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Performance of low input active aeration pile, turning pile and static pile for composting organic fertilizer

Sayan Tanpanich, Rewat Chindachia, Cholticha Niwasprakit and Montree Keawdoung

Thailand Institute of Scientific and Technological Research,
35 Moo 3, Klong 5, Klong Luang, Pathumthani 12120, Thailand.

*Author to whom correspondence should be addressed, email: sayan@tistr.or.th

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Abstract

Composting performance was carried out in low input passive aeration by using mechanical roof's ventilation fan in comparison with turning every 7 days and static piles. The three treatments under investigation are (1) mechanical roof's ventilation fan, (2) turning pile every seven days and (3) static pile. There were no significant differences in term of peak temperature, days to reach peak temperature, total duration which temperature above 55 °C, increasing rate and decreasing rate. The difference was the days to completion of the composting process. Treatment with mechanical roof's ventilation fan showed the most effective composting process regarding temperature profile. It was 79.50 days in completion. Whereas slower composting processes were recorded in turning pile every 7 days and static pile. These were 111.00 and 124.00 days, respectively. Composting under mechanical roof's ventilation fan showed significantly lower electrical conductivity (EC) than turning pile and static pile.

Keywords: composting organic fertilizers, aeration pile, turning pile and static pile

Introduction

In composting, the two conventional methods used are turning pile and static pile. The disadvantage of turning pile is labor intensive, which leads to high capital input. To minimize or reduce labor cost, the passive aeration method or natural convection method was recommended. However, the efficiency of the passive aeration using the horizontal pipes for aeration is limited by air feeding as it is difficult to ventilate the pipes by the natural

convection. Sylla et al. (2003) studied the effect of the number of the vertical pipes for the passive aeration on the composting rate found that the composting rate was increased when increasing in number of perforated pipes placed vertically in the composting bed.

Active aeration or forced aeration is another way to reduce labor cost. However, there are many inputs such as blower, electricity and perforate pipe. Sartaj et al. (1997) found that forced aeration made the compost pile reached the ambient temperature sooner than passive and natural aeration. On the contrary, it is less effective in conserving nitrogen than passive aeration

The objective of this study is to investigate the performance of low cost active aeration by using mechanical roof's ventilation fan to composting dairy cow manure mixed with rice straw compared with perforate pipe, turning pile and static pile.

Materials and Methods

Three treatments with four replications of interlocking block compost bin were built and monitored for a period of 12 weeks. The size of interlocking block compost bin was 1.25×1.5×1.5 m (W×L×H). The three treatments were as follows:

T₁ - Active aeration by using mechanical roof's ventilation fan;

T₂ - Turning pile every 7 days;

T₃ - Static pile

Each compost bin contains 825 kg. of raw materials at the beginning of the experiment. In order to adjust the C:N ratio to be closed to 30:1. 200 kg of rice straw was added to 625 kg. of dairy cow manure for each bin. Moisture content of the mixture was adjusted to approximately 60% at the beginning of the study. The Land Development's composting microorganism was used in all treatment in accordance with the instruction.



Figure 1: Model of compost bin with different placement.

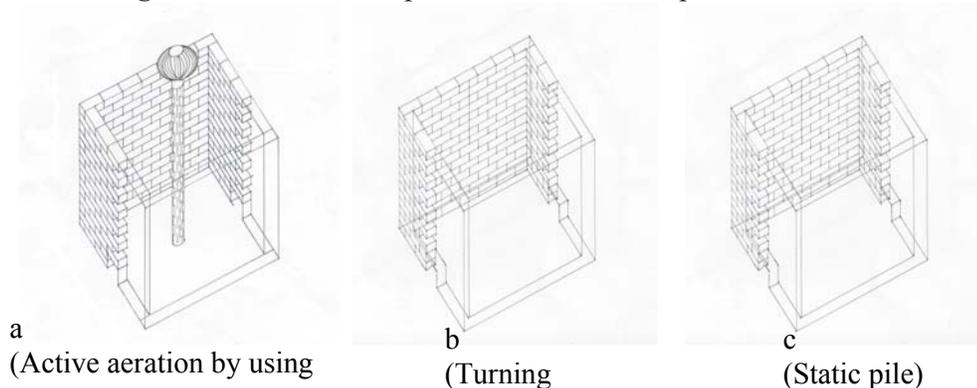


Figure 2: a (T₁), b (T₂) and c (T₃).

The top layer of each treatment was covered with mature compost to 15 cm. thick, to minimize moisture and temperature loss. Temperatures with each compost bin were recorded every three days in different spots (i.e. at 20 cm. from the top, at the center and at 20 cm. from the bottom). Ambient temperature was employed as an indicator of the completion of composting. Samples of compost were taken weekly for evaluation of moisture content. Chemical properties such as pH, electrical conductivity (EC), organic matter, C:N ratio, total nitrogen and total P₂O₅ were investigated at the start of the study, at week-4 and at the end of the experiment.

