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Course: Principles of Organic farming

B. Sc. Ag. 3rd Year

Composting

Composting

Composting is a process of allowing organic materials to decompose more or less controlled conditions to produce stabilized product that can be used as a manure or soil amendment. Composting is basically amicrobial process, which change the property of the organic material or mixtures.

Compost is the material resulting from the decomposition of plant residues under the action of bacteria and fungi. Composting is simply an acceleration of natural process or organic matter mineralization. Thefinal product is dark brown in colour and resembles FYM in its properties and appearance.

Essential requirements for composting

Bulky organic
manureA
suitable starter
Addition of
enough water
Aeration

Main systems of composting

ADCO process (Hutchinson and Richards of England)Activated compost process (Fowler and Rege)
The Indore process (Howard and Wad) The Bangalore process (C.N.Acharya) The Coimbatore method

Benefits of composting:

- Enables clean environment
- Absorbs odors, degrade toxic substances and heavy metals
- Avoids un-necessary dumping of wastes
- Supply valuable organic manure

Composting technologies

a. Crop residue composting

- ✓ Collect the available crop residues and weeds
- ✓ Shred them to a size of 2 to 2.5 cm length

- ✓ Mix these wastes with green residues (freshly collected), if available
- ✓ Form the compost heap (4 feet height)

- ✓ Add the bio-inoculants (2 kg of bio-mineralizer or 40 kg of cowdung for 1 tonne of waste)

- ✓ Properly aerate the compost either by providing perforated PVC pipes or by mechanical turning
- ✓ Maintain the moisture at 60 % by regular watering
- ✓ The compost will mature in 60 days

2. Vermi-composting

Vermi-composting is a process of degradation of organic wastes by earthworms. The species like Eisenia

foetida and Eudrilus eugeniae are effective in converting the agricultural wastes into compost. Thevarious steps involved in making vermi-compost are as follows

Methods followed:

Heap method
Pit method – aboveground and
belowground Belowground method
pit size: 10 X 1 X 0.3 mEach layer:
6-7cm thick
Sprinkle water once in 8-10 days Release: 2-2.5 kg worms / pit

Steps:

- ✓ Collect the predigested wastes and mix cattle dung @ 30 %.
- ✓ Place it in the pit/container layer by layer Moist the residues at 60 % moisture
- ✓ Allow the verms in to the feed material / residues @ 1 kg/ tonne of residue
- ✓ Protect the pit or container from ants and rats (which are the enemies of verms)
- ✓ The residue will be composted in 30 to 40 days
- ✓ Remove the composted materials layer by layer at a weekly interval so as to avoid any damage /disturbance to the feeding verms.

Nutritive value of vermi-compost

The nutrients content in vermi-compost vary depending on the waste materials that is being used for compost preparation. If the waste materials are heterogeneous one, there will be wide range of nutrientsavailable in the compost. If the waste materials are homogenous one, there will be only certain nutrientsare available.

The common available nutrients in vermi-compost is as followsOrganic carbon = 9.5 – 17.98%
Nitrogen = 0.5 – 1.50%
Phosphorous = 0.1 – 0.30%
Potassium = 0.15 – 0.56%
Sodium = 0.06 – 0.30%
Calcium and Magnesium = 22.67 to 47.60

meq/100gCopper = 2 – 9.50 mg kg-1
Iron = 2 – 9.30 mg
kg-1 Zinc = 5.70 –
11.50 mg kg-1
Sulphur = 128 – 548 mg kg-1

3. Coirpith composting

Coirpith is an agricultural waste produced from the coir industry. Approximately 180 grams of coirpithis obtained from the husk of one coconut. Coirpith contains Carbon : Nitrogen in the ratio of 112:1 and contains 75 per cent lignin which does not permit

natural composting as in other agricultural wastes.

Mushroom Pleurotus has the capacity to degrade part of the lignin present in coirpith by production of enzymes like cellulases and lactases. The carbon: nitrogen ratio of coirpith is reduced from 112:1 to 24:1as a result of composting.

Composting method

Select a shaded place of 5 x 3 m dimension and level it after removing weeds. Spread 100 kg of coirpithuniformly. Spread 100 g of Pleurotus spawn on this and cover with a second layer of 100 kg of coirpith. On the surface of the second layer, spread one kg of urea uniformly.

Repeat this sandwiching of one layer of coirpith with spawn followed by another layer of coirpith withurea up to one metre height.

