UNIT 4

Nursery Management

LEARNING / FACILITATING MATERIALS

CITRUS PRODUCTION
NATIONAL CERTIFICATE I

COTVET

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Introduction

The nursery is the place where seedlings are raised and cared for before they are transplanted unto the main field. It is therefore important that appropriate site is selected. Selection site for nursery depends on several factors. This unit will help the learner to adopt best practices in nursery management and factors to consider when siting nursery facilities.

This learning material covers all the learning outcomes for nursery management for the Certificate I programme.

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LEARNING OUTCOME **1**

Demonstrate understanding of Site Selection for Citrus nursery.

In this LO, you will learn to identify sources of water, appropriate tools and equipment for nursery, construct nursery facilities and explain reasons for locating nursery far from citrus farm.

PC (a) Identify reliable sources of water

Water is essential for citrus seedlings because it is the carrier that moves plant nutrients and other substances throughout the seedling.

Source and quality of water to be used for irrigation in citrus nursery must be of good quality. Some sources of water that can be used include:

i. Dams/ ponds
ii. Streams/ rivers
iii. Boreholes/ Wells
iv. Rain water

PC (b) Identify appropriate tools and equipment for nursery

Tools and equipment for nursery

Tools and equipment for nursery management are grouped based on the operation they perform. Tools can be grouped as follows:

- Land clearing
- Digging
- weeding
- Conveying
- Budding
- Pruning
- Watering and spraying.

The table below shows types of tools used in nursery management and their examples.

Type of Tool	Examples	uses
Land clearing	Cutlass, hoe	Clearing of vegetation
Digging	Mattock, pickaxe, hoe, earth chisel, foot fork	Digging, loosening
weeding	Cutlass, hoe, mechanical slasher	Weed management
watering	Watering can, sprinkler, water hose, pipes, water pumps	irrigation
Conveying	head pan, wheel barrow	conveying
spraying	Knapsack	Spraying chemicals (weedicide and insecticide)
Budding	Budding knife	Budding and grafting
Pruning	Hand shears, secateurs, pruning knife	Pruning plant parts
Stirring	Hand fork	Stirring, loosening

PC (c) Construction of nursery facilities

Preparing pre-nursery beds

A nursery bed could be a permanent or temporary structure held in place with adequate shade. Seedlings to be used as rootstocks are raised on pre-nursery beds and transferred onto permanent nursery beds.

Recommended bed dimensions are:

- Height 10 -15 cm
- Width 100-120 cm
- Length: as convenient

Procedure for constructing a nursery bed.

i. Identify appropriate site
   a. Accessible, preferably by road
   b. Close to permanent source of clean water
   c. Slope (gentle)
   d. Well drained soil (not prone to flooding)

ii. Prepare Site
   a. clearing vegetation
   b. Removal of stumps
   c. Level land as possible

iii. Demarcate and measure the size of bed

iv. Dig and shape bed using recommended dimensions above.

NOTE: Seed boxes and/or trays can also be used particularly during periods of excessive rainfall to avoid damping off in seedlings.

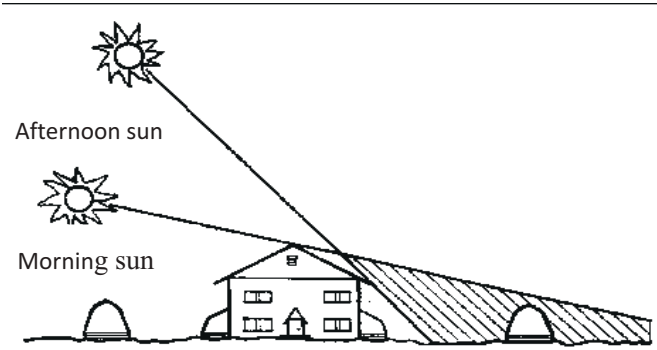
Green House

Green house is an artificial structure used in nursing and growing fruits and vegetables thus a building or complex in which plants are grown. These structures range in size from small sheds to industrial sized buildings.Green houses allow for greater control over the growing environment of plants. Depending upon the technical specification of a greenhouse, key factors which may be controlled include:

- temperature
- levels of light and shade
- irrigation
- fertilizer application
- atmospheric humidity

Building a greenhouse does not need to be expensive or time-consuming. The final choice of the type of greenhouse will depend on the growing space desired, home architecture, available sites, and costs, but the most important is that the greenhouse must, provide the proper environment for growing plants.

