Course Code 621

VERMICOMPOSTING
(REVISED)

NSQF LEVEL 4

(Job Role: Vermicompost Producer)

NATIONAL INSTITUTE OF OPEN SCHOOLING
(An autonomous organisation under MoE, Govt. of India)
A-24-25, Institutional Area, Sector-62, NOIDA-201309 (U.P.)
Website: www.nios.ac.in, Toll Free No. 18001809393

COURSE TEAM

ADVISORY COMMITTEE

Chairman
NIOS, NOIDA, U.P.

Director, Vocational
NIOS, NOIDA, U.P.

CURRICULUM COMMITTEE

Prof. Shailendra Singh Yadav
Director, School of Agriculture
IGNOU, New Delhi
(Chairman of Course
Curriculum Committee)

Dr Chandra Bhan Singh
Rt. Principal Scientist IARI
Pusa Campus, New Delhi

Dr Shivadhar
Principal Scientist
Division of Agronomy
IARI, Pusa Campus, New Delhi

Dr Dushyent Gehlot
Asstt. Soil Conservation Officer
Ministry of Agriculture and
Farmer's Welfare, New Delhi

Dr Srinivasamurty R.
JSO, National Centre of Organic
Farming, Ghaziabad

Dr Neelima Pant
Assistant Director (Academic)
NIOS, NOIDA, U.P.

LESSON WRITERS

Dr Pravin Kumar Upadhyaya
Scientist
Division of Agronomy
ICAR-IARI, New Delhi

Dr Rajanna GA
Scientist
Division of Agronomy
ICAR-IARI, New Delhi

Dr Minakshi Karwal
Assistant Prof., KIET
Muradnagar, Ghaziabad

Dr (Ms.) Lekhu Gehlot
Assistant Professor
Deptt of Zoology
J. N. Vyas University, Jodhpur

Dr V.K.Verma
Regional Director
National Centre of Organic
Farming, Ghaziabad

Dr R.K. Palta
(Ex-CTO) Biomass Utilization Unit
ICAR, New Delhi

EDITOR

Dr Shivadhar
Principal Scientist
Division of Agronomy
IARI, Pusa Campus, New Delhi

PROOF READER

Prof. Shailendra Singh Yadav
Director, School of Agriculture
IGNOU, New Delhi

COURSE COORDINATOR

Dr Neelima Pant
Assistant Director (Academic)
NIOS, NOIDA, U.P.

GRAPHICS/DTP

M/S Sri Krishna Graphics
Delhi

A Word With You

Dear Learner,

Welcome to the Vermicomposting Programme of Vocational Education, National Institute of Open Schooling! By enrolling with this Institution, you have become part of the family of the world's largest Open Schooling System. As a learner of the National Institute of Open Schooling's (NIOS) Vocational Programme, we are confident that you will enjoy studying and will benefit from this very unique system of learning.

The vocation of Mushroom Production is getting popular tremendously over the last few years. It is one of the few professions which requires less labour and can be taken up as a profession by men and women, young and old, both literate and illiterate. As there are less initial investments and quick returns hence families and unemployed youth can be encouraged to adopt this vocation. Mushroom production will improve the socio economic status and solve the employment problems of rural economy by generating the income and job opportunities.

The foremost aim of this course is to promote self employment. The course components comprises of nutritive and medicinal values of mushroom, different types of mushrooms, their cultivation practices, post harvest management etc.

We are confident that this course will prove to be beneficial to you. Sincere efforts have been made to present the content in a very simple manner for your easy understanding. Since this is a practical oriented subject we advise you to attend the Personal Contact Programmes and Practical/Training sessions organised at your Accreditated Vocational Institutes (AVI)/ Study Centre. Your AVI will give you the necessary hands on training that is very essential to master this vocational course.

We look forward to any comments and suggestions from you for further improvement.

We wish you all the best in your future career.

Course Team
National Institute of Open Schooling (NIOS)

How to use the Study Material

Congratulation! You have accepted the challenge to be a self-learner. NIOS is with you at every step and has developed the material in *Vermicomposting* with the help of a team of experts, keeping you in mind. A format supporting independent learning has been followed. If you follow the instructions given, then you will be able to get the best out of this material. The relevant icons used in the material will guide you. These icons have been explained below for your convenience.

Title: will give a clear indication of the contents within. Do read it.

Introduction: This will introduce you to the lesson linking it to the previous one.

Objectives: These are statements that explain what you are expected to learn from the lesson. The objectives will also help you to check what you have learnt after you have gone through the lesson. Do read them.

Notes: Each page carries empty space in the side margins, for you to write important points or make notes.

Intext Questions: Very short answer self check questions are asked after every section, the answers to which are given at the end of the lesson. These will help you to check your progress. Do solve them. Successful completion will allow you to decide whether to proceed further or go back and learn again.

What You Have Learnt: This is the summary of the main points of the lesson. It will help in recapitulation and revision. You are welcome to add your own points to it also.

Terminal Exercise: These are long and short questions that provide an opportunity to practice for a clear understanding of the whole topic.

Answers to Intext Questions: These will help you to know how correctly you have answered the questions.

www **Web site:** These websites provide extended learning. Necessary information has been included in the content and you may refer to these for more information.

NSQF (National Skill Qualification Framework)

The National Skills Qualifications Framework (NSQF) is a competency-based framework that organizes all qualifications according to a series of levels of knowledge, skills and aptitude. These levels, graded from one to ten, are defined in terms of learning outcomes which the learner must possess regardless of whether they are obtained through formal, non-formal or informal learning. The learning will enable the learner to acquire desired competency levels, transit to the job market and, at an opportune time, return for acquiring additional skills to further upgrade their competencies.

NSQF Level

Each level of NSQF is associated with a set of descriptors made up of five outcome statements, which describe in general terms, the minimum knowledge, skills and attributes that a learner needs to acquire in order to be certified for that level. Each level of the NSQF is described by a statement of learning outcomes in five domains, known as level descriptors. These five domains are Process, Professional knowledge, Professional skill, Core skill and Responsibility.

NOS (National Occupational Standards)

NOS define the measurable performance outcomes required from an individual engaged in a particular task. They list down what an individual performing task should know and also do. These standards can form benchmarks for various education and training programs and recruitment range of HRM practice. Just as each job role may require the performance of a number of tasks, the combination of all the NOSs corresponding to these tasks would form the Qualification Pack (QP) for that job role. The NOSs and QP for each job role corresponding to each level of the NSQF are being formulated by the concerned Sector Skill Councils (SSCs).

Course "*Vermicomposting*" is based on the following National Occupational Standards (NOS) for "Vermicompost producer" formulated by Agriculture sector Skill Council of India:

1. AGR/N1212 Identify appropriate site and prepare bed for vermicomposting
2. AGR/N1213 Inoculate earthworms in prepared unit and manage vermicomposting process
3. AGR/N1214 Identify maturity of vermicompost and harvest using approved procedures

4). AGR/N9908 Undertake basic entrepreneurial activities for small enterprise

5. AGR/N9903 Maintain health & safety at the workplace

For more information about NSQF and NOS, kindly browse in the mentioned websites:

https://nsdcindia.org/; http://www.asci-india.com/National%20Occupation%20Standards.php

CONTENTS

Notes

1

INTRODUCTION TO VERMICOMPOSTING

1.1 INTRODUCTION

In ancient times, there were no villages or towns. People in small groups used to move from one place to another, one forest to another in search of food. In the course of time, people learnt the art of farming and growing food articles. Then much later came the era of Green Revolution, where intensive agricultural practices, which included the use of fertilizers, pesticides, high yield varieties and hybrids etc. increased our food production. Over a period of time, the excessive use of chemical fertilizers and pesticides for increased productivity has led to degradation of the soil. Consequently, there has been decline in productivity. Many other side effects too have been observed. It was then that the disadvantages of pesticides and inorganic fertilizers came to light. Henceforth, the oldest form of agriculture now called organic or natural agriculture started being advocated.

Vermicomposting is one such method of organic farming where earthworms, the friends of farmers convert the agricultural waste into compost. It also enhances the fertility and productivity of the soil. Because of the ability of earthworms to regulate the quality and fertility of the soil by eating and digesting different kinds of organic materials, the ancient Greek philosopher and scientist, Aristotle called earthworms as "Intestines of earth". We shall learn some basic information about vermicomposting in this lesson.

OBJECTIVES

After reading this lesson thoroughly, you will be able to:

- differentiate between composting and vermicomposting;

Notes

- state the role of earthworms in enhancing soil fertility and crop production;
- comprehend benefits and properties of vermicompost;
- identify different vermicomposting products and their use; and
- explain the market for vermicompost, government schemes and financial support available.

1.2 COMPOSTING AND VERMICOMPOSTING

We use materials from the earth every day, for everything we do. We eat food, drink from aluminium cans or glass bottles, live in wooden houses, wear clothing made from cotton or a synthetic fiber, and use many plastic appliances. Some of these materials, such as metals and plastics, are non-biodegradable. These materials do not decompose, although many of them can be recycled. However, the biodegradable materials can decay, i.e. they can be decomposed; examples are wood, food scraps, paper, and grass clippings.

Activity 1: Identify biodegradable and non-biodegradable material

Enlist the things, which are generally waste at your home and classify them into biodegradable and non-biodegradable material.

Biodegradable	Non-biodegradable
Dried leaves	Polythene bag

By performing this activity, you will able to identify biodegradable and non-biodegradable material and gain a basic understanding of composting.

Do you know that the nutrients in biodegradable crop residue, cow dung and other plants and animal waste could be restored and reused through composting or vermicomposting? They can be used for making compost or vermicompost. You must be thinking, what is the difference between the two? Let us understand it.

Compost is an organic matter that has been decomposed and recycled as a fertilizer and soil amendment. Amendments are elements that are added to the soil to

Notes

increase its capacity to support plant life. Compost is a key ingredient in organic farming. At the simplest level, the process of composting simply requires making a heap of wet organic matter known as green waste (leaves, food waste etc.) and waiting for the materials to break down into humus after a period of weeks or months. Humus is the organic component of soil formed after decomposition of leaves and other plant material. Compost that is excellent for growing crops can be made from many different base ingredients. The process of making compost is called composting. **Composting** is defined as a natural process of decomposition of organic materials into available nutrient sources for plants through various microorganisms, such as bacteria, fungi, protozoa etc. The optimum moisture content, C : N ratio (Carbon : Nitrogen ratio is ratio of the weight of the total organic carbon to the weight of total nitrogen in a soil or in an organic material) and pH (measurements of hydrogen ion concentrations, and index of acidic, neutral or alkaline conditions) are needed to be maintained for the survival of microbes and proper functioning of the composting system. The decomposition process may be divided into two categories:

- Aerobic composting – Decomposition in the presence of oxygen.
- Anaerobic composting – Decomposition in the absence of oxygen.

Vermicomposting is a method of preparing enriched compost with the use of earthworms. Scientifically, **Vermicomposting** is a process of decomposition of organic material through the combined action of microorganisms (microscopic organism, which may exist in its single-celled form also called as microbes) and earthworms which convert organic waste into rich organic source of nutrients known as vermicompost. Vermicomposting is a non-thermophilic (that does not require high temperature) and aerobic process (that requires oxygen) that releases little heat. The reactor or the container where vermicomposting is done is known as a vermin-reactor (Fig. 1.1). The earthworms are used to generate compost for agricultural utilization through vermicomposting process. Earthworms feed the organic waste and excrete more in the form of vermin-cast. Since the intestine of earthworms is a home for many enzymes, microorganisms and hormones, it rapidly decomposes theingested organic substrate. For vermicomposting, the most commonly used earthworm species are ***Eisenia fetida***, ***Eudrilus eugeniae*** and ***Perionyx excavatus***. ***Eisenia fetida*** is the most widely used amongst the three species. You must choose the earthworm species on the basis of short life cycle, high reproduction rate as well as capability to decompose variety of organic matter at a rapid rate.

Notes

Fig. 1.1: Vermicomposting Bed or Vermibed or Vermin-reactor

1.3 ROLE OF EARTHWORMS IN MAINTAINING CROP PRODUCTION AND SOIL FERTILITY

Have you ever thought why nature has evolved earthworms in the soil ecosystem? What is their role? Well, earthworms have a significant role in the ecosystem (Fig. 1.2). Let us learn how they improve our ecosystem. Earthworms are also said to be a 'Farmer's friend' or 'Nature's ploughman'. Earthworms feed on the dead organic matters such as leaf, litter and other dead plant parts. They play an essential role in regulating the soil environment through recycling of agro wastes. They enhance the chemical, physical and biological characteristics of soil through their feeding, burrowing and casting activities (the breakdown of organic matter). They increase soil porosity, water holding capacity, soil microbial activity, agrowaste decomposition, accelerate nutrient cycling and modify plant root distribution. Porosity means being full of tiny holes. Water holding capacity of soil is one of the main functions of the soil. It is the capacity of soil to store moisture and supply it

Notes

to the plants between rainfalls or irrigations. Microbial activity is a characteristic of microorganisms that causes fermentation (breakdown of a substance by bacteria).

The earthworm conventionally have been considered as bio-indicators of soil health and soil fertility. They provide various services such as soil formation, enhancing crop production, heavy metal remediation (removal of contaminants such as metal particles in this case) and plant's protection against pests. They accumulate heavy metals inside their body from the organic substrate and thus, purify the soil from heavy metals.

Fig.1.2: Earthworms for Vermicomposting

You must have seen that the earthworms are long, cylindrical structured organisms having a number of segments in their body. They are present beneath the soil. At maturity, they develop a ring shaped Clitellum (thick saddle like ring found on the skin of the worm in which eggs are stored; Fig. 1.3). It secretes thick mucus to form a cocoon (Fig. 1.4). Cocoon is seed shaped case that forms protective covering to enclose eggs and sperms. Earthworm produces cocoons at the age of six weeks till the end of six months.

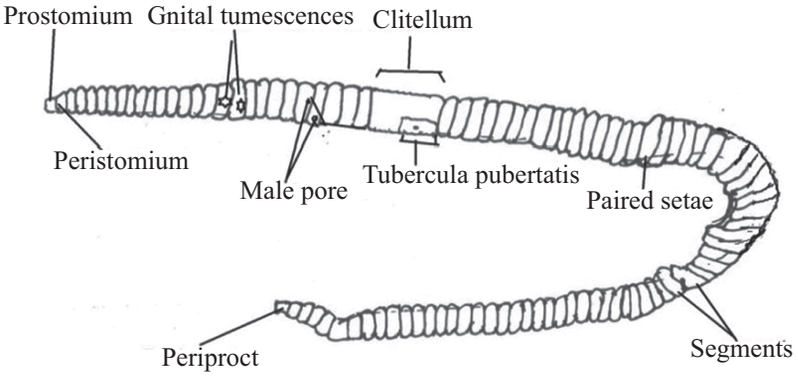


Fig. 1.3: Earthworm: Clitellum and Body Structure

Notes

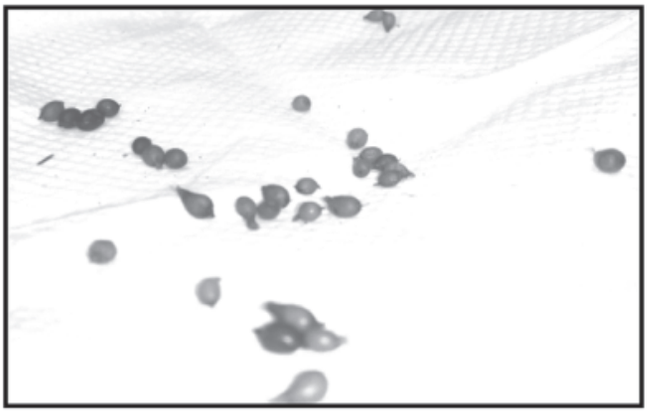


Fig. 1.4: Cocoon of Earthworm

For vermicomposting, earthworm species should have high rate of feed consumption, cocoon production and higher adaptability to environment. Earthworm population depends upon quality and quantity of organic waste used for composting. Their population can decline if toxic or unfavorable conditions prevail in the vermibed. Vermibed (Fig. 1.1) is a layer of good moist soil in which earthworms will inhabit it as their home. Utmost care is required during the vermicomposting process so that the population of earthworms doesn't decline.

1.4 ADVANTAGES OF VERMICOMPOSTING

You should know the different benefits of vermicompost due to which it is very popular amongst rural and urban farmers and plant growers. Let us enlist the advantages of vermicompost. These will motivate you to become a vermicompost producer:

- You can easily practice vermicomposting in your backyard or on a small piece of land in a field. You can make vermicomposting bed of variable sizes depending on the space available.
- Vermi-technology is a green technology, which is eco-friendly, low energy consuming, easy to manage, odorless and it is a safe process for the conversion of biodegradable waste into a humus and nutrient rich vermicompost.
- It is comparatively a faster process in comparison to traditional composting.
- Very less cost is required to establish a vermicomposting unit. It is a cost effective technique and has least input and maintenance cost in comparison to other methods.

Notes

- It has potential to improve the socio-economic condition of the rural people to generate income and employment opportunities.
- The raw materials used in vermicomposting techniques are generally waste materials therefore, it is considered as one of the emerging techniques for waste management.
- The rate of decomposition is 2-5 times faster in vermicomposting; thereby enhancing the bioconversion of organic matter into valuable compost. Moreover, vermi-technology generates more homogenous (of the same type) compost as compared to other composting techniques.
- Additional income can be generated by the sale of worms.
- As vermicomposting generates employment opportunities, it boosts the rural economy.

1.5 WHO CAN DO VERMICOMPOSTING?

If you have interest in vermicomposting, then you can easily learn the rearing and management of earthworms during vermicomposting. Homemakers, farmers, unemployed persons, and even students can earn a considerable amount of money by doing vermicomposting. There may be different purposes of vermicomposting:

- Commercial: To produce vermicompost and sell it for profit.
- Sideliner: To produce vermicompost for own use and sell the remaining amount for earning additional income.
- Hobbyists: To produce vermicompost as a hobby.

You may belong to any group, as per your choice and requirements. Write down your choice and requirements, in the space given below:

.....

.....

.....

1.6 PROPERTIES OF VERMICOMPOST

As explained earlier, vermicompost is considered as a nutrient rich and eco-friendly biofertilizer. A biofertilizer is a substance which contains living microorganisms. When it is applied to a seed or a plant surface or soil, it promotes

Notes

plant's growth by increasing the supply or availability of nutrients to the plant. Vermicompost has various distinctive properties due to which it is very popular amongst the scientists and farmers both. Can you guess properties of vermicompost that makes it unique? Let's identify them:

(i) It is a granular peat-like substance that **improves the physical, chemical and biological parameters** of soil such as porosity, structure, aeration (brings water and air together to remove dissolved gases) and water holding capacity. Healthy soil will provide healthy environment for crop growth and high yield.

(ii) It is a **good soil conditioner and an organic fertilizer that** is rich in macro nutrients such as nitrogen, phosphorous, potassium and micronutrients. It is also rich in important soil microorganisms, such as phosphate solubilizing (making a substance more soluble) and nitrogen fixing bacteria (nitrogen-fixing bacteria are microorganisms present in the soil or in plant roots that change nitrogen gases from the atmosphere into solid nitrogen compounds that plants can use in the soil). Vermicompost consists of many beneficial soil enzymes (a chemical substance that helps to cause natural processes) and plant growth promoting compounds, which improve the growth and development of plants. Thus, vermicompost is a more effective alternative to the chemical fertilizers.

(iii) Vermicompost has **good physio-chemical characteristics** that are harmless to plants and agricultural soil. In addition, vermicompost acts as a protector against various pests that results in enhancing the plant growth.

INTEXT QUESTIONS 1.1

State True or False

(a) Vermicomposting process involves action by earthworm and microorganisms.

(b) Vermicompost is rich in both macro and micro nutrients.

(c) *E. fetida* is most widely used species for vermicomposting.

(d) Vermicompost improves soil fertility and productivity.

1.7 VERMICOMPOSTING PRODUCTS

The vermi-technology creates excellent employment opportunity for the youth. This technology generates three main products. First, organic manure called **vermicompost,** which could be used as an organic source of nutrient. Second,

Notes

biomass product like earthworm **biomass** that could be sold in the market as a source of protein. A biomass is the material obtained from living individuals, viz. their body parts, dead parts, excretory products, etc. Third, the **vermiwash** produced from vermicomposting process, that may also be used as microbial inoculums (substances that provide artificial induction of immunity) for pre-composting phase during the initial process and directly used in the crops as a source of supplementary nutrients for the crop. Let us discuss these products in detail.

(i) Vermicompost

As already discussed, it is an ecofriendly manure produced by earthworms from the biodegradable waste. Earthworms break down the organic waste into smaller size pieces through their burrowing action. After that, the microorganisms present in the gut of earthworm hydrolyses organic macromolecules (containing unavailable forms of nutrients such has nitrogen, potassium, phosphorus sand calcium) and convert it into the available form of plant nutrients through action of different enzymes. Earthworms, thus convert the waste into matured odourless (if odour is there it is very less and pleasant as earthy fragrance, dark brown coloured and granular structured compost, like tea leaves. The optimum moisture (60–70%) content in substrates (underlying layer) is required for the growth of earthworms and cocoon production. The ideal temperature for earthworm growth and production of cocoons is between 25-30°C. Vermicompost (Fig. 1.5) then gets prepared within 6-7 weeks.

Fig. 1.5: Harvested Vermicompost

(ii) Earthworm Biomass

You need to culture earthworms to increase their number and biomass which is known as vermiculturing. The biomass of earthworm is a rich protein source (earthworm meal) for livestock that has natural de-toxicant properties. Hence,

Notes

surplus worms can be fed to poultry and fish as a source of protein. You can culture earthworms in a shaded place to avoid direct sun rays exposure and prevent water logging situation during rainy days.

(ii) Vermiwash

Vermiwash is basically a leachate produced from the vermicomposting system. It is a dark brown coloured liquid; which is a liquid fertilizer rich in different nutrients such as nitrogen, phosphorous and potassium and essential micronutrients like zinc, manganese, cobalt, iron, etc. Vermiwash has sufficient amount of microbial biota (flora and fauna), enzymes and growth promoting hormones to ensure healthy development of plants. Vermiwash needs to be diluted before application otherwise plants may die.

INTEXT QUESTIONS 1.2

Fill in the blanks

(a) Breakdown of macronutrients of substrate occur with the help of ..... present in the gut of earthworms.

(b) Matured vermicompost is dark brown coloured granular material looks like ..... leaves.

(c) Biomass of earthworms can be used as a source of ..... to feed fish poultry.

(d) Vermiwash is a dark brown coloured ..... produced during decomposition process through earthworms.

1.8 MARKETING OF VERMICOMPOST

Before establishment of vermicomposting unit, it is important for you to understand the market demand of vermicompost. You can use vermicompost as an alternative for chemical fertilizer. It is an essential component in organic farming. Now a days, a lot of emphasis is being given to organic cultivation and organic food products. Organic grains and other eatables are sold in the market at a higher price in comparison to non-organic eatables. This enhances the demand of vermicompost. Direct or indirect marketing of vermicompost can be done to:

(i) Individuals

(ii) Wholesale dealers

(iii) Nurseries

(iv) Local vegetable market

Notes

1.9 GOVERNMENT SCHEMES AND FINANCIAL SUPPORT AVAILABLE

Government of India provides subsidy schemes for setting up a vermicompost unit in association with NABARD to the eligible beneficiaries such as self-help groups, farmers, entrepreneurs, dairy cooperative societies etc. This is done in association with Commercial Banks, Regional, Rural and Urban Banks, State Cooperative Banks, State Cooperative Agriculture and Rural Development Banks and other such institutions. State government also provides financial support to the farmers through various schemes. For more information about the government schemes, you may visit the government websites as http://agricoop.nic.in/ and https://ncof.dacnet.nic.in/.

1.10 NATURE OF WORK

Most of the work in vermicomposting is not mechanized and you need to perform it manually. Thus, you must attend the practical training classes to acquire the required skills for starting a successful business.

As a vermicompost producer, you need to carry out the under mentioned preparations and steps:

- Seek advice of the experts.
- Find the suitable location for establishing vermicomposting unit.
- Prepare a business plan for vermicomposting.
- Arrange all the resources required for setting up a vermicomposting unit, place orders for supplies such as equipment like spade, water sprayer, cupboard to store items, raw materials, etc in advance.
- Plan the activities to be undertaken and estimate operating cost of each activity.
- Supervise various activities for vermicomposting and make sure that the temperature, aeration, agitation, moisture content and other conditions are proper.
- Decide the earthworm species to be used for vermiculturing, in consultation with an expert.
- Observe and record the quantities of vermicompost produced, expenditure incurred, and sale till the end of one batch.
- Adjust practices to increase production and decrease expenditure.

Notes

CASE STUDY

Case Study: Kinanagar not an ordinary village, it has India's largest unit of vermicomposting!

Sajagmahilaevam gram utthan sansthan Secretary, Dr. Monica Tyagi (late) started this project in 1995 with a vision to provide best quality and low cost organic fertilizers for the betterment of farming/agricultural sector and to support livelihood. Sajag purchased cattle dung from the dairies in large quantity and fed the same dung to the earth worms (Eiseniafetida). After a few months, the worms produced highly fertile manure called vermicompost.

Sajag has established its office in Kinanagar village situated at Garh Road. The Sajag produces about 100 tonnes of vermicompost every month on 3.0 acre land with a turnover of over Rs. 1.0 crore per annum. People of nearby localities too started accepting the concept and transition started from traditional to organic farming.

Fig. 1.6: Skill Development Training on Vermicomposting

At present Sajag a unit with more than 9,000 units in India is present in 14 states. Sajag provides training to entrepreneurs; unemployed youth and farmers. It helped people to develop skills in order to combat mass migration from villages to cities, which is one of the major problem of Rural India.

Notes

WHAT YOU HAVE LEARNT

Let us recapitulate and enlist the salient points that you have learnt through this lesson:

- Vermicomposting is a green technology that combined joint action of microorganisms and earthworms to decompose the biodegradable organic waste.
- Earthworms improve the soil environment through their feeding, burrowing and casting activity.
- Vermicomposting has large market potential as variety of products can be obtained from it.
- The products generated through vermicomposting are vermicompost, earthworm's biomass and vermiwash.
- Most commonly used earthworm species for vermicomposting are *Eiseniafetida, Eudriluseugeniae and Perionyxexcavatus.*
- Leachates produced during vermicomposting process is a dark brown colored liquid with many microbial biota and nutrients. It is commonly known as vermiwash.
- Direct or indirect marketing of vermicompost can be done to Individual/ Wholesale dealers/ Nurseries/ Local vegetable market.
- Various subsidy schemes are being run by the Central and State Governments in association with NABARD to promote vermicompost units.

TERMINAL EXERCISES

1. Do you think vermicompost can be an alternate to chemical fertilizer? Justify your answer.
2. Why Vermicomposting is essential for organic agriculture?
3. How earthworms improve the soil quality?
4. What care and preventive measures are required for multiplication of earthworms?
5. Explain the environmental significance of vermicomposting.

Notes

6. Differentiate between composting and vermicomposting.
7. Enlist few earthworm species used in vermicomposting process.
8. Write a short note on the following:
   (a) Vermiculture
   (b) Vermiwash

ANSWERS TO INTEXT QUESTIONS

1.1

(a) True (b) True (c) True (d) True

1.2

(a) Microorganisms (b) Tea

(c) Protein (d) Leachate

Suggested Activity 1

Pre-composting: Take some biodegradable raw waste such as vegetable peels, fruits waste etc. Put these mixture of waste in an earthen pot and do pre-composting for 20 days. Take care that you have to mix and agitate the waste thrice weekly. You will observe heat and smelly gases being emitted. The heat generation is dangerous to earthworms. That is why pre-composing of waste is required. Enlist various changes during pre-decomposition period of 20 days. You may find growth of insects, fungusetc. Based on the mentioned observations, you may be able to understand that pre-composting is a necessary activity before vermicomposting.

Suggested Activity 2

Vermiculturing: To initiate vermiculturing, you need to purchase starter/earthworm culture from market or get it from any vermicomposting training center. Arrange some containers such as bucket, tubs, sink, basin and make holes at the bottom of the vessel for aeration. Fill these containers with pre-decomposed cow dung/ buffalo dung and then spread earthworms above it. It is essential to keep on sprinkling water on it thrice a week or as and when required. Agitate the substrate carefully time to time. Observe changes in colour, texture, smell of cow dung (substrate) and subsequently multiplication of worms and production of cocoons.

Notes

You may place these containers under shade at your terrace or yard. Make sure that you have covered them with jute bags to protect them from sunlight and predators like birds and rats.

Key Learning Outcomes

- Differentiate between composting and vermicomposting.
- Elucidate benefits of vermicomposting for the soil as well in income and employment generation.

Notes

2

EARTHWORMS AND THEIR HANDLING

2.1 INTRODUCTION

Learners! In the previous lesson, you have learnt that the earthworms are native population of soil and also are good 'friends' of farmers. Do you know that the importance of earthworms for human was first recognized by Charles Darwin in the year 1881 (http://darwin-online.org.uk/EditorialIntroductions/Chancellor_Earthworms.html).