Sprinkle water to keep the heap moist. Allow the heap to decompose for one month.

Manure conversion

The coirpith is converted into good manure after 30 to 40 days and the lignin content is reduced from 40per cent to 30 per cent. The nitrogen content is increased from 0.20 per cent to 1.06 per cent. Coirpith compost contains macronutrients and micronutrients. It can absorb water up to eight times its weight.

Coirpith, when added to sandy soil at 2 per cent increases the water holding capacity up to 40 per cent. It can be applied to a wide variety of crops and can be used to prepare potting mixture and can be applied asorganic manure in kitchen gardens.

4. Composting of crop residues and weeds:

Composting is one of the useful ways for utilizing the some of the weeds and noncommercial plants like Parthenium, Water hyacinth, lpomoea etc. instead of their eradication. The plants can be composted usingTrichoderma viridi and Pleurotus sajorcaju as a microbial consortium with supplementation of urea.

Select an elevated shady area of a thatched shed and mark an area of 5x1.5 meter. Cut the composting materials into 10 – 15 cm size. Spread 100 kg of these materials over the marked area. Sprinkle 1 bottle of microbial consortia over this layer. Again spread another 100 kg of composting materials over this layer. Spread 1 kg of urea uniformly over this layer. Likewise repeat these processes of spreading composting materials, then microbial consortia, again composting materials followed by urea applicationuntil a minimum of 1-meter height is reached. Sprinkle water to attain a moisture level of 50% to 60%.

5. Method of composting the Municipal Solid Wastes

Biodegradable municipal solid waste should be separated and collected for composting. Five hundred kgof material should be heaped in the compost yard. In that heaped waste, 1 kg of TNAU microbial consortium should be applied in the form of slurry to cover the full waste material. This 1 kg microbial consortium can be mixed with 5 litres of water to make slurry. This slurry is sufficient to cover 0.5 tonneof material then; 50 kg of cowdung should be mixed with 30 litre of water to form cow dung slurry. Thiscow dung slurry should be sprayed over the heap of municipal solid waste then; 1 kg of urea should be mixed with solid waste. 60% moisture should be maintained throughout the period of composting.

6. Value addition of poultry waste compost

A known quantity of poultry droppings and coir pith @ 4:5 ratios should be mixed well to attain a C/Nratio of 25:1 to 30:1 which is considered to be the optimum C/N ratio for compositing. Pleurotus sajor-caju, a lignocellulolytic organism, should be inoculated into the mix @ 2 packets per tonne of waste in order to speed up the composting process. The mix should be heaped under the shade.

7. Enriched Farm Yard Manure (EFYM)/ Reinforced FYM

Phosphorus content in FYM is relatively low and complete utilization of nitrogen and potassium in the manure is seldom realized. Hence, heavy quantities intended to supply the needed quantity of phosphoruswill result in wastage of nitrogen in most soils. To overcome this P insufficiency, addition of superphosphate to the manure is recommended and the process is called reinforcing / enriching and the resultant material is called “enriched farmyard manure”. The Single Super Phosphate (SSP) can be sprinkled either in the cattle shed or on the manure heap. Rock phosphate can also be recommended for this purpose.

Factors affecting the Composting Process:

I. The Type and Composition of the Organic Waste
II. The Availability Of Microorganism
III. Aeration
IV. The C, N and P Ratios
V. Moisture Content
VI. Temperature
VII. pH
VIII. Time

Preparation of Coir Waste Compost Using Yeast Sludge:

Yeast sludge is a waste product by alcohol distilleries @ 2t/day. This waste contains 6% N, 0.3% P and 0.9% K with other micronutrients, vitamins and growth promoting substances. The coir waste should be sieved so as to remove all the fibrous materials. For one tone of coir waste 200 kg of yeast sludge and 10kg of rock phosphate should be added and mixed thoroughly. Moisture should be maintained at 60%.

After mixing the material should be formed as heap. Within 4-5 days the temperature of the heap will beraised to 50-60° C. Within 40 to 50 days the coir waste and yeast sludge will become as mature compost.The matured compost will turn from brown to black. There will not be any odor. The volume of the compost heap will be reduced to 1/3. The temperature of the heap will be 25-30°c and it should be constant. The compost will be very light and fine textured.

