BIOLOGICAL WASTE MANAGEMENT THROUGH COMPOSTING

COMPOSTING

Composting is the natural process of 'rotting' or decomposition of organic matter by microorganisms under controlled conditions. Raw organic materials such as crop residues, animal wastes, food garbage, some municipal wastes and suitable industrial wastes, enhance their suitability for application to the soil as a fertilizing resource, after having undergone composting.

Compost is a rich source of organic matter. Soil organic matter plays an important role in sustaining soil fertility, and hence in sustainable agricultural production. In addition to being a source of plant nutrient, it improves the physio-chemical and biological properties of the soil.

It is an ecological approach to the soil fertility management, which has favoured balanced cropping system or use of natural sources for nutrient supply, insect pest control for

increasing productivity in sustainable manner without harming the ecosystem.

Types of Composting

Composting can be divided into two categories by the nature of decomposition process. i.e.,

- ✓ Anaerobic Composting.
- ✓ Aerobic Composting.

Anaerobic Composting

In anaerobic composting, decomposition occurs where oxygen (O) 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. These substances have strong odours and some present phytotoxicity. It is a low temperature process. The process takes longer time than aerobic composting.

Aerobic Composting

Aerobic composting takes place in the presence of ample oxygen(O). 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. This composting process is shorter

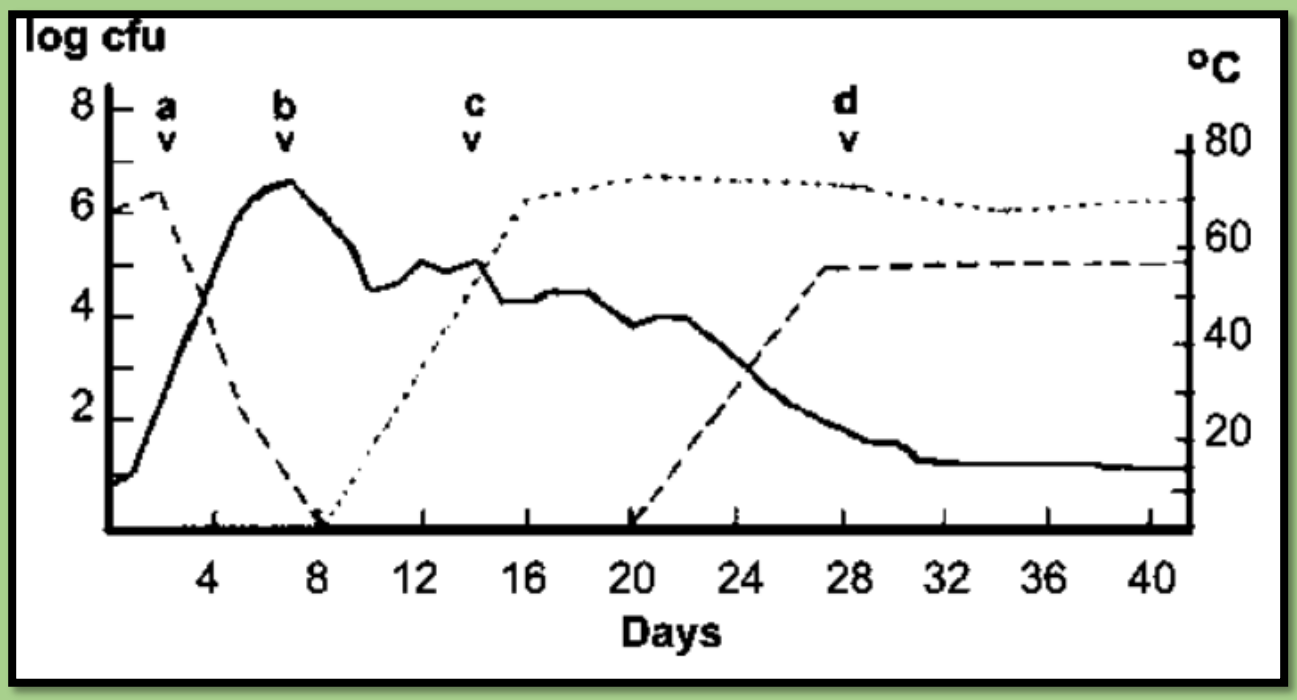
than anaerobic composting and undergoes high temperature. The heat generated accelerates the breakdown of proteins, fats and complex carbohydrates such as cellulose & hemi-cellulose and also destroys many micro-organisms that are human or plant pathogens, as well as weed seeds.

