brassica Juncea* var.)

Treatment	Leaf Length (cm)			
	Week 1	Week 2	Week 3	Week 4
Without Vermicompost	6.96	10.94	12.36	14.61
With Vermicompost	8.21	12.13	13.88	16.03
F-test	**	**	*	ns
5 % LSD	0.7626	1.0823	1.586	2.085
cv %	6.8	7.5	6.3	8.1

* 0.05% significant level, **0.01% significant level, ns - non significant, LSD - lease significantly difference, cv-coefficient variation

Table 6. Effect of Vermicompost Treatments on the Leaf Width of Mustard Greens (*Brassica Juncea* var.)

Treatment	Leaf Width (cm)			
	Week 1	Week 2	Week 3	Week 4
Without Vermicompost	5.26	9.05	10.85	11.64
With Vermicompost	6.52	9.94	12.02	13.06
F-test	*	ns	ns	ns
5 % LSD	0.6511	1.1361	2.3726	2.1796
cv %	8.1	14	9.2	11.9

* 0.05% significant level, ns - non significant, LSD - lease significantly difference, cv - coefficient variation

Conclusion

In the present work, the effective recycling of food wastes was carried out to produce organic fertilizer – vermicompost. The vermicomposting process took 3 months to produce black, light and odourless products. The results showed that vermicompost produced from mixed earthworm species gave higher yield than those produced by single species. The analysis of vermicompost revealed that it contained sufficient amount of both primary macronutrients – nitrogen (1.32%), phosphorus (0.72%), potassium (0.58%), and secondary macronutrients – calcium (0.79%) and magnesium (0.32%). Therefore, the vermicompost produced was rich in all essential plant nutrients

for providing excellent effect on overall plant growth, encouraging the growth of new shoots/ leaves and improving the quality of the product. It was also found that Mustard Greens plants with the application of vermicompost had better growth characters in terms of numbers of leaves per plant, leaf length and leaf width than those plants without application of vermicompost.

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