Preliminary Study on Composting Tropical Peat

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Summary : Tropical peat was studied for use as compost. The chemical properties of peat in Brunei Darussalam indicates a strong acidic pH value of 3.5. The water ratio was 500% indicating the peat was oversaturated. When lime was added to the peat to neutralize the pH and water content was maintained at 70%, calorific fermentation was stimulated. Compost quality was investigated using the bioassay method. The growth of tomato seedlings was best grass, then sawdust, leaf litter, peat, and topsoil, in that order. There was no evidence of chlorosis or root decay caused by post fermentation. Although the application of immature compost is believed to be feasible in the moist tropics, peat has to be used carefully because of ground settlement.

1 Introduction

At present, wide areas of tropical rain forests are being exploited in Southeast Asia. One such area is the peat swamp forest which has the potential for timber production and agriculture. Although tropical peats are located in Asia, Africa and Latin America, they are most widely distributed in Asia occupying 22.2 million hectares compared with 3.5 million hectares in Africa and 5.2 million hectares in Latin America (KYUMA *et al.*, 1986). Out of the 22.2 million hectares of Asian peatland, 18.2 million hectares are located in the tropical islands. Consequently, peat lands constitute one of the most important areas in insular Asia.

The total forest land in Brunei Darussalam occupies 469 046 ha, representing 80.6% of the total land area. There are 90 884 ha of peat swamps, or 15.6% of the total land area (Annual Report, 1986). The development of the peat formation was classified into three phases by ANDERSON(1964). In the first phase, mangroves encourage alluvial deposition at deltas and bays producing fresh water swamp forests. Shallow peat then formes under the mangrove forests. In the second phase, alluvium is deposited at the riverbanks by the backing up of the river and levees are formed. These levees create a concave base which accelerates peat accumulation, eventually resulting in the development of a domed convex structure. In the third phase, the rate of peat accumulation decreases in the swamp area and bog plains develop. The dominant species is *Shorea albida* in this area.

The following study is concerned with the utilization of peat as compost. Although topsoil has been the most common potting material, there are several problems associated with its use (KETOLA, 1985). According to KETOLA, compost was used instead of traditional topsoil, because it is difficult to find sufficient amounts of suitable quality top soil which is uncontaminated by weeds

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and bacteria, and is not are harmful to the seedlings. Topsoil also adds labor costs to nursery accounts.

Peat swamps are widely distributed in Brunei Darussalam. The utilization of peat as compost would have an economic impact and would affect the production of seedlings. In this study, the possibility of peat utilization as compost was examined. Tropical peat shows different chemical and decompositional properties from *Sphagnum* moss peat and grass peat. Therefore, different compost materials were examined. Sawdust, leaf litter and grass are also suitable for compost materials, and are available in Brunei Darussalam.

2 Materials and Methodology

2.1 Materials and piling

In this study, peat was considered as a raw material for compost and compared with sawdust, leaf litter and grass. Peat was taken from Tutong while the other materials were collected near Sungai Liang. All materials were commonly used in composts.

The experiment was begun May 25, 1989. In order to accelerate the decomposition of materials and the piling process, the following procedure was followed.
(1) Add the water and chicken manure. (2) Pile up the materials. (3) Check the temperature of compost materials. (4) Turn over once a week. (5) Add lime water (1:20) half way through the term. (6) Add chicken manure and ammonium sulfate. (7) After two months, take the samples to be checked. The condition of compost materials and amount of chicken manure and water are shown in Table 1.

2.2 Compost process check

(1) The temperature of piles was checked using TAKAR Thermistor every day in situ. (2) Water content of piles was by a handy moisture meter in situ. If the water content of piles was inadequate, water was supplied or aeration was controlled by turnover. Piles were tried to maintain the water content at 70%. (3) The pH of piles was measured by E.M.System soil tester (DEMETRA) in situ. If the pH was below 6.8, lime and/or water was supplied.