Aristotle, the ancient Greek Philosopher and Scientist realised the enormous importance of worms, calling them 'the intestines of the earth (https://www.discoverwildlife.com/animal-facts/insects-invertebrates/facts-about-earthworms/). In recent years, efforts have been made to use the potential of earthworms in recycling nutrients, waste management and vermicomposting at commercial scale. In this lesson, you will be learning about the earthworms in detail.

OBJECTIVES

After reading this lesson, you will be able to:

- classify the types of earthworms;
- summarize the morphology of earthworms and their body parts;
- explain the life cycle of earthworms; and
- rear and handle the earthworms scientifically.

Notes

2.2 CLASSIFICATION OF EARTHWORMS

Earthworms are widely distributed in nature. They constitute a large part of biomass (living bodies) in the soil. You will be surprised to know that there are 3000 earthworm species distributed around the world. However, 384 species of the earthworms are reported in India. Earthworms are known to have their origin during Precambrian era, around 600 million years ago. They belong to the group of higher non-chordates (animals without backbone) and its systematic position is as under:

Phylum: Annelida

Class: Oligochaeta

Order: Linicolae

Different species (a class of individuals having some common characteristics or qualities) of earthworms belong to separate family (a taxonomic group of one or more genera, especially sharing a common attribute). Some of the species are given as under:

Family	**Genus**	**Species**
Lumbricidae	*Eisenia*	*fetida*
	Eisenia	andrie
Eudrilidae	*Lumbrieus*	*rubellus*
	Endrilus	euginiae
Megascolecidae	*Perionyx*	*excavatus*
	Lampita	mauritii
Moniligastridae	*Dravida*	*willsii*

You may also identify earthworms based on their feeding habits or habitat. Let us understand it better.

Based on **feeding habits, earthworms** are of two types:

(i) Phytophagous: This type of earthworms feed on the semi-decomposed organic matter. They are also called *Humus or Manure farmers*. These types are more commonly used in vermicomposting. *Eisenia fetida and Eudrilus eugeniae* are important species of this category.

Notes

(ii) Geophagous: This type of earthworms usually feed on the soil. They are also called as *Humus feeder and Ploughman*. They remain present in deep furrows (a long, narrow trench made in the ground by a plough, especially for planting seeds or irrigation) under the soil. They are not used in vermicomposting, however, they play important role in aeration in soil.

Based on habitat, earthworm species can be classified into three categories:

(i) **Epigeic** (A Greek word that means "upon the earth")

They are surface dwellers and present near the surface litter (fallen leaves and partially decomposed organic matter). They are also called as the *Surface Feeder*. They can tolerate a wide range of temperature. They are efficient eaters and are good for vermicomposting. *Eisenia fetida, Eisenia andrei, Dendrodrilus rubidus, Eudrilus euginiae, Lumbricus rubellus, Perionyx excavates* and *Dendrobaena veneta* are considered as the Epigeic earthworms (Fig. 2.1).

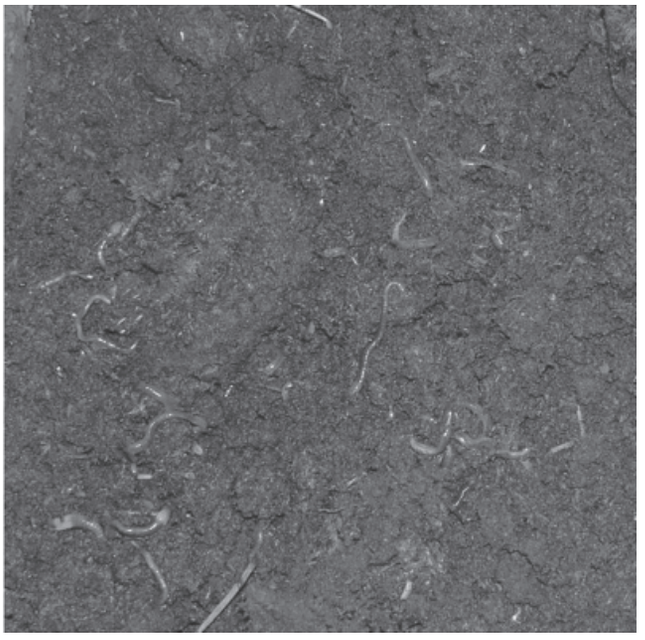


Fig. 2.1: Epigeic Worms

(ii) **Anecic** (A Greek word that means "out of the earth").

They are deep burrowing worms present in the deeper layer of soil. They have poor temperature tolerance. These species are moderate for decomposition. *Apporrectodea trapezoids, Lumbricus terrestris, Lampito polyphemus, Lampito mauritii*and *Apporrectodea longacare* are considered as the Anecic earthworms.

Notes

(iii) **Endogeic** (A Greek word that means "within the earth").

Endogeic worms are present below the soil surface. They are important for soil mixing and aeration processes. *Octochaetona thurstoni, Aporrectodea caliginosa, Allolobophora rosea, Drawidabarwelli and Amynthas species* are considered as the Endogeic earthworms.

Suitable Species for Vermicomposting

Amongst different species explained, Epigeic species *viz*., *Eudrilus eugeniae, Eisenia fetida and Perionyx excavates* are appropriate for vermicomposting. This brings us to the next question, as to what are the qualities of an earthworm species that makes it suitable for vermicomposting? So, let us know the desirable characteristics of appropriate vermicomposting species in the points given below:

- The worm should exhibit high biomass consumption. It should also have high efficiency to convert ingested biomass to body proteins. This is a prominent physiological trait that is required for achieving high growth rate.
- The worm should have wider range of tolerance to environmental factors. It should also be adaptable to feed on a variety of organic residues.
- The worm should produce large numbers of cocoons with short hatching time (time taken to release a fully developed young one from the egg) enabling rapid population growth.
- Life cycle of the worm should be such that mature/adult phase is quickly reached.
- The worm should be disease resistant.
- The worm should tolerate a wide range of climatic conditions like temperature, humidity, etc.
- Using a mixture of species is likely to be more useful than the use of a single species.

INTEXT QUESTIONS 2.1

State True or False

(a) Earthworms use biodegradable organic wastes as food.

(b) *Eisenia fetida and Eudrilus eugeniae* are geophagous types.

(c) Epigeic earthworms remain on the soil surface.

(d) Instead of a single worm species, use a mixture of species for vermicomposting.

Notes

2.3 MORPHOLOGY AND BODY PARTS OF EARTHWORMS

You must have observed that morphologically, earthworms have long and cylindrical body. Let us know an earthworm scientifically. They are tubular organisms with rings or annuli along the length of their body (Fig. 2.2). They don't have a distinct head, trunk or abdomen. About two centimeters behind the anterior end of the body, there is a thick collar or girdle, which is like glandular thickening of the body surface, called clitellum. Position of the clitellum is characteristic feature of each earthworm species. For example, in species *Eisenia fetida*, it may start from 24, 25 or 26th segment and end at 32th body segment. In *Eudrillus*erginiae, it may spread from 13th or 14th to 18th segment. For *Perionyx excavtus* clitellum, it covers from 12th or 13th to 17th segment. This structure is very prominent in all mature earthworms and plays an important role in formation of a purse like structure (cocoon) that encloses the eggs in it. The earthworms do not have any legs for locomotion, rather they move with S shaped chitinous (a nitrogen containing polysaccharide that forms a semitransparent horny substance and is a principal constituent of the exoskeleton or outer covering) structures called setae (bristle or hair like structures that help earthworms to attach to the surface and prevent backsliding during their motion). They are present along the circumference of each annulus. Annulus is an external circular ring found in segmented animals such as earthworms and leeches. These are not visible by the naked eye. Various pores are

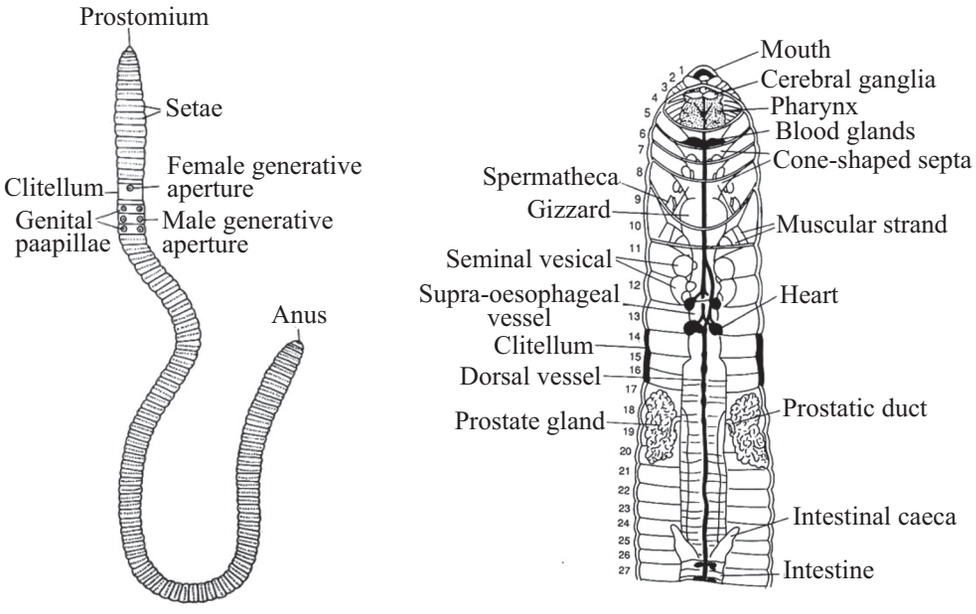


Fig. 2.2: Body Structure of an Earthworm

Notes

present upon the body of earthworm. Mouth is present at the anterior end and anus is present at the posterior end on the last segment. On the dorsal surface are present dorsal pores whose secretion keeps the body surface moist. Naphridio pores are found scattered on the body of the earthworms. It plays an important role in the respiratory and excretory system of the earthworms. Besides these pores are present spermathical (a sac for sperm storage in the female reproductive tract), female genital and male genital pores, which play important role during reproduction. Position of pores helps in identification of earthworm species.

Digestive system of the earthworms consists of a tubular alimentary canal extending from the mouth to the anus. The alimentary canal is mainly referred to as the pathway by which food enters our body and moves out through the anus during digestion. Mouth is followed by pharynx, oesophagus, gizzard, intestine and rectum. The gizzard is a grinding organ and it works the stomach that digests proteins. In intestine, digestion and absorption of the food takes place. The undigested food is thrown out of the body from the anus in the form of pellets known as castings or casts. Earthworms do not have any specialised organ for respiration (like lungs). Respiration is carried out from the general body surface, which is kept moist through the dorsal pores, nephridio pores and also through the soil moisture. Are you aware that the earthworms do not have any organ to hear or to see? Then, how do they respond? Actually, the earthworms are very sensitive to light and sound. Hence, they are able to respond because of their high sensitive power. They also have locomotive power of moving in both the directions.

2.4 LIFE CYCLE OF EARTHWORMS

Earthworms are bi-sexual or hermaphrodite organisms having both male and female reproductive organs (sperms and ovum respectively) in their body. Even being bi-sexual, the fertilization in earthworms (fertilization is the fusion of sperms and ovum to initiate the development of a new individual organism or offspring) takes place between two earthworms due to distant position of the reproductive organs. Maturity period of the sperms and ovum also differs. After fertilization, the earthworms form cocoon which takes about 6 hours. The earthworms become adult in about 30-45 days and start the fertilization process. One earthworm usually produces 17-25 cocoons and each cocoon produces 3-4 earthworms. The earthworms can produce cocoons up to six months and thereafter their reproducing capacity decreases. Under favourable conditions, one earthworm can produce approximately 5000-7000 earthworms.

Let us understand the life cycle of three earthworm species which are widely used in vermicomposting as explained in the succeeding paragraphs:

Eisenia fetida

It is popularly known as red wriggler or red worm or tiger worm. It is perhaps the most widely used earthworm for vermicomposting. The mature individuals can attain body weight upto 1500 mg. On an average, each mature worm produces one cocoon every third day. On hatching from each cocoon, one to three individuals emerge within 23 days (Fig. 2.3).

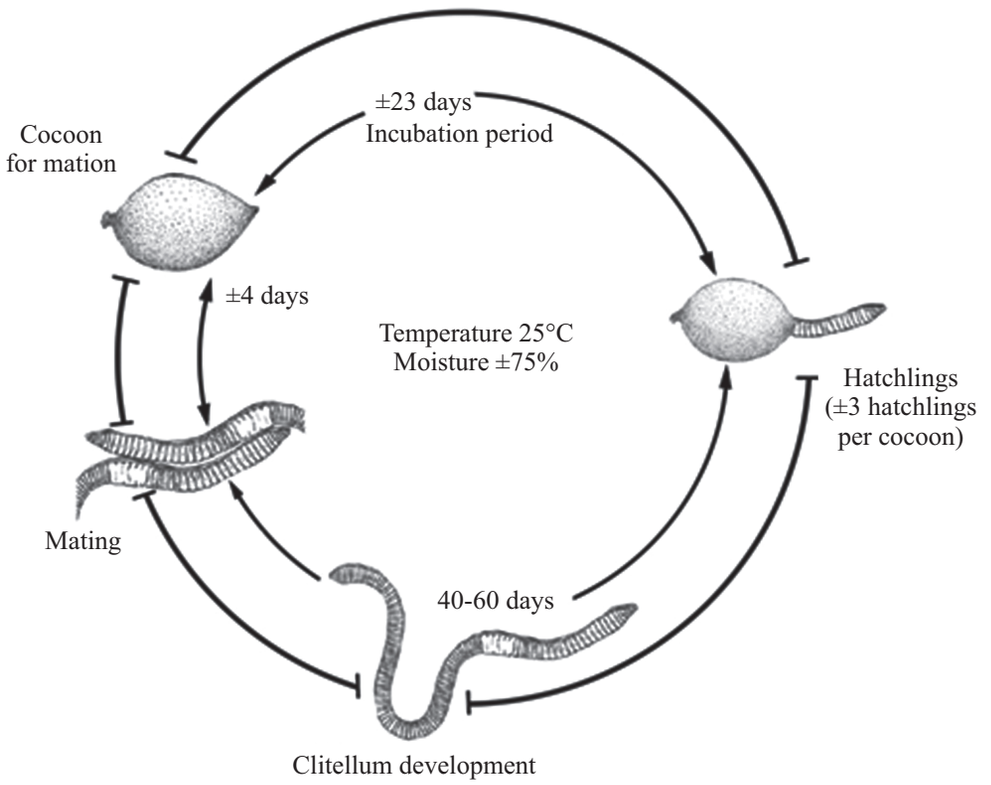


Fig. 2.3: Life Cycle of *Eisenia fetida*

(***Source***: Renuka Gupta and VK Garg (2007), CCS HAU, Lecture delivered on Vermicomposting technology for sustainable agriculture at RCOF, Hisar)

Eudrilus eugeniae

Eudrilus eugeniae, popularly known as 'Night Crawler, is the second most widely used earthworm for vermicomposting. It grows faster than the other species and accumulates mass at the rate of 12 mg/day. The mature individuals can attain body weight up to 4.3 g/individual. The maturity is attained over a period of 40 days and a week later, individuals commence laying of cocoons (on an average one cocoon/

Notes

day) (Fig. 2.4). Life span of *Eudrilus eugeniae is* estimated to range from one to three years in the laboratory. It is a native of Equatorial West Africa. It cannot tolerate lower temperatures when compared with *Eisenia fetida*. So, this species can be used for vermicomposting in tropical and sub-tropical regions.

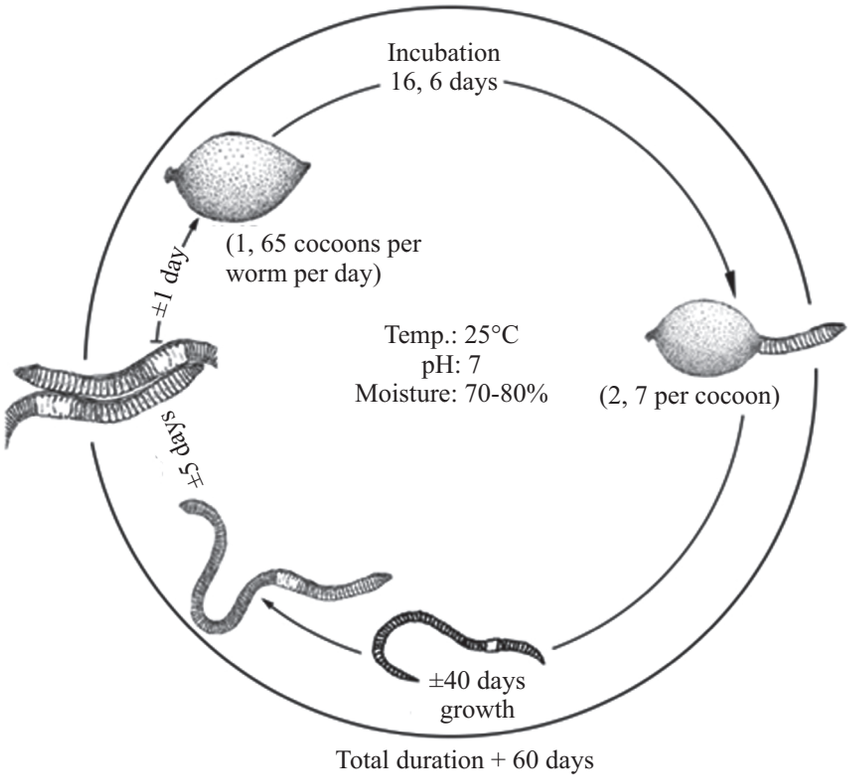


Fig. 2.4: Life Cycle of *Eudrilus eugeniae*

(***Source:*** Renuka Gupta and VK Garg (2007), CCS HAU, Lecture delivered on Vermicomposting technology for sustainable agriculture at RCOF, Hisar)

Perionyx excavatus

In India, this species is quite common in the Eastern Himalayas, Western Himalaya, West Bengal and Andaman Islands. It is highly adaptable and can survive in a wide range of moisture and quality of organic matter. The average growth rate of *Perionyx excavatus* is 3.5 mg/day and body weight (maximum) is 600 mg. The maturity is attained within 21-22 days and the reproduction commences by 24th day, with one to three hatchings per cocoon (Fig. 2.5). This species is best suited for vermicomposting in tropical climates.

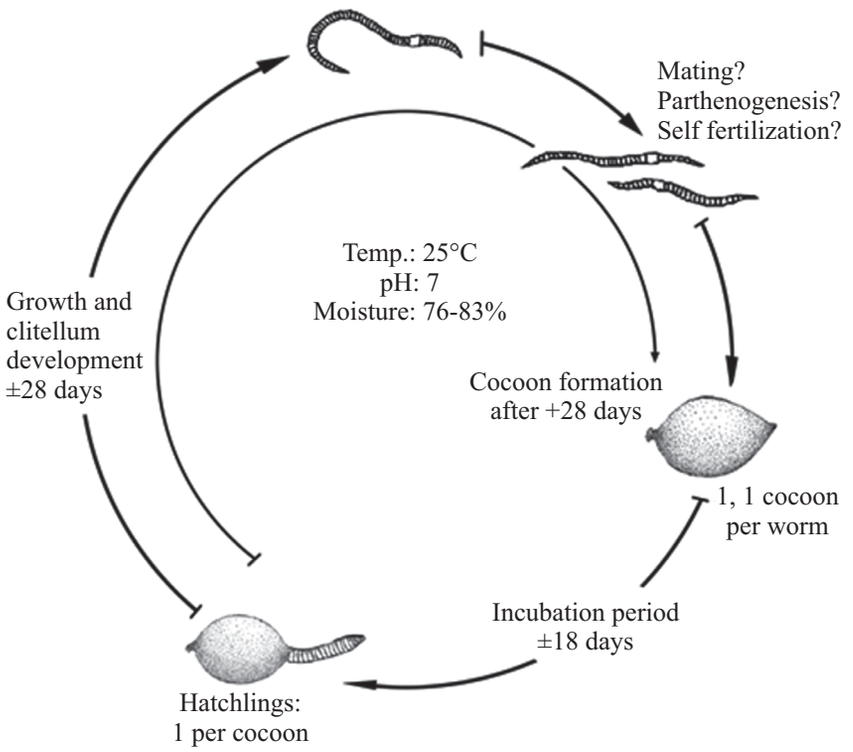


Fig. 2.5: Life Cycle of *Perionyx excavatus*

(***Source:*** Renuka Gupta and VK Garg (2007), CCSHAU, Lecture delivered on Vermicomposting technology for sustainable agriculture at RCOF, Hisar)

INTEXT QUESTIONS 2.2

Fill in the blanks

(a) ..... species of earthworms is most widely used for vermicomposting.

(b) After mating of earthworms ..... is formed.

(c) ..... species is best suited for tropical climate.

(d) An earthworm's maturity is attained over a period of ..... days.

2.5 HANDLING OF EARTHWORMS

While working in a vermicompost unit, you need to be very careful. As you are dealing with the living organisms, i.e. earthworms, hence, your vermicompost unit

Notes

should be frequently checked and maintained cautiously. Let us know the important components that you are required while handling earthworms.

Feed for Worms/substrate for Vermicomposting

Feed should not contain any harmful chemicals as that could be dangerous to the earthworms. The procurement of organic waste or feed for the earthworm should be checked for seepage and contamination. For initial multiplication, best feed substrate is the cow dung manure. Also, at the advanced stage of decomposition, feed should be free from the parasite/pathogens.

Some of the suggested feed and their advantages, disadvantages are given at Table 2.1:

Table 2.1: Different feeds for earthworms and their properties

Type of Feed	Advantages	Disadvantages	Remarks
Cow dung	Good nutrition; natural food, therefore, little care is required	Weed seeds make pre-composting necessary	All manures should be decomposed partially before consumption by worms
Poultry droppings	High nitrogen (N) content results in good nutrition and highly N-rich product	High protein levels can be dangerous to worms, hence it should be mixed with other organic residues or may be pre-composted	It is believed that poultry manure is not suitable for worms because of its high temperature. However, research says that worms can adapt well in it, if initial proportion of poultry manure to bedding is 10% or less by volume
Sheep/Goat excreta	Good nutrition	Requires pre-composting to kill weed seeds: small particle size can lead to compact packing, necessi-tating extra bulking material	With right additives to increase C:N ratio, these manures are also good beddings
Pig waste	Good nutrition; produces excellent vermicompost	Usually in liquid form, therefore, must be dewatered or used with large quantities of highly absorbent bedding	Vermicompost made with pig manure outperformed all other vermicomposts, as well as commercial fertilizer

Agricultural waste	Higher nitrogen content makes these good feed as well as reasonable bedding	Moisture levels not as high as other feeds; requires more input and monitoring	For better results, mix this feed animal manures
Horse excreta	It can be a very good material for vermiculture	Nitrogen content lesser than cow dung; C:N ratio is very high.	Must be mixed with other organic wastes such as cow dung before feeding to earthworms
Aquatic weeds	Good nutrition results in excellent product; high in micronutrients and beneficial microbes	Salt must be rinsed off, as it is detrimental to worms; availability varies by region	Certified organic vermicompost has been produced from cattle manure and seaweed. Water hyacinth has been tested as a feed stock for earthworms
Pre consumed vegetable waste	Higher nitrogen content results in excellent product; worms prefer this material	Moisture level is high, requires close monitoring	Pre consumed vegetable waste can be vermicomposted in 8-10 days
Paper waste	Excellent nutrition, worms like this material	Must be shredded and/or soaked (non-waxed) prior to feeding	Some worm growers claim that corrugated cardboard stimulates worm reproduction
Municipal Solid Waste (MSW)	Good nutrition; results in excellent product, high in micronutrients	Precautions are required to control the harmful microorganisms if sewage sludge is used	The Institute of Natural Organic Agriculture (INORA) has developed techniques for vermicomposting of MSW.
Source: CCS HAU, Hisar			

Moisture Management in Beds

The most important requirement of the earthworm is adequate moisture. They require moisture in the range of 50-60% (Fig. 2.6). Hence, the feed stock should not be too wet, otherwise it may create anaerobic conditions which may be fatal to earthworms.

Factors such as high levels of fatty/oily substances in the feedstock or excessive moisture combined with poor aeration may render anaerobic conditions in vermicomposting system. The worms suffer severe mortality, partly because they

Notes

are deprived of oxygen and partly because of toxic substances (e.g. ammonia) produced under such conditions. This is one of the main reasons for not including meat or other fatty/oily wastes in the worm feedstock unless they have been pre-composted to break down the oils and fats.

Fig. 2.6: Watering of Vermibed for Proper Moisture

Temperature

The activity, metabolism, growth, respiration and reproduction of earthworms are greatly influenced by the temperature. Most earthworm species used in vermicomposting require moderate temperatures from 10-35^{o}C. However, tolerances and preferences vary from one species to the other. The earthworms can tolerate cold and moist conditions far better than hot and dry conditions. For the *Eisenia fetida* temperature above 10^{o}C (minimum) and preferably 15^{o}C are maintained for maximizing vermicomposting efficiency. The higher temperatures (>35^{o}C) may result in high mortality (Fig. 2.7). The worms will redistribute themselves within piles, beds or windrows to get favorable temperatures in the bed.

Fig. 2.7: Temperature >35°C of Vermibed is not Suitable

Notes

pH

The worms can survive in a pH range of 5 to 9, but a range of 7.5 to 8.0 is considered to be the optimum. In general, the pH of vermibeds tends to drop over time due to fragmentation of the organic matter under series of chemical reactions. You can easily observe that if the food sources are alkaline, the effect is moderating one. This is because, the pH of the vermibed will tend towards neutral or slightly acidic with time which is suitable for worms to survive. But if the pH of the beds drops well below 7, pests like mites may become abundant. The pH can be adjusted upwards by adding calcium carbonate in the vermibed.

Enemies of Earthworms

Being a person with agriculture background, you must have seen enemies of various crops that damages them and decrease their yield. Similarly, earthworms also have some enemies, such as moles, rats, birds, flies, centipedes, etc. We will discuss the details of the same in lesson 3 under section-pest control.

INTEXT QUESTIONS 2.3

Fill in the blanks

(a) The feed stock for earthworm should not be too wet otherwise it may create ..... conditions, which may be fatal to the earthworms.

(b) Earthworms require moisture content in the range of .....

(c) Most earthworm species used in vermicomposting require moderate temperatures from .....

(d) ..... pH is considered to be the optimum for earthworms.

WHAT YOU HAVE LEARNT

Let us recapitulate and enlist salient points that you have learnt in this lesson:

- Earthworms help maintain soil fertility and productivity. They are native population of the soil and a friend of the farmers.
- Earthworms are bi-sexual or hermaphrodite organisms that have both male and female reproductive organs in the body.
- Based on feeding attributes, earthworms are classified as Phytophagous and Geophagous.

Notes

- Based on habitat, earthworms can be classified into three types, viz. Epigeic, Anecic and Endogeic.
- The epigeic species *viz*., *Eisenia fetida, Eudrilus eugeniae and Perionyx excavates* are appropriate for vermicomposting.
- Most important requirement of the earthworms is adequate moisture. They require moisture in the range of 50-60%.
- Factors such as high levels of fatty/oily substances in the feedstock or excessive moisture combined with poor aeration may render anaerobic conditions in the vermicomposting system.
- The worms can survive in a pH range of 5 to 9. However, a range of 7.5 to 8.0 is considered to be the optimum.
- Most of the worm species can survive well in a temperature range of 10-35°C.

TERMINAL EXERCISES

1. What is the role of earthworms in agriculture?
2. Explain the life cycle of an earthworm with a diagram.
3. Write a short note on classification & types of earthworms.
4. Name different types of earthworms based on their feeding habit.
5. Explain requirements for handling of earthworms and precautions for rearing.
6. What is the effect of temperature and $_{P}H$ on vermicompost preparation?

ANSWERS TO INTEXT QUESTIONS

2.1

(a) True (b) False (c) True (d) True

2.2

(a) *Eisenia fetida* (b) Cocoon (c) *Perionyx excavatus* (d) 30-45

2.3

(a) Anaerobic (b) 50-60% (c) 10 –35^{o}C (d) 7.5 to 8.0

Notes

Suggested Activity

Visit a nearby agriculture field. Observe the porous soil and try to find earthworms under the surface of the soil. Carefully pick up some the earthworms. Note down their shape, size and color. Try to identify the species. Rear few earthworms in an earthen pot filled with dung, soil and biodegradable waste. Rear them for about 30 days. Collect their cocoon and study them.

Key Learning Outcomes

- Understand the complete life cycle of the earthworms.
- Handling and rearing earthworms scientifically.

Notes

3

PREPARATION AND MAINTENENCE OF VERMIBEDS

3.1 INTRODUCTION

Learners! We have discussed about the basics of vermicomposting and role of earthworms in the previous lesson. To move ahead, let us now learn about where and how the earthworms are introduced/placed for making vermicompost. Here, we will be using a new term called "**Vermibed".** The term '**Vermibed'** is derived from two words *, i.e. vermi*, which means earthworms and bed, which means for bedding them. The earthworms are introduced into the bed, which the worms will inhabit as their home, hence the word '**Vermibed'.** In this lesson, you would be learning about the preparation of a good vermibed and its maintenance in detail.

