On-Farm Aerobic and Anaerobic Composting Methods

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Composting is the microbiological decomposition of organic matter into a relatively stable humus-like material. Composting is a common practice to dispose of and recycle the agro-wastes to valuable organic manures. In this process, various microorganisms, including bacteria and fungi, break down organic matter into simpler substances. Compost is a dynamic, earthy, smell less, granular, humus rich and stabilized (no Composting and Manuring further decomposition) material obtained after the composting

The environmental conditions prevailing within the composting system i.e., oxygen, temperature, moisture, material disturbance, organic matter and the size and activity of microbial populations affect the effectiveness of composting process.

Stages of composting

The composting consists of the following stages:

1. Mesophilic
2. Thermophilic
3. Curing

Mesophilic Stage

As soon as we pile keep the wastes and ensure proper conditions, the heap begins to heat up right away and the composting begins. This first phase of composting is called mesophilic stage. In this stage, the temperature remains below 45°C and microorganisms multiply and break down the easily available carbohydrates. The pH begins to drop as acids are produced. The pile become active and a series of processes are set in motion.

Thermophilic Stage

After mesophilic, the next stage is thermophilic which last for several weeks. As active composting takes place, temperature in the centre of pile rises to about 50-65°C. At this temperature range, heat loving (thermophilic) bacteria vigorously degrade the organic materials. Temperature will remain in this range as long as decomposable materials are available and oxygen is adequate for microbial activity. Many important processes take place during this stage. As the organic matter degrades, its particle size is reduced. Pathogens are destroyed as the heat in pile is more (above critical temperature 55°C). Fly larvae and weed seeds are destroyed when the temperature rise above to 63°C.

Curing

During this stage, the stability comes in the decomposed materials. The growth of actinomycetes and fungi which digest hemicellulose is enhanced. This stage is critical for developing disease-suppressiveness of composts.

Types of composting

Based on the nature of the decomposition process, composting may be divided into three categories *viz.*,

i. Anaerobic: In the absence or limited supply of O_2
ii. Aerobic: In the presence of O_2
iii. Vermicomposting: enzymatic degradation of organic materials by earthworms.

Anaerobic composting

Decomposition occurs where oxygen (O_2) is absent or in limited supply. Under this method, anaerobic micro-organisms dominate and develop intermediate compounds including methane, organic acids, hydrogen sulphide and other substances.

Anaerobic digestion of particulate organic matter takes places in three steps

i. Solubilization of organic solids
ii. Conversion of complex organics into volatile acids
iii. Formation of methane from volatile acids

Merits

- Little work involved
- Fewer nutrients lost during the process
- Gaseous by-products can be made use of.

- More concentrated source of nitrogen.

Demerits

- The intermediate compounds accumulate and are not metabolized further.
- Many of these compounds have strong odours and some present phytotoxicity, hence it should not be directly used
- As it is a low-temperature process, it leaves weed seeds and pathogens intact.
- The process usually takes longer than aerobic composting.

Aerobic composting

Decomposition takes place in the presence of ample O_2. In this process, aerobic microorganisms break down organic matter and produce carbon dioxide (CO_2), ammonia, water, heat and humus, the relatively stable organic end product.

Major reactions involved in the aerobic composting process include

i. Solubilization of solids
ii. Organic matter oxidation
iii. Autooxidation of cells

Merits

- Although aerobic composting may produce intermediate compounds such as organic acids, aerobic micro-organisms decompose them further.
- The compost has little risk of phytotoxicity.
- Processing time is shorter because heat generated accelerates the breakdown of proteins, fats and complex carbohydrates such as cellulose and hemi-cellulose.
- As it is high temperature process, it destroys pathogens and weed seeds
- More efficient and useful than anaerobic composting for agricultural production

Demerits

- More nutrient loss from the materials

Methods of composting

Berkeley method of hot composting (developed by Robert D. Raabe at University of California, Berkeley)

Time required for composting: 18 Days

Type of Composting: Aerobic

Procedure

- Build the compost heap of 1m x 1m x 1.5m with composting materials having C:N of 25-30:1.
- No turning for first 4 days.
- Compost is turned from outside to inside and vice versa to mix it thoroughly for every 2nd day for 14 days.

Indore method of composting (developed by A. Howard & Y.D. Wad at Institute of Plant Industry, Indore)

Time required for composting: 4 months

Type of Composting: Aerobic

Nutrient Composition

N: 0.8%, P: 0.3%, K: 1.5%

Raw materials

Plant residues (all the weeds, pruning's, stalks, stems, fallen leaves, chaff, and fodder leftovers), Animal dung and urine, Wood ashes and Water

Procedure

The waste materials are cut into small pieces and spread in layers of 10-15 cm thickness either in pits or in heaps of 1 m wide, 1 m deep and of convenient length. It is properly moistened with cow dung using earth. To ensure 50 % moisture sufficient water should be sprinkled to wet the composting materials. Periodically three to four turnings are given. To get proper aeration, the material is covered with a layer of 2 to 3 cm soil. Under the aerobic process of decomposition 40 to 50 % organic matter and nitrogen are lost at initial stage. Adequate level of moisture is to be maintained. The site of composting should be at the high level to avoid rain water stagnation.