Preparation of sugarcane trash compost using yeast sludge:

Sugarcane trash collected from sugarcane field has to be cut into small bits using chaff cutter or shredderto a size of 1-2cm. for every tone of sugarcane trash 200 kg of yeast sludge and 10kg of rock phosphate are added and mixed thoroughly. Moisture is maintained at 60%. the heap is formed to a height of 1-1½ m. within 45-50 days sugarcane trash compost will be ready for application to crops. The sugarcane trashcompost consists of N-1.2%, P-0.7%, K-1.5% and considerable quantities of micronutrients. This compost can be applied at the rate of 5t/ha.

d. Japanese method of composting:

Instead of pits in conventional composting system, vats of 18-30' in length, 3-4' in width and 2.5-3.0' height are made of bamboo stakes of 2.5-3.0' width. For growth a non-leaky surface is prepared with broken stone stable or brick and plastered with cement. About 2 feet space is kept free on one side of the vat to facilitate turning the residues regularly. Sliced and broken pieces of coconut, shells, leaves, fibrousmaterials, tender tree barks or pieces from the bottom 10-15 cm layer. Second layer of dry leaves, grass residues, groundnut haulms are of 10-15 cm height. Cow dung, urine, biogas slurry are sprinkled over and this layer of soil and ash is spread over.

Compost

A mass of rotted organic matter made from waste is called compost. The compost made from farm waste like sugarcane trash, paddy straw, weeds and other plants and other waste is called farm compost. The average nutrient content of farm compost is 0.5 % N, 0.15 % P_2O_5 and 0.5 % K_2O. The nutrient value offarm compost can be increased by application of superphosphate or rock phosphate at 10 to 15 kg/t of raw material at the initial stage of filling the compost pit. The compost made from town refuses like streetsweepings and dustbin refuse is called town Compost. It contains 1.4 % N, 1.00 % P_2O_5 and 1.4 % K_2O.Farm compost is made by placing farm wastes in trenches of suitable size, say, 4.5 m to 5.0 m long,

1.5 m to 2.0 m wide and 1.0 m to 2.0 m deep. Farm waste is placed in the trenches layer by layer. Each layer is well moistened by sprinkling cow-dung slurry or water. Trenches are

filled up to a height of 0.5m above the ground. The compost is ready for application within five to six months.

Compost prepared by traditional method is usually low in nutrients and there is need to improve its quality. Enrichment of compost using low cost N fixing and phosphate solublizing microbes is one of thepossible ways of improving nutrient statuses of the product. It could be achieved by introducing microbial inoculants, which are more efficient than the native strains associated with substrate materials. Both the nitrogen fixing and phosphate solubilising microbes are more exacting in their physiological andecological requirements and it is difficult to meet these requirements under natural conditions. The only alternative is to enhance their inoculums potential in the composting mass. Studies conducted at IARI, New Delhi, showed that inoculation with Azotobacter/Azospirillum and phosphate solubilising culture inthe presence of 1% rock phosphate is a beneficial input to obtain good quality compost rich in N (1.8%). The humus content was also higher in materials treated with microbial inoculants.

The following basic rules are important for the production of good quality compost:
1. The purpose of composting is to convert organic matter into growth promoting substances, forsustained soil improvement and crop production.
2. The organic matter is partially decomposed and converted by microbes. These microbes require propergrowth conditions, for their activity i.e moisture content: 50% and 50% aeration of total pore space of thecomposting material. This is achieved through stacking and occasional turning over. Microbes also need sufficient nitrogen for synthesizing their body cells [the optimum C: N ratio of the composting material is20:1 to 30:1]
3. Soil microorganisms constitute sufficiently to the decomposition of organic matter through their continuous activities.

4. Certain additives accelerate the conversion and improve the final product. The materials such as lime, earth, gypsum, rock phosphate act as effective additives. The addition of nitrogen (0.1 to 1 %) is important in case of large C: N ratio of the composting material. Addition of lime (0.3 to 0.5 %), if sufficient lime is not present. The preparation of compost takes 2-3 months. The composition of compostvaries with in wide limits.

Stages of composting

There is a huge difference between a backyard humanure composter and a municipal composter. Municipal composters handle large batches of organic materials all at once, while backyard composters continuously produce a small amount of organic material every day. Municipal composters, therefore, are"batch" composters, while backyard composters tend to be "continuous" composters. When organic material is composted in a batch, four stages of the composting process are apparent. Although the same phases occur during continuous composting, they are not as apparent as they are in a batch, and, in fact, they may be occurring concurrently rather than sequentially.