Aerobic Composting Process

The aerobic composting process starts with the formation of the pile. In many cases, the temperature rises rapidly to 70-80 °C within the first couple of days.

First, mesophilic organisms (optimum growth temperature range = 20-45 °C) multiply rapidly on the readily available sugars and amino acids (Figure 1). They generate heat by their own metabolism and raise the temperature to a point where their own activities become suppressed. Then a few thermophilic fungi and several thermophilic bacteria (optimum growth temperature range = 50-70 °C or more) continue the process, raising the temperature of the material to 65 °C or higher. This peak heating phase is important form the quality of the

compost as the heat kills pathogens and weed seeds. FIGURE -1



Note - Solid line = temperature; broken line = mesophilic fungi population; dotted line = thermophilic fungi population; left y-axis = fungal populations (logarithm of colony forming units (cfu) per gram of compost plated onto agar); right y-axis = temperature in centre of compost. a, b, c and d = heating phases.

The active composting stage is followed by a curing stage, and the pile temperature decreases gradually. The start of this phase is identified when turning no longer reheats the pile. At this stage, another group of thermophilic fungi starts to grow. These fungi bring about a major phase of decomposition of plant cell-wall materials such as cellulose and hemi-cellulose. Curing of the compost provides a safety net against the risks of using immature

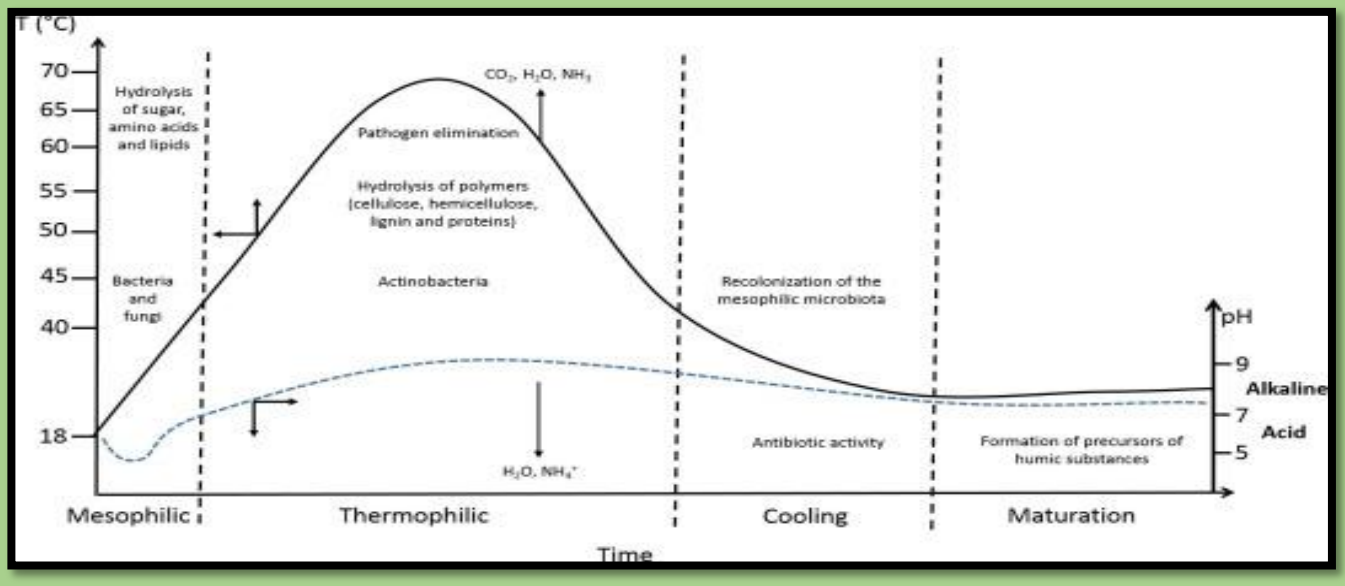
compost such as nitrogen (N) hunger, O deficiency, and toxic effects of organic acids on plants.

