Unit 3

Preparation of Media and Container for Commercial Cultivation in Greenhouses

Introduction

The production of greenhouse crops involves a number of agricultural inputs. Among these, growing media or substrate or soil is one of the most critical components. Growing media comprise material aimed to provide ideal physical and chemical characteristics for the root environment. In greenhouse agriculture, a good substrate has proper structural characteristics to support optimum irrigation, maintain proper moisture and aeration, development of roots, adapt to fluctuations in temperature, pH and EC as the plant grows. Various types of growing media used in protected cultivation include peat moss, vermiculite, perlite, shredded coconut husks (coco peat), or composted materials plus starter nutrients and a wetting agent. These media can also be combined in desired proportions as a recipe or formulation as per requirement of the crop or situation. These are used because soils from the field are often vulnerable to diseases and pests and may not provide healthy growth of plants particularly in containers. Besides, these media in right proportions can provide aeration, drainage, water-holding capacity and nutrient uptake by the plant while also resisting the development of diseases or germination of weeds.

Session 1: Growing Media and its Composition

Growing Media

The material in which plants grow in pots are known as the potting material. Substrate or the medium which is used to grow plants is commonly called the growing medium. Media is a source of mineral nutrients, moisture and support for the plant.

- *Mineral source*: Media supplies the necessary nutrients for plant growth.
- *Moisture source*: Media also supplies the necessary water for the plant.
- *Plant support*: The third major function of the media is to afford mechanical support for the plant and its roots, while also ensuring optimum moisture and aeration for roots.

Different Types of Growing Media

Fig. 3.1: Soil as a Growing Media

In most cases, two types of growing media are used in protected cultivation *viz.* soil and soilless media.

Soil as a Growing Medium

Soil is the basic natural medium for growing plants and is indeed the cheapest source. Loamy and porous soil, rich in organic matter with neutral pH (around 7) is good for the growth of plants. Soil is mixed with sand and farmyard manure (2:1:1) for better aeration, water-holding capacity and nutrient supply to the plants.

Problems of soil as a medium

(i) It is difficult to maintain the nutritive status, pH and water-holding capacity of soil as per the requirements of a particular crop for long duration.

(ii) The soil-borne pathogens pose a serious threat to the plants, resulting in lower production.

(iii) Some types of soil such as saline or ill-drained soil create problems in soil aeration, porosity,

nutrient uptake, etc., which in turn affect the crop productivity.

Soilless Substrates as Growing Media

(a) In recent years, due to the problems of using soil as a growing media, the media other than soil (solid or liquid) are used as a base to grow plants under protected conditions. This is called 'soilless culture'.

Fig. 3.2: Soilless substrates as a growing media

Advantages of Soilless Culture

(i) Soilless culture media, whether liquid or solid, facilitates precise nutritional requirement of the plant.
(ii) It helps pathogen-free cultivation.
(iii) More economical use of fertiliser is possible.
(iv) Labour saving in weeding and fertiliser applications.
(v) Saving basal doses of manure.
(vi) Crop cultivation under problematic soil conditions is possible.

Different Media or Substrates

Coco peat

Fig. 3.3: Coco peat

It is a byproduct of the coconut industry, and is used widely as a substrate due to its low cost, aeration, drainage and long life. It is supplied in loose form as well as in compressed brick forms. The compressed bricks are easy to transport at low costs. The bricks weigh about 4–5 kg and can expand to 4–5 times of their volume once water is added after loosening them. It is advisable to use coco peat after treatment with steam or other means of disinfestation.

Vermiculite

Fig. 3.4: Vermiculite

It is an aluminum–iron–magnesium silicate. It is a mica-like mineral which expands to open-flake structures on heating at high temperatures. Vermiculite is available in various grades and

particle sizes and can have a bearing on the choice, depending upon the size of nursery pots. The finer grades are used for small pots and nursery trays, while large or coarse grades may be used in large containers. Vermiculite has a range of pore spaces, which can retain considerable amount of moisture on wetting. It also contains important minerals, especially calcium and magnesium besides having a near neutral pH. Vermiculite is a critical desirable component of soilless root substrates because of its high nutrient and water retention and good aeration capacity while bearing a low bulk density.

Fig. 3.5: Perlite

Perlite

It is a crushed volcanic rock that has been heated and expanded to become a lightweight, white material. Perlite is sterile and has a neutral pH. It improves air space and water drainage of the nursery medium. It is a hard material that does not break apart easily. It can hold about 3–4 times of water equal to its weight in water. Use of perlite keeps the weight of the media lesser in comparison to soil.