The four phases include: 1) the mesophilic phase; 2) the thermophilic phase; 3) the cooling phase; and 4) the curing phase.

Compost bacteria combine carbon with oxygen to produce carbon dioxide and energy. Some of the energy is used by the microorganisms for reproduction and growth, the rest is given off as heat. When a pile of organic refuse begins to undergo the composting process, mesophilic bacteria proliferate, raising the temperature of the composting mass up to 44°C (111°F). This is the first stage of the composting process. These mesophilic bacteria can include *E. coli* and other bacteria from the human intestinal tract, but these soon become increasingly inhibited by the temperature, as the thermophilic bacteria take over inthe transition range of 44°C-52°C (111°F-125.6°F).

This begins the second stage of the process, when thermophilic microorganisms are very active and produce a lot of heat. This stage can then continue up to about 70°C (158°F),30 although such high temperatures are neither common nor desirable in backyard compost. This heating stage takes place rather quickly and may last only a few days, weeks, or months. It tends to remain localized in the upper portion of a backyard compost bin where the fresh material is being added, whereas in batch compost, theentire composting mass may be thermophilic all at once.

After the thermophilic heating period, the humanure will appear to have been digested, but the coarserorganic material will not. This is when the third stage of composting, the cooling phase, takes place.

During this phase, the microorganisms that were chased away by the thermophiles migrate back into the compost and get back to work digesting the more resistant organic materials. Fungi and macro organismssuch as earthworms and sow bugs that break the coarser elements down into humus also move back in.

After the thermophilic stage has been completed, only the readily available nutrients in the organic material have been digested. There's still a lot of food in the pile, and a lot of work to be done by the creatures in the compost. It takes many months to break down some of the more resistant organic material in compost such as "lignin" which comes from wood materials. Like humans, trees have evolvedwith a skin that is resistant to bacterial attack, and in a compost pile those lignins resist breakdown by thermophiles. However, other organisms, such as fungi, can break down lignin, given enough time; sincethey don't like the heat of thermophilic compost, they simply wait for things to cool down before beginning their job.

The final stage of the composting process is called the curing, aging, or maturing stage, and it is a long and important one. Commercial composting professionals often want to make their compost as quickly aspossible, usually sacrificing the compost's curing time.

Methods of composting

The process of composting was first initiated in England during the period of First World War (1914 -1918).

The various systems of composting are

1. ADCO process (Agricultural Development Company)
2. Activated compost process
3. Indore process

4. Bangalore process
5. Coimbatore process
6. Rain -water compost
7. Rural compost
8. Urban compost
9. Mechanical
compost and
10.Vermi-compost

1. ADCO process:

Agricultural Development Company was initiated, [A private concern operating at Harpenden, England]developed by **Hutchinson, H.B and Richards , E.H.** during 1914-1918, at Rothamsted Experimental Station , England.

Materials needed:

1. Straw and other wastes -Basic raw material)
2. Ammonium sulphate/Ammonium phosphate /Super phosphate/Muriate of potash

Ground limestone/urea –

Starters

Procedure:

The basic raw material straw is spread in layers and sprinkled over with a solution of ammonium sulphate. Then powdered lime stone is applied as broadcast. Then another straw layer is put on. The piling of the layer is continued till a decent heap of convenient height is built up. After about 3 months offermentation the resulting material is similar to FYM and hence called "synthetic FYM"

The ADCO process was patented and concentrated starters were put in the market with the trade namesof ADCO accelerator and ADCO complete manure with full direction for their use.

2. Activated compost process

This method was developed by Fowler and Ridge in 1992 at Indian Institute of Science, Bangalore

Materials needed:

1. Basic raw materials (straw and farm wastes
2. Starters: a) Cow dung b) Urine c) Night soil d) Sewage

and sludgeProcedure:

In this process the basic raw material for composting straw and other farm wastes is treated with mixtureof cattle dung and urine as decoction. So that every portion of mass comes in contact with the inoculants (dung + urine) and fermentation takes place evenly. On piling up in a heap of 3 feet or 4 feet height and turning over from time to time, keeping moist with dung and urine decoction, very high temperature attained. When the temperatures begin to drop at the end of one week, the volume of the material gets reduced.