2.3 Maturity test of compost

(1) The color of compost was determined by the Manssel color chart book. The texture and smell of composts were also tested. (2) The pH was measured using a glass electrode; inorganic nitrogen, by micro-KJELDAHL ; cation exchangeable capacity, by the Peech method; and exchangeable cation was measured by an atomic absorption spectrophotometer. Ash content was determined after complete combustion. (3) Bioassay of compost quality was conducted. Tomatoes were planted to check the quality of composts. Compost became potting soil after two months piling and mixed with topsoil in a mixed *Dipterocarp* forest. The mixing ratio of compost to topsoil was 1:1. Ten pots were filled with composts and the control pot was filled with topsoil. The tomato seeds were sown directly in

Table 1. Condition of compost materials

	fresh weight	dry weight	chicken manures	water weight
peat	145	34	17	28
sawdust	214	66	33	28
litter	43	28	14	55
grass	38	18	9	83

※weight shows in kg, respectively

the pots and kept in the nursery at random locations. After two weeks, grass height, leaf number, stem diameter, biomass, root weight, leaf color and growth condition were measured.

3 Results and discussion

3.1 Composting process

During compost piling, temperature changes in the composts was observed (Fig.1). Peat, grass and litter composts were less than 35°C until the second half of the test period, but sawdust compost maintained an average of greater than 40°C for the whole time. The temperature of the sawdust compost indicated calorific fermentation (FUJITA & OHTAKA, 1987). The composts of peat, grass and litter did not ferment without sawdust compost. Lack of fermentation was due to inadequate conditions of pH and water content of compost materials. The condition of calorific fermentation depended on pH and water content of composting materials. The optional conditions of composting materials for fermentation were shown to be a pH of 7.0 and water content of 70 % (FUJITA & OHTAKA, 1987).

When pH and water content of composting materials were measured after 40 days piling, the peat contained more than 150% excess water and its pH was about 4.0. Grass and litter were too dry and had low pH. All materials exhibited pH values of less than 7.0 and were acidic. Starting July 29, lime was added to convert the composts to neutral pH and water content was maintained at 70 %. Following this treatment, all composts began the fermentation process and temperatures increased accordingly. The utilization of tropical peat was belived to initiate the calorific fermentation by drying and neutraization.

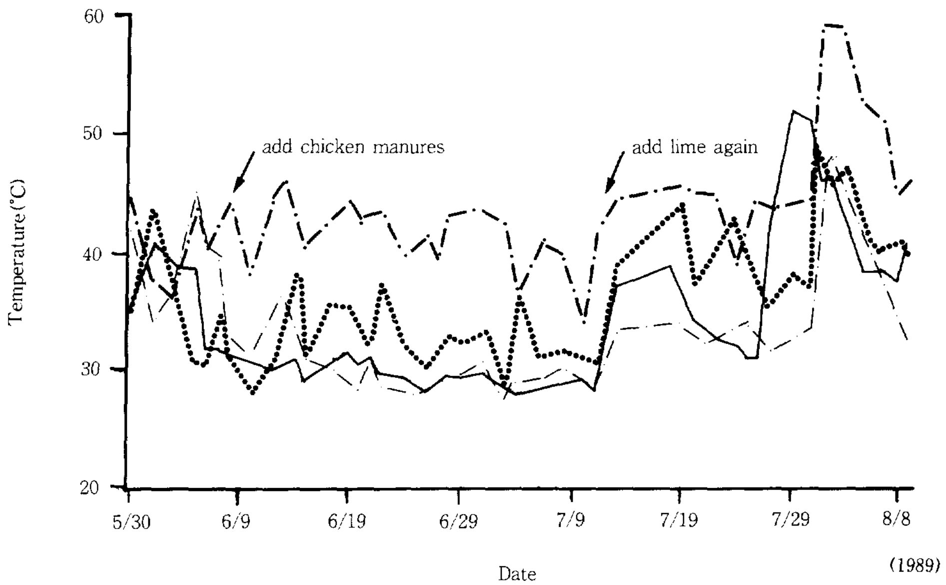

Fig.1. Changes of temperature in compost during piling process
——— Peat, —·— Sawdust, ······· Grass, —·— Litter

3.2 Morphology of composts

In this study, morphology, chemical properties and bioassay were applied in order to check the maturity of compost and the end of piling. When compost reaches maturity, it becomes black and granular and losses the odor of added chicken manure (FUJITA & OHTAKA, 1987). The morphology of composts at the end of the experiment are shown in Table 2. After 75 days, the composts of leaf litter and grass still indicated immaturity as they neither became completely black and granular nor lost their smell; however, the texture and color of sawdust and peat composts indicated semi-maturity. Because of their texture and color. They need to be piled continuously for maturity.