In constructing a greenhouse the following must be considered:



Locating greenhouse considering light

Location

The greenhouse should be located where it gets maximum sunlight. The first choice of location is the south or southeast side of a building or shade trees. Sunlight all day is best, but morning sunlight on the east side is sufficient for plants. Morning sunlight is most desirable because it allows the plant's food production process to begin early; thus growth is maximized.

Ventilation

Ventilation is the exchange of inside air for outside air to control temperature, remove moisture, or replenish carbon dioxide (CO_2). Carbon dioxide (CO_2) and light are essential for plant growth. As the sun rises in the morning to provide light, the plants begin to produce food energy (photosynthesis). The level of CO_2 drops in the greenhouse as it is used by the plants. Ventilation replenishes the CO_2 in the greenhouse. Several ventilation systems can be used. Natural ventilation uses roof vents on the ridge line with side inlet vents (louvers). Warm air rises to escape through the top, drawing cool air in through the sides.Mechanical ventilation uses an exhaust fan to move air out at one end of the greenhouse while outside air enters the other end through motorized inlet louvers. Exhaust fans should be sized to exchange the total volume of air in the greenhouse each minute.

Air Circulation

Installing circulating fans in your greenhouse is good because when the greenhouse is heated, there is the need to maintain air circulation so that temperatures remain uniform throughout the greenhouse. Without air-mixing fans, the warm air rises to the top and cool air settles around the plants on the floor.

Coverings

Greenhouse coverings include long-life glass, fiberglass, rigid double-wall plastics, and film plastics. Glass is the traditional covering. It has a pleasing appearance, is inexpensive to maintain and has a high degree of permanency. An aluminium frame with a glass covering provides maintenance free, weather-tight structure that minimizes heat, costs and retains humidity. The disadvantages of glass are that it is easily broken and is initially expensive to build

Heating

The heating requirements of a greenhouse depend on the desired temperature for the plants grown, the location and construction of the greenhouse, and the total outside exposed area of the structure. As much as the daily heat requirement may come from the sun, a greenhouse structure will need a great deal of heat in the night and during raining seasons. The heating system must be adequate to maintain the desired day or night temperature.

Irrigational facility

A water supply is essential to support the growth of seedlings in a nursery. Hand watering using the watering can is acceptable but a variety of automatic watering systems such as sprinklers can be used.

Simple green house structures

PC (d) Explain the reason for locating nursery far from citrus farm

Citrus nurseries are normally constructed away from the main or permanent field for transplanting. The major reason for locating citrus nurseries far from farm is to prevent transmission of diseases and pests from affecting the nursery.

Self-assessment

PC (a)

1a. You are to construct a nursery farm. Explain four reasons for sitting the nursery near to a permanent water source.

1b. Given recommended dimensions, state the procedures for constructing a nursery bed.

PC (b)

1. Make a freehand sketch of any one of the tools under the following headings;

i. digging
ii. weeding
iii. budding
iv. conveying

PC (c)

You have been tasked by your facilitator to make a citrus nursery. Explain briefly how the following can be performed.

i. clearing of vegetation
ii. Removal of stumps
iii. Levelling of land

PC (d)

1. One of the major factors to consider in nursery is to site it far from the farm. Give three (3) reasons for that.

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LEARNING OUTCOME **2**

Demonstrate understanding of seed selection, treatment and sowing in citrus nursery

In this LO, you will learn to identify types of seed for root stock, explain factors to consider when selecting seeds, treat seed and conduct seed germination tests and sow seeds correctly.