Results and Discussion

Temperature

Table 1: Analysis of variance of temperature profile.

Temperature profile	Treatment			Prop.>F
	T ₁	T ₂	T ₃	
Peak temperature (°C)	71.00	69.00	69.00	0.4163
Days to reach peak temperature	7.50	9.00	9.00	0.4648
Total Duration >55 °C (days)	22.50	27.00	40.50	0.1250
Increasing rate to reach peak temperature (°C/day)	18.92	15.21	15.21	0.3787
Decreasing rate to reach ambient temperature (°C/day)	1.15	0.83	0.82	0.2106
Days to reach 32 °C (ambient temperature)	79.50	111.00	124.50	0.0070

There were no significant differences in term of peak temperature, days to reach peak temperature, total duration which temperature above 55 °C, increasing rate and decreasing rate of temperature. However, the active aeration with mechanical roof's ventilation fan (T₁) showed highest in peak temperature, faster to reach the peak temperature and highest in increasing rate to reach the peak temperature than turning pile (T₂) and static pile (T₃). It showed significantly highest decreasing rate to reach ambient temperature than turning pile (T₂) and static pile (T₃).

All treatments showed total duration which temperature above 55 °C maintained for more than 15 days. Therefore, all means of composting can destroy pathogens (Wiley and Westerberg, 1969) and weed seeds (Larney and Blackshaw, 2003).

There were differences in days to completion of the composting process. Active aeration with mechanical roof's ventilation fan showed the most effective composting process regarding temperature profile. It was 79.50 days in completion. Slower composting processes were recorded in turning pile every seven days and static pile and these were 111.00 and 124.00 days respectively.

Chemical properties

Organic matter content and C:N ratio of raw material at the beginning of the experiment were 59% and 20.69 respectively. There were no significant differences in term of organic matter content, organic carbon, total N, C:N ratio and total P₂O₅ among composting treatments at the finish. Electrical conductivity (EC) and pH of active aeration with mechanical ventilation fan (T₁) was significant lower than in turning pile every seven days and static pile.

Table 2: Chemical properties of dairy cow manure mixed with rice straw at the beginning of the experiment.

Chemical properties	Dairy cow manure mixed rice straw		
	T ₁	T ₂	T ₃
Organic matter (%)	59.21	59.23	59.23
Organic carbon (%)	34.34	34.35	34.35
Total nitrogen (%)	1.66	1.66	1.66
C:N ratio	20.69	20.69	20.69
pH	7.83	7.83	7.83
Electrical conductivity (ds/m)	5.41	5.42	5.42
Total P ₂ O ₅ (%)	1.36	1.36	1.36

Table 3: Chemical properties of compost at finish.

Chemical properties	Treatment			Prop.>F
	T ₁	T ₂	T ₃	
Organic matter (%)	29.82	32.51	30.20	0.6912
Organic carbon (%)	17.30	18.86	17.52	0.6908
Total nitrogen (%)	1.79	1.75	1.77	0.3918
C:N ratio	9.65	10.78	9.93	0.5650
pH	7.50	7.93	7.90	0.0093
Electrical conductivity (ds/m)	4.21	4.83	5.11	0.0242
Total P ₂ O ₅ (%)	1.88	1.86	1.88	0.9503

Organic matter and C:N ratio

Organic matter changing and C:N ratio decreasing during composting as observed in general is a good indicator of the effective composting processes. The active aeration treatment with mechanical roof's ventilation fan showed the trend of decreasing organic matter and C:N ratio faster than the turning pile every seven days and static pile.

Table 4: Organic matter content at the beginning and at finish of the experiment.

Parameter	Treatment			Prop.>F
	T ₁	T ₂	T ₃	
Organic matter at beginning (%)	59.22	59.23	59.23	
Organic matter at finish (%)	29.82	32.51	30.20	0.6912
Difference in organic matter at beginning and at finish (%)	29.40	26.78	29.03	0.6618

Table 5: C:N ratio at the beginning and at finish of the experiment.

Parameter	Treatment			Prop.>F
	T ₁	T ₂	T ₃	
C:N ratio at beginning (%)	20.74	20.61	20.77	
C:N ratio at finish (%)	9.65	10.78	9.93	0.5650
Difference in C:N ratio at beginning and at finish (%)	11.09	9.83	10.84	0.5745

Conclusions

Results of the present study showed that the active aeration with mechanical roof's ventilation fan can be effectively used in low input active aeration in composting organic fertilizers, since

it showed more effective in composting in term of days to reach the ambient temperature, decreasing organic matter and decreasing C:N ratio.

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