Course- Agricultural Waste Management (ELP)
Course code- EL-AGP 810

Practical Manual

THE NEOTIA UNIVERSITY
ज्ञानम् आत्म प्रदीपाय

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Content

Experiment -1

Topic- Preparation of vermicompost and vermiwash

Aim: To study the method of vermicompost making

Objective: To study the preparation and use of vermicompost

Relevant information: Vermicomposting is a method of preparing enrich compost with the use of earthworms. Earthworms accelerate the process of composting, aerate the organic matter and enhances the finished compost with nutrients and enzymes secreted from their digestive tracts. This enriched product is eventually called "worm cast" or **black gold**.

Castings

The expelled manure from worm has a bit of mucus surrounding each granule. This gets hardens on exposing to air. When these granular castings are mixed into soil, the nutrient from compost releases slowly to feed the plant. However, the hardened particles of mucus do not break down easily, thus they help in soil aeration and drainage. Casting is an organic soil conditioner as well as a super natural fertilizer which contents 7 times more P, 11 times more K and 1.5 times more Ca than other composts.

Methods of vermicomposting

Out of various methods, heap/bed and pit method is the most popular methods.

Heap/Bed method

In this method, composting is done in the cemented or over ground floor by making a bed of 6 ft. × 2 ft. × 2 ft. in size. This method is easy to maintain.

Pit method

Here vermicomposting is done in cemented pit with a size of 5 m. long × 1 m. wide × 1 m. high. This pit is covered with grass or any other local material. This method is not favourable due to poor aeration, water logging at bottom and high cost of production.

Materials required:

1. Earthworm species: *Eisenia foetida*, *Udrilus eugene*, *Perionyx excavates* etc.

2. Raw materials: Crop residues, weed biomass, vegetable waste, dry leaf, waste from agro-industries, bio degradable portion of rural and urban wastes.

3. Cow dung

4. Water

Phases of vermicomposting

Vermicomposting has 3 distinguished phases:

Phase I: Pre-digestion of organic waste on earthworm bed.

Phase II: Collection of earthworms and putting them on pre-digested waste compartment.

Phase III: Storing of vermicompost for proper moisture and growth of micro-organism.

Procedure

i. Prepare a pit or heap according to the requirement or availability of materials.

ii. Select the site near a water source in an unused shady area but should not any water stagnation.

iii. Create 1-inch-thick layer of leaves.

iv. Put organic residue layer (finely chaffed material) up to 9-inch-thick over the first layer.

v. Create a third layer up to 2 inch with cow dung slurry by mixing equal amount of dung and water.

vi. On 24th day of processing, release 4000 worms in the pit (1 sq. m. - 2000 worms) without disturbing.

vii. Apply water regularly.

viii. The raw material will be turned into vermicompost in the form of worm excreta.

ix. The excess amount of water and excreta will be kept in a common outlet as vermiwash which is full of nutrients.



Fig. Preparation of Vermicompost at Instructional Farm, SAAS, The Neotia University

Observations:

Number of labour required-

Cost of raw materials-

Earthworm required/pit-

Size and colour of earthworms-

Days to decomposition-

Yield-

Conclusion:

Experiment-2

Topic- Preparation of NADEP compost using dried crop stalks and cowdung slurry

Aim- To study the different methods of compost preparation

Objective- To prepare compost by NADEP method

Relevant information- The NADEP method of compost making was first invented by a farmer named N. D. Pandharipande (also popularly known as NADEP kaka) of Maharashtra. The process includes the placing of selective layers of different types of compostable organic materials, followed by sealing with mud in a given structure prepared with brick and concrete/ mud. NADEP method is one aerobic method of composting.

Materials required-

i. Around 1500 kg of farm waste, like crop residues, weed, plant leaf, twigs, sugarcane bagasse, husk etc. It should be free from foreign materials like glass, plastic, stone etc.

ii. Cow dung (90-100 kg), the slurry from biogas plant can also be used.

iii. Dry ground soil.

iv. Water: as per the condition and types of material.

Procedure:

Pit size- A rectangular brick tank having a size of 10 ft (length) × 5 ft (breadth) × 3 ft (height) is required for making NADEP compost. Provide sufficient space in between the bricks for good aeration. The size may vary depending upon availability of raw material and demand.

Steps followed

Step I:

First layer: Fill the first layer to a height of 6 inches with farm waste with at least 100-120 kg material.

Second layer: Mix 4 kg of cow dung in 125-150 litres of water (cow dung slurry) and sprinkled on the farm waste and see whether the material is completely wet or not. The amount of water will be more in summer season.