PC (a) Identify types of seed for root stock in nursery

In citrus production, propagation by seed is the most common technique to get the rootstock. Propagation by seed is convenient for various reasons such as;

- cost effectiveness
- production of numerous varieties of seed for rootstock
- safest procedure for obtaining rootstocks that are free from pests, diseases, virus.

Seeds that can be used for root stock includes;

I. Rough lemon
ii. Grapefruit
iii. Cleopatra mandarin
iv. Volkamerians
v. Swingle citrumelo
vi. Rangpur lime

Rough lemon is the most popular rootstock used in Ghana. This is because of the following characteristics:

- promotes high yields of scion
- has a high degree of polyembryony
- highly adaptable to deep infertile soils
- deep rooted and drought tolerant
- moderately tolerant to high salinity
- adaptive to wide range of soil pH
- tolerant to citrus tristeza virus, exocortis and xyloporosis diseases
- gives "**true to type**"

Caution: not recommended for mandarin as fruit tends to dry out and become spongy.
Cleopatra Mandarin

The Cleopatra mandarin exhibits the following characteristics:

- tolerant to diseases such as tristeza virus, exocortis and xyloporosis
- adaptive to different types of soil
- tolerant to high salinity and pH more than 7.0

Caution: Bud rootstocks at a tender age using the chip technique to achieve high bud take.

PC (b) Explain factors to consider when selecting seeds for nursing.

Factors to consider when selecting seeds for nursing include weight and health.

The floating method is used to determine the weight

Flotation method: the seeds to nurse are soaked in a bucket of water. Viable seeds will sink to the bottom leaving the bad ones floating.

In order to have a healthy seed the following factors are to be considered. Seed must be tested for,

- Viability: Small, shriveled and broken seeds contain less nutrition for the developing seedling. By removing these inferior seeds, the farmer is able to grow stronger and healthier seedlings.
- Disease free: There are several diseases that are transmitted via the seeds. If seeds from an infested field are used to grow the next crop, these seed-borne diseases will immediately cause serious problems.

PC (c) Treat seed for nursing.

Good quality seeds are essential to grow a strong and healthy crop. Healthy seeds can be bought from trusted sources or farmers can produce their own seeds. Treating seeds for nursing includes seed stratification, hot water treatment and acid bath.

Procedure for treating seeds for nursing

- Dipping in hot water of about 15oC for 10 minutes to control Phytophora.
- Coating seeds with appropriate fungicide
- Dusting seeds with powdered charcoal and keep away from direct sunlight for about a week before sowing.

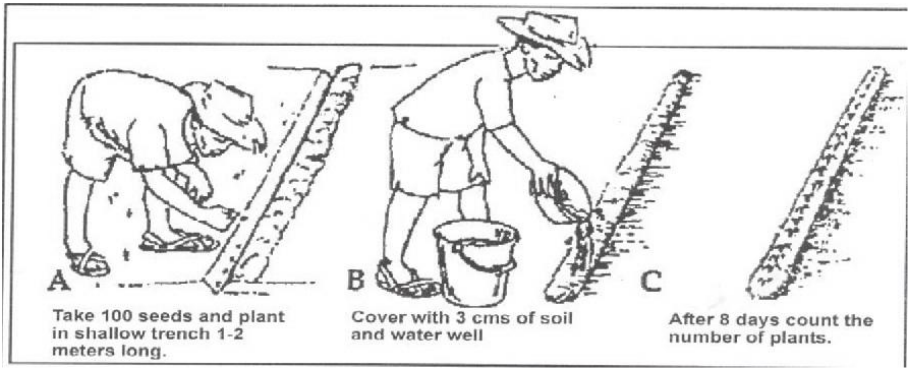
PC (d) Conduct seed germination tests.

Germination test is carried out to determine the germination percentage of seeds. Below are the steps to determine the germination percentage of seeds:

I. Take a random sample that is a representative of the seed lot (at least 100 picked at random).
ii. Place seeds on appropriate medium (sand, soil, newsprint) and provide adequate moisture to induce germination.
iii. Rough lemon takes 7 to 14 days, but depending on variety of rootstock, seeds germinate between 25 to 35 days.
iv. A germination percentage of 75 or more is recommended.