3. Indore process:

This process is developed in India by **Howard and Ward** at the Indian Institute of plant Industry, IndoreMaterials needed: a) Straw or organic farm wastes as basic raw materials b) Cattle dung as starter (urine, earth and wood ashes)

Procedure:

A compost pit of dimensions of 30 x 14 x 3 feet with sloping sides (narrow at bottom and at wide surface) is prepared and the raw material is spread in layers of 3" thickness. A mixture of urine, earth, and wood ashes is sprinkled and this is followed by 2" layer of dung. The pit is filled up this way until the material occupies a height of 3 feet above the ground level. As air can conveniently penetrate only toa depth of 1.5 to 2.0 feet extra aeration has to be provided, which is done by means of artificial vents (holes) of 4" diameter pipe for every 4 feet length of the pit. The pit is watered twice a day i.e., morning and evening with rose can. The material is turning over 3 times, i.e.,

First – at the end of the first fort night

Second – at the end of the second fort night

Third – when the material is two months old in the process of composting.

Observations:

I. After 10 days of composting the following things happens

A. Synthesis of humus begins i.e., development of fungi and the height of the material is reduced by half

B. Check anaerobic decomposition, as indicated by the foul smell and fly breeding

C. If there is an anaerobic decomposition, turn over material for proper aeration

D. If insufficient fermentation, hasten by watering the material.

II. At the end of two months

A. Fungal activity is over

B. Materials become dark

C. Now the bacterial aeration takes place

D. Stock the material on the ground after 2 months .So 25 % of additional free nitrogen will be fixedfrom atmosphere.

Compost is ready by 3-4 months. One cattle pair produced 50-60 cartloads per year.

4. Bangalore process

This process of composting was developed by **Dr. C.N. Acharya in 1949.**

1. Basic raw material used: Any organic material
2. Starters or inoculants: FYM or mixture of dung and urine or litter [Undecomposed]
3. Additives: Bone meal or oil cakes, wood ash

Procedure

[Pit size: 20 x 4 x 3 feet

The basic raw material is spread in a pit of 20 x 4 x 3 feet dimensions to a depth of 6 " layer, moistened with 20-30 gallons of water if the material is dry. Over this FYM or preferably a mixture of dung, urine and litter (undecomposed) from the cattle shed is placed as a layer of 2" thickness. It is again covered onthe top with a layer of earth to a thickness of 6". It is beneficial to mix the earth with bone meal or oil cakes, wood ash etc., to improve manorial value of the compost .The piling of layers is continued till theheap raises above the ground level to a height of 2 feet. Then the heap is kept open for one week to facilitate aerobic decomposition. Later the heap is plastered with a layer of moist clay for anaerobic fermentation to occur. Fissures or cleavages (cracks) that occur in the clay

layer , have to be sealed off periodically .The compost will be ready in 4-5 months period starting from the day of preparation .This process is called as aerobic and anaerobic decomposition of compost.

In this process the basic raw material is not so well decomposed as in the other methods .But organicmatter and N contents are well conserved. The number of turnings are reduced .The out turn of the compost is relatively greater and cheapest process.

5. The coimbatore process:

1. The basic raw materials: raw organic matter
2. Starters: Powdered bone meal and cattle dung and water emulsion prepared by mixingDung in water at 5-10 kg dung in 5-10 litres water.

Procedure

[Pit: 12 x 6 x 3 feet]:

The basic raw material loosely spread [Pit: 12 x 6 x 3 feet] to a depth of 9" and water is sprinkled till theentire material is moist. Then about one kg of powdered bone meal is broadcasted uniformly above the layer and above this an emulsion of 5 5-10 kg of fresh cattle dung in 5-10 liters of water is applied.

Repeat this process until a heap 2 feet above ground level is formed .Then the entire exposed surface areaof heap is plastered with mud to facilitate semi-aerobic fermentation which would takes place for above 4-6 weeks depending upon the nature of the raw material. After 4-6 weeks, the mud plaster is removed topermit aerobic fermentation. If the heap has sunk unevenly which is a sign of defective fermentation, the material is reheaped after forking and moistened .The decomposition is complete in 3-4 months and is fitfor application to the field.

6. Rain watered compost

In dry areas where it is difficult to obtain water for watering, the composting can be done with the aid ofrain fall.

The compost heap is built up as usual before the rains set in. The turnings are given during the rainy period at the end of rains the material will be ready for application. About 400 mm rain fall received in 3-4 months is considered sufficient.