OBJECTIVES

After reading this lesson thoroughly, you will be able to:

- enlist the characteristics of a good vermibed;
- select an appropriate site for vermicomposting;
- prepare a vermibed using appropriate techniques;
- take suitable precautions while preparing a vermibed;
- maintain the vermibeds properly; and
- manage threats of the earthworms and vermicompost.

3.2 CHARACTERISTICS OF A VERMIBED

The most important component for vermicomposting is creating appropriate bedding. A bedding is any material that provides a relatively stable habitat (the

Notes

natural home or environment) to the earthworms. As worms are living creatures like us, they need a good and suitable habitat , i.e. vermibed for their proper growth and development. In general, the selection of bedding material is key to successful vermiculture or vermicomposting. The worms can only be productive, if their survival conditions are optimised. However, their activities slow down, if their basic needs are not met. A well maintained vermibed can be identified by some of its prominent physical features as well as chemical composition. Let us understand and enlist the important characteristics of this habitat.

(i) Ability to Retain Water

The worms breathe through their skin. Therefore, they must have a moist environment around them. If a worm's skin dries out, the worm dies. The bedding must be able to absorb and retain the water fairly well. Water absorption in the bedding material is very important as most of the straws and even hay are not good at holding the moisture. This can be easily addressed by mixing some aged or pre-composted cattle or sheep manure with straw. About sixty percent moisture level should be maintained in the bed throughout the composting period. If required, water should be sprinkled over the bed rather than pouring over it. Watering should be stopped 2 -3 days before the harvest of vermicompost.

(ii) Good Bulking Potential

Good bulking potential refers to the materials having high straw content. Just like us, the worms too require oxygen to live. The different raw materials used in the bed affect the overall porosity of bedding. If the material is too dense, then the flow of air is reduced or eliminated. So, selection of the suitable material with good bulking potential is essential.

(iii) Optimum Carbon:Nitrogen (C:N) ratio

The rate of vermicomposting is also dependent on the chemical composition of the vermicomposting bed. For this process, the C: N ratio plays a very important role. If C:N ratio exceeds 40 or falls below 15, the process of composting goes down. So, you should try to maintain the optimum C:N ratio. If the ratio exceeds 40:1, use more green matter (nitrogen rich materials such as clippings of grass, subabul, daincha etc). In case the ratio is too less, use more browns like dried leaves and crop residues to adjust it to the optimum level. The vermicompost having high C:N ratio are not suitable for agriculture fields.

(iv) Protection from the Sunlight

The earthworms prefer dark conditions for their activities due to their nocturnal (active at night) behavior. Therefore, the vermibeds should be protected from direct sunlight.

Notes

(v) Protection from the Rainwater

The vermibeds should have proper shade to protect the beds from heavy rain. If there is heavy rain, the nutrients from the vermibed may wash away with rainwater. If the rain continues for longer period, there may be anaerobic condition, which may be detrimental to the worms.

The raw materials used for bedding is summarized as below (Fig. 3.1).

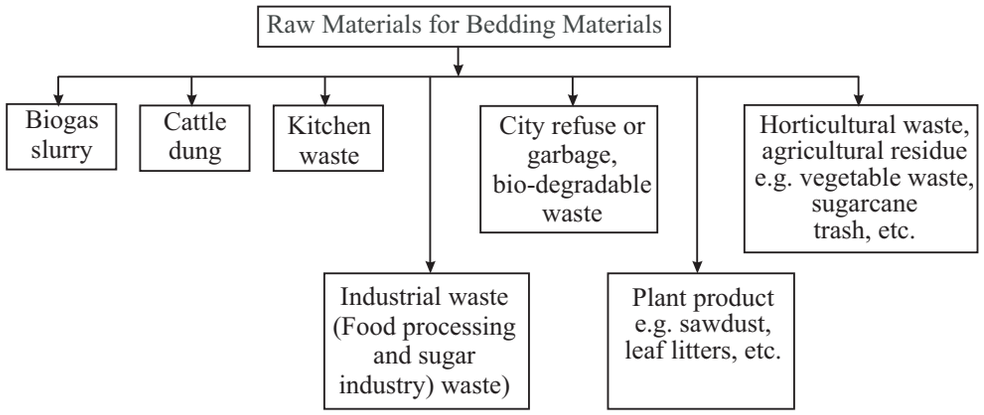


Fig. 3.1: Raw Materials for Bedding

3.3 SITE SELECTION FOR VERMICOMPOSTING

Vermicompost can be prepared under different types of sheds which can be of different dimensions. A particular type of shed can be constructed in an area depending upon the availability of raw materials, scale of production and the economic concern. The vermibed should be made at a flat and firm ground where

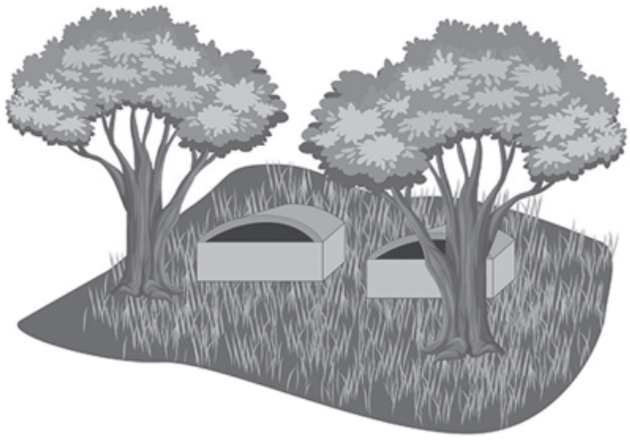


Fig. 3.2: Vermicomposting Under a Tree

Notes

water does not stagnate. To avoid waste water/ rainwater flow, bed should be raised from the surrounding ground level. The bed should be under shed to avoid direct sunlight and to keep the stack (pile of substrate) moist and cool. Water source should be available near the production unit to keep the stack moist. You can also do vermicomposting under a tree shade (Fig. 3.2).

However, the shed constructed for making vermicompost is primarily of two types:

- Temporary shed
- Permanent shed

Temporary Shed

The materials used for constructing temporary shed are bamboo and straw as shown in Fig. 3.3.

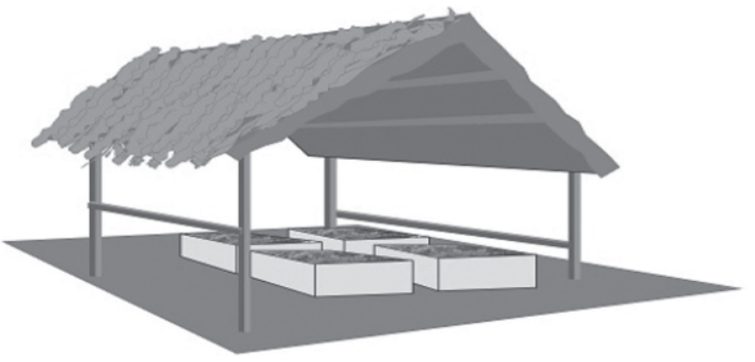


Fig. 3.3: Temporary Shed

Permanent Shed

The permanent shed can be made using the following materials in construction of its different components:

- Pillars: For making pillars of the shed steel pipe, bamboo or bricks can be used.
- Trusses: The trusses can be made of steel or bamboo.
- Purlines: The purlines can be made of bamboo or straw.
- Coverings: The coverings can either be of tiles or straw.

A permanent shed is shown below at Fig. 3.4.

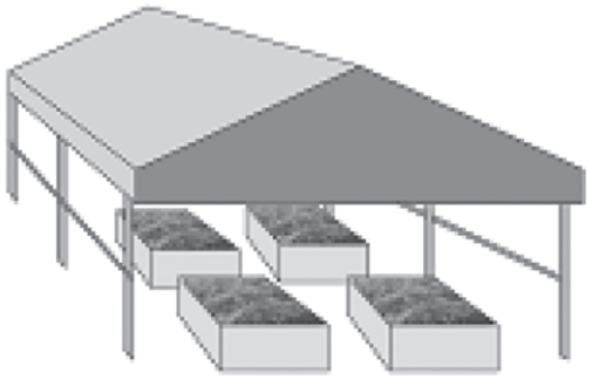


Fig. 3.4: Permanent Shed

3.4 VERMICOMPOSTING TECHNIQUES

For vermicomposting, a well-ventilated, infestations and predators free, shaded place is required. The shade may be permanent or temporary as per your requirement and availability. So, you need to select the vermicompost site judiciously. Broadly, vermicomposting is practiced in three types of structures; these are explained below:

(i) **Vermicomposting in the pits or trenches**: In this method, vermicomposting pits/trenches can be made up of 1.0m width and 0.5m depth. Length of the pit/ trench could depend on the available space and your requirements. These trenches may be made of concrete, bricks and cement (Fig. 3.5). Some agencies are also supplying readymade trenches that are made up of High Density Poly Ethylene (HDPE) material (Fig. 3.6). Technically, such pits are not preferred, because during rains or due to excessive watering, it may lead to water stagnation. This may result in leaching (soluble chemical or minerals

Fig. 3.5: Composting in Cemented Vermicomposting Pit

Fig. 3.6: Vermicomposting in HDPE Vermi-trenches

drain away from the soil by the action of water or rainwater) of the nutrients to the soil. Also, the water logging may reduce aeration in the pits which may kill the worms.

(ii) Vermicomposting in windrows: In this method, a series of heaps or windrows (a row of cut hay or small grain crop) are prepared on the ground. Normally, the heaps of 1.0m width, 0.5m height and length depending upon the available space is made. Also, the parallel windrows may be prepared if more space is available (Fig. 3.7 and 3.8). Distance between the two heaps could be 1.0 m. The windrows for vermicomposting may also be made by staking loose bricks (un-cemented) around the bed. In this way the rectangular beds of 1m width, 4-5 bricks height and about 30-40 cm length may be maintained as per the available space.

Fig. 3.7: Preparation of Loose Brick Vermibed

Notes

Fig. 3.8: Vermicomposting in Windrows Under Shade of a Tree

(iii) Vermicomposting in other structures: You can also prepare vermicompost at small scale in any earthen pot/unused plastic tank/wooden box/wash basin or any other abandoned structure (Fig. 3.9). For this, sufficient holes should be made at the bottom of these containers for aeration that allow excess water to drain out. Such types of structures are good for composting of kitchen/ garden wastes.

Fig. 3.9: Vermicomposting in Used Plastic Tank

Sometimes, it has been observed that the vermicompost is also prepared in rectangular compartments (10 m × 1.0 m × 0.75 m) made up of bricks or stoned slabs. Such structures are not preferred because excessive watering may result in water stagnation that can kill the worms, if proper drainage of water in not made at the bottom. Also, sometimes due to decomposition of the substrate, lot of heat generates and if open area is less, the overheating in chambers/beds may kill the worms. In such chambers, aeration is also a limiting factor, which slows down the vermicomposting process.

3.5 PROCEDURE FOR MAKING A VERMIBED

After selection of the site, bedding material and bedding structure, your next step will be to make a suitable vermibed. You need to follow specific steps to prepare a vermibed. Let us know them stepwise:

1. The vermibeds require shaded area. For this, the site selected for vermibeds preparation may be thatched (roof covered with straw or a similar material) from the locally available material. You may also make the bed in the form of a permanent structure.

2. Put a 5-6 cm thick layer of biodegradable material on the bed. This layer could be made of straw of wheat/rice or any other crop, dried leaves, banana or coconut leaves or any other decomposable material easily available to you.

3. On top of the biodegradable material, put a 30 cm thick layer of partially decomposed cow dung (15-20 days old).

4. Above this layer, put a 20 cm layer of the feed for the earthworms. The feed is made by mixing animal dung with any biodegradable waste such as agricultural waste, municipal waste, vegetable/fruit market waste, food processing/paper/distillery waste, biogas slurry, etc. (Fig. 3.10). This feed should be partially decomposed for 15-20 days before putting on bed.

Fig. 3.10: Preparing Feed for Earthworms

Partial decomposition of the waste

The waste should be chopped into small pieces (5 to 6 cm). It is mixed with animal dung, sprinkled with water and periodically turned and mixed. The earthworms prefer partially decomposed feed. By doing so, the vermicomposting process becomes faster. The waste will be partially decomposed and will be ready to put in vermibed in 15-20 days.

Notes

5. On top of the bed, release worms @1000 worms/m^2, preferably in the morning or in the evening hours.

6. Put gunny bag/coconut or banana leaves or a layer of rice straw on the top. The height of the bed could be maintained at 0.5 to 0.75 m.

7. Maintain 50-60 percent moisture content in the beds by sprinkling water periodically.

To ascertain the amount of water required in bed, there is a simple rule

Take some material from the bed and using it make a small ball. If the ball crumbles, it means that the bed needs more water. However, if you press and squeeze the ball and water comes out, it means that there is excess moisture in the bed. Also, if the ball is stable, it indicates that the moisture content is optimum in the bed.

3.6 PRECAUTIONS TO BE TAKEN IN PREPARING VERMIBEDS

As vermibeds are the place where your worms will grow and develop, you need to be very careful while preparing it. There are a few precautions that needed to be taken while preparing vermibeds. Let us note and remember them:

- Make your vermibeds under shade and at a slightly elevated place.
- Do not use saline water in the vermibeds. In the areas of high rainfall, avoid pit vermicomposting. Moisture level of the vermibed should be maintained at 50 to 60 per cent. pH of the bed should be maintained between 6.5 to 7.5. The vermibeds should be mulched (covered) with coconut/banana leaves/ wheat straw/rice straw/gunny bags or any other locally available material.
- Do not cover the vermibeds with plastic sheets, as it reduces aeration.
- Introduce the earthworms @ 1000 worms/m^2 for optimum results.
- Use only partially decomposed waste and cow dung (15-20 days old) as feed for the earthworms.
- Do not use any poisonous or salty or spicy food for the earthworms.
- Avoid the plant/vegetable residues with heavy smell, like citrus leaves and peels, eucalyptus leaves, etc.

Notes

INTEXT QUESTIONS 3.1

State True or False

(a) Fresh cow dung can be used as such in the vermibeds for composting.

(b) The composting material should have C:N ratio less than 12:1 for faster composting rate.

(c) The municipal corporation waste cannot be used for vermicomposting.

(d) For good growth of the earthworms, 50-60% moisture content in the vermibed is essential.

3.7 MAINTENANCE OF A VERMIBED

The maintenance of a vermibed is equally important as its preparation. This requires a proper understanding of different components used for preparation of the vermibed. Let us understand the important points that you should remember while maintaining a vermibed.

(i) Selection of the Appropriate Food Materials for the Worms

Under ideal conditions, the earthworms consume excess food as required to their body weight. They will eat almost anything organic (that is, of plant or animal origin), but they definitely prefer some foods over others. The earthworms can consume wastes upto 5 times of their body weight. It is estimated that one thousand earthworms can convert 4-5kg waste per day into compost. Manures are the most commonly used worm feedstock. The animal dung manure are generally considered as the best natural food for *Eisenia*, with the exception of rabbit manure. Alongwith the animal dung other biodegradable plant wastes can also be used for vermicomposting.

(ii) Smell of the Vermibed

A well-maintained vermibedis odourless. The smell of the bed is dependent on the types of composting materials added to the bed. An unhealthy worm bed may smell, potentially due to low oxygen conditions. The worms require gaseous oxygen. Oxygen can be provided by the pores in the bed. Occasional stirring of the bed content and removal of some bed content is recommended, especially if it becomes too wet or is too much in quantity. Otherwise, the decomposition process becomes anaerobic and the bed/bin will begin to produce smell of methane, ammonia, etc.

Notes

(iii) Moisture Content in the Vermibed

The vermibeds require frequent watering. The moisture content in vermibed must be maintained above 50 percent throughout the composting period. Lower moisture content will not support worm respiration and can increase worm mortality (death). If moisture content in the bed is less then sprinkle water over the bed. Avoid pouring the water. Watering should be stopped before the harvest of the vermicompost.

(iv) Worms Escaping

The worms generally stay in the bed. However, they may try to leave the bed when introduced for the first time or often after a rainstorm when the outside humidity is high. Maintaining proper condition in the vermibed and putting a light over the bed when worms are introduced for the first time are helpful in solving the problem of worms escaping.

(v) Nutrient Levels

The optimum nutrient levels in the bed are very important for good vermicomposting. Over nutrition is dangerous to the worm. The quality of the final produce also depends on the nutrient content available in the raw material.

(vi) Turning of the Vermibed for Aeration

Proper aeration is required for the growth and development of the earthworms. Anaerobic (lack of oxygen) situation causes mortality in the worms. Therefore, for the production of a good amount of compost, proper aeration is important. Turning helps in aerating the vermibed and also for maintaining the ambient temperature of vermibeds. Generally, 3-4 turnings are recommended depending upon the raw materials used.

(vii) Pest Control

Several types of organisms are present in the vermibed. Some are highly compatible with the worms and help in breaking down the food articles. However, few (insect - pests) may pose serious threat to them. Your knowledge about these insect-pests present in vermibeds (Fig. 3.11) and their effect may help you in managing them. Maintaining the correct pH (close to neutral) and water content of the bed can also help to avoid insect-pests. Let us discuss few important insect-pests that affect vermibeds:

Notes

Flies

The flies are harmless, but they are usually considered undesirable by humans because of their tendency to carry and spread disease. Covering vermibed with sheets of newspapers or gunny bags on top of bedding will keep the flies out of the bed. If the flies start gathering on top of the paper, change it frequently to eliminate them. Severe fly problems may require a complete change of bedding so that the eggs and larvae of the flies are destroyed.

Ants

Ants may be detrimental for the vermicomposting. These tiny, industrious creatures rob food from the bed and may attack worms as well. This problem can be checked by avoiding sweet feed stuff in the worm beds and maintaining the bed pH at 7 or slightly higher. Also, you may move worm bin to a different location to avoid ants attack. The vermibeds may also be surrounded with a moat (channel) of water to prevent ants from entering as they are not capable of crossing water. Appropriate moisture content in the bed is also helpful in avoiding their presence.

Centipedes

Centipedes eat the compost worms and their cocoons. Fortunately, they do not seem to multiply to a great extent within the worm beds or windrows. If they do become a problem, one method suggested for reducing their numbers is to heavily wet (but not quite flood) the worm beds. The water forces centipedes and other insect- pests (but not the worms) to the surface, where they can be destroyed by means of a hand-held propane torch or they can be picked out and destroyed. Make sure to wear gloves while picking them, since some species bite and release poison.

Mites

The white and brown mites compete with the worms for food and thus can have significant economic impact. However, the red mites are parasitic on earthworms (A parasite is an organism that lives in or on an organism of another species (its host) and benefits by deriving nutrients at the other's expense). They suck blood or body fluid from the worms and they can also suck fluid from the cocoons. If you notice any food covered by the mites, remove it right away and place a slice of bread on the surface of the bedding. Remove the bread when it is covered by mites and replace with another to trap more mites. Reducing the moisture of the bedding can make vermibed uncomfortable for these tiny pests. The high mite populations usually results from over feeding.

- *If we feed the earthworms meaty or wet feed, the population of mites increases*

Large mite populations are often the result of using over moist garbage and vegetable refuse as feed. Adding the occasional soggy vegetable leftover probably won't cause a problem but don't make a habit of it.

- *Over-watering*

Watering should be done to keep the beds damp but not wet. Poor bed drainage can also increase the mite problem and make the beds less hospitable for the earth worms. Ensure that there are adequate drainage holes at the bottom of your vermibed.

- *Protection from mites*

If your vermibed is overrun by mites, expose the beds to the sun for few hours. Cut back on water and feed and then for every one to three days, add calcium carbonate to the bed.

Moles, rats and birds

The moles prey on the earthworms and hence are often a problem when using windrows or other open-air vermicomposting systems. Damage due to rats and moles can be prevented by putting some form of barrier, such as wire mesh, paving, or a good layer of clay, under the windrow. Putting some type of windrow cover (e.g. old gunny bags) over the material will eliminate damage to the worms caused by birds, apart from improving the moisture retention and excessive leaching that is expected during high rainfall.

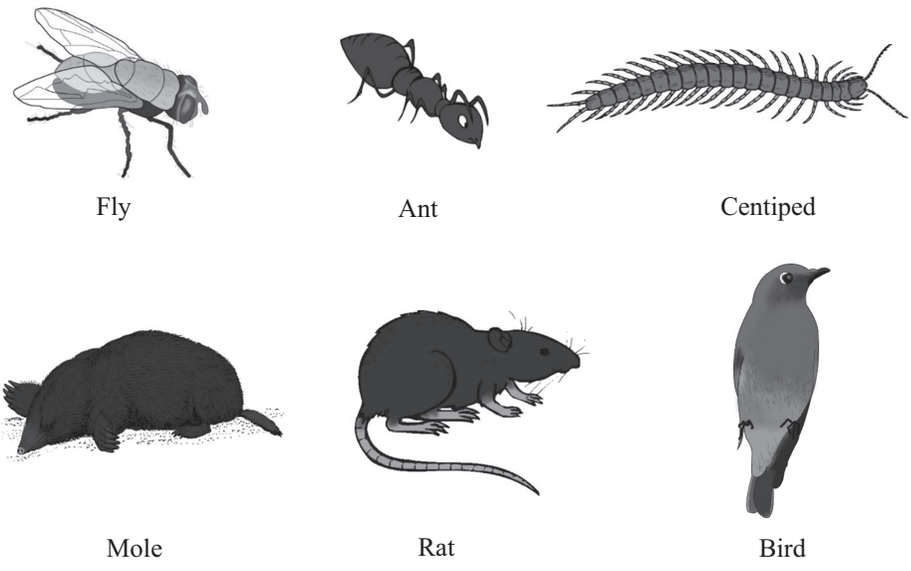


Fig. 3.11: Pests of Vermibed

3.8 PROTECTING VERMIBED

It is rightly quoted that "prevention is better than cure".

The best way to handle insect pests of vermibedis to ensure that they don't establish themselves in the bed. Though we have mentioned many points earlier as well, but let us revise them and ensure to keep your vermibed well maintained. You need to take the following safety measures:

- Your bed or farm enclosure is secure.
- The worms and the bedding should be covered with either a crop residue or a damp sheet of burlap (Hessian).
- The food scraps should be covered with bedding to prevent them from becoming mouldy that attract insect pests.
- Meat, greasy food, or pet faeces should not be included in the feed as these attract flies, maggots, rats, etc.
- The sour crop or protein poisoning happens when the worms are overfed. This leads to protein build up in the bedding and production of toxic acids and gases due to protein decay. The better option is to maintain proper feed quality and micro-environmental conditions, which rule out any possibility of sour crop.

For continuous vermicomposting, it is recommended to keep the vermibed, or other worm farming medium, in closed places such as garages, sheds, basements or out-buildings. Therefore, making them less accessible to pests. Also, a sheet of the mosquito netting draped over your vermibeds would eliminate most of the flying pests (Fig. 3.12).

Fig. 3.12: Covering of Windrows by Gunny Cloth or by Crop Straw Can Protect Worms from Predators, Direct Sunlight and Helps in Retaining Moisture

Notes

INTEXT QUESTIONS 3.2

Fill in the blanks

(a) In vermibeds, the material should be .....

(b) Mites in vermibed are ..... to them.

(c) Turning of vermibeds cause ..... in beds.

(d) Strong odour in bed indicates that the bed is ..... managed.

WHAT YOU HAVE LEARNT

Let us recapitulate and enlist the salient points that you have learnt through this lesson:

- For vermicomposting, we need a medium that contains the nutrients for the worms.
- We can use various types of raw materials as food for the earthworms.
- Suitable food for the earthworm should have proper C:N ratio (15 to 40).
- We can do vermicomposting in trenches, windrows or other structures that are not in use.
- The shaded area is required to protect worms from sun light and excessive heat.
- During the process of vermicomposting we should keep 50-60% moisture content in the bed.
- To initiate vermicomposting, 1000 worms per square meter is to be introduced in the vermibed.
- Suitable insect-pests and hygiene management is required in vermibeds.

TERMINAL EXERCISES

1. What do you mean by a vermibed?
2. Discuss about the characteristics of a good vermibed.

Notes

3. Enlist the precautions tobe taken while preparing the vermibed.
4. Describe the different techniques of vermicomposting.
5. Why maintenance of a vermibed is important?
6. Discuss the insect and pest management strategies for a vermibed.

ANSWERS TO INTEXT QUESTIONS

3.1

(a) False (b) False (c) False (d) True

3.2

(a) Pre-decomposed (b) Harmful (c) Aeration (d) Badly

Suggested Activity

Visit around 3-4 vermicomposting units in your locality. See how they are being managed. Now, assess how economically and efficiently, you can manage your unit using locally available cheap materials/inputs for your vermicomposting unit.

Key Learning Outcomes

- Preparing suitable feed for earthworms using available raw materials.
- Preparing and maintaining vermibeds for production of good quality vermicompost.

Notes

4

PREPARATION OF VERMIWASH

4.1 INTRODUCTION

Learner's, in the previous lesson you have learnt about the preparation and maintenance of a vermibed, which is one of the most important training component of this certificate programme. Now, in the current lesson we will be learning about a vital product produced from the vermicomposting system, which is the "Vermiwash". Well, you must be thinking as to what is this product? Broadly, vermiwash is an odourless dark brown coloured liquid organic-fertilizer. Let us now learn about vermiwash in detail.

OBJECTIVES

After reading this lesson thoroughly, you will be able to:

- explain the purpose of vermiwash in agriculture;
- discuss the principle of vermiwash preparation;
- prepare vermiwash as per recommended procedure; and
- establish and maintain a vermiwash unit.

4.2 PURPOSE OF VERMIWASH PREPARATION

Vermiwash is a mixture of the excretory products, mucus (a thick liquid produced in some parts of the body) discharge of earthworms and the macro and micronutrients released from the organic matter used in the vermicomposting medium. You must be aware that the macronutrients are those nutrients that are needed in larger amount and micronutrients are those nutrients that are required in smaller amount

Notes

by the body. Vermiwash is collected after the passage of water that flows through a column of worms and vermicomposting medium. You will be learning about it's preparation in the upcoming section.

Vermiwash is applied as a foliar spray in rice, maize, pulses, vegetables, mango, pomegranate, grapes, etc. It can be applied on almost all the crops without any adverse effects on them. When applied, it is easily transported to the leaves, shoots and the other parts of the plants. We can consider it environment friendly, when compared to the chemical fertilizers application. You can also use it as a liquid plant growth regulator, as it contains many growth promoting enzymes, vitamins and hormones, such as auxins, gibberellins etc. along with macro (Nitrogen, Phosphorus, Potassium) and micronutrients (Iron, Zinc, Manganese, Magnesium, Boron, etc.). So, vermiwash is used for many purposes. Let us make a list of them pointwise:

- Vermiwash is used for increasing the absorption of nutrients to the plants.
- It is used for correcting the deficiency (lack or shortage) of nutrients by immediate absorption by leaves.
- It is suitable as a micronutrient foliar spray to supplement the micronutrient requirements of the organic crop.
- It can be applied as a bio-pesticide (a form of pesticide based on micro-organisms or natural products) to protect and develop resistance against various disease and pests (A *pest* is an insect or small animal which damages crops or food supplies) in plants.
- Vermiwash can also be applied as anorganic fertilizer to initiate good flowering, high yield and better quality produce.
- It can also be used in crop nurseries and high value crops (high-value crop refers to the non-traditional food crops such as vegetables, fruits, flowers, house plants and foliage, condiments and spices, etc. that generate more revenue per unit area of land than a conventional grain crop). In these crops it is used as a nutrient source.

4.3 PRINCIPLE OF VERMIWASH PREPARATION

You might have observed that the earthworm's movement in the soil results in the formation of burrows (a hole or tunnel). These burrows are also known as 'Drilospheres', where large population of different microbes are present. When water passes through these passages, it washes the nutrients, microbes and enzymes from these burrows to the roots and it is later absorbed by the plants. The same principle is used in the preparation of vermiwash. Vermiwash is produced by

allowing water to enter through the passages made by the earthworms on the vermicompost unit. Then, water is collected in the containers placed at the outlet of the vermiwash collection unit.

4.4 PREPARATION OF VERMIWASH

You can establish a vermiwash unit by using the easily available materials such as plastic barrels, buckets, small earthen pots, cemented floors, polythene, etc. We will be explaining you a simple and economical technique to collect the vermiwash. For this a system needs to be made. This system would consist of a plastic or iron barrel or cemented tank of 200 litres capacity with dimensions 10 ft × 4 ft × 2.5 ft (Fig. 4.1). This structure should be constructed under a shade and fitted with a tap just above the base of the tank (Fig. 4.2). We need to make a hole on one side and a tube can be attached in a way that half to one inch of the tube projects inside the barrel. At the end of the horizontal limb a tap should be attached and the other end should be closed with a dummy nut. Each tank or barrel should be filled with a layer of broken pieces of bricks or stones upto a height of 5-8 cm to facilitate drainage of excess water. It should be followed by 8-10 cm layer of clean and coarse gravel and then a layer of sand forming the vermiwash filtration and accumulation compartment of the system. The excess water should be allowed to pass through these layers and drain without any blockage from the tap. Then an alternate layer of decomposed cow dung followed by a layer of soil is put in the tank.