Fig. 3.6: Rock wool

Rock wool

It is a burnt mixture of coke, basalt, limestone and also the slag from iron production. It is ground to produce a fine powdered or granular form. This powdered form used in the media provides good aeration and water-holding capacity. It is slightly alkaline; it neither contributes nor holds nutrients to any extent, therefore it is mixed with other growing media such as sphagnum peat moss.

Sand

It is the basic component of soil. Its particle size ranges from 0.05 mm–2.0 mm in diameter. It improves aeration and drainage and needs minimum cost incurrence. While sand is vulnerable to diseases and pests, however once sterilised, it can prove to be a good medium for both potting and propagation media.

Rice Husk

It is a byproduct of the rice milling industry. It is extremely light in weight and is very effective for improving drainage.

Bark

It is a byproduct of saw mills, which is used as a media for pot cultures as well as in greenhouses. It provides aeration at low cost. It is either used alone in containers or mixed with one-fourth part of peat moss for improving water-holding capacity. Bark particles of less than 3/8 inch (9.5 mm) in size are used as growing media in general. Bark has low nutrients and very low pH (3.5–6.5) when used unprocessed. For improving the pH of the bark medium, dolomite lime may be added to bring it above a pH of 6 at the least.

Sphagnum Peat moss

Fig. 3.7: Sphagnum Peat moss

It is also called peat moss or simply peat. Peat is the most popular component of most soilless substrate media or mixes used as soilless medium because of its lower cost and easy availability. It originates from the partial decomposition of plant material in peat bogs where oxygen availability is low. All the peats have very favourable water-holding capacity, high Cation Exchange Capacity (CEC), low nutrient contents, low pH (around 3 to 4.5) and requires limestone addition to balance the pH.

Saw dust

It is similar to peat moss in many ways and its quality depends on the type of trees. It may contain toxic substances such as resins, tannins or turpentine. It is acidic in nature and requires limestone to neutralise it.

Composition of Media

Many substrates are available that can be used singly or in combination by mixing in definite proportions, depending upon the crop requirements such as plant

support, aeration, nutrient and moisture retention. The selection of components generally depends on their availability and cost.

Standard soilless composition includes composite mixture of coco peat, vermiculite and perlite in 3:1:1 volume by volume ratio.

In case of seedling nursery, coco peat alone may be used as a growing media after treating it with calcium nitrate (50 g/kg) to reduce the electrical conductivity and pH of the media.

If timber is available in abundance, use of bark as a growing medium is economical. Sand is added to bark because it settles in spaces and nests among the bark particles, thus adding more surface area and as a consequence, more air and water are available in a given volume of substrate. Often, sphagnum peat moss is also added to the bark to further increase water-holding capacity as well as nutrient retention.

Practical Exercises

Activity 1: Prepare a soilless growing medium.

Materials required: coco peat, vermiculite, perlite, pot, etc.

Procedure

- Identify different components of soilless media.
- Measure the quantity of components used.
- Prepare composite mixture of coco peat, vermiculite, perlite in 3:1:1 volume by volume ratio.
- Fill the pot with prepare media.

Ckeck Your Progress

A. Fill in the blanks

1. The growing medium which is prepared from coconut fiber is known as _____.
2. Growing media which is obtained from volcanic rock is known as _____.
3. Vermiculite contains important minerals such as _____ and _____.
4. The standard soilless composition ratio of coco peat, vermiculite and perlite is _____.

B. Multiple choice questions

1. Substrate which is used to grow plants is commonly called the _____.
   (a) bark
   (b) rock wool
   (c) growing medium
   (d) vermiculite
2. Which is not used as soilless media?
   (a) Vermiculite
   (b) Perlite
   (c) Coco peat
   (d) Vermiwash
3. Sand as growing medium improves the _____.
   (a) aeration and drainage
   (b) water-holding capacity
   (c) nutritive status
   (d) pH
4. Growing media is a source of _____.
   (a) mineral nutrients
   (b) moisture
   (c) support to plant
   (d) All of these

C. Descriptive questions

1. Describe different types of growing media.

_____

_____

_____

2. Describe in brief
   (a) Problems of soil as a medium
   (b) Sphagnum peat moss
   (c) Coco peat

_____

_____

_____

D. Match the columns

	A	B
1.	Perlite	(a) Neutral base fibre
2.	Vermiculite	(b) Milling industry
3.	Coco peat	(c) Light, white, substrate
4.	Rice husk	(d) Mica-like mineral

Session 2: Sterilisation of Growing Media

Sterilisation can be defined as the process of removal or destruction of all forms of microbial life. Any sterile item in the microbiological sense actually has to be free of any living micro-organisms. Micro-organisms can be killed, inhibited or removed by exposing material to lethal agents which may be physical, chemical or ionic in nature or in the case of liquids, physical elimination of cells from the medium.

Soil Sterilisation

The soil or soilless media are used for growing the plants, supporting the plant, retaining the moisture and providing water and nutrients for the root system. The media used for cultivation of plants are also often congenial for the growth of micro-organisms *viz.* bacteria, fungi, actinomycetes, protozoa, viruses, insects, nematodes and weed seeds. The micro-organisms include beneficial as well as harmful, i.e., soil-borne plant disease causing organisms. To eliminate soil-borne pathogens, nematodes, insects and weeds to obtain healthy growth of plants, it is essential to sterilise or pasteurise the soil or soilless media.

Methods of Soil Disinfestation

A variety of techniques and agents are available for soil disinfestation. They act in many different ways and each has its own limits of application. The selection of a method depends upon the desired efficiency, its applicability, toxicity, availability and cost and effect on the properties of the object to be disinfested.

Among the variety of physical and chemical agents and techniques available, the more commonly used for soil or substrate sterilisation are moist heat, i.e., steam sterilisation and chemicals, i.e., fumigants.

Soil Solarisation

High intensity solar radiation during summer (April–June) is used as a lethal agent for the control of plant pathogenic organisms, insects, nematodes and weeds through the use of transparent polyethylene films and this is known as soil solarisation. The step-by-step procedure of soil solarisation includes—

(i) Soil should be ploughed first.
(ii) Irrigate the field very ligthly.
(iii) Cover the field with transparent UV-stabilised 25 micron polyfilm for 20–30 days.
(iv) The sides of the film should be covered with soil to avoid entry of outside air.
(v) Soil solarisation is not a foolproof method for sterilisation.

Soil Sterilisation by Formaldehyde

It is an excellent sterlising agent for controlling harmful soil microbes. It is marketed in aqueous solution as formalin which contains 37–40 per cent formaldehyde. The soil or root substrate to be sterilised is loosened and the solution prepared by mixing 4 L formalin in 19 L of water is poured or sprayed on the soil @5 ml/ sq m area. The rate of application depends upon the moisture content, depth of soil and type of soil. The land is covered with thin plastic film to retain the fumes generated. Removal of plastic film (after 7 days), complete evaporation of smell of formaldehyde will take place in about 15–20 days. After that, sowing or planting should be done. It has limited effect against nematodes and should not be used in standing crops. Its use has to be preferably avoided as it is a general biocide (a substance that destroys or inhibits the growth or activity of living organisms), deterimental to the health and safety of the production system.

Soil Sterilisation by Hydrogen Peroxide

Hydrogen peroxide with nano particle silver can be used for sterilisation. Since this solution is in liquid form, it can be applied using drip irrigation system. The recommended dose of the solution is 35–40 ml/ sq m, however care should be taken that the soil beds are gently watered beforehand. The main advantage of using this solution is that sowing/planting can be done the very next day.

Other sterilisation methods include heat or steam sterilisation, which have limitation of application under field conditions due to high expenditure.

Practical Exercises

Activity 1: Demonstrate procedure of soil solarisation.

Material required: polyfilm of 25–50 micron, water can, *'Khurpi'*, etc.

Procedure

- Open the soil surface with *Khurpi* and prepare a bed of 2.5 m × 2.5 m size.
- Irrigate the bed lightly.
- Place the polyfilm on the top of the area and cover the edges with soil.
- Leave it for 20–30 days.
- Observe germination of weeds.

Check Your Progress

A. Fill in the blanks

1. A high intensity solar radiation used for treating soil is known as _____.
2. An excellent sterlising chemical for controlling soil microbes is _____.
3. The recommended dose of hydrogen peroxide when used for sterilisation is _____ ml per sq m.

B. Mark the correct choice

1. For soil solarisation use UV stabilised transparent sheet of _____ micron
   (a) 25 (b) 35
   (c) 45 (d) 55
2. Physical method of soil disinfection by _____.
   (a) weedicide (b) fungicide
   (c) solarisation (d) formaldehyde

C. Descriptive questions

1. What is soil sterilisation? Describe the method of soil solarisation.

_____

_____

_____

2. Describe the soil sterlisation by formaldehyde.

_____

_____

_____

D. Match the columns

A	B
1. Soil Sterilisation	(a) Micro-organsim
2. Aseptic	(b) Fumigent
3. Bacteria	(c) Microbe-free
4. Formadehyde	(d) Peak Summer

Session 3: Preparation of Beds and Containers for Growing Crops

Preparation of Raised Beds

Bed preparation in a greenhouse, polyhouse, net house or a tunnel is very important and it plays a crucial role while growing plants. First of all, it is important to select 'well drained' soil for growing plants (like loam, red soil). If it is not available, then the soil should be improved by adding rice husk, compost (dry), etc., so that it becomes well-drained. The required composition for 4,000 sq m of land area is—Farm Yard Manure (FYM) 3 truck, rice husk 2 MT, neemcake1 MT, and fish meal/bonemeal 0.25 MT. Once it is mixed thoroughly, fumigation is done with hydrogen peroxide, after which the soil is kept closed for at least 24 hours and then the layout of beds is marked as per requirement. Pegs are used to fix lines before starting the bed preparation. The height of the bed should be equal, about 30–45 cm from the ground, with a width of 75–90 cm. The width of the path between two beds should be 50 cm. These beds are good for better aeration and drainage and are more common in greenhouse cultivation.

For crops other than flowers, cultivators prepare planting beds differently.

Fig. 3.8: Land preparation under polyhouse

Plant Growing Containers for Greenhouse Production

The duration of a crop in the greenhouse is the key to make the greenhouse technology profitable. Therefore, the use of containers in greenhouse production carries significance.

They are used for the following important activities in greenhouse production.

Fig. 3.9: Plant growing in different types of containers

(i) Raising of seedlings in the nursery.
(ii) Growing plants in greenhouses for hybrid seed production of flowers.
(iii) Growing cut flowers in greenhouses.
(iv) Growing potted ornamental plants in greenhouses.

Advantages of Containers in Greenhouse Production

(i) Increase in production capacity by reducing crop duration.
(ii) Quality production of nursery or crop.
(iii) Uniformity of plant growth, and better vigour and survival rates.
(iv) Provide quick take-off with little or no transplanting shock.
(v) Easy maintenance of sanitation in greenhouse.
(vi) Easy to handle, grade and shift for transportation.
(vii) Better water drainage and aeration in pot media.
(viii) Easy to monitor chemical characteristics and plant nutrition with advanced irrigation system like drip irrigation.
(ix) Protection from soil-borne pathogens.

Table 3.1: Advantages and Disadvantages of plant growing in containers

Containers	Advantages	Disadvantages
Polyurethane foam	• Requires less medium • Reusable • Easy to handle	• Requires regular fertilisation
Pro-trays	• Easy to handle • Reusable	• May be limited in sizes
Polyethylene bag	• Easy to handle	• Requires less storage space
Plastic pot	• Reusable, Good root penetration	• Requires handling as single plant
Plastic tray	• Available in many sizes • Reusable • Requires less medium	• Roots may grow out of the container
Clay pot	• Easy water management • Low cost	• They are heavy to handle, uses due to easy breakage. • Slow to work with pots and dry out fast

Single peat pot	• Easy to handle in field • Available in variable sizes (square/round) • Good root penetration	• Difficult to separate
Plastic bag	• Easy to handle	• Roots may grow out of container

Selection of suitable containers depends on the crop to be produced in the greenhouse, plant characteristics like crop stage, duration, vigour, growth habit, root system, etc. Generally, small containers are suitable for nursery and small plants or short plants with less growth of roots, while large containers are used for plants with profuse root system.

Practical Exercises

Activity 1: Prepare a raised bed

Material required: spade, measuring tape, pegs and rope, etc.

Procedure

- Measure the area of desired size.
- Insert the pegs as per identified area and encircle it with rope.
- With the help of spade loosen the soil.
- Lift the soil from the channels and put it on beds.
- Measure the width, height of the beds.

Check Your Progress

A. Fill in the blanks

1. The low cost container for growing plants is _____.
2. Easy to handle and reusable containers are _____.

B. Mark the correct answer

1. While preparing nursery bed, path width should be left between two beds
   (a) 30 cm (b) 40 cm
   (c) 50 cm (d) 60 cm
2. The large containers are used for plants with
   (a) small roots (b) medium roots
   (c) primary roots (d) profuse roots

C. Descriptive questions

1. Explain in brief the preparation of raised beds.

2. What are the advantages of using containers?

3. What are the types of containers needed for deep rooted crops?

D. Match the columns

	A		B
1.	Raised bed	(a)	Earthen pot
2.	Sterilisation	(b)	Plastic nursery tray
3.	Pro-trays	(c)	Making aseptic
4.	Clay pot	(d)	30–45 cm height