Eventually, the temperature declines to ambient temperature. By the time composting is completed, the pile becomes more uniform and less active biologically although mesophilic organisms recolonize the compost. The material becomes dark brown to black in colour. The particles reduce in size and become consistent and soil-like in texture. In the process, the amount of humus increases, the ratio of carbon to nitrogen (C:N) decreases, pH neutralizes, and the exchange capacity of the material increases.

Factors Affecting Aerobic Composting

Physical parameters–mainly include temperature, moisture content and organic content i.e., C/N ratio

- TEMPERATURE- The process of composting involves 2 temp ranges. First, mesophilic organisms (optimum growth temperature range = 20-45 °C) multiply rapidly on the readily available sugars and amino acids. They generate heat by their own metabolism and raise the temperature to a point where their own activities become suppressed. Then a few thermophilic fungi and several thermophilic bacteria (optimum growth temperature range = 50-70 °C or more) continue the process, raising the temperature of the material to 65 °C or higher. This peak heating phase is important for the quality of the compost as the heat kills pathogens and weed seeds the ideal temperature for initial step.



- MOISTURE CONTENT-the optimum moisture content is known to be between 50-60%. Where the pile is too dry, composting occurs more slowly, while a moisture content in excess of 65 percent develops anaerobic conditions. In practice, it is advisable to start the pile with a moisture content of 50-60 percent, finishing at about 30 percent.
- C/N RATIO - Micro-organisms require C, N, phosphorus (P) and potassium (K) as the primary nutrients. Of particular importance is the C:N ratio of raw materials. The optimal C:N ratio of raw materials is between 25:1 and 30:1 although ratios between 20:1 and 40:1 are also acceptable. Where the ratio is higher than 40:1, the growth of micro-organisms is limited, resulting in a longer composting time. A C:N ratio of less than 20:1 leads to underutilization of N and the excess may be lost to the atmosphere as ammonia or nitrous oxide, and odour can be a problem. The C:N ratio of the final product should be between about 10:1 and 15:1.

Biological factors – include all the living organism that control and manage the process of decomposition.

Aerobic composting is a dynamic system in which bacteria, actinomycetes, fungi and other biological forms are actively involved. The relative preponderance of one

species over another depends upon constantly changing food supply, substrate and temperature conditions.

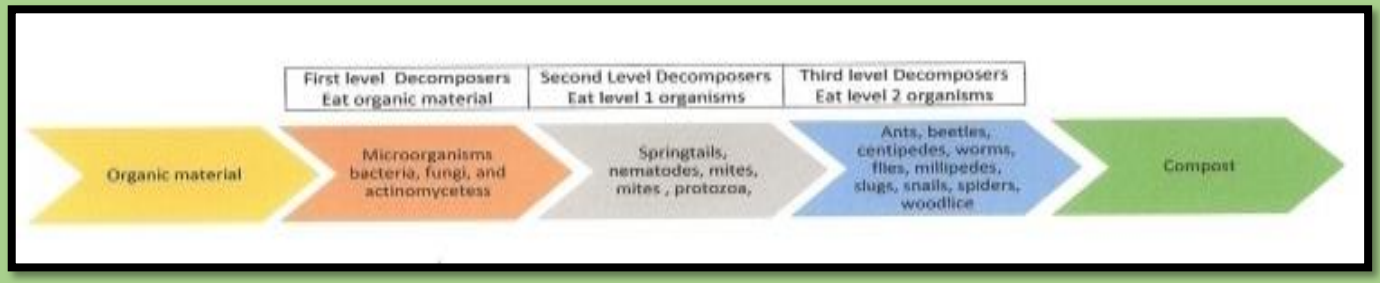
- 3rd level decomposers- These larger creatures, sometimes known as Macro-organisms, physically break down the organic material by chewing, tearing and, in some cases, sucking it into smaller pieces. Ants, beetles, centipedes, "composting" worms, flies, millipedes, slugs, snails, spiders, and. woodlice (sow bugs) are all in this group.
- *2nd level decomposers*- The second level decomposers e.g., springtails, nematodes, beetle mites, mold mites and protozoa, eat the organic matter and the organisms that make up the first level decomposers. These tend to be smaller and the use of a hand lens or stereoscopic microscope is useful to observe them in detail.
- *1st level decomposers*- The first level decomposers are the much smaller Microorganisms and they play the major role in the composting process. They include:

Bacteria- Alcaligenes faecalis, Brevibacillus *(*Bacillus) brevis, Clostridium thermocelium, Flavobacterium sp. are some common examples of bacteria involved in the

process. Bacteria play a major role in decomposition of proteins and readily biodegradable organic matter.