Fig. 4.1: Cemented Tank for Vermiwash Preparation

A thick layer of partially decomposed bio-waste (crop residues, grasses, dung, vegetable, wastes, etc.) amounting to about 100 kg should be added such that the substrates filled just upto the brim of the tank. The tanks should be watered frequently to ensure the sufficient moisture (about 50%) in the substrate. Introduce worms into the unit @ 1.5 kg per tank or 1000-1500 numbers. Water should be

added every day to keep the unit moist. Vermiwash from each tank can be collected periodically from the bottom of the tank by releasing tap in a separate bucket and can be used for foliar spray.

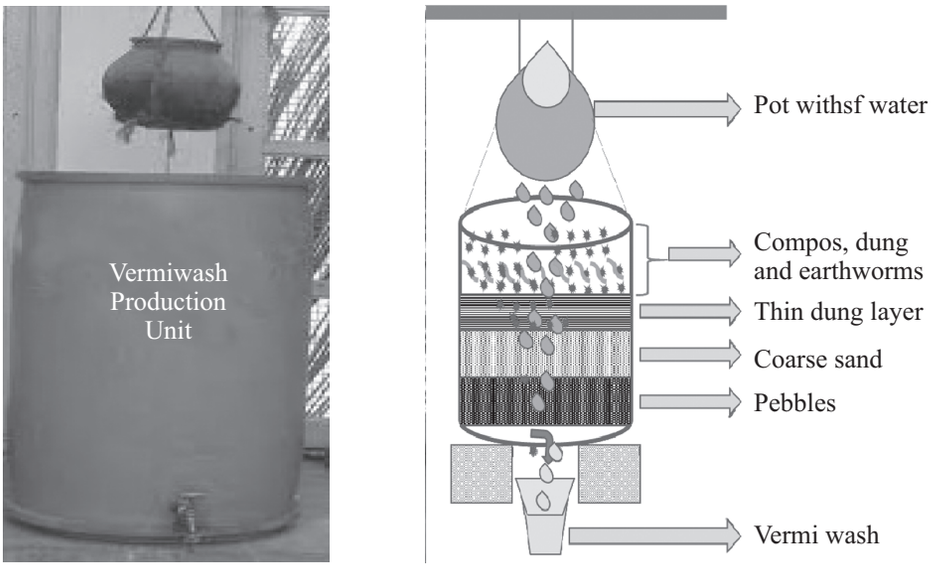


Fig. 4.2: Setting Up of a Vermiwash Unit

Let us understand the preparation of vermiwash stepwise through the following flow diagram (Fig. 4.3)**:**

Take one barrel or bucket/container (200 Litres Capacity)

↓

Put a layer of broken bricks, pieces of stones (5-8 cm thick) in the bottom of the container

↓

Put another layer of course gravel and sand (of 8-10 cm thick)

↓

Layer of partially decomposed cow dung (30-45 cm thick) over it

↓

Put another layer of soil that is 2-3 cm thick

↓

Put 1000-1500 earthworms in the tank

↓

Put a layer of crop residues (6 cm thick)

↓

Notes

Open the lid of the bucket and spray water regularly for a period of 15 days

↓

Every day 4-5 litres of water is to be filled in the hanging pot

↓

Keep the hanging bucket of water on vermiwash unit in such a way that the waterfalls drop by drop in it

↓

After 10 days, the liquid vermiwash can be transferred using a tap that is fitted at the bottom of the container to the other pot

Fig. 4.3: Flow Chart of Preparation of Vermiwash

Here, it is important to note that the layer of broken pieces of bricks or stones facilitates drainage of excess water. However, the coarse gravel and sand forms the vermiwash filtration and accumulation compartment of the system. The preferred earthworm species for vermiwash preparation are *Eudrilus eugeniae* or *Esenia fetida*.

So, we hope that you have understood the principle and process of vermiwash preparation now. We also recommend you to visit a nearby vermiwash unit to understand the process vermiwash producers follow.

4.5 FUNCTIONING/HANDLING OF A VERMIWASH UNIT

You need to follow a few simple rules here that will help you in the proper functioning and smooth handling of your vermiwash unit. Let us make a note of them.

- For the first 2 days, keep the tap open and let the solution flow freely. This is required to clear off the impurities.
- Now keep the tap closed for 12 days and start collection from the 13th day after establishment of worm activities.
- The above explained unit will give 4-5 litres of vermiwash per day for 10 days after which the soil and dung mixture is to be replaced/ added.

INTEXT QUESTIONS 4.1

1. State True or False

(a) Vermiwash is used for cleaning the plants.

(b) Micronutrients can be supplemented to the crops by vermiwash.

Notes

(c) Vermiwash can be collected from worms and composting columns.

(d) Vermiwash can be used after drying of liquid medium.

2. Fill in the blanks

(a) Earthworms are introduced into the unit @ .....

(b) Layer of broken pieces of bricks or stones facilitates .....

(c) Vermiwash can be collected after ..... day after establishment of worm activities.

4.6 COMPOSITION/QUALITY OF VERMIWASH

Vermiwash is alkaline (having a pH greater than 7) in nature and contains nitrogen, phosphorus, potash, calcium, magnesium and zinc in significant quantities. The nutrient status of vermiwash generally depends upon the amount and type of biological wastes used for the composting. The important nutrients present in vermiwash are given at Table 4.1.

Table. 4.1: Important Nutrients Present in the Vermiwash

pH	7.48 ± 0.03
Electrical conductivity (dS/m)	0.25 ± 0.03
Organic Carbon (%)	0.008 ± 0.001
Total Nitrogen (%)	0.01±0.005
Available Phosphate (%)	1.69 ± 0.05
Potassium (ppm)	25.0 ± 2
Calcium (ppm)	3.0 ± 1
Copper (ppm)	0.01 ± 0.001
Iron (ppm)	0.06 ± 0.001
Magnesium (ppm)	158.44 ± 23.42
Manganese (ppm)	0.58 ± 0.040
Zinc (ppm)	0.02 ± 0.001
Nitrosomonas (CFU/ml)	1.01×10^3
Nitrobacter (CFU/ml)	1.12×10^3
Total Fungi (CFU/ml)	1.46×10^3

Notes

For your easy understanding, the abbreviations/difficult words used at Table 4.1 are described below:

- dS/m-decisiemens per metre, it is a unit of Electrical Conductivity. Electrical conductivity is the ability of electric current to flow through a material.
- ppm-parts per million.
- CFU/ml-colony forming units per milli litre. CFU is a measure of viable bacterial or fungal cells per milli litre.
- Nitrosomonas and Nitrobactor-Nitrosomonas and Nitrobacter are bacteria found in soil and water that are responsible for oxidation of ammonium to nitrite (Nitrosomonas) and nitrite to nitrate (Nitrobacter).

4.7 PRECAUTIONS TO BE TAKEN DURING VERMIWASH PREPARATION

You need to take certain precautions while preparation-of vermiwash. Let us know them

- The tap of the container should always be kept open to collect the washings.
- The unit starts yielding good quality vermiwash only after 13 days. So, you need to be a patient.
- The vermiwash should be stored in a cool and dry place. While preparing vermiwash, the water should be poured slowly. Do not mix the undecomposed material in the unit. Always use pre-decomposed material only.

4.8 ADVANTAGES OF THE VERMIWASH SPRAY

As vermiwash comes in a liquid state, hence it is used for foliar application. Foliar application refers to the spraying of fertilizer solutions containing one or more nutrients on the foliage of growing plants. Before applying to the crop, it is recommended to dilute the vermiwash with water in 1:1 ratio or it could be diluted with 10 percent cow urine. There are various advantages of the vermiwash spray. Let us enlist some of them:

- Vermiwash is an eco-friendly natural organic fertilizer prepared from the biodegradable organic wastes, hence it is free from chemical inputs.
- Vermiwash when used upto 20-30% dilution inhibits (prevents) the growth of pathogenic (disease causing) fungi.

Notes

- Vermiwash is used as an effective bio-pesticide when diluted with 10% cow urine or neem extract or garlic extract.
- It does not have any adverse effect on the soil, plant and environment.
- It promotes better root growth and nutrient absorption in the plant.
- It can also be added to the compost pits to speed up the degradation process.

4.8 BENEFITS OF ESTABLISHING A VERMIWASH UNIT

Vermicompost-vermiwash units are considered as "**An income generating enterprise for rural population**". Production of vermiwash can benefit the farmers and industries both by generation of income and protection of environment as well. Let us know the other benefits pointwise:

Benefits to the Farmers:

- Low cost of crop production due to purchase of less amount of chemical fertilizers, as this will supplement as a nutrient rich fertilizer.
- Increased soil productivity through improved soil quality. Soil *productivity* is the capacity of a soil to produce certain yield of agricultural crops or other plants using a *defined* set of management practices.
- Better quantity and quality of the produce.
- Provides additional source of income generation to the landless people.

Benefits to the Industries:

- The waste organic products can be used. Waste management is a growing industry these days.
- Cost effective pollution reduction technology.
- Generate income by sale of the vermiwash.

Benefits to the Environment:

- Waste does not create any pollution, as they become valuable raw material for enhancing soil fertility.
- Organic waste management reduces the pollution of environment.

To the National Income:

- Boost the rural economy.
- Bring savings on the purchase of external inputs, such as fertilizers and pesticides.
- Less wasteland formation, which is one of the major concerns of today.

Notes

4.9 IS VERMICOMPOST AND VERMIWASH 100% ORGANIC?

In the production of vermiwash, water is passed through the burrows of *Eisenia fetida* or and *Eisenia eugeniae* cultured units that contain soil and partially decayed cow dung. The wash is filtered through a natural layer of sand and brick pieces. Therefore, as we are not using any type of chemicals, hence making vermiwash is 100% organic and an eco-friendly process.

Important Points to Keep in Mind While Working in a Vermiwash Unit

- Wash sands and pebbles before putting them in the vermiwash unit.
- Do not add fresh cow dung in vermiwash unit. Fresh cow dung releases high amount of methane and heat that can kill the worms.
- The vermiwash unit should be prepared at a shady place.
- The unit should be moist but not wet. This implies that excess water may kill the worms and this would reduce the quality of the vermiwash.
- Check the unit periodically for eggs of the worms. The population count of the eggs should be optimum (less eggs means there is problem in the unit because of moisture or other factors).
- Vermiwash has a shelf life of 2 months only, so use it before its quality deteriorates.

INTEXT QUESTIONS 4.2

1. State True or False

(a) Vermiwash is colourless bulky liquid organic fertilizer.

(b) Vermiwash unit should be placed where ample sunlight is available.

(c) Application of the vermiwash improves the nutrient status of the soil.

(d) Vermiwash is a liquid organic fertilizer which is rich in phosphorus, nitrogen, calcium, etc.

(e) Vermiwash has a shelf life of 6 months.

2. Fill in the blanks

(a) Vermiwash is ..... liquid organic fertilizer collected after passage of water flows through a column of worms.

(b) Before foliar spray vermiwash should be diluted with water in ..... ratio.

(c) Suitable earthworm species for vermiwash preparation are ..... and .....

(d) Vermiwash is ..... % organic product.

WHAT YOU HAVE LEARNT

Let us recapitulate and enlist salient points that you have learnt through this lesson:

- Vermiwash is a liquid fertilizer consisting of plant nutrients, enzymes and plant growth hormones.
- Vermiwash is alkaline in nature and a rich source of macro and micro-nutrients.
- Vermiwash can be prepared at vermicomposting units that can even be done at homes.
- Excess watering and collection of the filtered solution of compost are the prime steps of vermiwash preparation.
- Vermiwash preparation involves a number of systematic steps that should be followed alongwith undertaking proper precautions.
- Vermiwash can be applied to the plants as a nutrient source. It also controls disease and insect-pests in plants. Hence, acts as a bio pesticide.
- Vermiwash is 100% organic and eco-friendly. A vermicomposting- vermiwash unit can be a used in organic waste management processes.
- Vermiwash has a shelf life of 2 months only.

TERMINAL EXERCISES

1. Define vermiwash. Explain the purpose of vermiwash.
2. Name the earthworm species that are used in the vermiwash preparation.

Notes

3. What is the importance of vermiwash in organic agriculture?

4. Write down the steps involved in the preparation of vermiwash at a vermiwash unit.

5. State precautions to be taken in the production and application of vermiwash.

ANSWERS TO INTEXT QUESTIONS

4.1

1. (a) False (b) True (c) True (d) False

2. (a) 1.5 kg per tank or 1000-1500 numbers

   (b) facilitates drainage of excess water

   (c) 13^{th}

4.2

1. (a) True (b) False (c) True (d) True

   (e) False

2. (a) Odourless dark brown

   (b) 1:1

   (c) *Eudrilus eugeniae*; *Eisenia fetida*

   (d) 100

Key Learning Outcomes

- Preparing vermiwash as per recommended procedure.
- Establishing and maintaining a vermiwash unit.

Notes

5

HARVESTING AND POST HARVEST HANDLING OF VERMICOMPOST

5.1. INTRODUCTION

Learners, we hope that you may have prepared your vermibed as explained in lesson 3 and would be maintaining it properly. We are also sure that you must have prepared your vermiwash unit and would also be maintaining it properly. Now, you must be eager to know as when and how you can harvest (gather) your vermicompost. Well, vermicompost becomes suitable for harvesting and for putting it to use when the raw materials used are vermicomposting are fully decomposed. Generally, it takes about 2-3 months to harvest if agricultural waste is used. However, it is ready in about 1-1.5 months, if cow dung is used as the main substrate. This period is also dependent upon other factors such as the number of worms in the vermibed, environmental condition and how the vermibeds have been managed. Let us learn about harvesting and post-harvest handling of vermicompost in detail in this lesson.

OBJECTIVES

After reading this lesson thoroughly, you will be able to:

- harvest the vermicompost as per your requirement and as per the recommended procedure;
- assess nutritive value and the quality of vermicompost; and
- store and pack vermicompost for sale and usage.

Notes

5.2 HARVESTING OF THE VERMICOMPOST

If you have just initiated the vermicomposting, then your first lot will need about 2-3 months of preparation. Harvesting of vermicompost is a very important part of the vermicomposting process. Let us understand it step wise:

Step-1: Observe your vermicompost pit- The height of the pile would have dropped down to about one-third to one half of that of the original pile. Also, the final pile temperature should be close to the ambient temperature (ambient temperature is the actual temperature of the air at any particular place). The vermicompost should appear somewhat darkish brown to black and crumbly. It must have an earthy smell just like dry tea leaves. You must also observe that the vermicompost is light in weight and free from any bad odour.

Step-2: Once your compost is ready, do not provide water to bed for the next 2–3 days. This will allow the compost to dry and it will be easy to shift it thereafter for storage purposes.

Step-3: Pile the compost in small heaps and leave them under ambient conditions (common, prevailing, and uncontrolled atmospheric and weather conditions in a room or place) for a 6-24 hours period. This will allow all the worms to move down inside the bed (Fig. 5.1).

Fig. 5.1: Harvesting of Vermicompost by Making Heaps

Step-4: Now, separate the upper portion of the compost heap manually. Thereafter, sieve the lower portion of the heap to separate the earthworms from the compost.

Notes

Step-5: The left over compost in the bed contains different stages of the earthworm's life cycle, namely, cocoons, juveniles and adults. Transfer this compost to fresh half decomposed feed material for the next cycle of composting.

Step-6: The excess as well as big earthworms can be used as feed for the fish or poultry.

Step-7: Harvesting is continued until a 10-15 cm of the layer is left in the bed.

Step-8: Pack the harvested compost in the bags and store these bags in a cool and dry place.

5.3 METHODS OF VERMICOMPOST HARVESTING

There are different methods by which vermicompost can be harvested. The methods are dependent upon many factors, such as the scale of vermicomposting (scale means quantity), your purpose of vermicomposting, harvesting time etc. Let us discuss different methods of vermicompost harvesting in detail:

(i) Manual Harvesting

You can use this method, if you wish to collect a small amount of vermicompost just few days after introduction of the worms in the pile (heap). In this case, though the pile has not been fully decomposed, but you will be able to find a thin layer of vermicompost at the top of the pile. You can easily collect vermicompost present at the top of the pile by simply collecting them by hand or with the help of a spade. Transfer the collected vermicompost directly into a container (Fig. 5.2).

Fig. 5.2: Manual Harvesting

(ii) Bulk Harvesting by Pyramidal Method

In this method, the vermicompost is first gathered to form a pyramid or a cone like heap with the composting materials. It should be done in such a manner that the

Notes

heap is exposed to light. If required, transfer the vermicompost on a plastic sheet and place it over a flat surface where ample amount of sunlight is available.. The sensitivity of earthworms to light will tend them to move deep into the pyramid. Then, collect vermicompost from the bottom side and the top surface of the heap by hand (Fig. 5.3).

Fig. 5.3: Bulk Harvesting by Pyramid/Heap Method

(iii) Sieving Method

This method of vermicompost harvesting can be done at any time of the day. This is carried out mechanically or manually using the mesh sieve (Fig. 5.4). Vermicompost from the vermibed is loaded on the sieve. Then the sieve is shaken so that the fine vermicompost falls towards the ground and the undecomposed substrates are retained in the sieve. Here, the earthworms are separated manually. One shortfall of this method is that the mortality rate of earthworms is very high. This is because of mechanical injury to the tender body of the worms during the sieving process.

Fig. 5.4: Sieving Method: By Machine and Manual

(iv) Harvesting by Inducing Migration of Earthworms

The Biomass Utilization Unit of the Indian Agricultural Research Institute (IARI) has developed and standardized this technique for separation of worms and compost. This method is based on the ability of earthworms to detect their source

Notes

of food. Earthworms have the habit to migrate (move) from the piles of exhausted food towards the more palatable food material. IARI has developed vermibed with loose brick supported windrows (a long line of material heaped by the wind or machine) for vermicomposting. When the compost becomes ready for harvest, loose bricks of the windrow are removed from one side and small heaps of compost is made on the windrows. A fresh windrow is prepared close to the old windrow and the outer side of the fresh windrow is again surrounded by loose bricks (Fig. 5.5). Water sprinkling is stopped in the mature windrow. The earthworms would start moving to the new material and their migration would be completed in 10-15 days. After migration of the earthworms is over, the compost is collected and stored for sale or may be used for the crops.

Fig. 5.5: Harvesting by Inducing Migration of Earthworms

The migration of worms from **loose brick windrows is the cheapest and the easiest method of vermicompost harvesting**. This method ensures complete migration of the earthworms to new windrows containing fresh material. This method is superior over all the other harvesting methods. This is because, it saves the manual labour, which is used for harvesting and also for the segregation (separations) of worms from the matured compost. Thus, the cost involved in harvesting and separation of the worms can be saved to a great extent. Also, there is less mortality rate of the earthworms.

Notes

(v) Harvesting through a trap of fresh cow dung balls

After vermicompost production, the earthworms present in vermibed may be harvested by trapping method. In this method, before harvesting the compost, fresh cow dung ball is made and inserted in the vermibed at around 5-6 places. After 24 hours, the dung balls are removed. If you observe this, you will find that all the worms will stick to the ball. Now, the cow dung ball is put in a bucket of water to separate the adhered worms. The collected worms can be used for the next batch of composting. The worm harvesting by this method is generally carried out to sell the worms.

INTEXT QUESTIONS 5.1

State True or False

(a) First lot of the vermicompost needs 5-6 months for its preparation.

(b) Sieving method of the vermicompost harvesting can be applied at any time of the day.

(c) Induced migration method of the vermicompost harvesting is best over all the harvesting methods.

(d) Height of the compost pile would have dropped down to about one third to one half to that of the original pile, when it is ready.

(e) The mature vermicompost is dark brown to black in colour.

(f) The mature vermicompost is odourless.

5.4 NUTRITIVE VALUE AND QUALITY PARAMETERS OF VERMICOMPOST

The nutrient content in vermicompost varies a lot and depends upon the raw materials that are used for the preparation of compost. If the raw materials are a mixture of various biodegradable wastes, then the compost will be rich in a wide range of nutrients. The common available nutrients in the vermicompost and their levels are mentioned at Table 5.1.

Notes

Table. 5.1: Available Nutrients in Vermicompost

S. No.	Component	Quality/Quantity
1.	Colour	Black to brown
2.	Odour	No foul smell
3.	pH	6.8
4.	Electrical conductivity	1.17 (dS/m)
5.	Nitrogen	0.5 to 1.50%
6.	Phosphorous	0.15 to 0.50%
7.	Potassium	0.06 to 0.30%
8.	Calcium	2.0 to 4.0%
9.	Magnesium	0.46%
9	Copper	2.0 to 9.5 ppm
10	Iron	2.0 to 9.30 ppm
11	Zinc	5.70 to 11.50 ppm
12	Sulphur	128 to 548 ppm

Actually, the nutrient status of vermicompost depends upon the nutrient composition of the vermicast. You must be thinking as to what is the difference between vermicast and vermicompost? Isn't both the same? No, both are not the same. Vermicompost is the product of the decomposition process using various species of earthworms to create a mixture of decomposing vegetable, food or organic waste, bedding materials, and vermicast. Whereas, the vermicast (also known as earthworm castings, worm castings, worm humus, worm manure, or worm faeces) is the end-product of the breakdown of the organic matter by the earthworms.

So, the nutrient level of the vermicompost is based on the nutrient composition of the vermicast, which in turn depends upon the type of feed given to the earthworms. Let us know the chemical composition of the earthworm castings fed with different feeds; as given below at Table 5.2.

Notes

Table 5.2: Chemical composition of earthworm castings fed with different feeds (as percent of fresh weight)

Feed	Nitrogen	Phosphorous	Potassium	Calcium	Magnesium
Cow manure	1.70	0.62	1.22	10.0	1.53
Pig manure	1.89	1.50	0.34	10.8	1.46
Sheep manure	1.51	0.64	0.78	4.40	1.37
Sugarcane pulp	2.67	2.11	0.40	4.08	1.89
Banana	2.50	0.56	3.74	2.36	1.50
Ruminal contents	1.68	0.62	1.21	9.80	1.58
Urban/domestic waste	0.90	0.44	3.60	3.60	3.10

Source: Werner & Cuevas, 1996. *Biocycle*, p57-61

Therefore, you should select those raw materials/wastes that are having high nutrition composition so that your vermicompost would be of good quality and have high nutritive value.

5.5 STORING AND PACKAGING OF VERMICOMPOST

Depending upon the requirement, sometimes, you may need to use your vermicompost immediately and sometimes you may have to store it for sometime depending upon its usage. It is important to store and pack the vermicompost properly to retain its quality for longer duration of time. Here we are going to discuss about the storage of vermicompost:

Storage

The harvested vermicompost should be stored in a dark and cool place. It should contain a minimum moisture of 40%. The stored material should not be exposed to sunlight directly as this would lead to loss of moisture and nutrient content. It is advocated that the harvested composted materials should be stored in open in the form of heaps (Fig. 5.6) rather than packed in the sacs (bags). The heap may be covered with polythene sheets, straw, gunny bags, cloths, High Density Poly Ethylene (HDPE) sheet or tarpaulin to avoid moisture loss and exposure to direct sunlight.

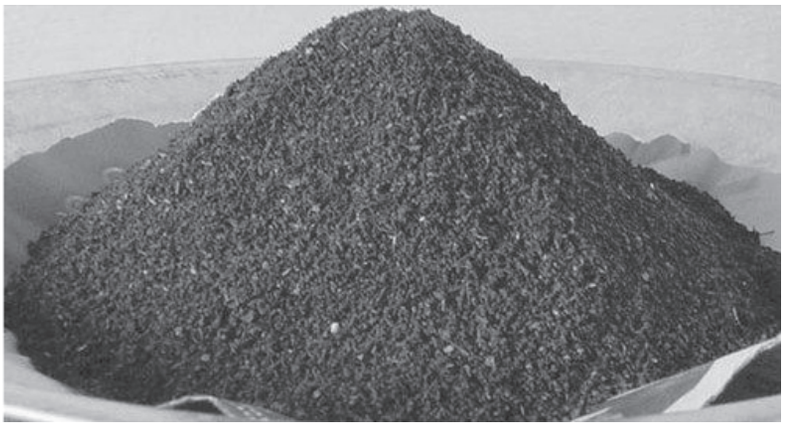


Fig. 5.6: Storage in a Dark and Cool Place

Packaging

Packaging can be done at the time of sale. If compost is stored at an open place, then periodical sprinkling of water is recommended to maintain its moisture level. This would also maintain population of the beneficial microbes present in the compost. If it is necessary to pack the compost, laminated sacs are used for packing. Nowadays, HDPE bags are also available for packing the compost (Fig.5.7). But, you should avoid the use of polythene bags for packing. Due to their long degradation period they may increase the problem of waste management. If you have to pack your compost for shorter duration, then packing may be done in cardboards. The cardboards are not suitable for long term packaging as they may be damaged due to the presence of moisture in the compost. The vermicompost can be stored for one year without loss of its quality, if the moisture in it is maintained at 40% level. However, its quality is good within 3 months and any delay in use may deteriorate it's moisture and nutrient content.

Fig. 5.7: Packets of Vermicompost

Notes

INTEXT QUESTIONS 5.2

State True or False

(a) The harvested vermicompost should be stored in a cool and dark place.

(b) Vermicompost can be stored for one year without loss of its quality, if the moisture is maintained at 20% level.

(c) Polythene bags are best for storing the vermicompost.

(d) Vermicompost quality is best within 3 months of harvesting.

WHAT YOU HAVE LEARNT

Let us recapitulate and enlist the salient points that you have learnt through this lesson:

- Vermicompost will be ready in about 2-3 months, if the agricultural waste is used and about 1-1.5 months, if cow dung waste is used as substrate.
- The vermicompost appears somewhat darkish brown to black, it is crumbly and smells earthy just like dry tea leaves.
- The processed vermicompost is light in weight and free from any bad odour.
- Manual harvesting, bulk harvesting, sieving, harvesting by inducing migrationof earthworms and harvesting through a trap of cow dung are different methods of vermicompost harvesting.
- The worm harvesting through a trap of cow dung is generally done in order to sell the worms.
- The nutrient content in vermicompost depends upon the raw materials that are used for compost preparation. If the raw materials are a mixture of biodegradable waste, then the compost will be rich in a wide range of nutrients.
- The harvested vermicompost should be stored in a dark and cool place.
- HDPE bags are available for packing of the compost. But, use of polythene bags for packing should be avoided, as their degradation period is too long.

- Packing of the compost for shorter duration may be carried out in cardboards. Due to moisture in the compost these are not suitable for long term packaging.
- The vermicompost can be stored for one year without loss of its quality, if it's moisture is maintained at 40% level.

TERMINAL EXERCISES

1. Explain harvesting of the vermicompost briefly.
2. What are the different methods of harvesting vermicompost? Which method is best amongst them?
3. Make a brief note on the nutritive value and quality parameter of the vermicompost.
4. Write a short note on the following:
   (a) Storage of vermicompost.
   (b) Packaging of vermicompost.
   (c) Mature vermicompost.

ANSWERS TO INTEXT QUESTIONS

5.1

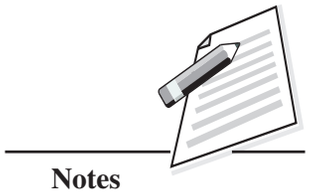
(a) False (b) True (c) True (d) True (e) True (f) True

5.2

(a) True (b) False (c) False (d) True

Key Learning Outcomes

- Harvesting vermicompost scientifically and as per requirement.
- Storing and packaging of vermicompost for sale and for longer usage.



Notes

6

MARKETING OF VERMICOMPOST

6.1 INTRODUCTION

Learners, we hope that after learning about the various aspects of vermicomposting and undergoing the practical sessions, you must have acquired the skills that are considered necessary for vermicompost production. It is important to note here that vermicompost production is a viable option for rural youth, like yourself, as it provides self-employment opportunities alongwith increasing your farm income.

After the production of vermicompost, the next question that arises is where would you sell this product? What are the potential markets for it and where are they located? Learners, you should be aware that the marketing of vermicompost is not as organized as is the case with other organic inputs. Though the potential market for vermicompost is available with fellow farmers and some organizations, it's marketing on a commercial scale is being done only by a few companies/ entrepreneurs. Currently, there does not exist a well-defined policy or guidelines regarding commercial production, processing and marketing of vermicompost. Whilst at some places, there is a large gap between demand and supply of good vermicompost. However, in other places, producers do not find a good market place to sell their produce. So, as a vermicompost producer, it will be beneficial to both the producers and the consumers, if there is a good marketing system in place that helps both the producers and the customers/farmers. It is also possible that you may enter into the vermicompost production yourself and create your own marketing channel, as a side business. For this you need to know about the economics of vermicompost production and available market opportunities by carrying out a cost-benefit analysis. This lesson covers all these aspects.

Notes

OBJECTIVES

After reading this lesson thoroughly, you will be able to:

- assess the economics of production and the marketing of vermicompost;
- assess the financial viability of an average size vermicomposting unit; and
- determine the appropriate marketing channel for the sale of vermicompost.