PC (e) Sow seeds correctly

Procedures for sowing citrus seeds are as follows;



I. wash and soak stored seeds in water for at most 24 hours
ii. dry seeds under shade for a day
iii. plant in rows 5cm apart and 3 cm within rows
iv. press lightly in the soil and mulch lightly to maintain soil moisture.
v. water regularly to keep soil moist (mostly morning and evening depending on weather)
vi. seeds germinate 3-5 weeks after sowing, depending on variety
vii. provide shade to newly germinated seedlings
viii. harden seedlings by gradually reducing shade until seedlings can tolerate full sunlight. Note: Excessive watering will induce dumping-off disease

Self-assessment

PC (a)

1. State three (3) types of citrus that can be used as rootstocks.

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2. Explain why Cleopatra mandarin is the preferred choice of rootstock in the high bud take.

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LEARNING OUTCOME **3**

Demonstrate understanding of budding and grafting citrus

In this LO, you will learn to identify types of budding and grafting, suitable mother plant, prepare seedling for budding and grafting, demonstrate the various techniques in budding and grafting and apply safety measures in budding and grafting.

PC (a) Identify types of budding and grafting

Grafting is any method which surgically connects a part of one plant to a part of another plant; the two then grow together to become a single plant. The scar where the two are joined and which may remain visible throughout the life of the tree is the graft union.

Budding is the process of combining two different parts from two distinct but related plants to unite and grow as one. The lower part which usually comes from a seedling or which provides the root is called the root stock. The upper part, usually a shoot from a mature fruiting tree (at least 10 years old) is called the scion or bud wood. Budding is simply a method of grafting in which the original scion had a single axillary bud eye on it. The bud eye is the tiny green bump just above the point of attachment of a leaf on the stem.

Types of budding and grafting

Types of budding: T/shield budding patch and chip budding
Types of grafting: wedge and side approach.

T budding or **shield budding** is a special technique in which the scion piece is reduced to a single bud.

Chip budding is the most common technique used in citrus.

PC (b) Identify suitable mother plant

Identification of suitable mother plant

To identify a suitable mother plant for budding and grafting the following must be considered;

- Mother plants (usually 10 - 15 years of age) having exceptionally good health, regular bearing and consistently high yield with good quality fruit must be selected.
- Inspection for pests must be conducted and managed if any is detected.
- The virus detection tests must be performed to know disease status of trees. Virus indexing should also be conducted. It is a process of testing plants for the presence or absence of viruses. Plant must be tested before using it as a mother plant to produce 'virus free stock'.

The primary method of detecting viruses is to transmit them by grafting or budding to a sensitive indicator plant under insect-proof, controlled conditions which then develops identifiable symptoms within a certain length of time.

PC (c) Prepare seedling for budding and grafting

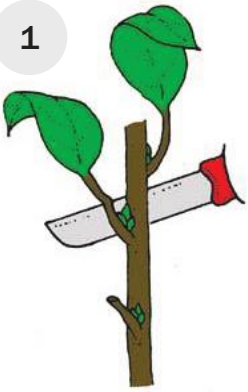
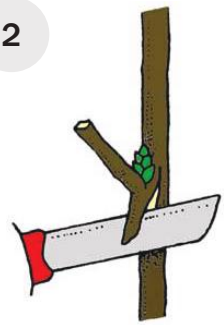
In preparing seedling for budding and grafting, the following steps must be considered:

- Amend the soil
- Select the variety of tree you wish to cultivate.
- Protect the seedling eyes from damaging
- Prune the basal leaves
- Spray insecticide to drive away pests

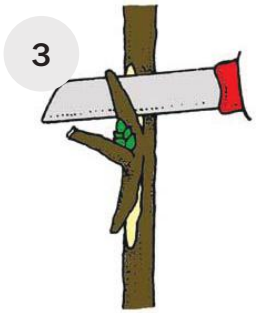
PC (d) Demonstrate the procedure used in budding and grafting