Third layer: Take 60 kg of clean soil and dilute in water and sprinkled over the second layer.

Step II:

i. After completion of first three layers, fill the tank with same series of three layers in same sequence up to one and half foot above the edge of the tank in the shape of a cone.

ii. In a standard sized tank, 11-12 series of layers can be placed easily.

iii. Seal the tank with three-inch layer of soil followed by plaster with liquid cow dung slurry. This will prevent cracks.

Step III:

Inspect the heap on regular basis. After a period of 15-20 days, you will notice that the volume of material will be reduced. It is due to degradation by microbial activities.

Open the tank and fill it again layer by layer in same sequence up to one and half foot above the edge of the tank. Once again, plaster it.

Step IV:

In order to maintain the moisture level (about 15-20%) and also to prevent cracking, apply cow dung slurry on the compost heap.

Cover the tank roof to prevent excess evaporation of water.

Fig. Preparation of NADEP Compost at Instructional Farm, School of Agriculture and Allied Science, The Neotia University

Observations:

The compost will be ready within 90-120 days. The compost will be deep brown in colour with a pleasant smell. It should be removed from tank and sieved.

Time in days	**Colour**	**Texture**	**Smell**	**Moisture content (%)**	**Temperature (°C)**

Conclusion:

Precaution:

i. The important technique in production of NADEP compost is that the entire tank should be filled in one operation.

ii. Filling should be completed within 24 hours and should never go beyond 48 hours, as this would affect the quality of compost.

iii. At any condition the compost should not be allowed to become dry. If cracks found, it should be promptly filled up with cow dung slurry.

Experiment-3

Topic- Production of Farm compost in pits using agricultural crop residues

Aim- To study the different methods of compost preparation

Objective- To prepare compost from non-utilizable farm waste materials

Relevant information- 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 contents of farm compost are 0.5 per cent Nitrogen, 0.15 per cent Phosphorus and 0.5 per cent Potassium. The nutrient value of farm compost can be increased by application of super phosphate or rock phosphate at 10 to 15 kg/t of raw material at the initial stage of filling the compost pit. 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 0.5 m above the ground. The compost is ready for application within five to six months. Composting is essentially a microbiological decomposition of organic residues collected from rural area (rural compost) or urban area (urban compost).

Materials required-

i. Around 1000 kg of farm waste, like crop residues, weed, plant leaf, twigs, sugarcane bagasse, husk etc. It should be free from foreign materials like glass, plastic, stone etc.

ii. Dry ground soil.

iii. Water: as per the condition and types of material.

Procedure:

Pit size- An oval shaped pit having a size of 4.5 m (length) × 1.5 m (breadth) × 1 m (height) is required for making farm compost. The size may vary depending upon availability of raw material and demand.

Steps followed

1. Start preparing the compost heap on bare soil to allow beneficial organisms to colonize the composting materials.

2. Make a base 30 cm high and 2 m wide with coarse materials such as twigs for good air circulation and drainage (any material that will note decompose can be used).

3. Add a 10 cm layer of carbon-rich material such as maize stalks (chop bulk materials into at least 3 inches).

4. Add a 10 cm layer of nitrogen-rich material such as fruit and vegetable scraps.

5. Add 2 cm layer of animal manure or old compost to activate the compost heat and speed the process.

6. Spread a layer of soil to mask odours and introduce micro-organisms that will accelerate the composting process.

7. Sprinkle ash and urine lightly onto these layers to accelerate the process of decomposition.

8. Water the heap thus formed.

9. Repeat these layers except the first layer of coarse material, until the heap reaches 1 to 1.5 m high.



Fig. Preparation of Farm Compost at Instructional Farm, School of Agriculture and Allied Science, The Neotia University

Observations:

The compost will be ready within 90 days. The compost will be deep brown in colour with a pleasant smell. It should be removed from the pit and sieved.

Time in days	**Colour**	**Texture**	**Smell**	**Moisture content (%)**	**Temperature (°C)**

Conclusion:

Precaution:

i. The important technique in production of farm compost is that the entire pit should be filled in one operation.

ii. Filling should be completed within 24 hours and should never go beyond 48 hours, as this would affect the quality of compost.

iii. At any condition the compost should not be allowed to become dry. If cracks found, it should be promptly filled up with cow dung slurry.

iv. Pits should be protected from predators like red ants, white ants, centipedes and others like toads, rats, cats, poultry birds and even dogs.