6.2 COST OF VERMICOMPOSTING

If you are aiming for commercial production of vermicompost then in addition to the cost of production, considerable amount would need to be invested on procurement of capital items (such as land and some machinery and tools). If you want to set up a vermin-culture hatchery center (where earthworms will be reared) and a vermicomposting unit, you would need approximately 0.5-1.0 acres of land.. This land will have at least 10-12 sheds; each shed having dimensions of approx. 300 sq. ft. This is an example only, you may consider smaller or larger units, and the cost will increase or decrease, based on the production capacity. If you are planning a big unit, then the land can be taken on lease for at least 10-15 years. Even sub marginal land (land that is not very good for farming), may serve the purpose.

For the smaller units, the onetime capital cost may work out to approximately, Rs. 5500 to 6500 for every tonne of vermicompost production. The high unit capital cost is due to the fact that these units require considerable expenditure on preparation of vermibeds, shed to provide shelter to these beds and machinery. However, these expenditures are incurred only once (known as non-recurring cost).

The operational cost would include the transportation cost of raw materials, raw material cost, product cost, etc. If the source of organic waste and dung are away from the production facility and the finished product requires transportation to far off places for marketing, the operational cost would increase appropriately to include the additional cost of these factors. Best option for reducing the cost of production is to have your own raw material and capital assets. For better market access (the ability of a company to sell goods across borders), cost effectiveness (the degree to which something gives good value in relation to its cost) of the finished product is of prime (main) importance.

For larger units, in order to operate them, expenditure on some items needs to be incurred on a recurring (occurring periodically) basis. These items include salaries of the staff, wage payments to the labourers, cost of procuring raw material, hiring cost for transporting the raw materials and finished goods, packing material cost, repairs and maintenance cost, and cost of power, insurance, etc. The number of the

Notes

office personnel and labourers need to be pre-decided. This can only be done by breaking each activity of the unit into a number of sub-activities and for each sub-activity, estimating the work involved and the capacity of the staff/labour that is needed to finish the work in the desired time frame. The number of persons should be so chosen to keep them engaged throughout. Make sure that you provide enough persons at various work points such as stores and vermibeds. Also, equip them with adequate number of implements to avoid undue waiting.

6.3 ECONOMICS OF VERMICOMPOSTING

As a vermicompost producer, you should maintain proper records of each activity of the unit. Table 6.1 shows the costs and returns from the production and sale of vermicompost from an average unit of 100 sqm. This is an illustrative analysis and actual cost varies from place to place depending upon various factors. You may visit a nearby vermicompost unit and prepare a table like the one that is given below. This will give you valuable experience before establishing your unit.

Table. 6.1: Costs and Returns from Production and Sale of Vermicompost from an Average Unit of 100 sqm

A. Non-Recurring Expenditure

S.No.	Item	Amount (Rs.)
1.	Expenditure on construction of vermibed Area: 90 sqm Size: 3m × 1m × 0.75m No. of beds: 30	50,000
2.	Expenditure on shed making Size: Total 100 sqm (@ Rs. 300/m^2)	30,000
3.	Procurement of starter culture (Earthworms) Quantity: 90 kg Rate: @ Rs. 200/kg	18,000
4.	Transportation cost of procurement of earthworms	1,000
5.	Machinery and Equipment Balance, Stitching Machine, Sieves, Shovel or spade, Cutter, Sealing Machine, Packaging Machine, etc. Total non-recurring cost	40,000 1,39,000

(Costs displayed are illustrative and will vary from place to place and time to time)

Notes

B. Recurring Expenditure

S.No.	Item	Amount (Rs.)
1.	Organic waste material (if purchased) Quantity: 750 quintal @ Rs. 100/quintal	75,000
2.	Filling of the beds No. of labourer: 8 @ Rs.300/person/day	2,400
3.	Filling of vermicompost in the bags Quantity/per year: 250 quintal Quantity per bag: 40 kg No. of bags: 625 Per unit cost for filling @ Rs. 2/bag	1,250
4.	Stitching of the bags	500
5.	Payment to the laborers	40,000
6.	Cost of HDPE (High Density Polyethylene)	15,000
	Total recurring cost	1,34,150

(Costs displayed are illustrative and will vary from place to place and time to time)

Total expenditure in first year (A+B) : Rs. 2,73,150

Income from sale of 250 quintal vermicompost (625 bags @ Rs. 400/per bag) : Rs. 2,50,000

Income from sale of earthworms (1500 kg @ Rs. 500/-kg) : Rs.3,75,000

Total Income (1st year) : Rs.6,25,000 – 2,73,150 = Rs.3,75,850

(Biological Utilisation Unit, ICAR-IARI, New Delhi)

Notes

INTEXT QUESTIONS 6.1

State True or False

(a) Vermicompost unit require non-recurring cost every year.

(b) Heavy machines are required for vermicomposting.

(c) Vermicomposting can be done in small units.

(d) The expenditure that are incurred only once is called the recurring cost of expenditure.

(e) A vermicompost producer needs to maintain proper records of each activity of the unit for better return.

(f) The operational cost will increase if the raw materials are transported from far places.

6.4 MARKETING CHANNELS

You must be aware that the marketing channel is the route by which a commodity is moved from the site of production to the site of its consumption. As explained earlier, the specialized market for vermicompost does not exist. The major amount of vermicompost is marketed directly from producers to the local consumers or farmers. Some farmers produce vermicompost for their own use. This saves the expenditure on procurement of inputs from the market. The local consumers are generally farmers, researchers, government agencies and public societies. There are various agencies and channels through which the product moves and reaches the consumer.

Also, there are several factors that affect the marketing of vermicompost such as, weight and bulkiness of compost, storage facilities, weak or strong marketing agency, distance between the producer and the consumer.

There are different types of marketing channels present in our country:

A. Producer → Consumer (peer sale).

B. Producer → Village merchant → Consumer (local sale).

C. Producer → Wholesaler-cum-commission agent retailer → Consumer.

D. Producer → Primary wholesaler → Secondary wholesaler → Retailer → Consumer.

Notes

Let us understand it more clearly through the flow diagram given at Fig. 6.1.

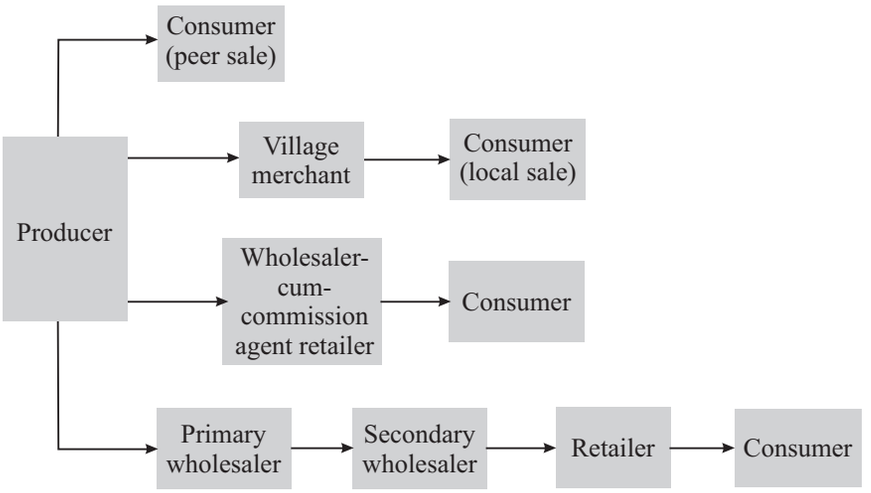


Fig. 6.1: The Marketing Channel

These channels have a large influence on the marketing costs (such as transport cost, commission charges, etc.) and market margins received by the intermediaries (such as trader/commission agent, wholesaler and retailer). The marketing channel decides the price to be paid by the consumer and share of it received by the farmer or producer. The channel is considered as good or efficient, when it makes the produce available to the consumer at the cheapest price and also ensures that the highest share is paid to the producer.

Goods and Services Tax (GST) and Vermicomposting

You must be have heard about the GST. You must be aware that **Goods and Services Tax** (GST) is a single and a broad based tax imposed on goods and services consumed in an economy. As in many agricultural commodities, GST is applicable to vermicompost also. You should understand that the vermicompost is a type of organic manure and is tax free only if you sell it unbranded. It attracts 5% tax as of now if you sell it in branded packaging. If you want to send vermicompost via transportation or courier, you will need to provide a valid bill with your goods. Also, if you are willing to sell it online, you'd be needing a GSTIN (GSTIN or Goods and Services Tax Identification Number is your unique business identity with the GoI (Government of India) that contains 15 digits alpha-numeric PAN based code) to register on ecommerce platforms like Amazon, Flipkart, etc. (Source: https://cleartax.in/s/fertilisers-gst-rate-hsn-code).Let us understand the applicability of GST on selling of vermicompost through a flowchart as given below, Fig. 6.2.

Notes

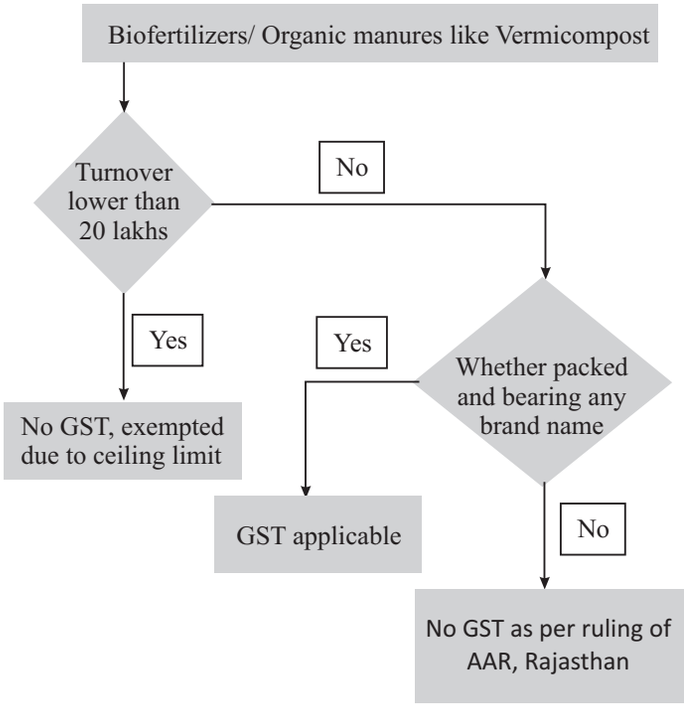


Fig. 6.2: Applicability of GST on Selling of Vermicompost

At the conclusion, it is recommended to plan your business well ahead to get the desired success. A thorough planning with a project plan will reduce risks in vermicomposting business. It is suggested to start with a small scale then gradually extend your business after gaining production and marketing experience.

INTEXT QUESTIONS 6.2

Fill in the Blanks

(a) The ..... decides the price to be paid by the consumer and share of it received by the farmer or producer.

(b) The channel is considered as ..... when it makes the produce available to the consumer at the cheapest price and also ensures that the highest share is paid to the producer.

(c) GST stands for .....

(d) Tax @ ..... is applicable if vermicompost is sold under a branded packaging.

Notes

WHAT YOU HAVE LEARNT

Let us recapitulate and enlist the salient points that you have learnt through this lesson:

- Vermicompost production provides a viable option for self-employment to the rural youth and to increase the farm income as well.
- There does not exist a well-defined policy or guidelines regarding large scale commercial production of vermicompost, its processing and marketing.
- The marketing of vermicompost is affected by several factors such as the weight and bulkiness of compost, storage facilities, weak or strong marketing agency, distance between the producer and the consumer.
- Best option for reduction of production cost is to have own raw material as well as own capital assets such as land and machinery.
- A good marketing channel is one that makes the produce available to the consumer at the cheapest price and also ensures that the highest share is given to the producer. An effective marketing channel would therefore need to be developed.
- GST is applicable to the vermicompost business as for many other agriculture commodities.
- The vermicompost is a type of organic manure and is tax free only if it is sold unbranded. However, a 5% tax is applicable if it is sold in a branded packaging.
- If the turnover of the company selling vermicompost is more than 20 lakhs, then GST @5% is applicable.
- A thorough planning with a project plan will reduce risks in vermicomposting business.

TERMINAL EXERCISES

1. How can you increase your income from your vermicompost unit using agricultural inputs?
2. Give an illustrative cost of the vermicompost production.

Notes

3. Draw a flowchart illustrating the applicability of GST on selling of vermicompost.

4. Write short notes on:

   (a) Marketing channels.

   (b) Economics of vermicomposting.

   (c) Marketing of vermicompost.

ANSWERS TO INTEXT QUESTIONS

6.1

(a) False (b) False (c) True (d) False

(e) True (f) True

6.2

(a) Marketing channel (b) Good or efficient

(c) Goods and Services Tax (d) 5%

Suggested Activity

Visit a nearby commercial vermicomposting unit. Discuss the requirements for vermicompost production with their staff. Note down the size and number of vermibeds located there. Visit the store room and observe the quality of vermicompost stock. Learn about available machines, tools and equipment as well as note down their prices. Based on your observation and data collected, estimate the cost of production of vermicompost in that unit.

Key Learning Outcomes

- Estimate the expenditure involved in vermicompost production.
- Make a business plan for starting a vermicompost unit alongwith other ongoing farm activities for generating additional source of income.

Notes

7

MAINTAIN HEALTH AND SAFETY AT WORKPLACE

7.1 INTRODUCTION

Learners, till now we have discussed about all the aspects of vermicomposting right from the selection of earthworms, selection of vermicompost site to the feed requirements of the earthworms, preparation and maintenance of the vermibed to harvesting, storage and sale of the product. We assume that after completion of this certificate programme you will be able to start your own vermicomposting farm. Here, maintaining the health and safety of yourself and your co-workers will be your foremost duty. You have to make sure that your co-workers and others are protected from any hazards (danger) and risks (a situation involving exposure to danger) that may harm them. This involves effective control of any risk or injury that could arise at the workplace. If you have a small unit, then your worries would be less, but you would still need to take precautions. However, large scale composting sites are associated with a number of health and safety hazards, which can cause harm to both human health as well as could cause financial losses. For handling the risks and hazardous materials, you need to under take proper analysis and find ways to manage risk. We will be discuss about the risks towards health and safety of equipment and stores that are associated with vermicomposting unit and their management at a vermicompost farm in this lesson.

OBJECTIVES

After reading this lesson thoroughly, you will be able to:

- explain the importance of health and safety at the workplace;

Notes

- identify the risks associated with vermicomposting sites and undertake risk management;
- maintain clean and efficient workplace;
- provide appropriate emergency procedures; and
- improve the health and safety at a vermicompost unit.

7.2 IMPORTANCE OF HEALTH AND SAFETY AT WORKPLACE

Workplace safety is very important for all the workers as everybody desires to work in a safe and protected atmosphere. Either you are having a small or large vermicompost unit, it is your duty and moral responsibility to look after the protection of your co-workers and provide them a safe working environment. There are numerous benefits of following health and safety practices in the workplace. Let us enlist a few of them:

- **Protecting Your Employees**

If you and your employees are following health and safety guidelines, it will primarily protect everyone from injuries/accidents, illness or any other form of harm that can take place at the workplace.

- **Reducing Absences and Improving Productivity**

Following health and safety guidelines and maintaining a safe work place will reduce the risk of work-related illnesses and injuries, and therefore reduce the instances of staff absences. Also, if one is working in a safe and healthy environment, it will increase his/her morale, which in turn will improve productivity of the farm. In addition, accidents and incidents may cause damage to equipment or people and stop the work for some period of time leading to financial losses.

- **Saving Money**

By maintaining health and safety practices at the workplace, and therefore reducing absences and improving productivity, you will be saving money by retaining staff. Money spent on accident repairs, equipment losses and staff absences will decrease and the business' profits will increase.

- **Minimizing Environmental Damage**

Vermicomposting is a good way for waste management. Proper health and safety procedures should be followed and safe disposal of farm waste should be done to minimize environmental damage.

Notes

7.3 IDENTIFYING RISKS AT COMPOSTING SITES/RISK ASSESSMENT

Large composting sites are associated with a number of health and safety hazards which can cause harm to human health and environment. Identifying the risks at the composting farm will help you and your unit to be safe from any hazards or accidents. Hence, analysis of the risks should be carried out so that all the safety measures can be taken properly and effectively. Let us identify the associated risks with health and safety of the employees at a vermicomposting site:

7.3.1 Health Related Risks

- **Diseases Caused Due to Dusts and Bioaerosols**

The composting sites inherently generate dusts and bioaerosols. The bioaerosols are made up of very small biological particles (fungi, bacteria, viruses and pollen), which remain suspended in the air and can be inhaled by people working there. Bioaerosols, organic dust, particulate matter of microbes, plant or animal origin materials and microbial constituents such as fragments, toxins and metabolites cause hazardous health issues to the workers working at the composting units. The concentration of bioaerosols are greatest in the lower part of the atmosphere and it decreases with altitude. Their size varies from 10 nanometres to 100 micrometers. Pollen grains are the largest bioaerosols and virus particles are the smallest one. The virus bioaerosols are less likely to remain suspended in the air over a long period of time, due to their heavy weight. These are typically introduced into the air through wind turbulence from earth surface and are responsible for causing diseases in the composting area. Well-known disease outbreaks caused by bioaerosols includes pneumonia and tuberculosis. The bioaerosols may increase human respiratory problems. This may be due to traces of heavy metals and microorganisms that are suspended in the air at the composting sites. Let us enlist a few important diseases at the composting sites at Table 7.1.

Table 7.1. Some Diseases and Causal Agents that Occur at Composting Sites

Name	Disease
Bacteria	
Vibrio cholera	Cholera
Salmonella typhi and other species	Typhoid and other enteric fevers
E-coli	Diarrhoea
Tubercle bacilli	Tuberculosis

Notes

Viruses	
Infectious Hepatitis	Inflammation of the liver
Epidemic gastroenteritis virus	Gastro-enteritis
Small round viruses (SRV's)	Food poisoning and gastroenteritis
Parasites	
Entamoeba histolytica	Amoebic dysentery
Balantidium coli	Balantidiasis (an infection)
Giardia lamblia	Diarrhea

Precise understanding of bioaerosols and its effect on the human health could be extremely important for you to undertake effective health risk assessment.

7.3.2 Potential Sources of Accidents and Incidents

- **Fire**

Fire is one of the potential hazards at a composting site. The fire may be caused due to sparks originating from vehicles, processing operations, lightening, cigarettes and spontaneous combustion of raw materials stored in bulk. It could also be caused by a short circuit. It is important for you to note that the large compost heaps can generate temperature of up to 80°C as a result of biological processes of organic matter decomposition. So, this may also cause fire in the composting farm. However, few safety measures are suggested to combat such a situation:

- As you can understand that fire can be caused due to human negligence as well as it could be due to short circuit. So, you need to train your workers about the risks caused due to fire and advise them to refrain from the bad habits that may lead fire in the unit including smoking.
- Proper moisture in the composting pit and turning of bed periodically prevents self-ignition of the compost heap. So, please do not forget this.
- If you have taken up vermicomposting on a large scale for commercial purposes, then you need to spend considerable amount of money on office space, permanent sheds for vermibed, storage place for raw material and the finished product, etc. Permanent buildings will reduce the risk of fires as compared to open/temporary structures.
- Fire safety planning includes emergency routes and exits, fire detection, warning systems and appropriate fire fighting appliances such as fire

Notes

extinguisher and fire hoses (Fig. 7.1). It is also important to provide suitable information to the employees and others at the workplace about fire safety in the form of notices or sign boards. Staff training/mock drill should also be conducted.

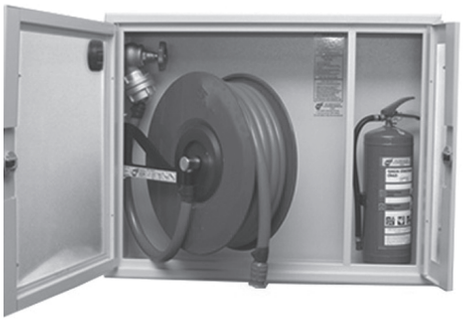


Fig. 7.1: Fire Safety Equipment and Sign Boards

(***Source:*** https://www.lrbconsulting.co.uk/health-and-safety-blog/simple-rules-to-tackle-a-small-fire/)

- **Accidents due to Human Negligence**

Any unattended vermicompost pit in the farm may lead to an accident or an incident. So, it is the responsibility of each and everyone working at the farm to be careful about this. Also, proper lighting should be provided near to pits so that no one falls into it.

7.3.3 Risks Associated with Poorly Managed Vermibed

- **Smells/Odours from Vermibeds**

You must have observed that a well-managed vermibed is odourless. But, when the feed material is high in nitrogen content and it is added to the bed, it leads to anaerobic condition. This causes the production of bad odour or smell in the bed. Even when the feed materials are not partially decomposed before their addition to the bed, it also results in the production of bad smell. The beds if they are more than 1m deep or they are too wet may also smell. The beds smell because of

Notes

production of certain gases such as ammonia, hydrogen sulphide, methane, carbon monoxide, etc. Do you know that these gases may cause global warming due to the greenhouse effect? Thus, a badly managed bed produces smells and also adds to environmental pollution. Such beds also attract pests and delay the composting process. You can easily avoid such situations by adopting good management practices such as the use of partially decomposed organic wastes.

- **Moisture Content in Vermibed**

Moisture content in the composting unit must be maintained above 50%. The lower moisture content in the bed results in increased worm mortality. Under anaerobic decomposition, addition of excess water must be avoided to restore healthy conditions and prevent the worms from dying. Maintain optimum moisture level in the bed by turning the beds periodically.

- **Needless Pest Species**

The composting units are the breeding (the natural process of reproduction) sites for fruit flies and rodents. The rodents are attracted by certain food materials from the kitchen wastes and they can cause spreading of certain diseases to the human beings. You should avoid the use of dairy or animal products in your worm bin to decrease the possibility of attracting pests.

- **Escaping of Worms**

Worms generally stay in the bin, but may try to leave the bin when introduced for the first time, or often after a rainstorm, when the outside humidity is high. Also, the dying earthworms cause unhealthy condition in the composting unit that may encourage the worms to escape. Maintaining proper conditions in the worm bin and putting a light cover over the bin when introduced for the first time would eliminate this problem.

- **Mold**

Mold in the bedding, not only indicates that the bedding is too wet, but also shows that it is too acidic. Change the mold affected bedding and remove the citrus fruits (which is too acidic) completely from the bedding until the problem is solved. Reintroduce the worms slowly and carefully. Some mold/fungi can cause health related problems to the human beings and pets too, so you need to be quite careful. The problems of poorly managed vermibeds can easily be tackled by taking proper management steps. We have already discussed the management of vermibeds at lesson 3, please go over it in case you face any problem.

Notes

INTEXT QUESTIONS 7.1

1. State True or False

(a) Vermicomposting is the best solution for waste management.

(b) Dust particles emitted from the composting units cause respiratory problems in the human beings.

(c) Bioaerosols are visible through the naked eyes.

(d) Compost heaps can generate high temperature that may cause fire in the composting farm.

2. Fill in the blanks

(a) Bioaerosols consists of ....., ..., ... and .....

(b) Maintain ..... condition to avoid emission of smells or odours from the composting bin/bed.

(c) ..... gas is emitted due to anaerobic condition of composting.

(d) Provide ..... to prevent escaping of worms from the composting unit.

7.4 RISK MANAGEMENT AT COMPOSTING SITES

Now, you might have understood that there are various types of risks pertaining to safety and health hazards at the composting site. Therefore, you need to follow few important steps for managing the risks associated with the composting sites:

- Adequate preventive measures should to be taken for all the personnel who come in contact with the composting area.
- Undertake basic safety checks before operation of all tools, equipment, machinery and vehicles.
- Always use protective clothing and equipment, such as, gloves, masks, safety glasses, boots etc. (Fig. 7.2) while working in the composting units.

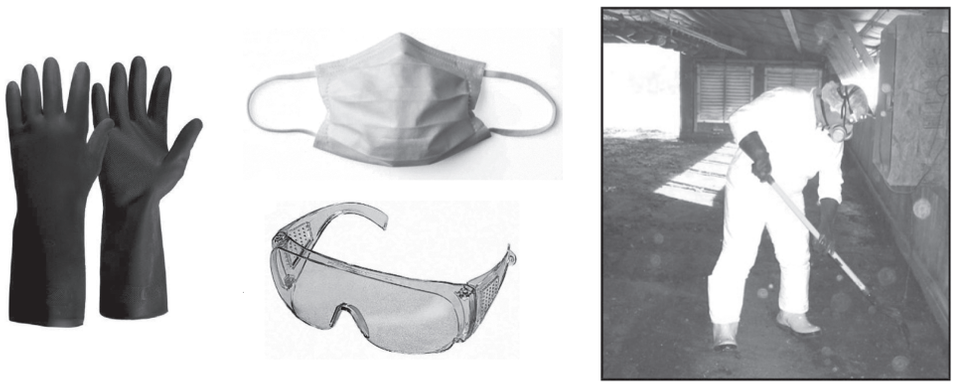


Fig. 7.2: Protective Clothing to be Used at a Vermicomposting Unit

(***Source***: https://www.aphis.usda.gov/animal_health/emergency_management/in-house_composting/ovr/ppe/ppe0038.html)

- Always handle composting materials with shovel and other forms of scoopers (Fig. 7.3).

Fig. 7.3: Handling Composting Material With Shovel

- Use equipment and materials safely and correctly and return the same to the designated storage area when not in use.
- Keep a lid on the composting bin or cover the vermibeds and ensure that the access for animals is blocked.
- *First aid* is the *first* and immediate assistance given to any person suffering from either a minor or serious illness or injury. This is done to preserve life, prevent the condition from worsening or to promote recovery. Always keep a first aid kit at the composting premises to provide necessary initial treatment, in case of any emergency. A first aid kit is a collection of supplies and equipment that is used to give medical treatment (Fig. 7.4.). In general the kit should contain:

Notes

- Antiseptic wipes or sprays: for reducing the risk of infection in abrasions or around wounds.
- Cotton Balls: for applying antiseptic lotions.
- Bandages: for securing dressings.
- Saline: for cleaning wounds or washing out foreign bodies from eyes.
- Dressing: a dressing is a sterile pad applied to a wound to promote healing and protect the wound from further harm.
- Antiseptic solution: to apply on wounds.
- Relispray: spray for pain relief.
- Ice pack: to keep on sprain or fracture for immediate relief.
- Soap: used with water to clean superficial wounds once bleeding is stopped.
- Scissors: to cut dressing/bandages.
- Thermometer: to check body temperature.
- Few recommended medicines for fever and pain relief.

Fig. 7.4: First Aid Kit

Notes

- Proper waste disposal should be encouraged without harming the environment.
- Maintain a healthy composting farm. You are required to maintain a healthy composting farm for obtaining better quality and quantity of vermicompost. There are a number of precautions that should be taken to maintain a healthy composting farm. Let us enlist some of them:
  - Floor of the unit should be compact to prevent the migration of earthworms into the soil.
  - Aeration in the vermibed should be maintained for the proper growth and multiplication of the earthworms.
  - Do not overfeed the worms. Also, the feed wastes should be free from plastics, chemicals, pesticides and metals.
  - Regulate the bin temperature between 18-25^{o}C for proper decomposition of the food waste. This can be done by periodical turning of the beds.
  - Use only 15-20 days old cow dung to avoid excessive heat generation in the bed.
  - Keep the bed moist (optimum moisture level between 50-60 %) at all the times.
  - Keep the bin dark (avoid light entering the bin) to ensure faster decomposition.
  - Address the worm problems intermittently, e.g. remove any harmful pests present in the vermibed.
  - Empty excess liquid (leachate) from the bin/vermibed. These can be used as a nutrient rich bio fertilizer. After maturity of the compost remove the worms to avoid their death due to feed scarcity.

7.5 IMPROVING HEALTH AND SAFETY AT A VERMICOMPOSTING UNIT

The Occupational Health and Safety Regulation (it is concerned with the health and safety of the people at work) is required for managing the prevention of work-related injuries and diseases at the workplace (Here, workplace refers to your vermicomposting unit). So, as an employer or vermicompost producer you must do the following:

- Create a plan for improving the health and safety by identify hazards at your workplace and take appropriate measures to eliminate or minimize them. So, you need to develop a safety plan.

Notes

- Inspect your workplace regularly. Check all the equipment and tools to ensure that they are well maintained and are safe to use.
- Manage a cordial relationship with your co-workers who may be stressed, frustrated, confused or angry. A positive working atmosphere would motivate and sustain your employees.
- Train your employees, especially if there is a risk for possible injuries associated with a particular job. Always provide written instructions and safe work procedures. This will help them as they can check for themselves what needs to be done, if they are unsure of a task or have forgotten some part of their training.
- Encourage your workers to share their ideas and thoughts on measures to improve the safety at the workplace.
- All employees should be aware of the local emergency services available. They should be able to communicate the location and directions on emergency situations. Also, everybody should be able to understand the emergency equipment and procedures including how to use the first aid kit as per the workplace requirements.
- Maintain a record of all the first aid treatments, inspections, incident investigations, and training activities that are carried out at the workplace. This information can help you to identify trends that result in accidents/ incidents or risky work procedures and thereafter you may take appropriate measures to enhance workplace safety.

INTEXT QUESTIONS 7.2

1. State True or False

(a) One should undertake the basic safety checks before operation of all tools, machinery and vehicles for managing the risks associated with the composting sites.

