A study on the efficiency of low cost vermicomposting structure

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Key words: Low cost vermicomposting, Perionyx excavates, vermiwash, cocoons

Abstract

The present study was conducted with the objective to find out the efficiency of the low cost vermicomposting unit as compared to conventional units involving higher cost of construction. The experiment was laid out in a five-replicated randomized block design (RBD) with 4 treatments using Perionyx excavates in low cost vermicomposting unit of various dimension with conventional unit as control. Among the 4 treatments T_1 ,T_2 and T_3 were found to be at par in terms of quantity of vermicompost harvested. Result revealed that among the different low cost vermicomposting units T_2 was efficient in terms of quantity of vermicompost harvested, vermiworms and numbers of cocoons produced followed by T_3. Production of vermiwash was highest in T_1 (12 to 10 L per week) followed by T_2(10 to 9 L per week). Daily temperature recorded in the vermi composting tanks was initially higher and gradually decreased with the decomposition process. Benefit: Cost ratio was highest in T_2 (6.56:1)followed by T_3(4.46:1).

Introduction

Vermes is a Latin word for worms and vermicomposting is the term given to the process of conversion of biodegradable matter by earthworms into vermicast. In the process, the nutrients contained in the organic matter are partly converted to the more bioavailable forms (Gajalakshmi *et al.,* 2003). The vermicomposting technology for conversion of solid organic wastes to useful product has been ranked higher than composting in certain aspects (Dominguez *et al,* 1997).Vermicompost contains more of available nutrients than regular FYM or compost. Secretions of earthworms that are in the vermicompost serve as plant growth stimulatory factor (Galli *et al*, 1990; Tomoti *et al*, 1990; Graff and Makeschin, 1980). Vermicompost can be effectively utilized as a carrier medium for *Azospirillum, Rhizobium* and phosphate solubilisers. To popularize the vermicomposting process among the small and marginal farmers there is a need to fabricate a vermicomposting unit involving lower cost so that the economically weaker section of the farmers can adopt the vermicomposting technology as the construction of conventional concrete structure involves higher cost. Therefore, keeping in view the above an experiment was carried out to fabricate a low cost vermicomposting unit for efficient production of vermicompost at par with the concrete structure. This will aid in mass production of vermicompost resulting in reduced application of chemical fertilizers detrimental to soil health.

Material and methods

The present study was conducted at the Dryland Technology Park, All India Coordinated Research Project for Dryland Agriculture, Biswanath Chariali Center Biswanath College of Agriculture, Assam Agricultural University, District Sonitpur Assam, India during 2012 -2013. Low cost vermicomposting units were fabricated using locally available low cost materials such as bamboo, dried banana leaves (for shading as side walls) and polythene sheet for roof and laying in the tank. A PVC pipe (1.27 cm diameter) was used for connecting the vermicomposting unit with an earthen pit (0.31 m x 0.31 m x 0.31 m) for collection of vermiwash. A layer of pebble (≈15 cm) and layer of sand (≈15 cm) were placed over the plastic sheet in the vermicomposting tank and a layer of bedding material was placed over the sand and pebble layer. Earthen drains were provided (0.61m x 0.31m) surrounding the vermicomposting unit as a bio-control measure against attack of earthworm enemies primarily for preventing entry of ants. The experiment was laid out in five replicated randomized block design consisting of 4 treatments viz., T_1: Vermicomposting in concrete tanks (Control) with dimension 2.5 m(L) X 0.91 m (B) X 0.91 m(D),T_2: Vermicomposting in low cost vermicomposting unit with dimension 2.5 m(L) X 0.91 m (B) X 0.91 m(D),T_3: Vermicomposting in low cost vermicomposting tanks with dimension 2.5 m(L) X 1.2 m (B) X 0.76 m(D),T_4: Vermicomposting in low cost

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vermicomposting tanks with dimension 2.5 m(L) X 1.2 m (B) X 0.46 m(D). *Perionyx excavates* worms were used for vermicomposting purpose. The units were filled with pre decomposed composting materials composed of biomass (chopped banana pseudo stem) and dried cow dung in 60:40 ratio which was allowed to decompose for a period of one month prior to vermicomposting in the tank. The pre-decomposed mixture was placed in the vermicomposting units and 750g *Perionyx excavates* worms were released in each tanks after two weeks of filling the tanks. The two weeks period was allowed for stabilization of temperature of the semi decomposed biomass mixture. Daily temperature of the tanks was monitored during the vermicomposting process using an ordinary thermometer. The results were statistically analyzed (Panse and Sukhatme, 1989) for interpretation.

Results

Temperature during the decomposition process: Temperature plays a very vital role in the growth and development of the earthworms. Requirement for optimal result is 20-30 °C (Sharma, 2009) .The bed temperature was monitored after one week of transferring the decomposed materials in the tanks for each cycle i.e. three cycles in a year. During the whole vermicomposting process (filling of tank to harvesting of worms) the initial maximum temperature after two weeks of filling of tank was 27.5 °C in T_1 and it slowly decreased with the decomposition of composting materials and the lowest value was recorded to be 23.5 °C. Similarly, in other tanks i.e. T_2 the daily temperature was slightly lower than T_1 and ranged between 26.5 to 22.0 °C followed by T_3 which ranged between 24.5 to 19.5°C and T_4 recoded the least daily temperature of 21.3 to 17.8 °C. The temperature in the vermicomposting tanks was maximum during summer months as compared to winter months.