Experiment-4

Topic- Production of Biochar using crop residues

Aim- To study the production technology of biochar preparation

Objective- To prepare biochar from agricultural waste materials

Relevant information- Biochar is a carbon-rich substance produced by heating up organic materials without oxygen or in a limited supply of oxygen. In other words, bio char is produced by dry carbonisation or pyrolysis and gasification of biomass. Pyrolysis is thermal decomposition process takes place in inert atmosphere. The pyrolysis process usually takes between 400 to 850℃. The thermal decomposition in a pyrolysis reactor takes place in order of hemicellulose, cellulose and lignin destruction in increasing order of temperature. The biochar is produced by various methods like slow pyrolysis, flash carbonisation, hydrothermal carbonisation etc. Biochar has been utilised in agriculture for a long time in various parts of Asia, particularly in Japan and Korea. Biochar stimulates soil microbial activity by providing carbon substrate and growth nutrients. In addition, it serves as a suitable habitat for growth and protects them from predators. Furthermore, biochar increases the buffering capacity of soil thereby minimizing pH variations in microhabitats present inside biochar particles.

Materials required-

1. Raw materials - Rice husks or straws or any other wastes

2. Iron made drum with drum lid

3. Wooden belcha shovel

4. Operating gloves

Procedure:

Biochar is produced by the method of pyrolysis. Pyrolysis of biomass is the thermal degradation of organic material in the absence of an oxidising agent, or in such a quantity that gasification does not occurs, to produce solid, liquid, and gas by products. The feedstock is heated slowly at a low heating rate (0.1 to 2°C per second) to moderate temperatures (400°C) for a long time in slow, or conventional, pyrolysis. The biomass is progressively devolatilized during slow pyrolysis, resulting in the generation of tar and char as the major products. Methane dominates the gas produced, with minor hydrogen, propane, ethylene, CO, and CO_2.

Steps involved in biochar formation:

1. Heating and Drying

The biomass is heated in this process until it reaches the necessary drying temperature. This procedure takes place at a temperature of 100℃ until all the moisture in the biomass has evaporated. Ideally biomass should have a moisture content less than 15% when it enters the pyrolysis kiln to ensure high yield and quality biochar.

2. Torrefaction

Torrefaction is a thermochemical pre-treatment process at 200–300°C in an environment with low oxygen, which transforms biomass into a relatively superior handling, milling, co-firing and clean renewable energy into solid biofuel (coal-like pellets). It takes place at 200 to 300℃, and a constant temperature is achieved throughout the process. In this process biomass is carbonised and biochar is formed.

3. Cooling

After the biochar is formed, the temperature is reduced before it is exposed to the air to stop further biomass degradation due to high temperature.

Fig. Production of Biochar using crop residues and dried crop stalks

Observations:

Conclusion:

Experiment-5

Topic- Preparation of balance sheet of produce from agricultural wastes

Aim: To study the cost of different production system of compost, biochar as well as biofuel and preparation of balance sheet

Objective: To learn the process of data collection and calculation of cost of production.

Introduction: These production system of compost, biochar as well as biofuel always has some differences with traditional system. The inputs are also different from traditional crop cultivation as a result the ultimate cost varies. The price of these products are also very high.

Procedure: Collect all the data related to all inputs required, cost of labour, collection of data and market study for organic produce.

Observation: Calculate the cost of production, gross return, net return and calculation of B: C ratio with all collected data.

Sl. No.	**Particulars**	**Operations**	**Quantity**	**Rate (Rs.)**	**Amount (Rs.)**
Total					
Cost of cultivation (Rs.)					
Gross return (Rs.)					
Net return (Rs.)					
B:C ratio					

Yield-

Price-

Cost of cultivation (Rs ha $^{-1}$)

The prices of the inputs that were prevailing at the time of their application utilized for determining the cost of cultivation which was given in rupees per hectare.

Gross return (Rs ha $^{-1}$)

The model prices of rice prevailing in the market immediately after its harvest were used for the calculation of gross returns.

Net returns (Rs ha $^{-1}$)

The net return per hectare was worked out by deducting the cost of cultivation from the gross return and expressed in rupees per hectare.

Benefit cost ratio

In order to find out the economics of rice cultivation, the cost of cultivation and the gross return of all the treatments were worked out separately, from which the net return was obtained. Dividing this net return by cost of cultivation, we obtained the benefit cost ratio.

$$\text{Benefit cost ratio} = \frac{\text{Net return}}{\text{Cost of cultivation}}$$

Return per rupee invested

$$\text{Return per rupee invested} = \frac{\text{Gross return}}{\text{Cost of cultivation}}$$

Conclusion

Experiment-6

Topic- Quality analysis of compost and vermicompost

Aim: To understand the quality of compost and vermicompost

Objective: To learn the quality analysis of compost, vermicompost.