When immature compost is used, post-caloric fermentation impedes plant growth. However, such compost will decompose quickly under the conditions of high temperature and humidity characteristic of the humid tropics. Henceforth it will be necessary to consider the piling time needed for compost to mature to avoid the application of immature compost in a nursery.

3.3 Chemical properties of composts

Chemical properties of composts before and after piling are shown in Table 3. The pH value increased and indicated neutrality or alkalinity; inorganic nitrogen and exchangeable cations also increased, while cation exchange capacity decreased. Changes in these chemical properties apparently occurred during fermentation and may have encouraged plant growth.

Tropical peat by sea water is made acidic by sulfates after exposure to the atmosphere, impeding plant growth. Furthermore, it contains much lignin, indicating insufficient decomposition and deficiency of minerals, especially calcium because of woody peat. The piling peat in this study contained no SO_4, but it showed a strong acidic pH value of 3.56 before piling. Also characteristic

Table 2. Changes of four materials in the process of composting after two months

		Before piling	After two months
Peat	color	10R 2.5/3	5XR 2/1
	texture	Blocky	Granular(Crum)
	smell	not particularly	Fungi
Sawdust	color	5YR 5/6	2.5YR 2/2
	texture	Crum, Powder	Granular(Crum)
	smell	timber smell	Fungi, little stink
Litter	color	7.5YR 4/6(5YR 5/0)	5YR 2/1
	texture	leaf, massive	fragment
	smell	not particularly	Fungi, little stink
Grass	color	7.5YR 6/4	7.5YR 3/3
	texture	fibric(straw)	fibric, Crum
	smell	not particularly	Fungi

of this peat was that nitrate content of inorganic nitrogen and exchangeable cations was extremely low, though cation exchange capacity was high. Since these properties are believed to adversely affect compost formation, the pH of peat was neutralized during piling by adding lime. The amount of inorganic nitrogen and exchangeable cations also increased in the peat compost through calorific fermentation. This evidence is considered caused by added chicken manure and decomposed peat. The cation exchange capacity of peat characteristically decreased by composting.

3.4 Bioassay of composts

A final test of compost quality was conducted using the bioassay method and a fast growing plant, the tropical tomato. Potting soil consisted of a 1:1 ratio of each material and topsoil. Grass and sawdust composts showed a sufficient growth of tomato seedlings two weeks after sowing (Table 4). Among the characteristics of tomato seedlings, increment of height and biomass displayed excellent growth occurred on grass and sawdust composts. According to these two composts, leaf litter and peat composts showed good tomato growth without topsoil. It will be neccessary to check the matured peat compost for nutrients, because tomato showed third growth rate and peat did not ferment sufficiently in this study. There was no evidence of chlorosis (nitrogen deficiency) in the tomato seedlings, because leaf color was greenish (7.5 GY, 4/4.5-4/6). In addition, impediments to tomato growth such as root decay by post fermentation, did not occur. Although all four materials indicated insufficient fermentation, they all nonetheless had the potential to be used as compost.

Peat indicated composting potential, when its water content was 70% and pH value was a neutral 7.0. According to an experiment using 400cc cylinder, peat showed about 6.0mm surface sinkage when water loss reached 40% (KOBAYASHI, 1989). The peat surface may have settled during decomposition and dehydration after forest clearing. However, since sawdust is suitable as a compost in the tropics, the effect of sawdust will be improved along with pH levels and aeration through the introduction of lime water and grass mixtures which will act priming effect. The high temperature and humidity of the tropics probably do not require mature compost, because there is no evidence that post fermentation impedes plant growth.