Earthworm population and yield of vermicompost: The data on earthworm population and yield of vermicompost is presented in table 1. The highest production of vermicompost was recorded in the tank T_1 of (914 kg/tank). Among the low cost vermicomposting tanks T_2 and T_3 was found to be at par in terms of production of vermicompost. The production of vermicompost in T_2 was 903 kg/tank followed by T_3 of 6.78 q/tank. The lowest production of vermicompost was recorded in the tank T_4 of (5.78 q /tank). The maximum quantity of vermiworms was recorded in T_2 (3.39 kg/tank) and was at par with T_1 (3.22 kg/tank). Whereas, numbers of cocoons was recorded highest in T_1 (108 nos/0.03m^3) and found to be at par with T_2 (107.3 cocoons/0.03m^3**)** followed by T_3 (1.91 kg/tank, 92 cocoons/0.03m^3). The lowest value was recorded in the T_4 (1.12 kg/tank, 54.1 cocoons/0.03 m^3).

Table.1: Yield of vermicompost, vermiworms and number of cocoons/0.03m^3 **(Stat. method: RBD)**

Treatments	Vermicompost harvested (q/tank)	Vermiworms harvested(kg/tank)	No. of cocoons/0.03m^3
$T_{1\ (Control)}$	9.14 ^{a}	3.39 ^{a}	108 ^{a}
T_2	9.03 ^{a}	3.22 ^{a}	107.3^a
T_3	6.78 ^{a}	1.91 ^{b}	92 ^{b}
T_4	5.78 ^{b}	1.12 ^{c}	54.1 ^{c}
CD 5%	4.12	0.19	2.34

Composition of vermicompost: The average chemical composition of vermicompost (banana pseudo stem) is presented (Table 2) which shows that the vermicompost is alkaline in reaction with a pH value of 7.43 containing macro and micronutrients required for plant growth Table 3 also shows that the vermicomposting process is also helpful in carbon sequestration as indicated by presence of high level of organic carbon content (26.45%).

Table: 2: Average Chemical composition of vermicompost (banana pseudo stem)

Composition of vermicompost											
pH	Org.C	N	P_2O_5 (%)	K_20 (%)	Ca (ppm)	Mg (ppm)	S (ppm)	Fe (%)	Mn (ppm)	Cu (ppm)	Zn (ppm)
7.43	26.45	2.30	2.90	3.10	170.0	64.0	182.0	0.078	207.0	11.98	81.55

Production of vermiwash and its composition: Vermiwash is a mixture of earthworm urine and water applied for keeping the biomass in the vermicomposting tank in a moist condition. The vermiwash is reddish in color with an alkaline reaction (pH =7.87) and carries the dissolved nutrients present in vermicompost. The vermiwash is collected through a drainage pipe fitted at the bottom of the vermicomposting tank and connected to a small chamber (earthen pit lined with polythene).An analysis of vermiwash (Table 3) revealed that it contains 1482 mgL^{-1} nitrogen, 189 mgL^{-1} phosphorus and 1513 mgL^{-1} of potash. The electrical conductivity value indicated that vermiwash is non saline and non alkaline (EC 0.09 dsm^{-1}).

Table: 3: Composition of vermiwash

pH	E.C (dsm^{-1})	Total N (mgL^{-1})	Total P (mgL^{-1})	Total K (mgL^{-1})
7.87	0.09	1482	189	1513

The maximum quantity of vermiwash (12 L per week) was collected from the tank T_1 (Control) followed by T_2, T_3 and T_4. Among the low cost vermicomposting units maximum vermiwash was recorded in T_2 (10 L per week). The higher quantity of vermiwash collected in T_1 because there was no loss in the conveyance process due to concrete structure as compared to low cost units owing to wear and tear of the plastic lining material laid in the tank.

Economics: Among the low cost units the highest Benefit: Cost ratio (Table 4) was recorded in T_2 (6.56:1) followed by T_3 (4.46:1) and T_4 (3.41:1).The Benefit: Cost ratio was recorded negative in the $T_1$with a net return of -3513.00 which is due to involvement of higher cost in construction of the concrete pits.

Table: 4: Economics of concrete and low cost vermicomposting unit

Treatments	Cost of structure	Gross Returns(Rs.)	Net Returns (Rs.)	B:C Ratio
$T_{1\ (Control)}$	21000.00	17487.00	-3513.00	---
T_2	2700.00	17715.00	15015.00	6.56
T_3	2620.00	11684.50	9064.50	4.46
T_4	2540.00	8665.50	6125.5	3.41

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Figure 1. Low Cost Vermicomposting Unit

Discussion

Temperatures in the summer months have the potential to rise to relatively high levels when air temperatures increase and this could have a detrimental effect on earthworm population. The ambient temperature was found to be lower as compared to the temperature of the decomposing biomass in the initial stages of the vermicomposting process probably due to initial higher level of microbial activity in all the treatments. The production of vermiwash was higher in the initial stages of vermicomposting process, which subsequently declined, with the advance of the vermicomposting process. In the control treatment vermiwash production continued till harvest probably due to absence of seepage loss in the concrete tanks. The end product of vermicomposting process yields an organic manure having a number of plant nutrients essential for growth and development of the plant without having any adverse effect on soil and the environment .Benefit: Cost ratio indicate that by adopting the low cost technology the farmers can get substantial benefit and augment farm income .

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