(b) Workers should wear protective clothing, masks and gloves while working at the composting units.

(c) Aeration in the vermibed should be maintained for the proper growth and multiplication of the earthworms.

(d) Training of employees should be carried out periodically, especially if there is a risk for the possible injuries associated with a particular job.

Notes

2. Fill in the Blanks

(a) A ..... should be made to improve the health and safety at the workplace.

(b) ..... is done to preserve life and prevent the individual's condition from worsening or to promote recovery.

(c) ..... is used for cleaning wounds or washing out foreign bodies from the eyes.

(d) The bin temperature should be regulated between ..... for proper decomposition of the food waste.

WHAT YOU HAVE LEARNT

Let us recapitulate and enlist the salient points that you have learnt in this lesson:

- Workplace safety is very important as everybody desires to work in a safe and protected environment. It is the duty and moral responsibility of an employer to look after the protection of his/her co-workers and provide them a safe working environment.
- The appropriate health and safety practices at the workplace results in protecting the employees from accidents and incidents, reduces absences, improves productivity and saves money spent on absences and damage to the equipment. It also minimizes environmental damage.
- Analysis of the risks should be carried out so that all the safety measures can be taken properly and effectively.
- The composting sites inherently generate dusts and bioaerosols that cause hazardous health issues to the workers at the composting unit.
- The bioaerosols may increase human respiratory problems due to traces of heavy metals and microorganisms that are suspended in the air at the composting sites.
- Fire could be caused due to sparks from vehicles, processing operations, short circuits, cigarettes and spontaneous combustion of raw materials stored in bulk at these sites. Fire safety planning and appropriate fire fighting equipment such as fire extinguishers and fire hoses should be installed in the unit as a precautionary measure to tackle different types of fire.

Notes

- Smells/Odours from vermibeds, improper moisture content in the vermibed, pests, escaping of worms and development of mold are the problems of a poorly managed vermibed. These can be easily tackled by taking proper risk and vermibed management steps.
- For risk management at the composting site you need to undertake the basic safety checks before operation of all tools, machinery and vehicles.
- Use equipment and materials safely and correctly and return the same to the designated storage when not in use.
- Always keep a first aid kit at the composting premises to provide necessary initial treatment, in case of any emergency.
- Proper waste disposal should be encouraged to prevent environmental damage.
- Maintain a healthy composting farm for obtaining better quality and quantity of vermicompost.
- Develop a plan for improving the health and safety by identifying the potential hazards at your workplace and take appropriate measures to eliminate or minimize them.
- Inspection of the workplace should be carried out on regular basis.
- All equipment and tools should be checked regularly to ensure that they are well maintained and safe to use.
- Written instructions and safe work procedures and checklists should be created in the form of Standard Operating Procedures (SOPs) and provided to the workers so that they can refer to it when required.
- Protective equipment, gloves, masks, safety glasses, helmets, etc. should be used while working at the composting units.
- Periodical training of the employees should be carried out, especially if there is a risk for possible injuries associated with a particular job.
- All employees should be able to use emergency equipment and follow emergency procedures including first aid as per the workplace requirements.

TERMINAL EXERCISES

1. Why health and safety is important at workplace? Enlist few benefits of a healthy and safe workplace.

Notes

2. What safety measures can be adopted to prevent fire at a vermicompost unit?
3. What do you mean by bioaerosols? What are the agents that cause health hazards in human beings at composting sites?
4. Enlist the measures to handle and maintain the earthworms in the composting pits?
5. What are the precautionary measures that should to be taken to maintain a healthy composting farm?
6. What are the steps involved in improving the workplace health and safety?
7. How do you manage hazards occurring at the composting sites?

ANSWERS TO INTEXT QUESTIONS

7.1

1. (a) True (b) True (c) False (d) True
2. (a) Fungus, bacteria, virus and pollen
   (b) Aerobic (c) Ammonia (d) Shade

7.2

1. (a) True (b) True (c) True (d) True
2. (a) Safety plan (b) First aid (c) Saline (d) 18-25^{o}C

Key Learning Outcomes

- Able to maintain safety and health of the worker sat a vermicomposting unit by taking appropriate risk management measures.

Course Code 621

VERMICOMPOSTING
(REVISED)

NSQF LEVEL 4

(Job Role: Vermicompost Producer)

PRACTICAL MANUAL

NATIONAL INSTITUTE OF OPEN SCHOOLING
(An autonomous organisation under MoE, Govt. of India)
A-24-25, Institutional Area, Sector-62, NOIDA-201309 (U.P.)
Website: www.nios.ac.in, Toll Free No. 18001809393

COURSE TEAM

ADVISORY COMMITTEE

Chairman
NIOS, NOIDA, U.P.

Director, Vocational
NIOS, NOIDA, U.P.

CURRICULUM COMMITTEE

Prof. Shailendra Singh Yadav
Director, School of Agriculture
IGNOU, New Delhi
(Chairman of Course
Curriculum Committee)

Dr Chandra Bhan Singh
Rt. Principal Scientist IARI
Pusa Campus, New Delhi

Dr Shivadhar
Principal Scientist
Division of Agronomy
IARI, Pusa Campus, New Delhi

Dr Dushyent Gehlot
Asstt. Soil Conservation Officer
Ministry of Agriculture and
Farmer's Welfare, New Delhi

Dr Srinivasamurty R.
JSO, National Centre of Organic
Farming, Ghaziabad

Dr Neelima Pant
Assistant Director (Academic)
NIOS, NOIDA, U.P.

PRACTICAL WRITERS

Dr R.K. Palta
(Ex-CTO) Biomass Utilization Unit
ICAR, New Delhi

EDITOR

Dr Shivadhar
Principal Scientist
Division of Agronomy
IARI, Pusa Campus, New Delhi

PROOF READER

Prof. Shailendra Singh Yadav
Director, School of Agriculture
IGNOU, New Delhi

COURSE COORDINATOR

Dr Neelima Pant
Assistant Director (Academic)
NIOS, NOIDA, U.P.

GRAPHICS/DTP

M/S Sri Krishna Graphics
Delhi

CONTENTS

Notes

Practical 1

VISIT TO A VERMICOMPOSTING UNIT

AIM

To visit a vermicomposting unit.

OBJECTIVES

After completing this practical, you will be able to:

- familiarize yourself with the layout of a vermicomposting unit;
- become familiar with the infrastructure of a vermicomposting unit;
- identify the inputs required to run a vermicomposting unit; and
- acquaint with the routine day-to-day activities to manage a vermicomposting unit.

PRINCIPLE

Management of vermicomposting unit involves the understanding and performance of a series of time bound activities. Such activities involve the selection of a suitable species of the earthworm, preparation of vermibeds, making food substrate suitable for feeding to the earthworms, inoculation (introduction) of earthworms to the vermibed, taking care of worms, harvesting of mature vermicompost, packing and marketing of vermicompost, etc. Such management practices need to be performed timely and efficiently. Thus, after visiting such a unit, you will be able to get familiar with such tasks that will help you to manage a vermicomposting unit efficiently and profitably.

TOOLS/EQUIPMENT/MATERIALS REQUIRED

- Vermicomposting unit with more than 10 operational beds.

Notes

- Notebook.
- Pen.
- Measuring tape

PROCEDURE

1. Visit a vermicomposting unit with at least 10 working beds.
2. Contact in-charge or manager of the unit, observe and noted own the series of activities being performed daily and their schedule.
3. Observe the unit and make note of the following :
   (i) Location of the unit, layout of the unit, infrastructure required for starting a unit, transport connectivity to the nearest bus stand/railway station, nearest source of raw material (feed) for earthworms and location of market outlets for the produce.
   (ii) Area of the vermicomposting unit, various types of rooms/sheds (permanent or temporary) in the unit. Draw a rough sketch in your notebook.
   (iii) Mode of transport of feed/cowdung for the earthworms from the nearest source to the unit, cost of procurement and their processing.
   (iv) Source of water. Is it tap water or water from the tube well? Also, note down the procedure for watering the beds.
   (v) Name of earthworm species used, number of days required to complete one life cycle, number of cocoons produced in a week, number of the young ones produced per cocoon and survivability of the young ones.
   (vi) Sources for procurement of earthworm species.
   (vii) Length, breath and height of the vermibed, rate of inoculation of worms and types of vermibeds being maintained.
   (viii) Harvesting- Duration when the first lot is ready to harvest and the method of harvesting.
   (ix) Packing and storage of the vermicompost.
   (x) Records maintained in the unit. Date of the start of the unit, date of introduction of worms, days taken to produce 1st lot of vermicompost, date of first harvesting and subsequent harvesting, quantity of the vermicompost produced in one cycle, income from the unit, etc.

Notes

OBSERVATIONS

(i) Name and address of the unit visited.

(ii) Name of the earthworm species used.

(iii) Different types of vermibeds and their lay out.

(iv) Infrastructure required for the unit and their placement.

(v) Shed and materials required for construction and their source.

(vi) Source of feed for the worm and their cost.

(vii) Routine unit activities and the number of persons engaged in the unit.

(viii) Number of vermibeds with mature compost.

(ix) Harvesting process and the separation of worms.

(x) Packaging – Quantity of packets, number of packets prepared per day.

(xi) Storage of vermicompost – Method and duration.

RESULT

Visited …… (name and address) of the vermicomposting unit and noted the following activities being performed on routine basis:

.....

.....

.....

.....

.....

PRECAUTIONS

- Before visiting the vermicomposting unit, fix an appointment with the in-charge of the unit and plan your visit accordingly.
- Do not interfere with the ongoing activities in the unit.
- Do not touch anything in the unit without permission.

Notes

- Wear protective clothing, such as apron, face mask, gloves, etc., before touching the vermibeds/earthworms.
- Maintain discipline and hygienic conditions in the unit.

KEY LEARNING OUTCOME

Proficient in understanding the layout of a vermicomposting unit, its infrastructure, its inputs requirements and routine activities performed at the unit.

NOTES

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

(Instructor's Signature)

Notes

Practical 2

MORPHOLOGICAL AND ANATOMICAL DESCRIPTION OF AN EARTHWORM

AIM

To study the morphology and anatomy of an earthworm.

OBJECTIVES

After completing this practical, you will be able to:

- recognize the different external parts of the body of an earthworm; and
- identify various internal parts of an earthworm's body.

PRINCIPLE

Before understanding the effective management of a vermicomposting unit, you should know about the morphology and anatomy of an earthworm. Morphology is the study of the physical form and external body parts and anatomy is the study of internal structures/parts of an earthworm. Such studies can help us to identify the species of the earthworm. You will also come to know as to how the earthworms feed, how and what change happens to the organic feed when it passes through the different parts of the digestive system? We will also come to know how reproduction and various other vital activities are going on inside the earthworm.

TOOLS/EQUIPMENT/MATERIALS REQUIRED

- Live earthworms.
- Local anesthetic drug to immobilize earthworms.
- Dissection tray.
- Pins.

Notes

- Magnifying glass.
- Notebook.
- Pen.

PROCEDURE

1. Visit a vermicomposting unit near to your place.
2. Pick a few earthworms and anaesthetize them.
3. Put an earthworm in the dissection tray and pin it.
4. Study the different body parts of the earthworm with the help of a magnifying lens.
5. Draw a well labelled diagram by observing the earthworm to depict its morphology.
6. Put another earthworm in the dissection tray.
7. Make a straight cut on the dorsal side from the posterior end to the anterior end. Stretch the skin by pinning it.
8. With the help of magnifying glass study the internal parts of the earthworm.
9. Draw a well labelled diagram of the internal body parts by observing through a magnifying glass.

OBSERVATIONS

A labeled diagram of an earthworm depicting the external body parts (Fig. 2.1) and internal body parts (Fig. 2.2) is given below. Record your observations as per the given diagram.

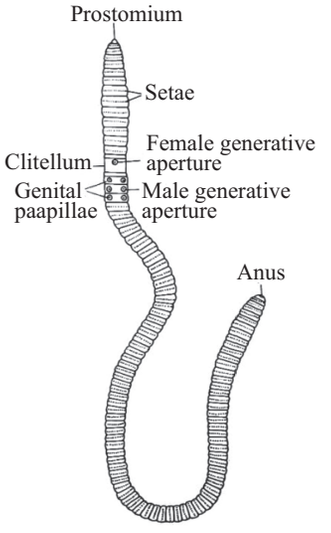


Fig. 2.1: External Body Parts of an Earthworm

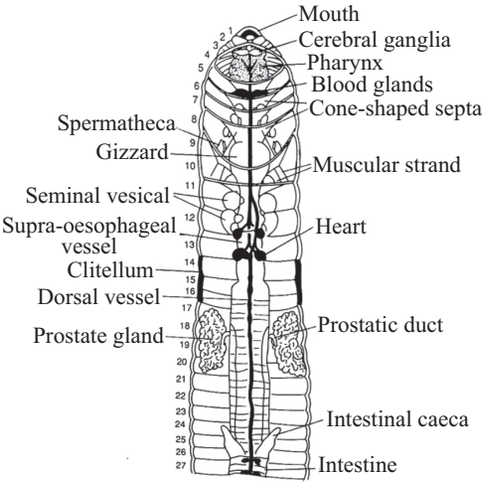


Fig. 2.2: Internal Body Parts of an Earthworm

Notes

RESULT

Observed the external and internal body parts of an earthworm. The labelled diagram of body parts is drawn below:

PRECAUTIONS

- Use hand gloves while taking out the earthworms from the vermibeds.
- Carefully draw a diagram of the external and internal body parts of an earthworm and label them.
- Enter a vermicomposting unit only after prior permission from the manager or in- charge.
- Do not interfere with the normal activities of the unit.
- Maintain hygienic conditions in the unit.

KEY LEARNING OUTCOME

Able to identify the external and internal body parts of an earthworm.

NOTES

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

(Instructor's Signature)

Notes

Practical 3

IDENTIFICATION OF DIFFERENT TYPES OF EARTHWORMS

AIM

To identify different types of the earthworms.

OBJECTIVES

After completing this practical, you will be able to:

- identify different types of the earthworms; and
- select the suitable earthworm species for vermicomposting at your place.

PRINCIPLE

More than 8000 species of the earthworms are found all over the world. Not all the species can be used for vermicomposting. This is because only a few species can adapt themselves to high temperature produced during the decomposition of the organic matter content. Few of such widely used species are *Eisenia fetida, Eudrilus eugeniae, Lampito mauritii* and *Perionyx excavatus*. It is therefore necessary to identify such species.

Fig. 3.1: Earthworms for Vermicomposting

Notes

TOOLS/EQUIPMENT/MATERIAL REQUIRED

- Different earthworm species collected from various places.
- 97% ethanol solution.
- 10% formalin solution.
- Magnifying lens.
- Protective covering such as, apron, protective glasses and gloves.
- Notebook.
- Pen.

PROCEDURE

1. Visit few local vermicomposting units and ask the name of the species being used for composting.
2. Collect earthworms of some popular species.
3. Note down biological features of the species.
4. Go to a fertile field or garden. Dig soil and collect some earthworms.
5. Go to a nearby dirty water drainage, pond or any other stagnant water body. Dig the soil and collect earthworms.
6. After collection, kill earthworms in 97% ethanol and preserve in 10% formalin solution.
7. Compare the earthworms collected from the different habitats using magnifying glass.

OBSERVATIONS

Note down your observations in the table given below:

Name of Species	Colour	Length	No of segments	No of segments in which clitelum is present	No of cocoons produced per week	No of young ones produced/ cocoon	No of days required to reach maturity	Whether used for vermicom-posting or not	Classify as excellent/ very good/ good/ average/ poor species for com-posting

Notes

RESULTS

Earthworm species ..... is/are promising for vermicomposting on our locality than other species .....

Some important characteristics of the promising earthworm species ..... are:

.....

.....

.....

.....

.....

.....

PRECAUTIONS

- Take proper care while collecting earthworms, they should not be hurt or damaged.
- Contact nearby Agricultural Institute/Krishi Vigyan Kendra / Agriculture University or Agriculture Department and enquire about the names of the suitable earthworm species recommended for vermicomposting in your area and their key features for identification. Carefully note down their features. These features are unique for each species, so they need to be observed carefully.
- Enter vermicomposting unit after prior permission from the manager or unit in-charge.
- Do not interfere in the unit activities.
- Use apron, protective gloves and take protective measures while working in the vermibeds and collecting earthworms.

KEY LEARNING OUTCOMES

Able to identify different types of earthworms and select the suitable species for vermicomposting for your location.

Notes

NOTES

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

(Instructor's Signature)

Notes

Practical 4

BEHAVIORAL STUDIES OF EARTHWORMS

AIM

To study the behavior of the earthworms.

OBJECTIVES

After completing this practical, you will be able to understand the response of earthworms to:

(a) Acidic or alkaline conditions; and

(b) Sun light

PRINCIPLE

Earthworms live in immediate contact with the soil medium. As the physical and chemical conditions in the medium change, they have direct impact on the behavior of the earthworms. Earthworms may respond positively or negatively to the stimulus. Earthworms show negative behavior (they are photophobic) to light. Their response to the stimuli determines survivability, longevity, growth and fecundity (fertility). This directly influences the rate of production of vermicompost. Therefore, behavioral responses are important to study effective management of vermicomposting.

A. RESPONSE OF EARTHWORMS TO ACIDIC OR ALKALINE CONDITIONS

TOOLS/EQUIPMENT/MATERIALS REQUIRED

- Earthworms (*Eisenia fetida*) from composting beds.
- pH meter or pH indicator strips.

Notes

- Petridishes.
- Blotting papers.
- Sodium hydroxide (NaOH) solution of pH-8,9,10,11.
- Hydrochloric acid (HCl) dilutions of pH-1,2,3,4,5,6.
- Glass marking.
- Notebook.
- Pen/pencil.

PROCEDURE

1. Take petridishes, cut blotting papers to the size of petridish, place them in the petridishes.
2. Mark different dilutions (pH-1, 2, 3, 4, 5, 6) of HCl with the help of $_{P}$H meter or indicator strips.
3. Soak the blotting paper with each dilute of acid solution (pH-1, 2, 3, 4, 5, 6) separately.
4. Put identification mark of the dilution on the petridish using a pen/pencil.
5. Similarly, make different sets of petridishes with sodium hydroxide solution (pH-8, 9, 10, 11) as above.
6. In each petridish, release four earthworms and observe their response.

OBSERVATIONS

Record your observations in the table given below:

pH of solution	Response of earthworms		% Respons	
	Name of active earthworms (out of four)	Number of irritated earthworms (out of four)	Active	Irritated
1.				
2.				
3.				
4.				

Notes

5.				
6.				
7.				
8.				
9.				
10.				
11.				

RESULTS

- Earthworms (*E. fetida*) is active within a pH range from ..... to .....
- Earthworm species ..... that is suitable at my location/will be used by me for composting is active within a pH range of ..... to .....

PRECAUTIONS

- Petridishes should be cleaned properly and handled carefully.
- Earthworms of the same species, which are used or going to be used by you for composting should be used in the experiment.
- After taking the earthworms out of the vermibeds, the earthworms should be gently washed to get rid of any soil particles sticking to them.
- During experiment, the earthworms should be kept sufficiently wet.
- After completion of the experiment, all the left over earthworms should be washed gently in sufficient water to remove any acid or alkali sticking to their skin and put them back in the composting bed.

B. RESPONSE OF EARTHWORMS TO THE SUN LIGHT

TOOLS/EQUIPMENT/MATERIALS REQUIRED

- Earthworms.
- Six glass jars (approximate diameter 9 inches).
- Vermicompost.

Notes

- Rubber bands.
- Notebook.
- Pen.

PROCEDURE

1. Take two sets of glass jars with 3 jars in each set.
2. Fill each glass jar half with vermicompost.
3. Put water in each jar.
4. Cover one set of jars (three jars) with black cloth and tighten it with rubber bands so that no light can enter into jar.
5. Keep the other set of jars (three jars) uncovered and keep them under sun or strong light.
6. In each jar, introduce 10 earthworms on the surface.
7. Keep them for five minutes.

OBSERVATIONS

Observe the earthworms, whether they have moved into vermicompost or are staying at the surface.

S.No. of Jars	Covered Jar		Uncovered Jars	
	No of earthworms visible on surface	% of earthworms visible on surface	No of earthworms visible on surface	% of earthworms visible on surface

RESULT

Earthworms tend to avoid the light (photophobic). They are inclined to move to darkness.

Notes

PRECAUTIONS

- Earth worms after taking out from vermibeds should be washed gently to remove any particles attached to them.
- During the experiment, earthworms should be kept sufficiently wet.
- Vermicompost used to fill the glass jars should have sufficient moisture in it.
- The covering of jars is done in such a manner that it allows no entry of light into jars.
- To protect yourself from infections, use protective clothing such as, apron, gloves, etc.

KEY LEARNING OUTCOMES

Be able to demonstrate the response of earthworms to acidic or alkaline conditions and to the sun light.

NOTES

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

(Instructor's Signature)

Notes

Practical 5

DESIGNING A SHED FOR VERMICOMPOSTING

AIM

To design a shed for vermicomposting.

OBJECTIVES

After completing this practical, you will be able to:

- recognize different types of sheds used for vermicomposting; and
- design a vermicomposting shed suitable for your location and requirement.

PRINCIPLE

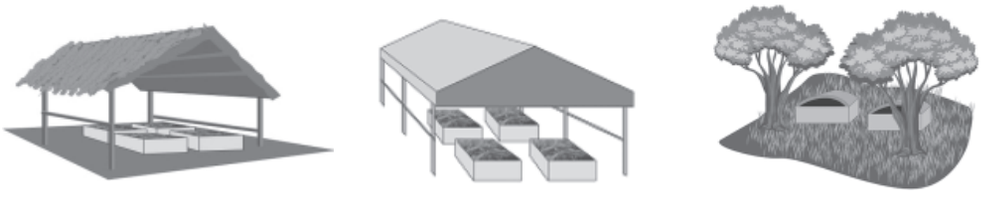
The purpose of designing a vermibed is to protect the earthworms from rain, sun and heat. Design for vermicomposting shed varies from region to region and place to place. Preferably, it should be made from locally available raw materials so as to keep its construction cost low. For those areas, where tree branches or bamboo are available, they can be used as poles for the shed. Thatched roofing may also be done with dry vegetation such as straw, palm branches etc., based on their availability. These are called as temporary shed. Vermicomposting sheds may also be made from steel pipes or angles and roofing can be done with galvanized or steel sheets. These types of sheds are called as permanent shed. Roofing can also be done with High Density Polyethylene (HDPE) sheets, but if possible avoid them as they get overheated due to sun. Open sheds are preferred because of their low cost and they maintain ideal conditions for growth and multiplication of earthworms. Depending upon the availability of funds, composting sheds may also be made by bricks and the roof can be made with terracotta roof tiles, roof shingles, corrugated metal, steel sheets, timber clad, etc. The shed should be made

Notes

at some elevated level ground so that during rain the water does not stagnates. Old abandoned structures like that of factories or sheds can also be used for the purpose. But they should be well ventilated. Floor may be made up of soil or may be pakka (or cemented bricked). Kachha (unbricked) floor is also good but problem comes when soil burrowing predatory insects attack the beds.

One such insect is mole cricket (*Gryllotalps sps.),* which feed on cocoons and juveniles of earthworms. The cricket burrows in the soil and many a times become very difficult to control. In such cases, floor may be made pakka to prevent burrowing of these predators. To prevent entry of similar predators, a trench containing water may be made around the composting shed. In the absence of composing shed, vermicomposting can be done under the shade of a tree. While making sheds for your composting unit, the undermentioned points should be kept in mind:

- The shed should be made at an elevated platform.
- The shed should have outward slope.
- The shed should be well ventilated and near to a clean water source.
- The shed should be protected from pathogens, predators and contaminants.



Temporary Shed | Permanent Shed | Vermicomposting Under a Tree

Fig. 5.1: Vermicomposting Under Different Sheds

TOOLS/EQUIPMENT/MATERIALS REQUIRED

- Vermicomposting unit.
- Notebook.
- Pen.

PROCEDURE

1. Visit a few vermicomposting units in your area.
2. Record distinguishing features of each vermicomposting shed.

Notes

3. Record measurements of each shed with the number of beds present in it.
4. Note the raw material required, source of their procurement and cost for designing the shed.
5. Compare different type of sheds, cost of construction and their pros and cons.
6. Select the shed type that suits your budget and composting requirements.

OBSERVATIONS

Record your observations in the table given below:

Type of shed	Raw material required/used	Appropriate cost of construction (Rs.)	Remarks

RESULT

The design drawn below is suitable for my location for vermicomposting (draw a sketch of the shed):

PRECAUTIONS

- Enter the unit after taking prior permission of the unit manager or in-charge.
- Always follow the bio-security and hygienic measures in the vermicomposting unit.
- Do not interfere with the farm activities.
- Wear protective clothing, face mask, eye protection glasses, gloves, etc. in the unit.

KEY LEARNING OUTCOMES

Be able to design an appropriate shed using the right materials for vermicomposting as per your requirement, location and budget.

Notes

NOTES

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

(Instructor's Signature)

Practical 6

IDENTIFICATION OF DIFFERENT TYPES OF RAW MATERIALS FOR VERMICOMPOSTING

AIM

To identify the different types of raw materials used for vermicomposting.

OBJECTIVES

After completing this practical, you will be able to:

- identify the different types of raw materials that can be used for vermi-composting; and
- select the suitable and available raw materials for vermicomposting.

PRINCIPLE

Earthworm species like *Eisenia fetida* and Eudrilus eugeniae can feed on a wide variety of biodegradable organic matter and convert them into compost. Some of the biodegradable materials are preferred more by earthworms. So, rate of composting depends on the type of organic matter offered as feed. Non biodegradable materials such as glass, plastics and stones cannot be composted. You should also avoid spicy cooked food and non-vegetarian food for composting.

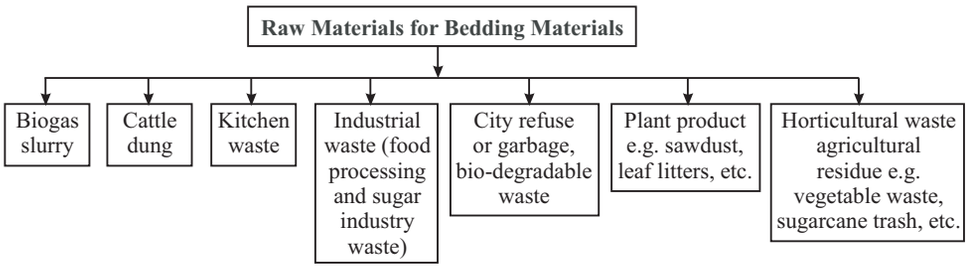


Fig. 6.1: Raw Materials for Bedding

Notes

TOOLS/EQUIPMENT/MATERIALS USED

- Vermicomposting unit in Agricultural Universities/Agriculture Institutes/ Krishi Vigyan Kendras/ Municipal Corporation Composting Sites/NGOs/ Nearby private composting units.
- Protective clothing and coverings such as apron, hand gloves, etc.
- Notebook.
- Pen.

PROCEDURE

1. Visit a few nearby vermicomposting units (as mentioned above).
2. Notedown the name and location of the vermicomposting units.
3. Observe and record the raw materials used for vermicomposting and its composting quality.

OBSERVATIONS

Record your observations in the table given below:

Name, address of the vermicomposting unit	Raw materials being used	Suitability of the raw material in composting (Excellent/Very Good/ Good/Average/Poor)

RESULT

Following types of biodegradable materials were found suitable for vermicomposting:

(i) Agriculture waste from the left over, stalks of wheat, paddy, maize, cotton, millets, pulses, sunflower, ground net, shells, etc.

(ii) Wastes of fruits and vegetables.

Notes

(iii) Forestry waste such as, wood shavings, peals, sawdust, pulp, etc.

(iv) Leather cutting waste.

(v) Leaf litter.

(vi) Weeds.

(vii) Wastes from paper mills, breweries, sericulture, sugarcane, coffee/and mushroom industry.

(viii) Left over slurry from biogas production.

(ix) Waste products from the vegetable market.

(x) Municipal solid waste.

(xi) Animal dung.

(xii) ..... (write yourself)

(xiii) ..... (write yourself)

PRECAUTIONS

- Enter the vermicomposting unit only after seeking prior permission from the manager or in-charge of the unit.
- Do not interfere with the routine activities of the unit.
- Maintain hygienic conditions while visiting the vermicomposting unit.
- Carefully record all the information in a note book.
- Use protective clothing such as, apron, gloves, etc. in the unit.

KEY LEARNING OUTCOMES

Able to identify and select the suitable raw materials for producing a good quality vermicompost.

NOTES

.....

.....

.....

Notes

.....

.....

.....

.....

.....

.....

.....

(Instructor's Signature)

Notes

Practical 7

PREPARATION OF VERMIBEDS

AIM

To prepare a vermibed.

OBJECTIVES

After completing this practical, you will be able to:

- use suitable tools and equipment for preparing appropriate vermibed; and
- prepare vermibeds of different shapes and sizes.