Procedures used in budding and grafting

The **table** below shows some steps with sketches and activities involved in budding and grafting

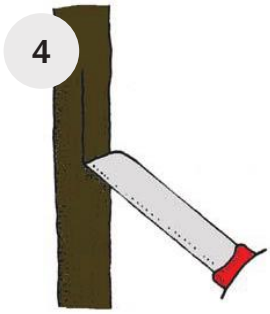
Sketches	Activity	Description
1 	**1. Selection of bud wood**	Bud wood having plump, healthy buds are suitable scions. These bud woods should be on branches that exhibited good growth during the current season. Thick water sprouts that grew very vigorously are often poor scions. Leaf blades are clipped from the bud wood, leaving the petiole intact. This leaves a convenient "handle" for holding the bud while it is cut from the bud wood. See sketch 1.
2 	**2.Cutting of scion**	The bud and a small sliver of the wood underneath it are cut from the bud wood using an upward slicing motion. The cut should begin about 1/2 to 3/4 inch below the bud and should go deep enough into the wood so that when the cut is finished about 1/2 to 3/4 above the bud, the bark and a small sliver of wood are cut off. See sketch 2

NOTE: Budding knives should be kept very sharp so that as little damage as possible is done to the bud. Dull knives strip and tear the wood, leaving cuts that do not heal properly.Buds must be cut from the bud wood just prior to budding, otherwise they will dry out.



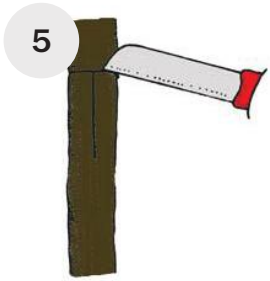
3. Downward cutof scion

Make a downward cut as the second cut to removethe bud from the bud wood. This works well as long as it does not result in too much of the underlying wood being removed with the bud.
See sketch 3



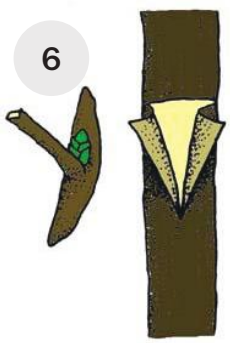
4. vertical cut on stem of root stock

A vertical cut is made on the stem of the root stock. The cut should be deep enough to insure that the bark will separate at the cambium layer.
See sketch 4



5. Perpendi-cular cut on root stock

The "T is then crossed." That is, a perpendicular cut is made at the upper end of the vertical cut. In areas with heavy rainfall during the budding season, or in species in which the rootstock is likely to "bleed" heavily, an upside down, or inverted T bud can be used to prevent water or sap from pooling in the graft.
See sketch 5



6. Opening of incision

The bark is carefully slipped from the stem of the rootstock exposing a "pocket" into which the bud shield can be placed. Care should be taken not to tear the flaps of bark in the process of spreading them.

If the bark does not slip easily, this indicates that the stock is not in active growth and the process should be conducted later when active growth has resumed.

An alternative method for budding which does not require the bark to slip is the technique of chip.

budding in which the bud is cut out with a "chip" of the underlying wood. This requires that a chip of corresponding size be cut out of the stock piece in order to align the cambia for proper graft healing.

See sketch 6

7

Insertingscion

The bud shield is carefully slipped in between the bark flaps. The top of the bark strip on the bud shield is trimmed to fit tightly against the horizontal cut (the cross of the T) so that the bud fits within the "pocket".

See sketch 7

8

Tying of scion to rootstock

The bark flaps are held tightly against the bud as they are wrapped with a budding rubber, grafting tape or other suitable closure. This closure must either breakdown by weathering (as budding rubbers do), or must be removed in 2 to 3 weeks after the union has taken. If the material does not break down, it will girdle the rootstock.

After the union has taken, the upper part of the rootstock plant can be cut off to force the bud to grow

See sketch 8

Note: remove side shoots below the union regularly, since that can affect the growth of the scion.