Although peat had the potential to become compost, some problems were encountered therefrom. First of all, the *Shorea albida* forests have very unique structures and are scientifically important among tropical rain forests because only one species is dominant and consists of the pure forest on the peat swamp. Secondly, drying and decomposition case the peat to shrink and subside. Third, the structure of peat layers indicated complex layers alternating between peat and mud clay, the latter which usually contains pilight and transforms into sulfate after oxidation. Therefore, peat must be carefully considered for use as a compost.

Table 3. Chemical properties of composts before and after piling

	Peat		Sawdust		Litter		Grass		Chicken Manures	Topsoil	
	Before*	After**	Before	After	Before	After	Before	After			
pH	3.56	6.82	4.95	8.34	5.39	7.64	6.64	7.53	7.31	4.66	
Inorganic Nitrogen											
MH_4-N	22.1	846.0	5.2	476.4	56.8	885.6	35.2	396.5	995.1	4.4	(mg/100g
NO_3-N	1.1	466.2	0.0	37.3	0.0	148.4	0.0	165.6	56.9	0.0	dry soil)
total	23.2	1 212.2	5.2	513.7	56.8	1 034.0	35.2	562.1	1 051.0	4.4	
Cation Exchangeable Capacity	224	182	117	151	161	291	189	193	—	87	(me/100g dry soil)
Ca^{2+}	0.00	22.97	0.00	11.74	3.52	17.93	6.13	25.47	17.37	0.00	
Mg^{2+}	1.70	5.22	1.32	3.75	3.46	4.06	3.55	4.94	21.74	4.33	(me/100g
K^+	1.09	29.00	1.18	25.22	4.20	24.61	16.66	30.12	68.08	1.09	dry soil)
Na^+	0.00	7.51	0.00	5.36	0.52	6.15	3.89	6.49	16.22	0.00	
Ash %	31.2	51.8	2.3	21.2	13.3	24.3	23.7	60.2	45.7	91.1	

* Composting material air-dry

** Two months after piling, adding chicken manure and sulfate ammonium and lime

Table 4. Bio-assay of compost quality using tomato seedling

	Height (cm)	Stem diameter (mm)	Leave no.	Biomass (mg)	Root weight (g)	Leaf Color	Growth condition
Peat compost	7.6	1.3	4.4	12.5	1.2	7.5GY 4/4.5-4/6	good
Sawdust compost	9.4	1.6	5.1	17.1	1.3	7.5GY 4/4.5-4.5/5.5	very good
Litter compost	8.1	1.5	4.9	15.0	1.8	7.5GY 4/4.5-4.5/5	good
Grass compost	9.6	1.7	5.5	17.9	1.6	7.5GY 4/4.5-4.5/5	very good
Topsoil(control) MDF	3.0	0.7	3.5	3.6	1.0	7.5GY 4/4.5-5/5	bad

4 Conclusion

Peat had the potential to become compost after natural drying if water contents were maintained 70%, and the pH was adjusted to 7.0 through the addition of lime and chicken manure. Sawdust, leaf litter and grass also tended to ferment after neutrization by adding lime water and keeping the water content at 70%. The bioassay test on tomato seedlings showed their vigorous growth represented the changes in compost. There was no evidence to suggest that post fermentation caused either chlorosis or root damage.

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熱帯泥炭の堆肥化の予備的研究

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摘　　要

熱帯泥炭の有効利用としての堆肥化について検討した。ブルネイの泥炭はpH3.5と強酸性を示し，含水率も500%以上と過飽和の状態にあった。また，無機態窒素やミネラルの含量が乏しかった。この泥炭をライムでpH7.0に調節し，含水率を約70%に抑えると発熱発酵が促されることが認められた。泥炭，鋸屑，リター，牧草を用いた堆肥を培地資材として植物検定した結果，トマトの初期成長は，牧草＞鋸屑＞リター＞泥炭＞表層土の順で良かった。堆積期間が短く，いずれも未熟な堆肥であったが，後熟による根腐れやクロロシスは認められなかった。湿潤熱帯では未熟な堆肥でも利用が可能であると考えられたが，泥炭の利用開発は地盤沈下などを伴うために注意する必要がある。

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