PRINCIPLE

Vermicomposting can be carried out broadly in two ways. First, is in vessel composting system. In this type, you can use any locally available vessel like earthen pot, wash basin, garden pot, used plastic tank or wooden or metallic box etc. Vessel composting is more suitable for house hold composting. You can also do composting in cement or HDPE cistern or tank which may be placed over or under the ground. Second system of composting is composting in windrow or beds. In this type, the organic waste is placed in the form of a row or pile. Sometimes, composting is also carried out in tank or pits. However, the tank or pit system has got certain disadvantages such as high cost of construction, less chances of aeration, low exposed area, and stagnation of water in deeper layers, which slows down the rate of decomposition. Thus, vermicomposting in windrows or in beds on the surface is preferred.

Selection of a particular system of composting also depends upon many factors such as the quantity of waste to be handled, quality of waste, site of production, availability of raw materials, rain fall, day and night temperatures, profit target, availability of shed etc.

Composting in Cemented Vermicomposting Pit

Vermicomposting in HDPE Vermi-trenches

Vermicomposting in Windrows Under Shade of a Tree

Vermicomposting in Used Plastic Tank

Fig. 7.1: Various Vermicomposting Systems

TOOLS/EQUIPMENT/MATERIAL USED

- Bricks.
- Feed/ Raw materials for vermicomposting.
- Protective clothing and coverings, such as gloves, apron, eye protection glasses, face mask, etc.
- Notebook.
- Pen.

PROCEDURE

1. Visit a few vermicomposting units of your area. Pen down their names and locations.
2. Observe the different type of the beds. Note down sizes, pros and cons of each bed.

Notes

3. Prepare a composting windrow or bed by putting the organic matter or feed in the form of a row. Keep the width of the windrow as 1m and height as 0.5m, respectively.

4. Each windrow can be demarcated by loose bricks. Windrows can be made even without demarcation of bricks.

5. Keep the length of bed/windrow as per the available area/space.

OBSERVATIONS

Record your observations in the table given below:-

Name and address of the composting unit	No. of Beds maintained	Type of the Bed/ system (in vessel or windrow)	Size of each Bed (Length, width and height)	Remarks/Pros and cons of each Type of Bed

RESULTS

..... type of vermibed is suitable for my location and requirements.

PRECAUTIONS

- Enter the composting unit only after taking prior permission from the unit manager or in-charge.
- Do not obstruct the ongoing farm activities in the unit.
- Wear apron, face mask, protective glasses, gloves (if required).
- Always follow the bio-security and hygienic measures in the composting unit.
- Do not keep width of windrow/bed more than 1 m, as it slows down the rate of decomposition.
- Do not keep the bed higher than 0.75m as it reduces the composting efficiency.

Notes

KEY LEARNING OUTCOMES

Be Proficient in making appropriate type vermibed using suitable tools and equipment.

NOTES

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

(Instructor's Signature)

Practical 8

PREPARATION OF FEED FOR EARTHWORMS

AIM

To prepare feed for the earthworms.

OBJECTIVE

After completing this practical, you will be able to:

- procure raw materials from suitable source; and
- process the raw material and make it ready as feed for earthworms.

PRINCIPLE

Biodegradable raw materials are not preferred to be used as such for earthworms. They need some preliminary treatment prior to putting in vermicomposting beds. Such treated materials are readily accepted by the earthworms. Another reason for this treatment is that it reduces the time taken for composting as well. In other words, the process of vermicomposting becomes faster after partial decomposition of the raw materials.

Fig. 8.1: Preparing Feed for Earthworms

Notes

TOOLS/EQUIPMENT/MATERIALS REQUIRED

- Raw materials for vermicomposting (as identified in practical 6).
- Cowdung/sheep dung /goat dung.
- Spade.
- Rake.
- Garden hose.
- Wheel barrow.
- Protective coverings such as gum boots, apron, glasses, etc.

PROCEDURE

1. Transport the raw materials for vermicomposting (as identified in practical 6) from source to the site of composting.
2. Transfer the raw materials near to the composting shed with the help of spade and a wheel barrow.
3. Segregate non- compostable materials such as plastics, stone glass, ceramics, metals from the compostable materials.
4. If compostable materials contain large pieces, then, break them into smaller pieces.
5. Transport cowdung or animal dung to the source using wheel barrow.
6. Break the large lumps of cowdung, if it is there.
7. Mix the cow dung and raw materials (in the ratio of 3:1) using the rake.
8. Sprinkle water using the water hose or watering can.
9. Make a heap of the mixed material.
10. Keep the heap for partial decomposition for 2 to 3 weeks.
11. During this period, turn the heap by 5-6 times using the rake.
12. Keep the contents sufficiently moist by sprinkling water on it (maintain moisture level between 50-60%).

OBSERVATIONS

..... (kg) organic matter took ..... days for its partial decomposition.

RESULT

Organic matter waste is partially decomposed and is ready to be offered to the earthworms as feed.

Notes

PRECAUTIONS

- Wear apron, eye protection glasses, gloves, gum boots etc. for your safety and hygiene.
- Use 2-3 days old cow dung or animal dung.
- Break the large lumps to smaller pieces.
- Heap should retain moisture whose range should be between 50 to 70% during the vermicomposting process.
- Partial decomposition period can be increased in case of wastes that are harder (e.g. the waste that takes more time for decomposition such as dried stems, palm leaves etc.) and accordingly, time can be reduced for the wastes that are softer (such as flowers and green leaves).

KEY LEARNING OUTCOMES

Able to prepare feed for earthworms after partial decomposition of the raw materials.

NOTES

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

(Instructor's Signature)

Notes

Practical 9

FILLING THE ORGANIC MATERIALS IN VERMIBEDS

AIM

To fill the organic materials in the vermibed.

OBJECTIVES

After doing this practical, you will be able to:

- fill the biodegradable waste materials in the vermibeds whilst; and
- taking proper precautions.

PRINCIPLE

Earthworms need feed (waste organic material) for their growth and development. They feed on the waste materials, crush them and finely convert the matter into fine particles, pass them through gut, partially digest them and excrete them in the farm of pellets or casts or vermicasts. This vermicast is rich in organic matter, microbes, enzymes and hormones. These further increase the rate of decomposition of the organic matter so that the process of vermicomposting goes on at a faster rate. Thus, filling of organic materials in the beds is an important step in vermicomposting.

TOOLS/EQUIPMENT/MATERIAL REQUIRED

- Partially decomposed organic matter.
- Spade.
- Rake.
- Protective coverings such as gum boots, gardening gloves, apron, etc.

Notes

- Wheel barrow.
- Garden hose bucket.
- Any locally available biodegradable material.
- Sand.
- Garden soil.

PROCEDURE

1. Select a vermicomposting bed of a size that is suitable to your requirements.
2. Lay a basal layer of sand upto 3-5 cm on the bed.
3. It is followed by 5 to 7 cm thick layer of garden soil.
4. On top of the previous layer, make a bedding layer which is made up of any locally available biodegradable material such as dried leaves, hay, straw (paddy or cereals or legumes), leaves, saw dust, peat moss, mushroom spent, coconut leaves, sugarcane wastes etc. Maintain thickness of this layer within 5 to 7 cm.
5. This layer is followed by a layer of partially decomposed organic matter as prepared in Practical 8.
6. Maintain the height of the filled bed upto 75cm.
7. Break the large lumps of materials that are used and level the bed using rake.
8. Sprinkle water on the bed with a garden hose or a watering can.
9. Leave the beds for 3-4 days. Record your observations.
10. Note the emission of heat by digging the bed with a gardening fork. If smell or any heat is evolved, sprinkle water, overturn the material with rake and wait for it to cool down.

OBSERVATIONS

Observations were made on evolution of heat or foul smell, if any

.....

.....

RESULT

The bed is suitable for introducing earthworms.

PRECAUTIONS

- Fill only pre-decomposed organic matter in the beds.

Notes

- Fill only decomposable organic matter (no stone, glass, plastics or ceremics etc. be put).
- Do not add any dairy, meat products, oily cooked food, citrus fruits, eggs in the beds.
- Keep height of the bed till 75cm only. In beds higher than 75cm, the rate of decomposition slows down.
- If beds evolve heat or foul smell donot introduce earthworms into the bed.
- In the absence of the availability of sand or soil you can straight away put straw layer followed by partially decomposed organic waste.
- In case, it is not possible to construct a shed, beds can be laid down under the trees such as, drumstick, subabul, banana or any other tree, so that the leaves falling from them add to the nutritive value of the compost. Moreover, your income will also be supplemented from the produce of these trees.

KEY LEARNING OUTCOMES

Be skilled to fill biodegradable waste materials in vermibeds as per the recommended procedure whilst taking proper precautions.

NOTES

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

(Instructor's Signature)

Practical 10

INOCULATION OF EARTHWORMS IN VERMIBED

AIM

To inoculate (introduce) earthworms in the vermibed.

OBJECTIVES

After completing this practical, you will be able to:

- procure suitable earthworm species for vermicomposting; and
- introduce the earthworms in the prepared vermibeds.

PRINCIPLE

The presence of earthworms in the vermibeds increases the rate of decomposition of organic matter. By their movements, they keep turning the organic matter and thus cause aeration of the medium. They also consume the organic matter and convert them into fine matter. The earthworms mix enzymes, hormones and microbes from their gut to the excreted materials. All these factors create a conducive condition that leads to an increase in the rate of vermicomposting. That is why composting in the presence of earthworms takes less time and is superior to the ordinary compost.

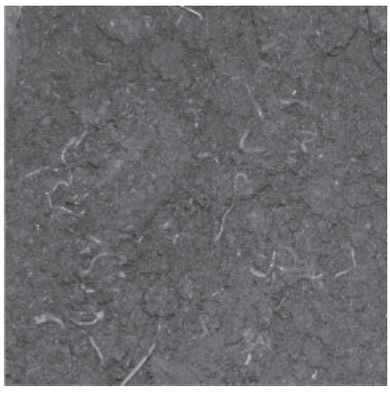


Fig. 10.1: Earthworms in Vermibed

Notes

TOOLS/EQUIPMENT MATERIALS REQUIRED

- Garden rake.
- Protective coverings, such as hand gloves, apron, face mask, etc.
- Antiseptic soap.
- Watering can.
- Garden can/hose.

PROCEDURE

1. Visit some vermicomposting units/Agriculture University/Krishi Vigyan Kendra/ Agricultural Institute/State Agriculture Department and arrange for obtaining a few suitable species of earthworms that are recommended for vermicomposting.
2. Pack the earthworms in the pre-existing vermicompost and sprinkle some water on it.
3. You could do it yourself, take the help of a garden rake and open some area of the pre- existing vermicomposting bed. By picking with the help of hands, collect earthworms in a trough (manger). Put some compost over it and sprinkle some water over it.
4. Carry the earthworms to the vermibeds to be inoculated.
5. Gently place the earthworms on the surface of the beds @ around 1000 worms/m^2.
6. Sprinkle water on the bed with a water can or a garden hose.
7. Observe the movement of the earthworms into the bed.
8. Wash your hands with an antiseptic soap after inoculation is done.

OBSERVATIONS

Record your observations as per points given below:

(i) Earthworm species procured for inoculation .....

(ii) Quantity of earthworms inoculated in each vermibed:

  (a) Vermibed 1.....

  (b) Vermibed 2.....

  (c) Vermibed 3.....

  (d) Vermibed 4.....

(iii) Movement of earthworms into the bed .....

Notes

RESULT

Inoculation of earthworms in vermibeds is done.

PRECAUTIONS

- Wear an apron, hand gloves and take other hygiene and safety measures, while working at the vermicomposting unit.
- Beds should have sufficient moisture in them prior to inoculation of earthworms.
- During transportation of the worms from the source, they should be packed carefully with sufficient food, moisture and provision of air.

KEY LEARNING OUTCOMES

Able to inoculate earthworms in a prepared vermibed after taking correct precautions to obtain an optimum composting process.

NOTES

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

(Instructor's Signature)

Notes

Practical 11

WATERING OF VERMIBEDS

AIM

To provide water to the vermibeds.

OBJECTIVES

After completing this practical, you will be able to:

- judge the water requirement of the vermibeds; and
- provide right quantity of water to the vermibeds.

PRINCIPLE

Earthworms donot have lungs for their breathing. They respire through their skin. Earthworms keep their skins moist with mucilage and water. Atmospheric air gets dissolved in the moist layer and by diffusion oxygen enters into the blood capillary of the earthworms. The insufficient moisture makes the earthworms uncomfortable and they may die due to lack of oxygen. Even for normal functioning of decomposition, microbes need moisture. That is why vermibeds need continuous availability of moisture. For normal vermicomposting, an optimum moisture level of 50 to 60% is required.

TOOLS/EQUIPMENT/MATERIALS REQUIRED

- Watering cane/ water hose/ sprinklers.
- Protective covering such as, hand gloves, apron, etc.
- Moisture meter.

Notes

PROCEDURE

1. Observe the vermibeds for water requirements.
2. You can make use of moisture meter to exactly know the level of moisture in the beds.
3. You can use a simple test (Hand squeeze test) to known the right level of the moisture.

Hand Squeeze Test

The test is a simple rules of thumb test. Take some material from the bed in your hand and try to make a ball of it. If water squeezes out of the ball that means water level is more. However, if the ball crumbles that means water level is too less. Also, if the ball is stable, it indicates that the moisture content is optimum in the bed.

4. Water vermibeds with the help of watering cane or water hose or sprinklers.
5. During summer, water is required more frequently than in winter.

OBSERVATIONS

Select any four vermibeds and observe the moisture level in the beds and record your observations in the table given below:

S.No. of Vermibed	Moisture Level			Remarks
	Too less	Right level	Too much	

RESULT

..... vermibeds were moisture is deficient. This is fixed by .....

..... vermibeds had right level of moisture.

..... vermibeds were over flooded. This is corrected by .....

Notes

PRECAUTIONS

- The beds should not be too wet or too dry.
- In case you see the water oozing out of beds, stop watering them, otherwise nutrients will flow away and quality of the vermicompost will degrade.
- Vermibeds should be watered with soft water only. In case you are using underground water get it tested so that it is not hard. The hard water is not suitable for vermicomposting.
- Wear apron, gloves and adopt other safety and hygiene measures in the unit.
- After finishing the work, wash your hands and face with antiseptic soap to avoid any infections.

KEY LEARNING OUTCOMES

Able to identify the moisture level of the vermibed and provide the right quantity of water to the beds.

NOTES

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

(Instructor's Signature)

Practical 12

COVERING OF VERMIBEDS

AIM

To cover vermibed with suitable covering material.

OBJECTIVES

After completing this practical, you will be able to:

- select suitable covering material for the vermibeds; and
- cover vermibeds as per the recommended procedure.

PRINCIPLE

As you know, the earthworms are dark creatures (photophobic), so they move away from sunlight. They are therefore not seen feeding at the surface of the beds. If the beds are covered, then they can come near the surface and feed. This in turn increases the rate of vermicomposting too. Covering beds helps in retaining moisture. Hence, the covered beds don't need to be watered frequently. Covering vermibeds also saves the earthworms from predators. The covering material decomposes with time and acts as feed for the worms.

Fig. 12.1: Covered Vermibeds

Notes

TOOLS/EQUIPMENT/MATERIALS REQUIRED

- Gunny bags/hessian cloth or any other locally available biodegradable material.
- Protective covering such as hand gloves and apron.
- Rake.

PROCEDURE

1. Visit a few well settled vermicomposting units of your area.
2. Note the location and address of the unit.
3. Note the type of covering material being used in the unit and enquire about other options available for covering the bed.
4. Observe and note all the possible ways to cover the beds.
5. Practice covering of one bed using gunny bags/hessian cloth or any other locally available biodegradable material and rake.

OBSERVATIONS

Name and address of the vermicomposing unit	Number of beds being maintained	Material used for covering the beds	Any other material suggested	Remarks (Pros and cons of the material used)
1.				
2.				
3.				
4.				

RESULT

..... is found to be the best material for covering vermibeds in my locality because

.....

.....

.....

.....

Notes

PRECAUTIONS

- The bed covering material should be cheap and locally available.
- The material should be biodegradable.
- The material should not be polythene or HDPE or any other synthetic material.
- Before visiting the vermicomposting unit, take prior permission from in-charge or manager of the unit.
- Do not interfere with the normal functioning of the unit.
- Adopt all safety and hygienic means in the unit.

KEY LEARNING OUTCOMES

Able to select and use suitable and locally available covering material for the vermibeds.

NOTES

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

(Instructor's Signature)

Notes

Practical 13

TURNING OF VERMIBEDS FOR AERATION

AIM

To turn the vermibeds for ensuring proper aeration.

OBJECTIVES

After completing this practical, you will be able to:

- judge the right time for turning of the beds; and
- turn the vermibeds properly.

PRINCIPLE

Turning of the vermibeds brings the undecomposed/partially decomposed material to the surface so that it is readily available to worms and aerobic microbes for decomposition. Thus, turning of the beds makes the process of vermicomposting

Fig. 13.1: Turning of the Vermibed

Notes

faster. Beds need to be turned when slow activity is observed in the beds or there is foul smell or composting is almost completed in the upper layer of the bed and lower layers are still underdecomposing. After turning and settlement of the earthworms in the bed, the top layer of the bed should be leveled gently using a rake so that the earthworms are not hurt.

TOOLS/EQUIPMENTS/MATERIALS REQUIRED

- Protective coverings such as apron, face mask, eye protection glasses, hand gloves, etc.
- Rake.
- Notebook.
- Pen.

PROCEDURE

1. Observe the vermibeds. First turning to bed should be given when the material on the top layer of the bed seems to be almost matured (composting process is completed in top layer).
2. Observe the bed, it should not be too wet at the time of turning. A wet bed will not allow proper aeration by the earthworm and microbes and affect the decomposition process.
3. Turn the bed gently using rake.
4. The earthworms should not be hurt during the process.
5. Visit some well settled vermicomposting unit of your area. Observe and note down its location, address and number of beds.
6. For each bed, enquire the date of putting the feed material in the bed, introduction of earthworms and number of earthworms initially inoculated, stage of beds/composting at first turning and date of 1^{st} turning.
7. Similarly, note down the data mentioned above for 2^{nd} or any other subsequent turnings.
8. Record your observations in the table.

OBSERVATIONS

Name, location and address of composting unit	Serial number of bed	Food material used in bed	Number of earth-worms introduced in bed (x)	Mean no. of earthworms introduced in bed $\frac{x_1 + x_2 - x_{10}}{10}$	Date of introduction of worms	Date of 1st turning of bed	Condition of bed at 1st turning (colour, texture, stage of composting)	Date of 2nd or more subsequent turnings	No of days taken for composting (y)	Mean no of days taken for composting $\frac{y_1 + y_2 - y_{10}}{10}$
1.										
2.										
3.										
4.										
5.										
6.										
7.										
8.										
9.										
10.										

Notes

RESULT

With ..... mean number of earthworms and ..... Turnings, vermicompost is ready for harvesting ..... days. More than one turnings of bed was needed in the following conditions:

.....

.....

PRECAUTIONS

- Wear hand gloves, eye protection glasses, face mask and adopt other safety or hygiene measures while working in the unit.
- Before visiting the vermicomposting unit seek prior permission from in charge or manager of the unit.
- Do not interfere with normal functioning of the unit.

KEY LEARNING OUTCOMES

Able to identify the right time for turning of beds and learnt to turn the beds correctly for proper aeration.

NOTES

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

(Instructor's Signature)

Notes

Practical 14

IDENTIFICATION OF MATURITY STAGE OF VERMICOMPOST

AIM

To identify the maturity stage of vermicompost.

OBJECTIVES

After completing this practical, you will be able to:

- assess the physical properties of the vermicompost; and
- identify the mature vermicompost.

PRINCIPLE

As a vermicompost producer, it is very important for you to identify the right maturity stage of the vermicompost. If you apply under mature (complete decomposition has not taken place) vermicompost in the field/beds, they can be harmful for the plants. Moreover, if the mature compost is not harvested timely (kept in vermibeds for a longer period of time), it may be detrimental to the growth and multiplication of worms. In such a case, nutritive value of the vermicompost may decline. Thus, identification of the correct maturity stage of vermicompost is very important for effective and economic management of vermibeds. When vermicompost is completely formed, you cannot recognize any residue in the substrate. Mature beds are darker in colour. The surface of the mature bed looks brown to black with granular appearance. It looks like boiled tea leaves spread on the surface. Mature vermicompost is free of any foul odour. Many times the upper surface of the vermibed becomes granular, but lower layers remain under composed. In such cases, turning of the vermibed increases the rate of composting and gives desirable results in less time.

Notes

Fig. 14.1: Mature Vermicompost

TOOLS/EQUIPMENT/MATERIALS REQUIRED

- Protective covering such as, apron, face mask, hand gloves, etc.
- Notebook.
- Pen.

PROCEDURE

1. Seek permission from the manager or in-charge unit to visit vermicomposting units.
2. Visit the vermicomposting unit.
3. Enquire about the vermibeds having mature vermicompost and mark them.
4. Observe the marked vermibeds (mature beds) carefully and see how they differ visually from immature beds.
5. Visit each bed and record your observations in the notebook.

OBSERVATIONS

Record your observations in the table given below:

Serial No. of bed	Presence of any undecomposed lumps of cow dung or residues	Colour of the surface of bed	Presence of granules on surface	Smell of the materials of beds	Maturity stage of bed (Is it mature or not mature)
1.					
2.					
3.					
4. 5.					

Notes

6.					
7.					
8.					
9.					
10.					

RESULTS

The identification features of the vermicompost at the maturity stage are as follows:

.....

.....

.....

PRECAUTIONS

- Enter the composting unit only after taking permission from in-charge or manager of the unit.
- Do not interfere in the routine activities of the unit.
- Maintain healthy and hygienic environment in the unit.
- Make use of protective clothing and covering such as hand gloves, masks, apron etc.
- In case, you observe any large lumps of cow dung or any other under composed material, just break them into smaller pieces for further decomposition.
- At the stage of appearance of granular material at the surface of the beds, turning of beds help in rapid decomposition.
- After finishing your work in vermibeds, wash your hands properly with antiseptic soap.

KEY LEARNING OUTCOMES

Skilled in identification of maturity stage of the vermicompost.

Notes

NOTES

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

(Instructor's Signature)

Notes

Practical 15

ASSESS TIME TAKEN IN FORMATION OF VERMICOMPOST

AIM

To assess the time taken in the formation of the vermicompost.

OBJECTIVES

After completing this practical, you will be able to:

- assess the time duration in which formation of the vermicompost takes place; and
- co-relate the various factors that affect the vermicomposting duration.

PRINCIPLE

The vermicomposting process is accomplished by microbes, earthworms and enzymes. It involves physical as well as biochemical changes in the feed substrates. Earthworms ingest large food particles, crush them in their intestines to reduce the size of the particles and mix several bacterial and enzymes to the substrate and excrete them in the form of aggregates/pallets or casts or vermicasts. These excreted materials are an ideal medium in which decomposition process of the substrate takes place faster. Earthworms by their burrowing activities cause aeration of the substrate, which leads to increased activities of aerobic microbes and results in quicker formation of vermicompost. Due to these reasons, formation of vermicompost/vermicomposting takes less time than other forms of composting.

TOOLS/ EQUIPMENT/ MATERIALS REQUIRED

- Protective coverings such as, hand gloves, apron, face mask, etc.

Notes

- Notebook.
- Pen.

PROCEDURE

1. Visit vermicomposting units after seeking approval from the in-charges or managers of the unit.
2. Mark the mature vermibeds.
3. Enquire from the incharge or the manager of the unit, regarding materials used for composting, date of starting the bed, date of maturity of bed, species of earthworm used and any amendments or techniques used for making the process faster.
4. Record your observations in the table given below.

OBSERVATIONS

S.No. of Bed	Raw materials used for composting	Number of earthworms inoculated in beds	Date of starting of vermibed	Date of maturity of vermibed	Time taken for maturity of compost	Remarks (Amendment of substrate or any other technique used for making composting faster)
1.						
2.						
3.						
4.						
5.						
6.						
7.						
8.						
9.						
10.						

Notes

RESULTS

With ..... species of earthworms and ..... waste material, time taken for vermicomposting ranged between ..... to ..... days.

PRECAUTIONS

- Enter vermicomposting unit only after seeking permission from in-charge or manager of the unit.
- Do not interfere with the normal functioning of the composting unit.
- Maintain healthy and hygienic conditions in the unit.
- Record all the observations carefully.
- Make use of protective devices such as apron, face mask, hand glove, etc. if required.
- Carefully wash your hands with antiseptic to prevent any chance of infection.

KEY LEARNING OUTCOMES

Able to assess the approximate time duration for the formation of vermicompost.

NOTES

.....

.....

.....

.....

.....

.....

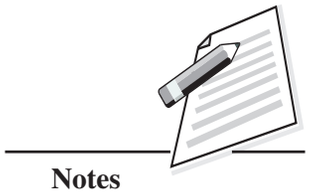
.....

.....

.....

.....

(Instructor's Signature)



Notes

Practical 16

HARVESTING OF VERMICOMPOST

AIM

To harvest the matured vermicompost.

OBJECTIVES

After completing this practical, you will be able to:

- identify the matured vermicompost by its physical appearance; and
- harvest matured vermicompost from the vermibeds as per recommended procedure.

PRINCIPLE

Earthworms and decomposers (an organism, especially a soil bacterium or fungus that decomposes organic material) present in vermibeds convert the biodegradable organic matter to vermicompost. When vermicompost is matured the upper surface of the bed show granular dark brown appearance just like boiled tea leaves. This is right stage for harvesting of vermicompost. Timely harvesting of vermicompost is necessary otherwise multiplication and growth of earthworm slowed down and maturity of vermicompost is delayed. Harvesting is a laborious process and involves some techniques. Such techniques can be perfected by learning and experience.

TOOLS/EQUIPMENT/MATERIAL REQUIRED

- Protective coverings such as, apron, face mask, hand gloves, etc.
- Rake.

Notes

- Trough.
- Watering can.
- Notebook.
- Antiseptic soap.
- Wheel barrow.
- Spade.

PROCEDURE

1. Observe the maturity of vermicompost by its physical appearance, odour and touch.
2. Follow any of the below mentioned method (as per recommendation for your locality) to harvest vermicompost.

Heap/Pyramid Method

- With the help of a wood strip, scrap the top layer of the bed and make small conical heaps.
- In this way make several heaps in a bed.
- Keep the height of each heap less than 25cm, preferably.
- Leave them as such for 6-24 hours.
- Earthworms present in heaps will move down.
- Collect the compost.
- Repeat the process several times to collect the compost.

Fig. 16.1: Bulk Harvesting by Heap/Pyramid Method

Harvesting by Inducing Migration of Earthworms

- When vermibeds are being laid down keep a gap of 1 m between two beds.
- After maturity of vermicompost in these two beds, put a fresh layer of feed in the gap between these two beds.
- Stop watering those two mature beds and continue watering to the fresh feed layer. This will ensure movement of earthworms from older beds to new beds.
- Fill the two older vermibeds with feed for earthworm.
- In this way keep on filling the vermibeds and harvesting of vermicompost.

Fig. 16.2: Harvesting by Inducing Migration of Earthworms

3. Visit three vermicomposting units.
4. Note address of each unit.
5. Seek permission from the in-charge or manager of the unit.
6. In each unit, ask the various methods being adopted for harvesting of mature vermicompost.
7. Make note of various observations on different techniques of harvesting along with their pros and cons.

Notes

OBSERVATIONS

Record your observation in the following table-

Name and address of the unit	Techniques used for harvesting of compost	Remarks for each technique
1.	1. 2. 3.	1. 2. 3.
2.	1. 2. 3.	1. 2. 3.
3.	1. 2. 3.	1. 2. 3.

RESULT

..... method is considered best for harvesting of vermicompost in my location.

PRECAUTIONS

- Enter the composting unit only after seaking permission from the in-charge or manager of the unit.
- During winter and rainy seasons, for drying the upper surface of bed, stop watering to vermibeds for 4-5 days or more until the upper layer gets dried.
- It is advisable that after 2 days of stopping watering process dug the bed with rakes and leave it as such for another 2-3 days so that the vermibeds dry faster.
- Break the large lumps of compost so that the earthworms are released and they could move to the deeper layers that still are having moisture.
- Slowly keep on harvesting the vermicompost until you are left with 10cm of the basal bed material containing migrated worms. Put fresh feed on top of it to start a new bed.
- Record all observations in the notebook carefully.

Notes

- Do not interfere with normal functioning of the unit.
- Maintain hygienic conditions in the unit.
- Wear apron , face mask, hand gloves etc., as per need.
- Wash your hands regularly with antiseptic soap to prevent any infection.

KEY LEARNING OUTCOMES

Be able to identify the matured vermicompost and harvest matured vermicompost from the vermibeds as per the recommended procedure.

NOTES

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

(Instructor's Signature)

Notes

Practical 17

SIEVING AND SEPARATION OF EARTHWORMS FROM HARVESTED VERMICOMPOST

AIM

To sieve and separate earthworms from the harvested vermicompost.

OBJECTIVES

After completing this practical, you will be able to:

- sieve the compost properly and separate earthworm from harvested compost; and
- collect earthworms separately without harming them.