Relevant information: In recent few decades, dumping of huge quantity of organic wastes from different sources like domestic, agriculture and industrial wastes have caused serious environmental hazards and economic problems. Most of these wastes are either burnt or used for land filling. Burning of organic wastes contributes large amount of Carbon dioxide to the atmosphere that causes environmental pollution. This over all process tremendously leads to destroy the surface soil organic matter, decreases soil microbial population and affects the physical properties of the soil. Proper utilization of organic wastes can not only promote recycling of plant nutrients, it also improves soil health and environmental quality. Utilization of various organic residues such as Kitchen waste, weed wastes, Sewage and sludge, livestock wastes and agricultural wastes by making compost and vermicompost is very important in organic farming. It is very essential to analyze the quality of the compost and vermicompost before use.

Quality standards of vermicompost given by FCO

1	Moisture present by weight	15-25
2	Colour	Dark brown to black
3	Odour	Absence of foul odour
4	Particle size	Minimum 90% material should pass through 4.0 mm sieve
5	Bulk density (g/cm^3)	0.7-0.9
6	Total organic carbon, present by weight, minimum	18.0
7	Total nitrogen (as N), present by weight, minimum	1.0
8	Total phosphate (as P_2O_5), present by weight, minimum	0.8
9	Total potassium (K_2O), present by weight, minimum	0.8

10	Heavy metal content, (as mg/kg), maximum	
	Cadmium (as Cd)	5.0
	Chromium (as Cr)	50.00
	Nickel (as Ni)	50.00
	Lead (as Pb)	100.00

Materials required:

pH meter, Electric Conductivity (EC) meter, Hot air oven, aluminium moisture box, digital weight balance, distilled water, 100 ml beaker, mesh sieve, Core sampler, compost and vermicompost sample.

Procedure:

Determination of *pH*: The *pH* of the compost sample is determined as per the procedure described by Chandrabose *et al*., (1988).

- Take 30 gm of air-dry sample and sieve it through 2mm mesh sieve.
- Transfer the fine sample to a clean 100 ml beaker and add 60 ml of distilled water.
- Stir the contents intermittently and the sample suspension just before taking the reading.
- Immerse the electrodes into the beaker and record the meter reading.

Determination of Electrical Conductivity (EC): The electrical conductivity of the test samples was determined as per the procedure outlined by Chandrabose *et al*., (1988). Electrical conductivity is the measurement of total amount of soluble salts present in the sample and is expressed as millisimens/cm (mS/cm).

- Take 5 gm of the experimental sample and add 50 ml of distilled water.
- Stir well and allow the suspension to settle for eight hrs.
- Immerse the electrode of the conductivity cell into the sample solution and record the EC (mS/cm).

Moisture content: Moisture meters give an immediate reading but these are said to lack accuracy. Oven drying provides an accurate method for measuring the moisture content of compost and vermicompost.

- Weight an empty aluminium moisture box and record the weight (W_1).
- Collect fresh compost/ vermicompost sample and record the weight of compost/ vermicompost+ aluminium moisture box (W_2).
- Put the box (with lid open) in a hot air oven at 105° C for 24 hours.
- Record the weight of dry soil sample+ aluminium moisture box (W_3).
- Calculate the moisture content of compost/vermicompost by using the following formula.

$$\text{Moisture content (\%)} = \frac{W_2 - W_3}{W_3 - W_1} \times 100$$

Bulk Density (g/cm^3):

- Record the weight of an empty aluminium moisture box.
- Determine the volume of core ($\pi r^2 h$)
- Drive the core of known volume vertically into the compost and draw sample.
- Collect the sample from the core in aluminium moisture box.
- Keep the moisture box (with lid open) in hot air oven at 105° C for 24 hours.
- Record the weight of dry sample.
- Calculate the bulk density of compost/vermicompost by using the following formula.

$$\text{Bulk density (g/cm}^3\text{)} = \frac{\text{Weight of oven dry sample (g)}}{\text{Volume of sample = volume of core } (\pi r^2 h)}$$

Observations:

Type of compost	***pH***	**EC (mS/cm)**	**Moisture content (%)**	**Bulk Density (g/cm^3)**	**Colour**

Conclusion: