Horticultural Crops Production

Level-III

Learning Guide -15

Unit of Competence: Design and prepare growing media /soil

Module Title: Designing and preparing growing media /soil

LG Code: AGR HCP3 M05 LO1-LG-15

TTLM Code: AGR HCP3 TTLM 0120v1

LO 1: Identify of research specification for growing media

Instruction Sheet	Learning Guide # 15

This learning guide is developed to provide you the necessary information regarding the following **content coverage** and topics:

- Investigating various media components
- Determining components of a growing media
- Determining nutrient requirements
- Investigating different sources of nutrients
- Analyzing growing media on chemical, physical and biological characteristics
- Determining the sterilization method of growing media
- Establishing growing media composition.

This guide will also assist you to attain the learning outcome stated in the cover page. Specifically, upon completion of this Learning Guide, you will be able to:

- Investigate various media components
- Determine components of a growing media
- Determine nutrient requirements
- Investigate different sources of nutrients
- Analyze growing media on chemical, physical and biological characteristics
- Determine the sterilization method of growing media
- Establish growing media composition

Learning Instructions:

1. Read the specific objectives of this Learning Guide.
2. Follow the instructions described below 3 to 4.
3. Read the information written in the information “Sheet 1-7”.
4. Accomplish the “Self-check 1-7” in page -6, 13, 20,25, 33,36 and 39 respectively.

Information Sheet-1	Investigating various media components

1. Introduction

Growing media are an integral part of most horticultural production systems. There is a wide range of media. Probably hundreds of different kinds of growing medium available. Anything that a plant can grow in is considered a growing medium. There are manmade as well as organic (natural) mediums. Even plain old air can be an effective growing environment for roots. The variety of planting media can range from soil, sand, rocks or bricks, clay pellets or sphagnum moss to a combination of two or more.

Growing media are the substrates in which a plant will grow. They provide anchorage for the plant's roots; air paces to allow respiration; and retain sufficient available water to enable plant growth.

When selecting media, the grower needs to find the optimum balance between their requirements and those of the plants to be even in "soil-less" systems, growing media are usually used. The best growing medium for your purpose depends on many variables.

1.1. Functions of Growing Media

1. Physical Support

The growing medium must be porous yet provide physical support. Young plants are fragile and must remain upright so that they can photosynthesize and grow. With larger nursery stock in individual containers, a growing medium must be heavy enough to hold the plant upright against the wind. Bulk density is the responsible factor and will be discussed in the next section.

2. Aeration

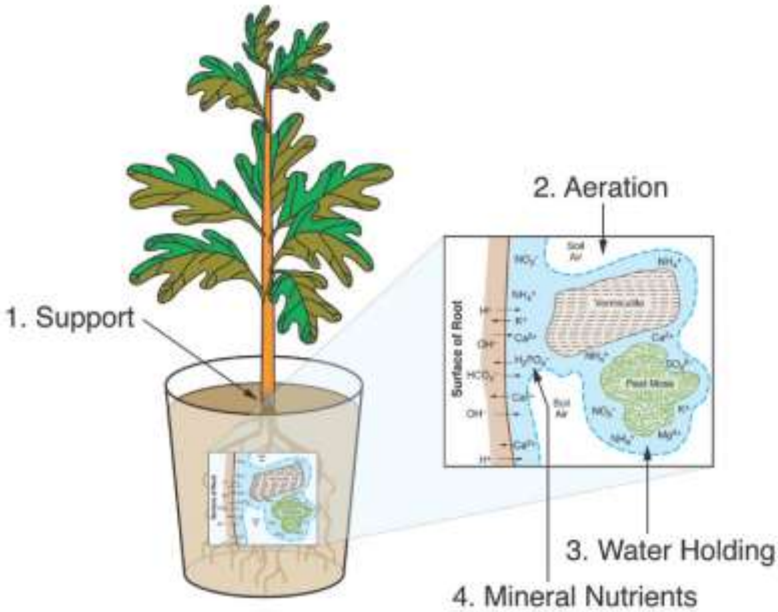
Plant roots need a steady supply of oxygen to convert the photosynthate from the leaves into energy so that the roots can grow and take up water and mineral nutrients. The byproduct of this respiration is carbon dioxide that must be dispersed into the atmosphere to prevent the buildup of toxic concentrations within the root zone. This gas exchange occurs in the large pores (macropores) or air spaces in the growing medium. Because nursery plants grow rapidly, they need a medium with good porosity—a characteristic termed "aeration" that will be discussed in more detail in the next

3. Water Supply

Nursery plants use a tremendous amount of water for growth and development, and this water supply must be provided by the growing medium. Growing media are formulated so that they can hold water in the small pores (micropores) between their particles. Many growing media contain a high percentage of organic matter such as peat moss and compost because these materials have internal spaces that can hold water like a sponge. Therefore, growing media must have adequate porosity to absorb and store the large amounts of water needed by the growing plant.

4. Supply of Mineral Nutrients

Most of the essential mineral nutrients that nursery plants need for rapid growth must be obtained through the roots from the growing medium. Most mineral nutrients are electrically charged ions. Positively charged ions (cations) include ammonium nitrogen (NH4+), potassium (K+), calcium (Ca+2), and magnesium (Mg+2). These cations are attracted to negatively charged sites on growing medium particles up to the point when the roots extract the cations. The capacity of a growing medium to adsorb these cations is referred to as cation exchange capacity (CEC), and this important characteristic is discussed in the next section. Different media components vary considerably in their CEC, but peat moss, vermiculite**,** and compost have a high CEC value, which explains their popularity in growing media.



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1.2. The Various media component constitutes

- **Organic matter**:
    - Peat

- Charcoal
- Softwood and hardwood barks
- Compost
- Rice hulls
- Sawdust and other organic waste products

➢ **Inorganic mater:**

- Gravel
- Sand
- Vermiculite
- Perlite
- Tuff and pumice
- Polystyrene.

Good plant development depends to a large part on the growing medium used. If a plant develops a good root system in a well-balanced substrate, this does not mean that the plant is pampered and will not adapt to the harsh life outside a nursery. In fact, the opposite applies.

To survive in the harsh environment of a field, often without additional watering and fertilizing, a plant needs a well-developed and strong root system. The development of a healthy root system depends not only on the genetic properties of the plant but to a large extent on the physical and chemical properties of the substrate used.

Self-Check -1	Written Test

Directions: Answer all the questions listed below. Use the Answer sheet provided in the next page:

1. What is growing media? (2pts.)
2. Discus the importance of growing media? (3pts.)
3. Explain the advantage and disadvantages of growing media in growing horticultural crops? (2pts.)
4. Discus some of organic and inorganic growing media? (2pts.)

Note: **Satisfactory rating - above 9 points** **Unsatisfactory - below 9 points**

You can ask you teacher for the copy of the correct answers.

Answer Sheet

Score = ___________

Rating: _____________

Name: _________________________ Date: _______________

Information Sheet- 2	Determining components of a growing media

2.1. Determining the growing media for plant requirements

Growing media components are either organic or inorganic. Organic components include peat moss, bark, coconut coir, rice hulls, etc. Inorganic components include perlite, pumice, vermiculite, sand, hydrogel, etc. Some of these components hold water on their surface, others hold water within their structure, while others hold little compared to other components.

There are also components, such as perlite, that hold very little water, if any. Specific type of ingredient can vary in its water holding capacity and physical structure, depending on its origin and how it is processed. For example, bark can vary greatly in its source and structure depending on how it is processed, aged, composted and screened. This is also true for peat moss. Light brown, fibrous peat moss has a porous structure and can hold up to 16 times its weight in water.

All nursery managers have their own favorite's growth substrate. These vary depending on availability, but in developing countries they are mainly soil from agricultural or forest areas, sometimes mixed with sand and/or manure. Forest soil is often a main component of potting mixtures. Soil is usually a mixture of mineral components from weathered parent rock and of organic components from decomposed litter. Whereas the topsoil (the top 10-20 cm) can be very rich in nutrients, subsoil from deeper layers is often very poor and depleted. When using soil as a potting substrate it is advisable to use only forest topsoil.

Topsoil usually has a good CEC. Its pH is largely determined by the parent rock and the plant composition (soil under conifers tends to be more acidic). However, nurseries requiring large volumes of substrate need to consider the damage soil mining does to the forest floor. As a rule of thumb when soil is to be part of the growing medium, use the following mixtures (topsoil: fine gravel: well-decomposed organic matter such as manure or compost):

- For heavy (clayey) soils 1:2:2
- For medium (loamy) soils 1: 1:1
- For light (sandy) soils 1: 0:1

The two major groups and components of soil media are:

a. Inorganic: for example, gravel, sand, vermiculite, perlite, tuff and pumice, polystyrene.
b. Organic: for example, peat, charcoal, softwood and hardwood, barks, compost, rice hulls, sawdust and other organic waste products.

The choice for substrate components will depend on the:

- Location of the nursery
- The resources available and
- Plant requirements.

1. Inorganic components

Inorganic components improve the physical structure of a substrate by increasing the aeration pore space and the drainage properties. Many inorganic materials have a low CEC and provide a chemically inert base for the substrate. Heavy materials, such as gravel, can be used to improve the stability of containers.

a. Sand and gravel

Sand is a common substrate for germinating seeds. Sieve and wash all sand to remove fine silt particles that lead to crusting of the surface. You will get best results with particle sizes between 0.5-1 mm for germinating seeds and 1-2 mm for rooting cuttings. Sand that comes from a seaside beach may contain high levels of salt that need to be washed out before use. Fine gravel (5 mm) has been used successfully in rooting cuttings and as an addition to potting mixtures. It needs to be thoroughly washed to remove soil and sand particles. Both sand and gravel are heavy (bulk densities 1000-1700 g/L) and make transport of seedlings to the field difficult. Sand, especially fine sand, must never be used as an addition to potting substrates, since it clogs up pores.

b. Vermiculite

Vermiculite is a hydrated magnesium-Aluminum iron silicate; there are extensive deposits in the USA and South Africa. Its mineral structure is layered, like mica, and it expands when heated above 1000°C. After processing, vermiculite has a very low bulk density (ca 120 g/L). It is insoluble in water but can absorb about 5 times its own weight. It has a neutral pH and a high CEC and thus can hold nutrients in reserve. Horticultural vermiculite is graded to three sizes: course (2-3 mm), medium (1-2 mm) and fine (0.75-1 mm). The coarse grade is used most in growing substrates, the medium and fine grades are used in seed germination. The structure of vermiculite is fragile and once compressed the particles cannot be expanded. It is therefore important that vermiculite is not pressed during handling or mixed with large quantities of heavy material, such as sand. Use only horticultural vermiculite, because vermiculite from packing materials is often coated with water repelling chemicals.

c. Perlite

Perlite is a silicaceous material of volcanic origin, mined from lava flows. The crude ore is crushed and heated to about 760°C, causing the enclosed water to vaporize and expand the particles like a sponge. It is very light (80- 100g/L), can hold 3-4 times its own weight in water and has a near neutral pH but a very low CEC, and it contains no mineral nutrients. It is most useful to increase aeration in a mix and it is, in combination with peat moss, a very popular substrate for cuttings in the USA.

d. Tuff (pumice)

Tuff is produced from ash and rock fragments ejected during volcanic eruptions. Some particles melt together in the heat. The material is very porous and consists of mostly silicon dioxide and Aluminum oxide with small amounts of iron, calcium, magnesium and sodium. After mining, it is screened to different sizes but is not heat treated. It increases aeration and drainage in a propagation mix.

e. Polystyrene

Expanded polystyrene flakes and other synthetic plastic aggregates are often added to improve drainage and aeration, and to decrease the bulk density of the substrate. They are inert (do not add nutrients), do not decay and do not absorb water.

fig2. Common inorganic components used in growing media. Starting in the upper left, going clockwise: vermiculite, perlite and rice hulls. Source: Premier Tech Horticulture."

1. Organic components

The organic components improve the physical structure of the substrate by reducing weight and increasing its water-holding properties. They are also resilient to compaction. Organic matter has a high CEC and can store nutrients until needed by the plants. Some organic materials, such as compost, can contain considerable amounts of nutrients. Peat is the most popular organic component, but because of the destruction of valuable biotopes for the harvest of peat, alternative materials with similar physical and chemical properties are sought.

a. Peat

Peat is plant material that has decomposed under partial exclusion of oxygen. These anaerobic conditions slow down bacterial and chemical decomposition and often peat is many thousand years old. Tropical peat originates from younger deposits with varying properties. Peat from different sources varies greatly in the vegetation from which it originated the state of decomposition and mineral content. All peats have good water-holding capacity, high CEC, low level of nutrients and low pH (around 3-4.5). The most common peat is sphagnum peat, a slightly decomposed peat from Sphagnum mosses. It has a high water holding capacity of 15-30 times its dry weight and contains small amounts of nitrogen (0.6-1.4%). Its dry bulk density is around 110 g/L. This particular material originates mainly in Canada, Ireland and Germany. In tropical countries other less decomposed peats can be substituted for it.

b. Charcoal

Charcoal dust or small pieces help to improve the CEC of a substrate. Charcoal is readily available everywhere.

c. Shredded bark

Softwood or hardwood bark is good alternatives to peat moss with much the same properties. Bark is a cheap byproduct of many sawmills. It can be used from softwood (cedar, pine, fir) or hardwood species; the bark of tree ferns is also recommended. There is only limited information about the suitability of tropical tree species.

Bark should be hammer milled (shredded) through a 2-3 cm screen and then composted for 4-6 months because fresh bark can contain tannins, phenols, resins or terpenes which are toxic to plants unless they are broken down. The higher temperatures of composting also help reduce insect and pathogen levels. When bark is not completely composted, plants grown in this medium may suffer from nitrogen deficiency because the composting bacteria need nitrogen to break down the organic matter. Please note that in areas with severe shortages of firewood, bark might be used for this purpose by the population, and the nursery should find alternative materials so that their operations do not compete for this scarce resource.

d. Compost

Composting is the physical and chemical breakdown of materials that liberates nutrients available to plants. Microorganisms (fungi and bacteria) digest the material during decomposition. Compost from green material generally has a high nutrient level and a good CEC. Producing consistently good compost takes practice and it may be worthwhile to conduct studies to learn how different species react to the addition of compost to their potting medium, and to make adjustments if necessary. Any organic material can be composted; a mixture of materials is best.

e. Other materials

Coconut husks, rice hulls, sugar cane bagasse, coffee shells, old sawdust and other waste materials can be used similarly to the materials listed above. New materials will doubtless be found through continuous research. Most soil-less substrates can be used alone or added to soil to improve its properties.

Fig3. Common organic components used in growing media. Starting in the upper left, going clockwise: bark, sphagnum peat moss and coir. Source: Premier Tech Horticulture."

Self-Check -2	Written Test

Directions: Answer all the questions listed below. Use the Answer sheet provided in the next page:

1. Differentiate the difference between organic and inorganic growing media? (3pts)
2. What are the consideration to be taken during choosing the type of growing media for the plant growth? (3pts.)
3. Discus the organic inorganic media components? (4pts.)

Note: **Satisfactory rating – 10 points** **Unsatisfactory - below 10 points**

You can ask you teacher for the copy of the correct answers.

Answer Sheet

Score = ____________
Rating: _____________

Name: ___________________________ Date: _______________

Short Answer Questions

Information Sheet-3	Determining nutrient requirements

3.1. Plant nutrients

Plant cells need essential substances, collectively called nutrients, to sustain life. Plant nutrients may be composed of either organic or inorganic compounds. An organic compound is a chemical compound that contains carbon, such as carbon dioxide obtained from the atmosphere. Carbon that was obtained from atmospheric CO_2 composes the majority of the dry mass within most plants. Plants need 16 essential nutrients, or elements. These include the carbon (C), oxygen (O) and hydrogen (H) they draw from water and the air. The remaining elements are drawn from the soil. Essential element is a term often used to identify a plant nutrient. The term nutrient implies essentiality, so it is redundant to call these elements essential nutrients. All 90 or so naturally-occurring elements are found in normal plant tissue. Only 16 or so elements are truly essential for plant growth. The rest of the elements present in plant tissue are largely taken up in small quantities incidentally (or accidentally!) as plants take up the nutrient elements that they need for growth and reproduction. Although common sense goes a long way in defining the concept of an essential element, a more precise set of criteria were established by Arnon and Stout in 1939, who stated that an essential element:

- Must be required for the completion of the life cycle of the plant.
- Must not be replaceable by another element.
- Must be directly involved in plant metabolism, that is, it must be required for a specific physiological function.

These nutrients can be divided into three categories: primary (macronutrients), secondary and minor (micronutrients).

a. Primary elements (macronutrients)

Plants need large quantities of these elements. That is why they are called “primary” or “macronutrients.”

Element	Role in plant growth
Nitrogen (N)	Basic component of proteins and chlorophyll (the pigment that gives plants their green colour). Plays an essential role in plant growth. Also feeds microorganisms in the soil.
Phosphorous (P)	Plays an important role in root growth and promotes the establishment of young plants, flowering, fruiting and ripening, photosynthesis, respiration and overall plant growth.
Potassium (K)	Moves through the plant. Promotes the movement of sugars, turgor and stem rigidity. Also increases the plant’s overall resistance to cold, diseases, insect pests, etc. Promotes the formation of flower buds, the hardening-off of woody plants and fruiting.

a. Secondary elements

Less of these elements is required than of primary elements.

Element	Role in plant growth
Calcium (Ca)	Plays a vital role in plant structure, because it is part of cell walls and holds them together. Promotes the development of the root system and the ripening of fruit and seeds. Found in the growing parts of plants (apex and buds).
Magnesium (Mg)	An important part of chlorophyll. Helps fruit ripen and seeds germinate. Reinforces cell walls and promotes the absorption of phosphorous, nitrogen and sulphur by plants.
Sulphur (S)	A component of several proteins, enzymes and vitamins. Contributes to chlorophyll production. Helps plants absorb potassium, calcium and magnesium.

b. Minor elements (micronutrients)

Although only small quantities of these elements are required, they are essential to plant growth.

Element Role in plant growth

Iron (Fe)	Essential to chlorophyll production. Also contributes to the formation of some enzymes and amino acids.
Boron (B)	Essential to overall plant health and tissue growth. Promotes the formation of fruit and the absorption of water.
Manganese (Mn)	Promotes seed germination and speeds plant maturity. Plays an important role in photosynthesis by contributing to chlorophyll production. Essential for nitrogen assimilation and protein formation.
Molybdenum (Mo)	Essential for nitrogen assimilation by plants and nitrogen fixation by bacteria. This means that it is needed for the production of nitrogen-based proteins.
Chlorine (Cl)	Stimulates photosynthesis.
Copper (Cu)	Activates various enzymes. Also plays a role in chlorophyll production.
Zinc (Zn)	Plays an important role in the synthesis of proteins, enzymes and growth hormones.It is used in the formation of chlorophyll and some carbohydrates, conversion of starches to sugars and its presence in plant tissue helps the plant to withstand cold temperatures. Zinc is essential in the formation of auxins, which help with growth regulation and stem elongation. Nickel: is a component of some plant enzymes, most notably urease, which metabolizes urea nitrogen into useable ammonia within the plant. ... In this case, nickel deficiency causes urea toxicity. Nickel is also used as a catalyst in enzymes used to help legumes fix nitrogen.

3.2. Determining plant Nutrient requirements

Plants require different nutrient levels at different stages of growth. Nutrient requirements might be determined by:

1. Plant analysis
2. By experience
3. Experimenting, and/or
4. By accessing information from research papers.

3.2.1. Identifying symptoms for certain nutrient deficiencies

- Yellow-edged leaves (old growth) – Indicates a magnesium deficiency.

- Warped, misshaped new leaves – Reveals a calcium deficiency.
- Purple/reddish leaves – Lack of phosphorus.
- Deformed fruits – Typically due to potassium, though nitrogen excess can contribute.
- Blossom end rot (tomatoes) – Widespread cause is from lack of calcium.
- No flowering/dropped flowers – Can point to lack of phosphorus.
- Light green foliage (rather than dark green) – An "anemic" appearance could be nitrogen deficiency.
- "Burnt" leaf-tip appearance – Points to depletion of phosphorus.
- Abnormally dark green old foliage – Another sign of not enough phosphorus.
- Dark black or scorched leaf appearance – Potassium deficiency.
- Wilted old growth – Potassium deficiency.

3.2.2. Plant Growth Stages

Besides abnormal appearances, specific nutrients to a plant depending on what stage of growth it is in, and even what variety or species of plant it is.

a. Young growth: Nitrogen is especially helpful to give, though adequate levels of all nutrients are critical at this phase.
b. Newly transplanted: Will benefit especially from higher amounts of root-supporting nutrients, like phosphorus and potassium.
c. Blossoming: Benefits from phosphorus, potassium, and calcium in particular.
d. Fruiting: It's important to include decent amounts of phosphorus and potassium, while not overdoing it with nitrogen.

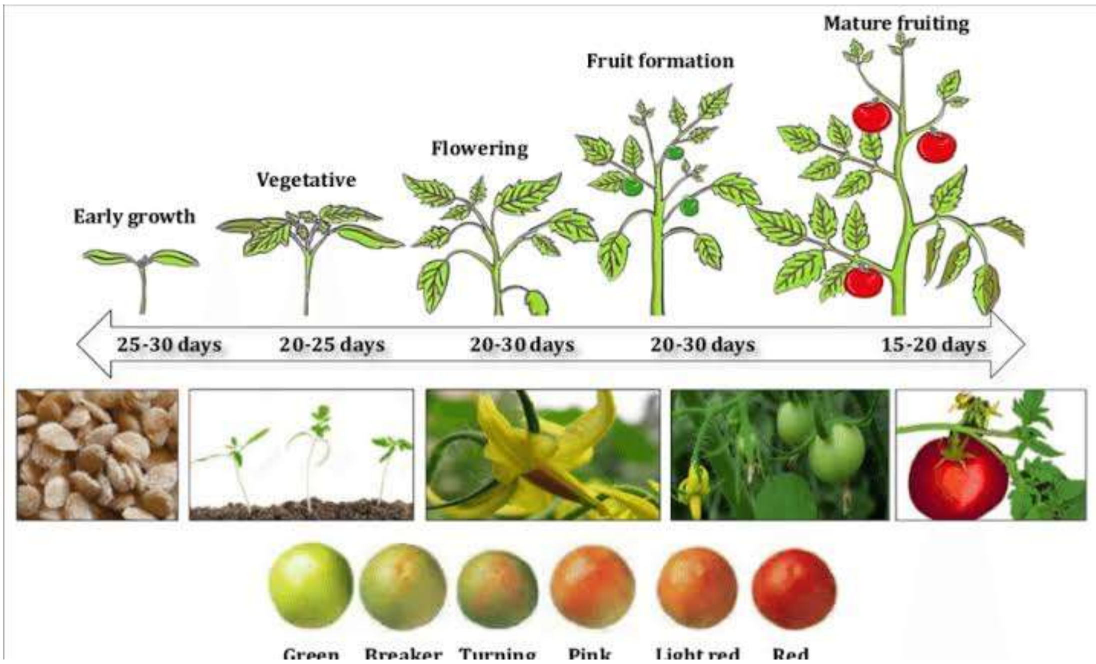

Fig4. growth stage of tomato

3.2.3. Diseases

In some cases, plants suffer from certain illnesses – fungal, viral, bacterial, and more – due to a lack of certain nutrients in their environment.

As with people, the intake of certain nutrients can be a key to forestalling illness, like vitamin C's associations with reducing symptoms of the common cold.

a. Fungal plant diseases

Downy mildew, fusarium, and others directly invade plant tissues that are weak from a lack of nutrients. A rise in fungal illness may signify the need for calcium, potassium, or phosphorus.

b. Viral plant diseases

Excess of certain nutrients (especially nitrogen and phosphorus) can increase susceptibility to viruses. This can sometimes be balanced with more potassium.

c. Bacterial plant diseases

After adding any amendment, wait a week or two and watch for improvement. If it's not obvious that your plants are getting healthier, then you may want to diagnose for other problems just to be safe. Low calcium, nitrogen, and potassium can make your plants susceptible to bacterial illnesses, On the other hand, too much nitrogen can help certain bacteria to thrive as well.

d. Pests

A lack of proper plant nutrition can have a big impact on the influence of pests.


fig5. Aphid infestation.

It's a no-brainer that a nutrient-depleted, unhealthy field will be much more vulnerable to pests, in comparison to a perfectly nutrient-healthy field. Some nutrient factors in the soil may contribute to the increased likelihood of undesired pest outbreaks. Excessive nitrogen is the most notable: reveal that too much leads to increased pest populations of arthropods (i.e. **aphids**, mites, etc.), so take care not to go overboard!

Weak, undernourished plants also send out chemical signals to pests that they are languishing thus, depleted plants without adequate nutrition quickly hasten their own end.

On the other hand, healthy plants with plenty of nutrients do just the opposite, **attracting more beneficial bugs** than harmful varieties, even some that are ready to dine on nearby pests to prevent damage!

3.2.4. Soil Conditions

Plant nutrients can hold sway over soil conditions at times, most specifically on soil pH, or acidity versus alkalinity. In fact, it can be better said that pH determines nutrient availability, rather than the other way around. More acidic soils tend to have less bioavailability of certain nutrients, such as calcium, magnesium, potassium, and others; alkaline soils may have an excess of the same.

Table 1. Nutrient requirement of some fruit crops

Common name	N g /tree /yr	N mg / tree / day	WW required (l) @ 30-44 mg/l N	P g / tree / yr	P mg / tree / day	WW required (l) @ 1-5 mg/l P	K g / tree / yr	K mg /tree / day	WW required (l) @ 11-15 mg/l K
Ber (*Zizyphus mauritiana)*	450	1233	28-41	150	411	82-411	150	411	22-31
Mango (*Mangifera indica)*									
1 yr old sapling	100	274	6-9	75	205	41-205	100	274	15-21
5 yr old plant	500	1370	31-46	450	1233	246-1233	400	1096	60-83
Guava (*Psidium guajava)*									8-42
1-2 yr old sapling	50	137	3-5	30	82	16-82	50	137	30-42
5 yr old plant	200	548	12-18	120	329	66-329	200	548	
Orange (*Citrus spp)*									
1 yr old sapling	50	137	3-5	50	137	27-137	50	137	8-12
5 yr old plant	250	685	16-23	250	685	136-685	250	685	37-42

Self-Check -3	Written Test

Directions: Answer all the questions listed below. Use the Answer sheet provided in the next page:

1. What is plant nutrients? (3pts)
2. Discus the symptoms of deficiency of nutrients? (3pts)
3. Discus the growth stage of plant for their nutrient requirements? (3pts)

***Note:* Satisfactory rating – above 9 points** **Unsatisfactory - below 9 points**

You can ask you teacher for the copy of the correct answers.

Answer Sheet

Score = ____________
Rating: _____________

Name: ___________________________ Date: ________________

Information Sheet-4	Investigating different sources of nutrients

4.1. Sources of nutrients

A. Fertilizer

When using soil or soil-based media, you might not need to fertilize the seedlings immediately because the substrate has residual fertility. However, with most soil-less substrates and during the production phase, seedlings need the addition of balanced nutrients. In this chapter, we describe the essential plant nutrients and discuss various organic and inorganic fertilizers.

Fertilizers provide plants with the nutrients necessary for healthy growth. Apart from the macronutrients N, P, K, Ca, Mg, and S there is a known suite of micronutrients (Fe, Mn, B, Cu, CI, Zn and Mo) that play important roles in the plant's metabolism.

When using soil-less substrates, apart from compost, it becomes very important to fertilize seedlings. Most soil-less media contain few or no nutrients and, with a few exceptions, their CEC is very low. Seedlings need nutrients from the growth substrate after the nutrients provided in the cotyledons become depleted. This is usually within the first couple of weeks after emergence — from then on, plants grown in a soil-less substrate need to be fertilized regularly and frequently. Fertilizer can be applied in various forms as either organic or inorganic fertilizer.

I. **Organic fertilizers**

Compost from vegetative matter or animal manure has been discussed in the previous section as an organic component of potting substrates. Due to its generally high nutrient content it is also a valuable fertilizer and helps improve the physical and chemical properties of soil-based mixtures.

a. **Animal manure**

Manure differs in its nutrient composition depending on the animal source (see page 49) and the season. This source will only have consistency if it is collected from reputable commercial farms where animals are fed a controlled and constant diet. In all cases where animal manure is used, include it in a composting programme.

Leave manure to rot for 6-10 weeks to reduce the risk of 'burning' plants due to high nitrogen concentrations. This is particularly important for chicken or other bird manure in which nitrogen levels are very high. You can test whether manure is ready by using the same method you can use for compost: put two handfuls of the moist material into a small plastic bag and leave it sealed for 24 hours in a dark place. If it heats up considerably and there is a strong smell of ammonia when you open the bag, it is not ready to use yet. Apart from nutrients, manure adds a high amount of organic matter to a potting substrate and improves its physical conditions. Analytical monitoring of the nutrient composition of manure is essential for uniform plant production. Weeds and insects can easily be introduced into the nursery with manure unless it is properly composted. Manure can also be suspended in water and used for irrigation. This practice utilizes mainly the nitrogen component in manure.

b. Composted green matter

Like manure, compost properties vary with its components, the composting duration and the temperatures maintained during composting. It takes considerable time and experience to produce compost of a uniform quality from batch to batch.

c. Animal waste

These include hoof and horn meal, bone meal, fish meal and chicken feathers. They are fertilizers which slowly release nutrients into the substrate. Hoof and horn meal and feathers are rich in nitrogen; bone and fish meals rich in phosphorus. These materials also have a positive influence on the porosity of the substrate.

II. **Inorganic fertilizers**

1) **Granular**

Inorganic fertilizers are divided into single fertilizers, compound fertilizers and full fertilizers. They can be applied by broadcasting or by mixing with the irrigation water ('fertigation'). Fertilizers are commonly known by the contents of the main nutrients N, P and K. The numbers on the bags show the content of these components. For example 20-10-20 fertilizer contains 20% N, 10% P, usually in the form of P205, and 20% K, usually in the form of K203. Urea, a single fertilizer containing only nitrogen is labeled 46-0-0, indicating that it has 46% nitrogen, but neither phosphorus nor potassium.

The remaining parts are made up of the non-N (P2 05, K20) parts of the molecules and inert carrier materials. When soil-less growth media are used, fertilizing with full fertilizers which also include micronutrients is necessary. Especially under tropical conditions and with irrigation, plants can grow actively throughout the year. This means that they need nutrients continuously and fertilizer needs to be applied at frequent intervals (weekly or fortnightly). Fertilizer should not be applied during germination, because it leads to increased bacterial and fungal infections. As seedlings develop, fertilizer schedules have to be adjusted. Some people use a mixture of fast- and slow-release fertilizers so that seedlings are planted into the field with a fertilizer reservoir.

2) **Controlled-release fertilizers**

Controlled-release fertilizers provide an attractive alternative to granular fertilizers. These are fertilizer 'cocktails' that slowly release nutrients to the substrate. The release depends on water availability or soil temperature.

Controlled-release fertilizers are more expensive than the more common water soluble fertilizers, but they have several advantages:

- The danger of over-fertilizing is reduced as the release of fertilizers occurs gradually fertilizing is necessary only occasionally, sometimes only once in a season.
- A balanced fertilizer mixture is provided at all times as the plants get what they need at different growth stages nutrients do not leach from the substrate so the plants receive all the nutrients applied.

The principle of controlled-release fertilizers

In products using the Osmocote technology, resins based on natural organic oils, such as soybean or linseed oil, are used to coat fertilizers. Different thicknesses of resin coating are applied to the base fertilizer to achieve different release periods. Water enters the granule and dissolves the nutrients and they pass through the coating at a rate controlled by the soil temperature. Controlled release fertilizers provide an attractive alternative to granular fertilizers.

As temperatures fluctuate the rate of nutrient release changes, matching plant demand as growth rates rise and fall in correlation with these changes. The resin coating remains intact throughout the life of the product. When all nutrients are expended the coating dissolves. There are products for specific markets, such as ornamentals, vegetables and nursery production. They last from 3-4 months to 16-18 months depending on the soil temperature. Estimated lifetime is based on an average temperature of 21°C; release rates change by about 25% for every 5°C. In a tropical environment with an average soil temperature of 28°C, a product labelled four months would last roughly three months.

Self-Check -4	Written Test

Directions: Answer all the questions listed below. Use the Answer sheet provided in the next page:

1. Discuss the sources of plant nutrients? (3pts.)
2. What are the principles of controlled-release fertilizers? (2pts.)

Note: **Satisfactory rating – 5 points** **Unsatisfactory - below 5 points**

You can ask you teacher for the copy of the correct answers.

Answer Sheet

Score = ___________
Rating: ____________

Name: ___________________________ Date: _______________

Short Answer Questions

Information Sheet-5	**Analyzing growing media on chemical, physical and biological characteristics**

5.1. Analyzing growing media

5.1.1. Physical characteristics

The physical properties of the substrate may include:

i. Color:

It is produced by the minerals present and by the organic matter content. Yellow or red soil indicates the presence of oxidized ferric iron oxides. Dark brown or black color in soil indicates that the soil has a high organic matter content. Wet soil will appear darker than dry soil.

Fig6. soil colour

ii. Texture: It explains the relative size particles of the substrate

- Sand/gravel
- Clay
- silt

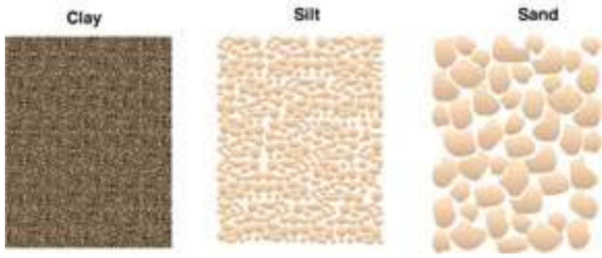

Fig7. Texture of the soil

iii. **Structure**

When particles are unorganized, soil structure is poor (right). When particles are organized into larger particles, such as clay particles "glued" by decomposed organic matter or humus, soil structure improves, increasing air porosity.

Mixing components of varying particle size dramatically affects air porosity. For example, smaller particles located in the spaces left by larger particles reduce pore diameter (Fig. 3). Mineral soils tend to have smaller particles. When mixed with organic components, which usually are comprised of larger particles, soil lodges between the larger particles, reducing air porosity and increasing water retention.

Water-holding capacity

A substrate that allows a large amount of water to be held without water logging does not need frequent irrigation. The water-holding capacity is also a function of the container used. In shallow containers the substrate has a higher water-holding capacity than in deep containers.

Use an ordinary sponge to show how container height affects the water holding capacity: saturate the sponge and hold it flat over a tray (A). When the sponge stops dripping, turn it on its side — more water will drop out (B). When it stops dripping, stand it on end and more water will drain into the tray (C). Each time the height of the water column in the sponge increases, the amount of water it can hold decreases.

In other words, deeper containers hold proportionally less water than the same amount of substrate in a shallow container. This explains why native soils, when put into a container, are often waterlogged: their depth has been reduced from meters to a few centimeters.

Calculating water-holding capacity and porosity , You can calculate the water-holding capacity and porosity of a substrate by the following steps:

1. With drainage holes sealed in an empty container, fill the container with water and record the volume required to fill the top of the container. This is the container volume.
2. Empty and dry the sealed container and fill it with dry substrate to the top.
3. Using a measured volume of water, irrigate the substrate in the container very slowly until it is saturated with water. This might take several hours; you must be sure you don't trap air in the substrate. The saturation point is reached when water stays visible

on the surface of the medium. Note how much water you have used. The volume of water needed to reach this point is called the total pore volume.

4. Remove the seal from the drainage holes and catch the water as it runs out. Wait several hours until all water has dropped out. Record the volume collected - this is the aeration pore volume.
5. Calculate total porosity, aeration porosity and water-holding porosity using the following equations:
    - Total porosity (%) = total pore volume / container volume * 100
    - Aeration porosity (%) = aeration pore volume / container volume* 100
    - Water-holding porosity (%) = total porosity – aeration porosity.
    - A good growing medium for most agro-forestry trees has a total porosity of above 50% of which 30-50% is aeration.

Porosity

A good porosity is needed to allow sufficient oxygen to reach the roots to prevent rotting. All living cells, including plant roots, need oxygen for respiration and growth, and they give off carbon dioxide. To maintain adequate oxygen and carbon dioxide levels in the substrate, gas exchange with the atmosphere must be guaranteed. Oxygen content of below 12% in the substrate inhibits new root initiation; between 5 and 10% the levels are too low for established roots to grow; and at levels below 3%, roots do not function and eventually they die. Desirable total porosity values which maintain oxygen levels above 12% are around 50-80% by volume. Clay soils, which are unsuitable for seedling production, can have values of 40% or lower.

Plasticity

A substrate that shrinks and cracks when drying, such as a clayey soil, damages the plants by shearing off roots.

Bulk density

A substrate that has a light weight is easier to transport to the field. However, containers have to be sufficiently heavy so that they do not get blown over in the wind.

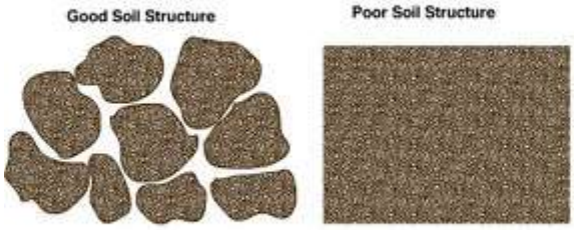

fig7. soilstructure

5.1.2. Chemical properties

Fertility

As soon as a seedling has used up the nutrients provided by its cotyledons (about two weeks after germination), it needs nutrients from the growth medium. The basic nutrients, of which plants require relatively large amounts, are nitrogen (N), phosphorus (P) and potassium (K). Plants also need very small amounts of other nutrients ('micronutrients') and deficiencies in micronutrients can occur in the nursery. The micronutrients that agro-forestry trees are most often lacking are iron (yellow, 'chlorotic' leaves), especially in soils with a high pH or those derived from limestone, and boron (shoot tip dries out), especially in soils from igneous rocks.

Acidity

The right substrate pH is very important for healthy plant development. The reason for this is that nutrients become available for plants at different pH levels. The optimum is around 5.5 for organic soils and around 6.5 for mineral soils. Most plants grow best in a medium with near-neutral pH (5.5-6.5), although some plants are particularly tolerant of acidity (for example Inga edulis, Casuarina junghuhniana) or alkalinity (for example Prosopis chilensis, Tecoma stans).

Buffer capacity/cation exchange capacity

The cation exchange capacity (CEC) is the ability of a material to adsorb positively charged ions ('cations'). It is one of the most important factors affecting the fertility of a growth substrate. The main cations involved in plant nutrition are calcium, magnesium, potassium and ammonium, listed in order of decreasing retention in the substrate. Many micronutrients are also adsorbed, such as iron, manganese, zinc and copper.

These nutrients are stored on growth medium particles until they are taken up by the root system. In practical terms, the CEC indicates the fertilizer storage capacity of the substrate and indicates how frequently fertilizer needs to be applied. Some soils contain high amounts of clays which absorb cations so strongly that they become unavailable for plant nutrition (mineral 'fixation').

These soils are unsuitable for nursery purposes. Although the CEC of some soil-less substrates is very high, anions get washed out easily and need to be replenished frequently. This is particularly important for phosphorus and for nitrogen in the form of nitrate. Mixing a slow-release P fertilizer, such as rock phosphate, into the substrate before planting can help alleviate this problem.

Bulk densities and CEC for various growth substrates

CEC is traditionally measured on a weight basis for field soils, but CEC per volume is more meaningful for container growth media, because of the relatively low bulk density of most media and the small volumes of the containers. CEC values for some typical growth medium components are compared below. Vermiculite and peat moss have the highest CEC values, whereas materials such as perlite and sand have very low CEC values.

substrate	approximate dry bulk density (g/L)	CEC meq/L
perlite	ca 100	1.5–3.5
sand	1400–1700	45–105
pine/fir bark	200–300	ca 100
vermiculite	ca 120	88–165
peat	ca 110	110–198

5.1.3. Biological characteristics

The biological characteristic of the growing media refers to composting which includes decaying plant material, humus and micro-biotic content. Composting is the physical and chemical breakdown of materials that liberates nutrients available to plants. Microorganisms (fungi and bacteria) digest the material during decomposition. Compost from green material generally has a high nutrient level and a good CEC. Producing consistently good compost takes practice and it may be worthwhile to conduct studies to learn how different species react to the addition of compost to their potting medium, and to make adjustments if necessary. Any organic material can be composted; a mixture of materials is best.

Producing compost

Each nursery site can have unique materials for composting because all that is needed is a very large supply of low cost vegetative material (green matter shrinks to only a fifth of its original volume during the composting process). For compost production the only machine needed is a straw cutter, cheap and available in any agricultural community. This is needed because the vegetative material must be chopped to fairly uniform small sizes. The compost heaps will be above the ground and can be either in the open during the dry season or under shelter from rain. Good compost requires careful management of the micro-organisms which digest the vegetative material — their diet is best fed with vegetative material having a C:N ratio of 25-30 (see examples on p. 40). They also require moisture and oxygen. Heaps should not be wet — the best moisture level is 55%. Initially there will be adequate oxygen but as the micro-organisms function.

To make good compost you need material with a C: N ratio of 25-30. Keep the heap at 55% moisture and at a temperature of about 60°C. This will be used up in the process of digestion. In addition, the temperature of the heap will quickly increase due to the activity of the micro-organisms. Two types of micro-organisms are present in the compost-making process: (1) the 'normal' type, which occurs in abundance during normal decomposition; (2) 'thermophilic' (temperature loving) micro-organisms. The normal microorganisms quickly raise the temperature of the heap to 40°C. At this temperature they die, leaving the thermophilic micro-organisms to continue digestion. These heat-loving organisms operate very quickly, raising the temperature considerably and using up oxygen rapidly. They die if the temperature exceeds 65°C, the oxygen supply fails or the heap becomes either too dry or too wet.

C: N values for some materials

Material	C: N ratio
Cow manure	18
Horse manure	25
Young hay clippings	12
Cut straw	48
Rotted sawdust	208-210

Raw sawdust	400-511
Sugarcane trash	50
Fruit wastes	35
Cabbages	12
Tobacco	15
Potato tops	25
Pine wood	723

In general, substrate/growing media should:

- Be light in weight to ease transport to the planting site
- Hold cuttings or seedlings firmly in place
- Retain enough moisture to avoid need for frequent watering
- Be porous enough for excess water to drain easily
- Allow sufficient aeration of the roots
- Be free from seeds, nematodes and diseases
- Be able to be sterilized without changing its properties
- Have enough nutrients for a healthy initial development of plants
- Not have a high salinity level
- Have a suitable ph
- Be stable and not swell or shrink excessively or crust over in the sun.

Self-Check -5	Written Test

Directions: Answer all the questions listed below. Use the Answer sheet provided in the next page:

1. List the major the properties of growing media? (3pts.)
2. What are the importance of knowing the properties of growing media? (3pts.)
3. Write the general characteristics of growing media? (3pts.)

Note: **Satisfactory rating – 9 points** **Unsatisfactory - below 9 points**

You can ask you teacher for the copy of the correct answers.

Answer Sheet

Score = ____________

Rating: _____________

Name: ___________________________ Date: ________________

Short Answer Questions

Information Sheet-6	Determining the sterilization method of growing media

6.1. **Methods of growing media sterilization**

Sterilization may be used to destroy soil or media borne pathogens known to be harmful to plants or seedlings. The acceptable techniques may include:

A. High temperature

For seeds, tubers and roots, hot water soaks (40-55°C) are recommended. Temperature and duration depend on the species. You can find the best range with simple experimenting, for example by soaking material at two different temperatures for half an hour, two hours and four hours. Eg heat

Table 3. Temperature necessary to kill soil pests

s/no.	Temperature required(deg.F)	
1	115	Water molds (pythium and phytophthora)
2	120	Nematodes
3	135	Worms, slugs, centipedes
4	140	Most plant pathogenic bacteria
5	160	Soil insects
6	180	Most weed seeds
7	215	Few resistant weed seeds& plant viruses

B. Chemicals

Dipping cuttings into a 10% household bleach solution for 20 minutes is a practice recommended for some hardwoods but it should be tested for phytotoxicity on all species first.

Fungicides : Seeds or cuttings can be coated with a dust or slurry of fungicides. Captan and Benlate are the most commonly used fungicides for seed treatment. Captan is a contact fungicide which kills pathogens present on the seed coat; Benlate is a systemic fungicide which penetrates into the seed and has an effect on the embryo during germination, giving the seed a longer-lasting protection. However, most fungicides have a high toxicity to seeds and they often act only on one of the number of pathogens that are usually present. Recent work suggests that coating the seed with a bacterial formulation, esp. Trichoderma harzianum or Pseudomonas spp., would be helpful. However, for the time being, this technique is out of reach for most institutions in developing countries.

Table 4. Fungicides and their effect on a few fungi

Chemical	**Rate of application**	**Effect against**
Captan	2 g/l of water	Pythium, Fusarium, Rhizoctonia and Phytophthora. Some extent to root and stem rot, white mold,black rot, crown rot and damping off.
Metalaxyl + Mancozeb (Ridomil MZ 72 WP)	1 g/l of water	Pythium, Phytophthora, Fusarium and other soil borne pathogens

Self-Check -6	Written Test

Directions: Answer all the questions listed below. Use the Answer sheet provided in the next page:

1. What is soil media sterilization?(4pts)
2. Discus types of sterilization methods? (3pts.)

Note: **Satisfactory rating – 7 points** **Unsatisfactory - below 7 points**

You can ask you teacher for the copy of the correct answers.

Answer Sheet

Score = ___________

Rating: ____________

Name: _________________________ Date: _______________

Short Answer Questions

Information Sheet-7	Establishing growing media composition

7.1. **Growing media composition**

The most common material used in growing media are made of peat moss, perlite, vermiculite, bark, soil and sand. Soil is a very complex and can vary from muck to sand. Even though soil has the advantage to be cheap, it remains very difficult to find soil of good quality. Furthermore, soil, which is usually heavy (50 lbs/cuft) can be inconsistent from year to year, it has to be sterilized since it may contain toxic material such as pesticide residues or can be contaminated with weed seeds. Sand, an inert material, is usually used to add weight to mixes. Like soil, because of possibility of pathogen and weed seed contamination, sand should be sterilized and knowing where the sand comes from will be a good indication .Wood shavings, chips, and sawdust can be used because in some areas they are in high quantity and are inexpensive. However, they have the disadvantage of lacking nitrogen depriving the plants of the nitrogen and in that case additional nitrogen needs to be supplemented.

The main factors affect composition of growing media

1. air and water status in containers
2. the media components and ratios,
3. height of the media in the container,
4. type of crops will plant
5. media handling and watering practices.

Table5. Composition of media component

Volume/Volume Ratio	Components
2:1	Peat, Perlite z
2:1:1	Peat, Perlite, Vermiculite
2:1	Peat, Sand 3:1 Peat, Sand
3:1:1	Peat, Perlite, Vermiculite

2:1:1	Peat, Bark, Sand
2:1:1	Peat, Bark, Perlite
3:1:1	Peat, Bark, Sand
2:1	vermiculite + FYM

Table6. Contents of nutrient ratio in fresh animal manure

Approximate nutrient contents of fresh manure of various farm animals			
	nitrogen (%)	phosphoric acid (%)	potassium (%)
cow	0.35	0.2	0.1-0.5
goat/sheep	0.5-0.8	0.2-0.6	0.3-0.7
PIg	0.55	0.4-0.75	0.1-0.5
chicken	1.7	1.6	0.6-1
horse	0.3-0.6	0.3	0.5

Self-Check -7	Written Test

Directions: Answer all the questions listed below. Use the Answer sheet provided in the next page:

1. What is the importance of knowing the composition of growing media? (3pts.)
2. Discus the factors which affect the composition of growing media? (2pts)

Note: **Satisfactory rating – 7 points** **Unsatisfactory - below 7 points**

You can ask you teacher for the copy of the correct answers.

Answer Sheet

Score = ___________

Rating: ____________

Name: _________________________ Date: _______________

Short Answer Questions

Reference

1. Handreck K A 1983 Particle size and the physical properties of growing media for containers. Commun. Soil Sci. Plant Anal. 14, 209–222.
2. Ed Bloodnick 2018. Fundamentals of Growing Media
3. Bartok, John W.; 1994. Steam Sterilization of Growing Media
4. https://m.espacepourlavie.ca/en/plants-nutrient-requirements

Horticultural Crops Production

Level -III

Learning Guide-16

Unit of Competence: Design and prepare growing media /soil

Module Title: Designing and preparing growing media /soil

LG Code: AGR HCP3 M05 LO2-LG-16

TTLM Code: AGR HCP3 TTLM 0120v1

LO 2: Prepare and store growing media

Instruction Sheet	Learning Guide # 16

This learning guide is developed to provide you the necessary information regarding the following content coverage and topics:

- Undertaking work
- Storing components in a safe and hygienic environment.
- Weighing, mix media components
- Storing Media in safe and hygienic

This guide will also assist you to attain the learning outcome stated in the cover page. Specifically, upon completion of this Learning Guide, you will be able to:

- Undertake work
- Store components in a safe and hygienic environment.
- Weigh, mix media components
- Store Media in safe and hygienic

Learning Instructions:

1. Read the specific objectives of this Learning Guide.
2. Follow the instructions described below 3 to 6.
3. Read the information written in the information "Sheet 1-4".
4. Accomplish the "Self-check 1-4" in page 44, 47, 53 and 58 respectively.
5. If you earned a satisfactory evaluation from the "Self-check" proceed to "Operation Sheet 1" in page -59.
6. Do the "LAP test" in page – 62 (if you are ready).

Information Sheet-1	Undertaking work

1.1. Major activities of preparing growing media

1. Preparing materials tools and equipment
2. Use personal protective equipment
3. Identifying the media components includes compost, peat, vermiculite, sand, etc.)
4. Mixing the media components according to the correct ratio of required
5. Treating the mixes
6. Storing the prepared media in well-designed place
7. Keeping the hygiene of the media and the environment as well
8. Cleaning, maintain and storing of the materials tools and equipment
9. Management and Dispose wastes materials tools and equipment

Self-Check -1	Written Test

Directions: Answer all the questions listed below. Use the Answer sheet provided in the next page:

1. Discus the major activities of papering growing media? **(3pts)**

***Note:* Satisfactory rating above 3 points Unsatisfactory - below 3 points**

You can ask you teacher for the copy of the correct answers.

Answer Sheet

Score = ___________

Rating: ____________

Name: _________________________ Date: _______________

Short Answer Questions

Information Sheet-2	Storing components in a safe and hygienic environment.

2.1. Production requirements of Media Components

The general requirements of organic growing media from a plant-raisers perspective. The physical requirements for organic growing media are that there is a suitable balance of water, air and particle sizes. It must be capable of being made into blocks or filled into modules or pots mechanically, anchoring plant roots and also holding together for mechanical planting. It should wet up and re-wet evenly and not slump.

The biological requirements are that it is free of plant pathogens or viruses, pests and weed seeds. It should be biologically active and safe to handle for operators. The chemical requirements are suitable pH, correct levels of nutrients for germination and growth, some buffering capacity and no contamination. Other requirements are that it should be ready to use, perform consistently and reliably and have a reasonable shelf-life. Rigorous quality control and full traceability are important, with a full and open specification.

2.2. Storing of growing media components

The raised covered slab or covered bin facilities suggested for component storage can be used for prepared media. Media prepared with the proper fertilizer amendments should generally be stored in such a way to minimize leaching. Since there can be release of fertilizers in the medium during storage and salt levels could reach critical levels, the salinity level of media stored for several weeks should be determined before it is used. Avoid this problem by preparing or purchasing only the amount of media needed to satisfy the short-term demand.

2.2.1. Component Storage

Components must be stored off the ground and protected from surface water. A concrete slab or bin is ideal for components received in bulk. The surface water patterns around the concrete slab must be adjusted to eliminate the possibility that surface water, carrying pathogens, weed seeds and/or insects, could come into contact with the medium component. Bulk components should be covered with black plastic film or other suitable covering to prevent contamination with wind-borne seeds, pathogens and other pests when access is not necessary. The length of storage period determines whether bagged components are stored outdoors or at least under cover. Most bags will remain intact outdoors for 6 to 8 weeks, but if an annual supply is purchased, indoor storage is needed. Covering bags stored outdoors with opaque plastic film will extend the life of the bags.

Self-Check -2	Written Test

Directions: Answer all the questions listed below. Use the Answer sheet provided in the next page:

1. Discus the media component storage structures? (5pts)
2. Explain the production requirements of component storage? (3pts.)

Note: **Satisfactory rating –8 points** **Unsatisfactory - below 8points**

Answer Sheet

Score = ___________

Rating: ____________

Name: _________________________ Date: _______________

Short Answer Questions

Information Sheet-3	Weighing, mix media components

3.1. Weighing/ calculating the amount of substrate needed

Before mixing, you need to know roughly how much substrate you will need. Start with the container volume and the number of containers to fill. To calculate volume seal the drainage holes of the container and fill it with water from a measuring cylinder, noting how much water you filled. Or can calculate it by measuring the height and diameter of the container, assuming it is cylindrical:

Volume = hr2

(height x 1/2 diameter squared x 3.1416).

Once you know the volume of the container, multiply this by the number of containers needed.

For example: volume = 500 ml; 10, 000 seedlings needed.

Total volume needed is 500 x 10 000 = 5 000, 000 ml or 5000 liters or 5 m3. Then calculate the amount of each component needed

3.1.1. Mixing Growing Media

Improper media mixing is one of the major causes of variation in container plant quality. Mixing should be performed by diligent, experienced workers who will faithfully monitor the growing media quality. Creating a uniformly mixed growing medium that has not been compacted, contaminated, or compromised is the challenge and the goal.

Small batches of growing media ingredients can be mixed by hand. Measure out the ingredients by volume and mix together in a wheelbarrow or bucket. Workers can mix larger batches on any clean, hard surface using hand shovels. Pile the ingredients on top of one another and broadcast any amendments over the pile. Then work around the edge of the pile with a large scoop shovel, taking one shovel full of material at a time and turning it over onto the top of the pile. Make sure that all parts of the pile are mixed by gradually moving the location of the pile

Fig8. Mixing of growing media

When mixing, it is important that all components are finely ground and sieved through a 5 mm sieve to remove excessively large particles. When mixing by hand, the components are placed in layers on a heap and then turned thoroughly with a shovel. Alternatively, a cement mixer or a drum can be used. When peat or shredded bark is part of the mixture, it is very important that the material is wetted before mixing. Although the literature often recommends the addition of wetting agents, this is not necessary when special attention is given to thorough wetting of the mixture during the mixing process.

fig9. Screening growing medium ingredients may be necessary to achieve the desired particle size

Fig10. Nurseries that mix their own media can do so by hand or by using the moving pile technique

General mixing and handling

- Testing the media pH and total soluble salt (electrical conductivity)and wettability before use
- Do not make change to your current growing media with out experimenting
- Do not over mix
- Do not store media that contain fertilizer for long period of time ,especially, if the media is moist
- Avoid contamination

A. For germination

Often fine, washed quartz sand (0.5-1 mm) is adequate. However, it needs constant monitoring as sand dries out easily. If easily available, fine grade vermiculite, vermiculite mixed with peat or hammer milled and composted bark, or composted coconut husks are good alternatives.

B. For cuttings

Depending on the species' moisture requirements, fine, washed quartz sand, sand mixed with fine gravel at various ratios or composted sawdust, bark or vermiculite is used. When starting with a new species, the best bet is usually sand (2 mm fraction), and research at a later stage will determine if any of the other media are better. Sterile media without nutrients are usually recommended in the rooting stage, and once rooted the cuttings can be transferred to other substrates with fertilizers. Alternatively, cuttings can also be rooted in substrates treated with fertilizers, which will avoid the transplanting step. However, in substrates containing fertilizer, infection of the cuttings with bacterial molds and algae growth are more prevalent. It is very important that cuttings should not be set in soil or media containing soil because these substrates usually do not have the required high porosity for sufficient gas exchange, which can lead to rotting of the cuttings. Exceptions are stakes of easy-to-root species (such as Gliricidia sepium) that can be directly struck at the final field location.

C. For container seedling production

There are probably as many recommended potting mixtures as there are nurseries. Global recommendations do not exist. Usually the mixtures contain vermiculite, peat or hammer-milled bark in various proportions, and fertilizers. For tropical countries alternative substrates, such as coconut husks, rice hulls and compost have given good results with various species. Although the use of many different mixtures in a nursery is not feasible, simple screening experiments testing three or four mixtures can easily be carried out for each species.

Although many soils-less media do not contain nutrients, they are very popular in commercial plant propagation. This is mainly because the fertilizer schedule for the plants can be individually tailored to each species and development stage. Compost, on the other hand, is popular because it is usually so rich in nutrients that it can be used as a substrate which at the same time has good fertilizer properties.

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Self-Check -3	Written Test

Directions: Answer all the questions listed below. Use the Answer sheet provided in the next page:

1. Why the weighing of growing media is important before mixing?()3pts
2. Discus the general mixing and handling?(4pts)

Note: **Satisfactory rating – 7 points** **Unsatisfactory - below 7 points**

You can ask you teacher for the copy of the correct answers.

Answer Sheet

Score = ___________

Rating: ____________

Name: _________________________ Date: _______________

Short Answer Questions

Information Sheet-4	Storing media in safe and hygienic manner

4.1. Storing media

Quality manufacturers of growing media products, peat moss and aggregates strive to produce and deliver products in a safe environment that ensures product freshness. Herbicides or other harmful chemicals are not kept in or near the manufacturing facilities. Every effort is made to select shipping carriers that are reputable and agreements require them to operate clean trailers. In order to ensure your satisfaction, consider these suggestions and implement similar safety and product freshness measures as well to help maintain the quality of the products you receive.

Proper Storage

Once the mix has been removed from the delivery truck, ensure the mix has been properly stored. Sometimes algae builds up within the layers of shrink wrap and can give a false impression of the mix's quality. Most pallets are capped with black plastic and shrink wrapped, so the less light that can be provided to the packages, the better.

Some growers who do not have facilities for mix storage will cover the entire soil load with opaque tarps. If growers store mix longer than six to eight months in full sun, weathering of the wrapping material and a reduction in wetting-agent efficacy may occur. Long-term storage under extreme conditions can make a mix difficult to wet. If such conditions exist, test the mix for wettability before potting. Avoid placing heavy items on top of the pallets that would compress and compact the mix.

Storing the mix in a dry, low-light environment is always best. If the environment can be controlled, try to keep the temperature between 40 and 70¡ F, especially when using biologicals and controlled-release fertilizers that are sensitive to temperature extremes. Mixes should not be stored in greenhouses during production for fear of accidental wetting, adult fungus gnat movement into bags and reduced wetting agent efficacy from extreme heat.

A. Inside Storage

It is preferable to store growing media products inside a building with a clean, solid floor. Exposure to excessive heat and sunlight causes decay of packaging and accelerates degradation of nutrients and wetting agents in mixes. Products should be kept on shrink-wrapped and covered pallets until time of use. No product should be stored under or near chemicals such as herbicides, insecticides, disinfectants or even fertilizers. Whether liquid or dry, such chemicals can penetrate packaging and affect the contents. Growing media products should also be stored away from seed and seed products such as bird food, livestock feed, and forage or pasture seeds, which are common in warehouse and retail settings.

B. Outside Storage

If it is necessary to keep potting mixes, peat moss or aggregates outside, they should be stacked on pallets or a raised platform to minimize exposure to vegetation, water and soil. The stacked bales or bags should be shrink-wrapped and under an open-air roof or covered with a tarp. The goal is to eliminate direct sunlight and precipitation, yet provide ample circulation and prevention of heat build-up. Prolonged heat exposure can result in drying or hardening of growing mixes and peat moss as well as degradation of wetting agents. If not protected appropriately, water can enter loose-fill bags through the vent holes if exposed to precipitation. When growing mixes get wet in the bag, nutrients can be lost and lime is activated causing pH to rise. This leads to performance issues when the product is used.

Products stored outside should not be placed where they are subject to drift, splash or spray from chemicals used on farms, ranches, railroads, power lines, ditches, manufacturing facilities, roadways, etc. Furthermore, bales or bags kept outside are more likely to pick up drifting weed seeds that get caught in folds or stick to the packaging.

4.2. Shelf Life

Normal stock rotation practices i.e., first in/first out (FIFO) should be observed with growing media products. Ensure that potting mix ships to you soon after being manufactured, and work with your potting mix manufacturer to be able to read and understand their dating/coding system. Ideally, all plug and propagation mixes should be used within the first six months of being manufactured. If plug and germination mixes are one year or older from the date of manufacture they should be properly disposed.

Standard potting mixes should not be stored for more than six months either. However, the usage of these mixes may be possible up to one year. If the product is older than one year according to the production code on the bag or bale, you should test the mix for wettability prior to planting.

4.3. Controlled-Release Fertilizers and Special Additives

Some growing media manufacturers offer flexibility and convenience by incorporating controlled-release fertilizers (CRF), fungicides, or other special amendments and additives into growing mixes. However, precautions apply. Please note that all controlled release fertilizers are not created equal and therefore manufacturers have specific storage guidelines when they are added to potting mixes. Most CRF manufacturers suggest that potting mixes be used within one week after manufacturing, with some exceptions. Refer to the CRF product label for specific instructions on longevity and usage of CRF incorporated potting mixes.

Incorporated bio-fungicides and similar products can also have a shelf life and are affected by storage conditions such as temperature, moisture and oxygen. It is important that the mix not only be used rather quickly (ideally within a few weeks; check with the manufacturer) but also be stored out of harsh conditions as noted above.

4.4. Production Codes

Most reputable mix manufacturers stamp or label their products in some manner with production codes. For example, Sunshine will have an adhesive sticker on the side of the bag or bale with a code such as E10 215, which means the product was produced at the

Elma, MB facility in 2010 on the 215th day of the year. A placard is often attached to the pallet shrink-wrap with the same information. We encourage the education of all employees on how to read and understand the production codes. This will aid in maintaining FIFO practices and maximum mix performance.

In addition to producing quality products, reputable growing media, peat moss and aggregates manufacturers will perform extensive tests to assure quality. Records and samples are kept from each lot produced. Every bag or bale should have a code number and record, which should be traceable to bills of lading and/or invoices as needed. This information can be very useful if a question arises as to the quality or freshness of a product. As growers, you should also keep records of these numbers on your own invoices or production records.

Self-Check -3	Written Test

Directions: Answer all the questions listed below. Use the Answer sheet provided in the next page:

1. What is the importance of storing the media? (3pts)
2. Discus the internal storage and external storage? (3pts)

   a._____________________________________

   b. _____________________________________

Note: **Satisfactory rating - 6 points** **Unsatisfactory - below 6 points**

You can ask you teacher for the copy of the correct answers.

Answer Sheet

Score = ____________

Rating: _____________

Name: ___________________________ Date: ________________

Short Answer Questions

Operation sheet	Weighing, mix media components

Objective: to know the mixing proportion of media

Tools and Materials and Equipment:

- Glove
- Protective clothing
- Shovel
- Garden Hoe
- Digging Fork
- Wheel barrow
- Large heavy duty tarp
- water hose
- clear plastic sheeting (for solarizing)
- large plastic containers or feed sacks (for storing unused blends) large plastic garbage cans with lids are great or large buckets also with lids
- large sifter or screen

Procedure:

1. All-purpose mix: can be used everywhere outside, in garden beds, raised flower beds etc. (used as basis for other mixes further down the page)

- 1/3 mature compost screened
- 1/3 garden topsoil
- 1/3 sharp sand

2. Seedling starter mix:

- 2 parts compost screened
- 2 parts peat moss, pre-wet

- 1 part vermiculite, pre-wet
- 1/2 part sand

3. Planters and hanging pots:

- 4 parts all-purpose mix (#1)
- 2 part peat moss
- 1 part perlite or vermiculite

4. Mix for rooted cuttings:

- 1 part all-purpose mix (#1)
- 1 part sand
- 1 part vermiculite

5. Mix for acid loving plants: ==> Azaleas, gardenias, blueberries etc.

- 2 parts all-purpose mix (#1)
- 3 parts peat moss pre-wet
- 1 part sheep or cow manure, 2 season aged or readily available in bags at the gardening centers
- 1 part sand

6. Mix for flower beds: ==> Lavendar, Geraniums, Chrysanthemums, Fuchsias etc.

- 2 parts all-purpose mix (#1)
- 1 part sand
- 1/2 part peat moss pre-wet
- 1 part sheep or cow manure
- 1 lb of bone meal to each bushel of mix

7. Heavy Veggie plot mix: (cauliflower, broccoli, squash, jack-o-lantern pumpkins etc.)

- 3 parts al- purpose mix (#1)
- 1 part compost
- 1 part cow or sheep manure, 1 year + aged or the readily available in bags at the gardening centers
- 1 part vermi-compost (if available)

8. Potting mixture for cactus and succulents: (Hens and Chicks, Sedum telephium etc.)

- 2 parts all-purpose mix (#1)
- 2 parts sand

- 1 part perlite
- 1 lb bone meal per bushel of mix
- 1 lb lime per bushel of mix

9. In-house potting soil: (works super well)

- 1 part all -purpose mix (#1)
- 1 part sand
- 1 cup Epsom salt per 1/2 bushel of mix
- 2 -3 cups coffee grounds
- 12 dried and crushed eggshells

10. Potting mix for trees and bushes:

- 3 parts all - purpose mix (#1)
- 1 part sand
- 1 part vermiculite
- 1 part perlite
- 1lb bone meal per bushel of mix

LAP Test 1	Weighing, mix media components

Name: ______________________________ Date: ________________

Time started: ________________________ Time finished: ________________

Instructions: Given necessary templates, tools and materials you are required to perform the following tasks

Task 1: perform mixing of media components.

Reference

1. Thomas D. Landis, Douglass F. Jacobs, Kim M. Wilkinson, and Tara Luna. Growing media
2. Laurent Boudreau, Harold Fonda, Jamie Gibson, Hugh Poole, Bob Steinkamp and Michael Tilley, 2009. Growing Media Handling Guide
3. Todd Cavins, 2010. Media Storage Basics

Horticultural Crops Production

Level -III

Learning Guide-17

Unit of Competence: Design and prepare growing media /soil

Module Title: Designing and preparing growing media /soil

LG Code: AGR HCP3 M05 LO3-LG-17

TTLM Code: AGR HCP3 TTLM 0120v1

LO 3: Complete preparation and record growing media

Instruction Sheet	Learning Guide # 17

This learning guide is developed to provide you the necessary information regarding the following content coverage and topics:

- Safe handling and disposing of waste
- Maintaining required equipment
- Keeping records

This guide will also assist you to attain the learning outcome stated in the cover page. Specifically, upon completion of this Learning Guide, you will be able to:

- Dispose of waste
- Maintain required equipment
- Keep records

Learning Instructions:

1. Read the specific objectives of this Learning Guide.
2. Follow the instructions described below 3 to 4.
3. Read the information written in the information "Sheet 1-3".
4. Accomplish the "Self-check 1-3" in page -69, 72, and 74 respectively.

Information Sheet-1	Safe handling and disposing of waste

1.1. **Waste handling and management**

Waste management is the collection, transport, processing or disposal, managing and monitoring of waste materials. The term usually relates to materials produced by human activity, and the process is generally undertaken to reduce their effect on health, the environment or aesthetics. Waste management is a distinct practice from resource recovery which focuses on delaying the rate of consumption of natural resources. All wastes materials, whether they are solid, liquid, gaseous or radioactive fall within the remit of waste management

Waste management practices can differ for developed and developing nations, for urban and rural areas, and for residential and industrial producers. Management for non-hazardous waste residential and institutional waste in metropolitan areas is usually the responsibility of local government authorities, while management for non-hazardous commercial and industrial waste is usually the responsibility of the generator subject to local, national or international controls.

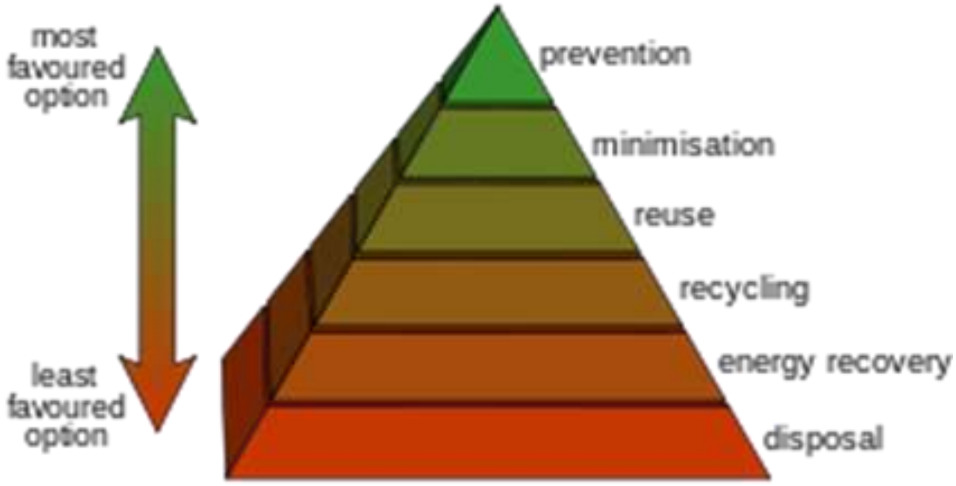

Fig. Diagram of the waste hierarchy.

There are a number of concepts about waste management which vary in their usage between countries or regions. Some of the most general, widely used concepts include:

Waste hierarchy - The waste hierarchy refers to the "3 Rs" reduce, reuse and recycle, which classify waste management strategies according to their desirability in terms of waste minimization. The waste hierarchy remains the cornerstone of most waste minimization strategies. The aim of the waste hierarchy is to extract the maximum practical benefits from products and to generate the minimum amount of waste see: resource recovery.

Polluter pays principle - the Polluter Pays Principle is a principle where the polluting party pays for the impact caused to the environment. With respect to waste management, this generally refers to the requirement for a waste generator to pay for appropriate disposal of the unrecoverable material.

1.2. Methods of disposal

A. Landfill

Disposal of growing media in landfill is unlikely to lead to a leaching risk because of the wide geographic spread of nurseries and relatively small quantities of waste discarded in different landfill sites. The situation would change if only a handful of landfill sites were used. Mixing with other waste is also likely to occur leading to a dilution effect. On landfill sites, temperatures generated in the mixed media can be extremely high and this will tend to result in a rapid degradation/denaturing of pesticide residues. Waste media is usually stored on site in a skip which is routinely collected and taken to a landfill site for disposal Waste media is disposed of to landfill sites when any of the following conditions apply:

- There is not enough space for a large compost heap.
- There is no other outlet for the waste.
- Nursery hygiene requires the waste to be removed
- The waste media does not easily biodegrade

B. **Incineration**

A waste treatment technology, which includes the combustion of waste for recovering energy, is called as “incineration”. Incineration coupled with high temperature waste treatments are recognized as thermal treatments. During the process of incineration, the waste material that is treated is converted in to IBM, gases, particles and heat. These products are later used for generation of electricity. The gases, flue gases are first treated for eradication of pollutants before going in to atmosphere.

Among waste-to-energy technologies, incineration stands taller. Other technologies are gasification, PDG, anaerobic digestion and Pyrolysis. Sometimes Incineration is conducted with out the reason for recovering energy.

In past, incineration was conducted without separating materials thus causing harm to environment. This un-separated waste was not free from bulky and recyclable materials, even. This resulted in risk for plant workers health and environment. Most of such plants and incinerations never generate electricity.

Incineration reduces the mass of the waste from 95 to 96 percent. This reduction depends upon the recovery degree and composition of materials. This means that incineration however, does not replace the need for landfilling but it reduced the amount to be thrown in it. Recycling

C. **Recycling**

It is a resource recovery practice that refers to the collection and reuse of waste materials such as empty beverage containers.

Self-Check -1	Written Test

Directions: Answer all the questions listed below. Use the Answer sheet provided in the next page:

1. What is waste? (2pts.)
2. Discus the routes or methods of disposing waste? (3pts)
   a.____________________________________
   b. ____________________________________
   c. ____________________________________
   d. ____________________________________

Note: **Satisfactory rating - 5 points** **Unsatisfactory - below 5 points**

You can ask you teacher for the copy of the correct answers.

Answer Sheet

Score = ___________

Rating: ____________

Name: ________________________ Date: _______________

Short Answer Questions

Information Sheet-2	Maintaining required equipment

2.1. Materials, tools and equipment

1. wheel barrow
2. shovels
3. bobcats and front end loaders.
4. large heavy duty tarp==> good for mixing large amounts of soil blends
5. water hose water
6. clear plastic sheeting (for solarizing)
7. large plastic containers or feed sacks (for storing unused blends) large plastic garbage cans with lids are great or large buckets also with lids
8. large sifter or screen ==> old window frame with 1/4" wire mesh stapled to it work perfectly great
9. mixer
10. spade

2.2. Handling Cleaning and maintain materials, tools and equipment

A. **Sanitation**: Prior to pot filling, ensure that all tools are clean, including box cutters, bale slicers, shovels and brooms. Dirty tools and containers may pose the risk of introducing soil-borne pathogens to a clean mix. If using a mixer, minimize the blending time to avoid a grinding effect that results in changes to physical properties (normally witnessed as a drop in air space and an increase in container capacity). A 2- to 10- percent reduction in air space has been observed before and after the mix is blended. Some growers have installed timers on augers and hoppers to control the amount of blending, while others count how long the mix is blended. For growers with pot fillers, try to avoid recycling, or reduce the fines that fall off of the mix line as this can reduce the air space and create "tighter" mixes.

B. Check Equipment

Equipment adjustments should be made prior to running flats and pots through the system. Gates on hoppers should deliver the right amount of mix to containers. Rollers and brushes should be set to minimize compaction and reduce excess mix to be recycled. Mix shrinkage in the container can be caused by a few factors: first, by the mix being too dry and flowing out of the bottom of the container through the drainage holes; second, by an excess of air in the mix because of "bridging" of particles during the filling process or not filling fully to the top of the container; or third, brushes set too low that remove mix below the rim of the container.

When substrates, in particular soil and organic material, are brought into a nursery, they provide easy ways for pests to come too. In bare-root nurseries or when practicing open-ground propagation, pests may accumulate in the soil and make large-scale treatments or, in extreme cases, a move to a new location, necessary.

The standard treatments for substrates are either chemical fumigation or sterilization with hot steam or sunlight. Chemical fumigation with methyl bromide or related chemicals is very hazardous and expensive. Methyl bromide is highly toxic to humans and it destroys the earth's ozone layer. It is scheduled to be banned worldwide, although this ban will not be effective in most countries until 2010. We therefore strongly discourage the use of methyl bromide.

Environmentally safer options are sterilization (correctly called 'pasteurization' because it is not a complete process) with either hot steam or sunlight ('solarization'), or selective treatments with herbicides or fungicides if necessary. Substrates that have been manufactured using high temperatures, such as vermiculite or perlite, do not need to be sterilized unless they are recycled.

Self-Check -2	**Written Test**

Directions: Answer all the questions listed below. Use the Answer sheet provided in the next page:

1. Discuss the manual handling of equipment? (4pts.)
2. Discus how to check the equipment? (3pts.)

Note: **Satisfactory rating - 7 points** **Unsatisfactory - below 7 Points**

Answer Sheet

Score = ____________

Rating: _____________

Name: ___________________________ Date: ________________

Short Answer Questions

Information Sheet-3	Keeping records

3.1. Recording information

In the preparation of growing media the following information will be documented or recorded.

- Pant requirements of growing media Components
- Information on workplace practices and OHS practices
- The Various media component used
- Type of Nutrient required by plant
- Sources of nutrients
- Properties/characteristics of growing media
- Sterilization methods of the growing media
- Growing media composition/ratio/proportion

- OHS practice
- Maintaining equipment
- Storage condition of Components
- Weight of the growing media
- Method of handling Waste
- Media storage condition

Self-Check -3	Written Test

Directions: Answer all the questions listed below. Use the Answer sheet provided in the next page:

1. What is recording record keeping? (3pts)
2. Discuss the type of forecasting? (2pts)

Note: **Satisfactory rating – 8 points** **Unsatisfactory - below 8 points**

You can ask you teacher for the copy of the correct answers.

Answer Sheet

Score = ____________

Rating: ______________

Name: ________________________ Date: _______________

Short Answer Questions

Reference

1. https://study.com/academy/lesson/weather-forecasting-definition-types.html
2. Official and Transitory Records: A Guide for Government of Alberta Employees
3. ISO Standard - 15849 - Information and Documentation - Records Management

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