Coimbatore method of composting (developed by Manickam in 1967)

Time required for Composting: 4 – 5 months

Type of Composting: Anaerobic decomposition to start with, following by aerobic fermentation.

Nutrient Composition: N=0.8%, P=0.3%, K=1.5%

Raw materials

1. Farm wastes (weeds, straw, leaves)

2. Vegetable refuse 3. Animal dung

Size of the pit

1. Length: 3.6 m (according to the volume of the wastes)

2. Breadth: 1.8 m 3. Depth: around 1 m 4. Water

Procedure

Fill crop residues & farm wastes in pits of 4m X 2m X 1m depth to a thickness of about 15 cm. 5 cm cow dung slurry is spread over this layer to increase its biodegradation. Follow the same in alternate layers till the height reaches 0.5 m above ground level. Cover this with soil or mud to prevent the entry of rain water. After 35 to 40 days turning of material is done to make it an aerobic process. Thereafter the compost will be ready within 4 to 5 months.

NADEP method of composting (developed by N.D. Pandharipande from Maharashtra)

Time required for composting: 4 months

Type of Composting: Aerobic

Nutrient Composition: N: 0.8%, P: 0.4%, K: 1.5%

Raw materials

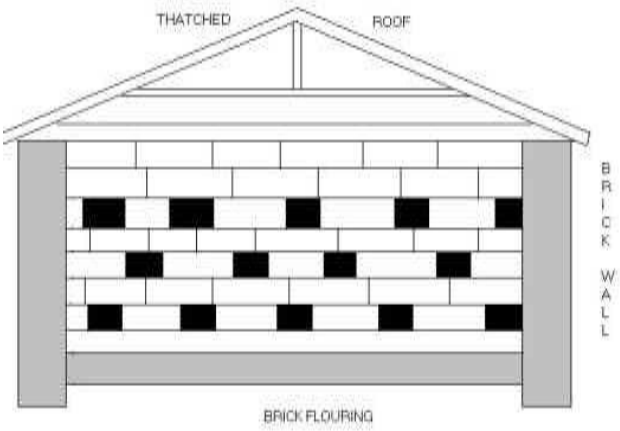
Agriculture waste (Weeds, crop residues, forest litter), Cattle dung/biogas slurry, Fine sieved soil and Water

Size of the tank: 10 x 5 x 3 feetFilling the tank:

- **First layer:** 4 - 6 inches of stems and sticks are spread at the bottom to facilitate aeration. It is followed by a 4 - 6 inches layer of agricultural wastes (about 100 kg).
- **Second layer:** Slurry that is made using 4 - 5 kg of cow dung and 100 - 125 litres of water is sprinkled over the dry wastes to facilitate microbial activity.
- **Third layer:** 60 kg of sieved dry soil is spread evenly over the second layer for moisture retention.

Procedure

The entire tank needs to be filled by the same process within 24 hours (not more than 48 hours) of



time. After 15-30 days the volume of the materials gets reduced to 2 feet and is refilled with the layers of the dry wastes, slurry, and sand. The entire mass is covered with a thatched roof to prevent the loss of moisture from the tank. Leave it undisturbed for 3 months. Meanwhile, water is added for every 1 - 2 weeks to maintain the moisture percentage in the tank. If the tank develops any cracks, those can be filled with the slurry to maintain the quality of the compost.

Bangalore method of composting:

Dr. L. N. Acharya in 1939 at **Indian Institute of Science, Bangalore** had initiated the work of composting the town refuse and night soil. This process is also called **Hot Fermentation Mechanism of composting or the Bangalore method**. It has been adopted to solve effectively the problems of safe disposal of night soil and producing high quality compost.

Time required for composting: 6-8 months

Type of Composting: Anaerobic

Nutrient Composition: N - 1.5%, P - 1%, K - 1.5%

Pit preparation

Pits/trenches should be dug 1 m deep while length and breadth can be varied according to the land availability and volume of wastes to be composted.

Procedure

Wastes are dumped into the trenches to make a layer of 15 cm. Then night soil is discharged over this and spread to a layer of about 5 cm. The trench is filled with town waste and night soil in alternate layers, until it reaches to 15 cm above the ground level, with a final layer of town refuse on the top. It could be made dome shape and covered with a thin layer of soil to prevent breeding of flies and moisture loss. Sewage

water may be sprayed over the layer of refuse. This system provides a method of disposal of various kinds of waste including slaughter house waste, sewage, sludge etc. This heterogeneous mass is allowed to remain as such without turning and watering for about 3 to 4 months.

Benefits of Compost

- ✓ Most plant nutrients in compost are in an organic form.
- ✓ Nutrients are released slowly over a long period of time
- ✓ Excellent soil conditioner
- ✓ Increase soil organic matter and water holding capacity of the soil
- ✓ Improve manure handling
- ✓ destruction of weed seed and pathogen
- ✓ Lower risk of pollution.

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