PRINCIPLE

The harvested vermicompost contains a large number of earthworms and cocoons. If they are not separated from the compost most of them will die. So earthworms and cocoons should be separated from the compost and put back to the left over beds. These left over earthworms rebuilt their population to continue the process of composting.

TOOLS/EQUIPMENT/MATERIALS REQUIRED

- Protective coverings such as garden gloves, face mark, apron, etc.
- Garden rake.
- Sieve of 2.5 mm mush.

Notes

PROCEDURE

1. Stop watering the vermibeds for 2-3 days before separation of the matured vermicompost from the beds.
2. Make conical heaps of the compost on bed.
3. Keep the heaps undistributed for 6 to 24 hours so that the left over worm can move into deeper moist layers. In this way most of the earthworms are separated from the compost.
4. Left over earthworms and cocoons can be separated by hand picking or sieving.
5. Separated vermicompost is sieved through mesh of size 2 to 2.5 mm to separate any earthworm left and cocoons. For sieving purpose you can use a mesh used by builders for sieving and or crushed stone powder. Even motorized sieving machines can be used for sieving in bulk.
6. Put the collected earthworms and cocoons back to the vermibeds.
7. Fill the beds again with partially decomposed feed to continue the process.

Fig. 17.1: Separation of Earthworms and Cocoons by Sieving Method

8. Visit few vermicomposting units.
9. Note name and location of each unit.
10. In each unit, ask the in -charge or manager for the method being used for sieving and separation of earthworms and cocoons from matured vermicompost.
11. Note down the information collected and observations in the note book carefully.

Notes

OBSERVATIONS

Record your observations in the table given below:

S.No. of the vermicompost unit	Name and location of the vermicomposting unit	Method used for separation of earthworm and cocoons	Remarks (pros and cons of each method)	Techniques used for sieving vermicompost
1.				
2.				
3.				

RESULT

Harvested vermicompost in free from earthworms and cocoons.

PRECAUTIONS

- Before seiving vermicompost, dry it under shade to reduce its moisture content, so that can easily pass through the mesh.
- Maintain hygienic environment in the unit.
- Wash you hands carefully with a antiseptic soap/solution for maintaining the hygienic conditions.
- Wear apron, face mark, hand gloves, etc. while working in the vermicomposting unit.
- Note down all the informations carefully.

KEY LEARNING OUTCOMES

Able to sieve and separate earthworms from the harvested vermicompost without harming earthworms.

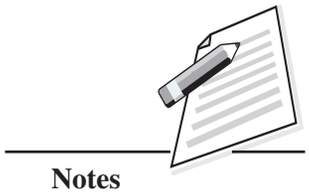
NOTES

.....

.....

.....

.....



Notes

.....

.....

.....

.....

.....

.....

(Instructor's Signature)

Notes

Practical 18

ASSESSMENT OF PHYSICAL APPREARANCE OF VERMICOMPOST AT DIFFERENT STAGES OF FORMATION

AIM

To assess the physical appearance of vermicompost at different stages of formation.

OBJECTIVES

After completing this practical, you will be able to:

- recognize appearance of vermicompost at different stages of its maturity; and
- differentiate between the unmatured and matured vermicompost.

PRINCIPLE

Biodegradable materials filled in vermibeds undergo various physical, chemical and biological changes with time. These are the stages through which an organic waste passes to become a mature vermicompost. If you recognize those stages, you can assure yourself of the progress undergoing in vermicomposting process. Any variation or delay in these stages invites use of some intervention management steps so that the final product is of good quality and meet desired profit level.

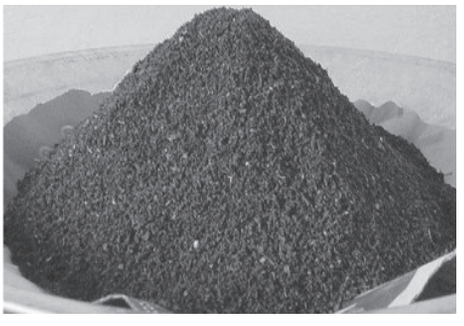


Fig. 18.1: Matured Vermicompost

As the time proceeds, materials present in vermibeds undergo certain changes in texture, colour and odour so that final product, i.e. matured vermicompost

Notes

(Fig. 18.1) is a dark brownish- black in colour which just looks like boiled tea leaves. The final product is free from of any unpleasant odour.

TOOLS/EQUIPMENT/MATERIALS REQUIRED

- Protective coverings such as, apron, face mask, gloves, etc.
- Rake.
- Notebook.
- Pen.

PROCEDURE

1. Visit some vermicomposting unit.
2. Contact in-charge or manager of the unit and ask for three sets of beds.
3. Enquire about the date of start of the bed.
4. In each set mark the beds which were 15 days, 30 days, 45 days, 60 days, 75 days, etc. days old.
5. Collect the sample of decomposable materials from the vermibeds.
6. In your notebook, record various observations such as, the presence of lumps of decomposable materials, colour of the bed, texture of the material and odors, if any.

OBSERVATIONS

Record your observations in the following table

Serial no. of the beds	Decomposable material filled in beds	Preliminary treatment given to material	Days after the treatment	Appearance				Remarks
				Presence of large lumps of undecompo-sable matter	Colour	texture	Odour	
1.			15 30 45 60 75 --					

2.			15 30 45 60 75 --					
3.			15 30 45 60 75 --					

RESULT

The materials in the vermibeds takes ..... to ..... days for full decomposition. The decomposed material has following qualities:

.....

.....

.....

.....

PRECAUTIONS

- Before entering the composting unit seek prior permission for the in-charge or manager of the unit.
- Do not interfere with normal functioning and ongoing activities of the unit.
- Main healthy environment in the unit.
- Use protective clothing such as, apron, hand gloves, face mask, etc., if any required.
- Wash your hands properly with antiseptic soap to safe guard yourself.

Notes

KEY LEARNING OUTCOMES

Able to recognize appearance of vermicompost at different stages of its maturity and differentiate between the unmatured and matured vermicompost.

NOTES

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

(Instructor's Signature)

Notes

Practical 19

MOISTURE DETERMINATION OF VERMICOMPOST

AIM

To determine the moisture in vermicompost.

OBJECTIVE

After completing this practical, you will be able to:

- determine the moisture content of vermicompost; and
- fix the moisture content related issues in the vermibeds.

PRINCIPLE

As you know the vermicompost is a dynamic medium containing lot of microbes, hormones, enzymes, plant growth promotors, etc. A moisture content less then 50% in the vermibed is not good for survival or viability of the aforesaid ingredients. A too less moisture content reduces the quality of the vermicompost. Also, if the moisture is too much, it just unnecessarily add to the weight of the compost. A moisture level less than the optimum not only deteriorate the quality but also makes it to look like dry soil which fetch less price in the market. So, now you have understood as why it is necessary to maintain proper moisture content in the vermicompost. For moisture determination, various type of moisture meters/analysers are available in the market by which we can quickly find out the moisture level. Also, to fix the moisture content related issues in the vermibed, either provide water to the vermibed, if moisture content is less (Fig. 19.1) or stop watering them, if moisture content is in excess. Here, is described an easy and cheap laboratory moisture determination method.

Notes

Fig. 19.1: Watering of Vermibed for Proper Moisture

TOOLS/EQUIPMENTS/MATERIALS REQUIRED

- Vermicompost sample.
- Oven proof container.
- Oven.
- Protective coverings such as, hand gloves, apron, etc.
- Weighing balance.

PROCEDURE

1. Take weight of an empty oven proof container (W_1).
2. Put small sample of vermicompost in the container and weigh it (W_2).
3. Heat the container containing vermicompost at 220°F or 104°C for 24 hours to completely dry it and weigh (W_3).

OBSERVATIONS

Record your observations and do calculations as per formula given in the table below.

Replicate (in g)			Average Moisture content $= \frac{I + II + III}{3}$ (% moisture)
I	II	III	
Description Weight of empty container (W_1) = ... g Weight of container + vermicompost (W_2) = ... g Weight of Container + Dry compost (W_3) = ... g	**Description** Weight of empty container (W_1) = ... g Weight of container + vermicompost (W_2) = ... g Weight of Container + Dry compost (W_3) = ... g	**Description** Weight of empty container (W_1) = ... g Weight of container + vermicompost (W_2) = ... g Weight of Container + Dry compost (W_3) = ... g	
Calculation Weight of water ($W_2 - W_3$) = ... g Weight of solid ($W_3 - W_1$) = ... g% Moisture = $\frac{W_2 - W_3 \times W_3 - W_1}{100}$	**Calculation** Weight of water ($W_2 - W_3$) = ... g Weight of solid ($W_3 - W_1$) = ... g% Moisture = $\frac{W_2 - W_3 \times W_3 - W_1}{100}$	**Calculation** Weight of water ($W_2 - W_3$) = ... g Weight of solid ($W_3 - W_1$) = ... g% Moisture = $\frac{W_2 - W_3 \times W_3 - W_1}{100}$	

RESULT

Average moisture content of vermicompost is ..... %.

PRECAUTIONS

- Take sample of vermicompost from three different depths.
- Wear hand gloves and apron while taking sample.
- Maintenance hygienic conditions in the vermicomposting unit.
- Wash your hands with soap to prevent any infection.

KEY LEARNING OUTCOMES

Be able to determine the moisture content of vermicompost and fix the moisture content related issues in the vermibeds.

Notes

NOTES

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

(Instructor's Signature)

Notes

Practical 20

IDENTIFICATION OF IDEAL PACKING MATERIAL FOR VERMICOMPOST

AIM

To identify the ideal packing material for vermicompost.

OBJECTIVES

After completing this practical, you will be able to:

- identify various packaging materials available for storing the vermicompost; and
- select suitable packaging material for storing vermicompost.

PRINCIPLE

As you know vermicompost contains mainly earthworm castings with sufficient number of microbes (fungi, bacteria, etc.), enzymes, hormones, plant growth promotors etc. For their survival sufficient moisture is required. So, vermicompost should be kept moist to maintain its quality. For maintaining its moisture content you can sprinkle water on it. Packing of the compost can be done after getting the order for sale. Too many surplus bags should not be filled as it might lead to loss in quality of compost. Preferably compost should be packed in moisure proof laminated eco-friendly bags. This will minimize the moisture evaporation loss. For this purpose laminated LDPE (Low Density Polyethylene) bags can be used. Now bio LDPE, bio MDPE (Medium density Polyethylene) and bio HDPE (high density polythylene) bags are also available which are environment friendly. Select the type of bag which is eco-friendly, economical and durable.

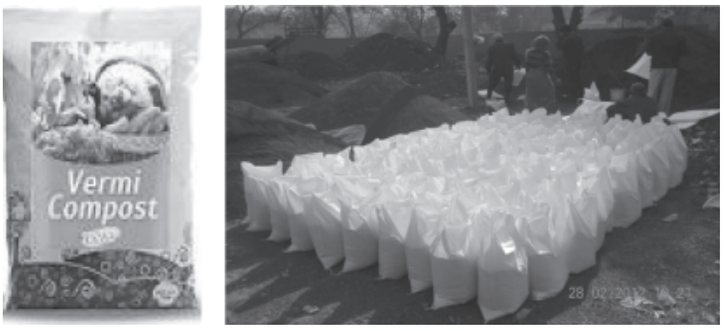


Fig. 20.1. Packets of Vermicompost

TOOLS/EQUIPMENT/MATERIALS REQUIRED

- Protective clothings, such as apron, gloves, etc.
- Notebook
- Pen

PROCEDURE

1. Visit 3 composting units.
2. Note down name and address of each unit.
3. Meet the in-charge or manager of the unit and enquire about the bags they are using for packing of vermicompost.
4. Ask whether the material of bags is eco-friendly (safe to environment) and moisture proof.
5. Note down address for procurement of the bags.
6. Record pros and cons of each packing material.

OBSERVATIONS

Record your observations in the table given below:

Name and address of composting unit	Type of material of bag	Remarks (Are the bags eco friendly and moisture proof?)	Source of bags/unit	Cost of bags/unit
1.				
2.				
3.				

Notes

RESULT

..... bag material is ideal for packing vermicompost.

PRECAUTIONS

- Select the types of bag that is not banned by authorities in your area.
- Material of the bag should be safe for environment.
- The bag should not show the release of any toxic material in compost during its storage.
- The bag should be of sufficient strength to bear the weight of compost packed in it.
- The design of the bag is such that it is easy to carry.

KEY LEARNING OUTCOMES

Able to identify and select suitable packaging material for storing vermicompost for longer usage.

NOTES

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

(Instructor's Signature)

Notes

Practical 21

SAFE STORAGE OF VERMICOMPOST

AIM

To learn safe storage of vermicompost for long duration usage.

OBJECTIVE

After completing this practical, you will be able to

- store vermicompost safely for longer duration.

PRINCIPLE

After harvesting the vermicompost, it should be dried to achieve a moisture content of 30% and then sieved through mesh. Left over undecomposed materials, earthworms and cocoons are transferred to beds for further composting. Next step is storage. Proper storage of vermicompost ensures long shelf life of the product. Vermicompost should be stored in dark, cool place. It should be protected from direct sunlight as it may lead to moisture loss of vermicompost. If moisture is lost then microbes and beneficial products present in compost become less active. Vermicompost should also be protected from rain water as it can carry away the compost and may increase water content in the product that can cause anaerobic condition which is not good for quality of the compost. The vermicompost should be stored in a shed type structure. Water should be sprinkled on vermicompost periodically to maintain moisture content (minimum 35%). In absence of any pakka permanent (bricked) storage structure we go can go for temporary store made from locally available material like bamboo, straw, palm leaves, etc.

TOOLS /EQUIPMENT/MATERIALS REQUIRED

- Protective clothings.

Notes

- Notebook.
- Pen.

PROCEDURE

1. Visit any three vermicomposting unit is in your area.
2. Note down name and address of each unit.
3. Meet the in -charge or manager of the unit and visit the storage structures being used by them for storing vermicompost.
4. Note whether the storage structure is permanent bricked or temporary structure.
5. Record how structure is constructed.
6. Ask any suggestion by which construction cost may be reduced further.
7. Notedown as how compost is being transported from site of production or sieving to the shed.
8. Record moisture level of stored compost and see how it in maintained at optimum level.

OBSERVATIONS

Record your observations in the table given below:

S. No.	Name and address of composting unit	Type of storage structure		Materials used for designing the structure	Appropriate cost of construction	Remarks (Prons and cons each type structure)
		Permanent	Temporary			
1.						
2.						
3.						

RESULT

..... type of storage structure made up of ..... materials are ideal for storing vermicompost in ..... locality.

PRECAUTIONS

- Storage structure should preferably be made from locally available raw materials to reduce the cost of construction.

Notes

- Storage shed should be situated near the site of production or sieving to reduce labour for transportation.
- During storage, a minimum 35% moisture level should be maintained.
- Sprinkle water to maintain required moisture level, if necessary.
- Protect the compost from sun light and rain.
- Storage structure should be well aerated.
- Storage structure preferably be protected from pests and predators.

KEY LEARNING OUTCOMES

Able to store vermicompost safely for longer duration without deteriorating its quality.

NOTES

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

(Instructor's Signature)

Notes

Practical 22

MONITORING POPULATION AND HEALTH OF EARTHWORMS

AIM

To monitor population and health of earthworms in vermibeds.

OBJECTIVES

After completing the practical, you will be able to:

- monitor population and health conditions of earthworms in vermibeds; and
- identify the healthy and unhealthy population of the earthworms.

PRINCIPLE

In vermicomposting beds, we should regularly monitor population and health of the earthworms. This is because the rate of vermicomposting depends upon the earthworm population density, growth and their health conditions. Poor population growth and bad health of earthworms slow down composting rate. Poor earthworm population density may be due to some wrong combination of feed substrate (like imbalance in C:N ratio), presence of anaerobic condition in beds, presence of some predators, unhealthy earthworms or due to mismanagement of vermibeds. An unhealthy earthworm may show some unusual symptoms, like swellings or constrictions on body surface, change in color of skin, reduced mobility size and other activities. These abnormal symptoms may be due to some microbial infections or chemical contamination in feed of the earthworms. Such earthworms may sometimes be destroyed, if required.

Health of the earthworm population can be improved by adopting proper management practices of the vermibeds.

Notes

TOOL/EQUIPMENT/MATERIALS REQUIRED

- Protective clothings, such as hand gloves, face mask, apron, etc.
- Rake.
- Notebook.
- Pen.

PROCEDURE

1. Visit few vermicomposting units.
2. Meet the in- charge or manager of the unit and enquire about earthworm populations with any abnormal symptom, observe the symptoms and record them.
3. Ask about the various management remedies being adopted by the unit to maintain good population and health of the earthworms.
4. Note down the reasons and proper remedies to be adopted.
5. For further information visit nearby Krishi Vigyan Kendra/Agricultural University/ Agricultural Institute or Department.

OBSERVATION

Record your observations in the table given below:

Table- 1

Reason for poor population growth	Treatments/Remedies given
1.	
2.	
3.	
4.	
5.	
6.	
7.	
8.	
9.	
10.	

Notes

Table-2

Symptoms of ill health observed	Treatments/Remedies given
1.	
2.	
3.	
4.	
5.	
6.	
7.	
8.	
9.	
10.	

RESULT

Monitored population and health of earthworms in vermibeds of different composting units.

PRECAUTIONS

- Take prior permission from in-charge or manager of vermicomposting unit before visiting it.
- Earthworms should not be damaged during the observation process.
- Donot interfere with normal functioning of the composting unit.
- Maintain healthy conditions in the vermicomposting unit.
- Wear hand gloves, mask, apron, if required.
- Destroy sick earthworms, if necessary.
- After finishing all work, wash your hands and face with an antiseptic soap to avoid any infection.

KEY LEARNING OUTCOME

Skilled in identifying healthy and unhealthy population of the earthworms present in the vermibeds.

Notes

NOTES

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

(Instructor's Signature)

Notes

Practical 23

IDENTIFICATION AND CONTROL OF PESTS AND PREDATORS

AIM

To identify and control pests and predators of the earthworms.

OBJECTIVES

After completing this practical, you will be able to:

- identify different pests and predators of the vermicompost; and
- control the pests and predators of the vermicompost using suitable measures.

PRINCIPLE

The vermibeds are visited or inhabited by various types of organisms. Some of them are harmless for earthworms and may be good decomposers of organic waste while others may be quite harmful for the worms. Few organisms that can harm worms are some anaerobic bacteria, ants (red ants are very harmful), mites, flat worms, leaches, centipeds, mole crickets, etc. Besides these, certain vertebrates like rodents, snakes, predatory birds directly or indirectly harm earthworms (Fig. 19.1) Most of these pests and predators may be controlled by proper habitat manipulation, and good management practices.

Fly

Ant

Centiped

Mole Rat Bird

Fig. 23.1: Pests of Vermibed

TOOLS/EQUIPMENT/MATERIALS REQUIRED

- Protective clothings, such as hand gloves, apron, etc.
- Garden rake.
- Enamel/ plastic trays.
- Notebook.
- Pen.

PROCEDURE

1. Visit a vermicomposting unit.
2. Meet the in-charge or manager of the unit.
3. Request the in charge or manager to show various types of common pests and predators of earthworms.
4. Using rake and plastic trays collect few pests and predators.
5. Note names of pests and predators collected and identify them.
6. Note down the control measures being adopted.

OBSERVATIONS

Record your observations in the table given below:

Name of pests or predators	Identifying features	Symptoms of their presence in beds	Stage of earthworms being attacked (cocoons, juveniles or adult)	Preventive measures being adopted	Remarks
1					
2					
3					
4					
5					
6					

Notes

RESULT

....., ... and ..... are major pests and predators that are harming earthworms in the composting unit.

PRECAUTIONS

- Visit the vermicomposting unit only after seeking permission from the in-charge or manager of the unit.
- Donot interfere with normal functioning of the unit.
- Maintain hygienic conditions in the unit.
- Make use of protective materials, such as hand gloves, apron, face mask, etc. while collecting pests.
- Be careful while handling pests and predators.
- After finishing the work, wash your hands with an antiseptic soap to avoid any infection.

KEY LEARNING OUTCOMES

Able to identify and control pests and predators of the earthworms.

NOTES

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

(Instructor's Signature)

Notes

Practical 24

PREPARE AND COLLECT VERMIWASH

AIM

To prepare and collect vermiwash.

OBJECTIVES

After completing this practical, you will be able to:

- prepare the vermiwash using suitable techniques; and
- collect vermiwash in suitable

PRINCIPLE

Vermiwash is a dark brown liquid which is made after passing water though a column of worms with medium. It is rich in nutrients, microbes, enzymes and plant growth promoters. It is a good liquid biofertilizer. It can be sprayed on plants. Application of vermiwash to plants is known to have beneficial effects on growth of crops. It also increases yield and quality of the produce. Vermiwash is diluted with water (10%) before spray. You can also mix 1 liter of vermiwash, one liter of cow urine, then add 10 liters of water, and keep it overnight and then spray. The spray also controls various crop diseases. Vermiwash is an eco-friendly bio fertilizer. It inhibits growth of fungi. It also acts as bio-pesticide (with mixed cow's urine or neem extract or garlic extract). It promotes better root growth and nutrient absorption. Application of vermiwash does not have any adverse effect on soil, plant and environment. Use of vermiwash reduces use of chemical fertilizers and thus saves us from harmful effects of chemical fertilizers.

TOOLS/ EQUIPMENT/MATERIALS REQUIRED

- Plastic barrels or an iron barrel or cemented tanks of capacity 200 liters.

Notes

- Earthworms species *Eisenia fetida* or *Eudrilus engeniae* (1-1.5 kg).
- Crop residues or dried leaves.
- Partially decomposed cow dung.
- Garden soil.
- Gravel.
- Sand.
- Containers (5 liter capacity)
- Buckets.

PROCEDURE

1. Take a plastic or iron barrel or cemented tank of capacity 200 liters, keep it under shade.
2. Make a hole just above bottom of the barrel and put a tap in it. Attach a pipe on the other end of tap projecting into barrel.
3. Each tank or barrel is filled with a layer of broken pieces of bricks upto a height of 5-8 cm.
4. The above layer is followed by a layer of gravel and then sand which is kept 8 to 10 cm thick.
5. On the top of above layer place a layer of partially decomposed cow dung. Thickness of this layer may be kept upto 30-45 cm.
6. On top of it, put another layer of garden soil having 2-3cm thickness.
7. Cover the above layer with crop residues or dried leaves (6 cm thickness).
8. Spray water on top to ensure moisture level 40%.
9. After a period of 10 days put 1-1.5 kg of earthworms of species *Eisenia fetida* or *Eudrilus engeniae* (1000- 1500 worms).
10. The unit is left as such for 15 days. Water may be sprinkled on top to maintain minimum moisture level (40%).
11. On top of the barrel, hang a container having holes at the bottom. 5 liters of water is put in the container and allowed to sprinkle on barrel overnight.

Notes

12. Open tap of the barrel next morning and collect vermiwash.
13. Next evening, fill the containers with 5 liters of water again, sprinkle water on top and repeat the process again. In this way 7- 10 liters of vermiwash is collected daily.
14. The collected vermiwash can be diluted with water or with cow urine (1.1).

OBSERVATIONS

.....

.....

.....

RESULT

Prepared and collected the vermiwash using suitable procedure.

PRECAUTIONS

- After installation of the unit, for the first 2 days keep the tap open to clear off all the impurities.
- Do not collect any vermiwash for 12 days of establishing it.
- For better quality of vermiwash, it is preferred to change soil and cow dung after every 10-15 days of its use.
- Wash sand and pebbles before putting them in the barrel.
- Use only 2-3 weeks old partially decomposed cow dung.
- In the unit minimum 40% moisture level should be maintained.
- Install the unit in shady place.
- Maintain sufficient population of earthworms (1000-1500 worms) in the unit and if required introduce more worms to maintain their activity.
- Store vermiwash in cool and dark place. Vermiwash can be used within two 2 months of its preparation.

KEY LEARNING OUTCOMES

Skilled in preparation, collection and use of vermiwash.

Notes

NOTES

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

(Instructor's Signature)

Notes

Practical 25

DEMONSTRATION OF ONLINE MARKETING

AIM

To demonstrate the online marketing of vermicompost.

OBJECTIVE

After doing this practical you will be:

- aware about various online marketing avenues available for vermicompost, vermiwash, earthworm and cocoons; and
- sale vermicompost and related products online.

PRINCIPLE

Scope of online marketing, or digital marketing is increasing day by day. It constitutes a major bulk of the total marketing in India. The objective of online marketing is to reach potential customers through online channels where they spend time in reading, searching, shopping or socializing. Online marketing make use of email, websites, display of advertisements, social media, etc. One of the major advantage of online marketing is that potential customers can be reached at affordable prices, as you reduce your cost for office premises, man power and advertisements. You get access to a wide range of market at a cost lower than by traditional methods. Your results are traceable and measureable. Through online tools you can make personal touch with each customer. Online purchasing is convenient for customers also. For online marketing you can setup your own website or open an account in Facebook or Instagram. You can upload videos, photos, related details, advertisements, etc. related to your product and establishment. Some of these media allow you to open a business account to

Notes

operate. You can give an attractive title to you account or website. You can also do marketing by Whatsapp. In these media at the end of the page or by the sides of the page a link for purchase is given and options for payment like with cash, credit card/debit card/internet banking/paytm/e-wallets/Google pay, phonepe etc. are given. You can put your products for sale on websites like Amazon and Flipkart. You may also give option of cashdown payment and cash on delivery. You should take some expert's advice before going for online marketing.

TOOLS/EQUIPMENT/MATERIALS REQUIRED

- Vermicomposting unit actively engaged in online marketing.
- Notebook.
- Pen.

PROCEDURE

1. Visit a vermicomposting unit which is active in doing online marketing of vermicompost and related products.
2. Meet the person who is dealing with online marketing.
3. Enquire about various means and details of marketing.
4. Request the concerned person for marketing demonstration on computer or smart phone.
5. Practice the procedure of marketing in front of the concerned person, if possible.
6. Record your observations carefully.

OBSERVATIONS

Record your observations in the table given below:

S.No.	Common online marketing websites	Special features of the website	Problems associated with the website

Notes

RESULT

..... website is best for online marketing of the vermicompost and related products.

PRECAUTIONS

- Take permission from in-charge or manager of the composting unit before entering the unit.
- Do not interfere with functioning of the unit.
- Record your observations carefully and note all procedures and cautions/ cyber risks regarding online marketing.

KEY LEARNING OUTCOMES

Able to demonstrate and use online marketing platforms for sale of vermicompost and related products.

NOTES

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

(Instructor's Signature)

Notes

Practical 26

EXPOSURE VISIT TO COMMERCIAL VERMICOMPOSTING SET UP

AIM

To visit a commercial vermicomposting set up.

OBJECTIVE

After completing this practical, you will be able to:

- set up a commercial vermicomposting unit.

PRINCIPLE

Commercial vermicomposting units are set up with high investments. It aims at utilization of waste in large quality to produce large quantity of vermicompost continuously and to make large profits, like a business. The various processes involved need support of large number of machines. The objective of commercial vermicomposting unit is to keep cost of production to a low level. Mechanization leads to less use of man power. Various jobs like transportation of waste from source to unit and unit to beds; turning of beds; transportation of compost; watering of beds, sieving and packing of compost may be done by machines. Visit to such unit may give a exposure to that type of opportunities.

TOOLS/EQUIPMENT/MATERIALS REQUIRED

- Protective coverings such as, apron, face mask, gloves, etc.
- Notebook.
- Pen.

Notes

PROCEDURE

1. Visit a commercial vermicomposting unit.
2. Meet manger or in-charge of the unit and observe how various activities are being undertaken in the unit.
3. Record your observations in notebook.

OBSERVATIONS AND RESULT

1. Name and address of the commercial composting unit.

   .....

   .....

2. Decomposable raw material being used.

   .....

   .....

3. Sources of the raw material.

   .....

   .....

4. Quantity of raw material being utilized daily.

   .....

   .....

5. Quantity of vermicompost produced daily.

   .....

   .....

6. Type of vermibeds.

   .....

   .....

7. Type of shed for vermibeds.

   .....

   .....

8. Means of transporting waste to beds in the unit.

   .....

   .....

Notes

9. How vermibeds are turned?

.....

.....

10. How vermibeds are watered?

.....

.....

11. How earthworms are separated from vermicompost?

.....

.....

12. How the sieving of vermicompost is being done?

.....

.....

13. Type of shed being used for storing vermicompost.

.....

.....

14. Transportation of vermicompost to shed for storage.

.....

.....

15. Type and material of the bag being used for packing.

.....

.....

16. How packing of the bags is being done?

.....

.....

17. Daily quantity of compost being sold.

.....

.....

RESULT

Visited ..... (name and address) vermicomposting unit. The following important activities are being performed in the commercial vermicomposting unit:

.....

.....

Notes

PRECAUTIONS

- Visit the unit only after taking permission from the manager or in-charge of the unit.
- Maintain hygienic conditions in unit.
- Wear apron, mask, goggles, hand gloves, if required.
- Do not interfere with routine activities of the unit.
- After visiting unit, wash your hands with an antibacterial soap.

KEY LEARNING OUTCOME

Able to set up a commercial vermicomposting unit.

NOTES

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

(Instructor's Signature)