Fungi- include Aspergillus fumigatus, Humicoli grisea, Humicoli insolens, Humicoli lanuginose, *Penicillium sp (incl P. dupontii)*, Myriococcum thermophilium etc. They play an important role in the decomposition of cellulose and lignin.

Actinomycetes-prevalent in compost are Streptomyces *Frankia*, Micromonospora, they play a major role in the decomposition the less easily degraded than that favored by other bacteria. Actinomycetes can also tolerate dryer conditions than other bacteria and produce a chemical (geosmin) responsible for the typical musty, earthy smell of compost.



Chemical parameters -

- pH--Although the natural buffering effect of the composting process lends itself to accepting material with a wide range of pH, the pH level should not exceed eight. At higher pH levels, more ammonia gas is generated and may be lost to the atmosphere.
- Polyphenols and lignin- include hydrolysable and condensed tannins. Insoluble condensed tannins bind the cell walls and proteins and make them physically or chemically less accessible to decomposers. Soluble condensed and hydrolysable tannins react with proteins and reduce their microbial degradation and thus N release. Polyphenols and lignin are attracting more attention as inhibiting factors.

Azad Composting Tumbler-an initiative taken up by Azad Environment Protection Society

Under guidance of Dr. Y. K Singh Sir, Environmental nodal officer of Chandra Shekhar Azad Institute of Agriculture and Technology, we the members of Azad Environment protection society and B.Sc.(hons.) Ag 8th semester along with RTTC team decided to come up with a project which mainly focused to reduce the waste present all around and convert it into a useful product. With this objective in mind there emerged an idea to make a portable composting tumbler.

Azad Composting Tumbler serves as a simple method to transform the waste into a product that not only serves as a source of plant nutrient but also improves the physio-chemical and biological properties of the soil.

COMPOSTING TUMBLER

A compost tumbler is a fully sealed container which can be rotated to mix the composting materials. The sealed container also helps contain the heat generated by the composting process, thereby speeding the process of converting raw organic material into compost. Compost tumbler make composting simpler and faster.

Structure consists of two drums mounted vertically on the iron angle frame. Hole are made on the top and bottom of each drum to insert iron rod so as to hang and hold the drum to bearing attached on the frame via rods.

Top mounted drum consist of cut out door with lid for addition of composting material. Four grinder blades are attached to the mid rod to shred the raw organic waste into small pieces. Handles are provided on the extension of rod outside the drum to turn the blades easily, as well as to turn the tumbler to empty the shredded waste into the bottom tumbler.

Bottom mounted drum consist of air vents to facilitate aerobic decomposition. Blades are attached to central rotating rod which is connected with handles outside to facilitate turning of compost inside tumbler from time to time. Perforated pipes are inserted to maintain moisture level and to add biofertilizer and other inoculants.

MODEL SPECIFICATIONS

- Height - 5 ft
- Width - 2 ft
- Length - 3 ft

Drums heights – 31 & 34 inches

Drums volume - Top drum- 120 litres

Bottom drum – 220 litres

Initial volume of raw waste = 220kg

Final volume of compost after decomposition = 176kg

Material required –common material available are:

- Crop residues, tree litter and weeds
- Green manure,
- Urban and rural wastes
- Agro industrial by product
- Marine wastes.

The green / brown ratio should be 1:1.

ECONOMICS

MATERIALS USED		PRICE(₹)
1.	Drums	1700
2.	Angle	1200
3.	Bearing	1120
4.	Rod	600
5.	Blade	200
6.	Nut bolt	200
7.	Porous pipes	30
8.	Cork	30
9.	Meters	1200
10.	Electrode	100
11.	Cutting blade	200

12.	Iron bar	200
13.	Drill	200
Total		**₹6780**