PC (e) Safety measures in budding and grafting

Safety must be a priority in budding and grafting in citrus production. Here are some safety measures which must be observed when budding and grafting

Personal	Others	Tools and equipment
• Always practice safe knife handling. Cut away from yourself, consider where the knife will go if and when it slips	• Use indications to direct or inform others. • Train other workers or people how to safely use tools, equipment and also techniques involved in budding and grafting. • Require everyone to use the proper safety equipment to do his job.	• Use the proper serviceable tool for the job. • Do not remove safety guards/ shields • Wash, clean, oil and disinfect tools and equipment used in budding and grafting

Self-assessment

PC (a)

1. You are to bud and graft citrus seedling in the school garden. State the type of budding and grafting that will be suitable

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PC (b)

1. State two (2) reasons why you will select a mother plant.

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PC (c)

1. Explain the procedure used in budding and grafting

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PC (d)

1a. Using suitable materials and tools, demonstrate how to bud and graft.

b. State the safety measures to be observed in budding and grafting

Demonstrate understanding of nursery management

In this LO, you will learn to identify the various planting materials, demonstrate how to bag the media, how to prune off-shoots from rootstock, the application of basic hygienic techniques in nursery and the application of cultural practices in nursery.

PC (a) Identify the various planting media

To construct citrus nursery, the following facilities are required:

I. Potting medium
ii. Potting bags

Potting medium: seedlings need to be well nourished to ensure steady and healthy growth. The potting medium should be well-drained and fertile enough to ensure good bud-take and sustain seedling growth
A good potting medium includes:

i. Topsoil
ii. Well decomposed manure or compost
iii. River sand
iv. Carbonated rice husk (Biochar)

How to prepare potting bags
In preparing the potting bags, both sealed and unsealed bags may be used. However, for easy handling and transportation, bags with one end sealed are preferred.

Steps to consider:

a. Perforate or cut the two lower ends of the bag to promote drainage of excess water.
b. Using a hand trowel, fill the bag with medium to within 1/3 of the top and firm.
c. Push in the corners and fill up to within 5cm of the top

NOTE

- Choose a pot that is taller than it is wide as it will provide better drainage for citrus.

- Plastics are resistant to breaking, and are light in weight. Modern, high quality plastics can look good, and will hold up well to the elements. One disadvantage some plastics is that the sides are thin, a characteristic which may cause roots on the sunny side of the pot to be damaged by the heat of the sun.
- Be sure the container you choose has good drainage.

PC (b) Demonstrate how to bag the media

The media provides support for the plant, holds moisture, serves as a reservoir for nutrients, and provides the pore space (air space) needed to ensure the gas exchange required by a healthy root system.

Do not use ordinary garden soil for container citrus, no matter how good it is for growing plants in the ground. Diseases and weeds may be introduced if you use common garden soil. A good mixture is four to five parts ground pine bark and one part sand. If you want a mixture that holds a little more water, substitute one part peat moss for one part sand.

Do not plant the tree too deeply in the container. You should be able to see the root flare on the plant trunk at the surface of the growing medium.

Keep the growing medium off of the trunk to prevent decay. To bag media the following steps must be considered:

i. identify the container (potting bag)
ii. Select suitable soil for citrus plants
iii. Fill container with selected soil using the right tool
iv. Provide holes on bags to allow water to drain (this prevent root rot)

Note: where garden soil is used the soil must be sterilized. This can be done by burning debris or pouring hot water on top of soil or roast the soil.

PC (c) Demonstrate how to prune off-shoots from rootstock

After the union (where budding and grafting was done) has taken, the upper part of the rootstock plant can be cut off to force the bud to grow (After the upper portion of the rootstock is removed, the scion bud grows vigorously).

In pruning off-shoots from rootstock the following must be considered:

- Identify the bud from the rootstock
- Cut other branches on the rootstock and make the bud the highest growth which will grow vertically. Cut it as close to the rootstock as possible. This will prevent other growths on the root stock.

- Do not seal, sealing does nothing to improve healing and/or keeping infections out of the wound.

PC (d) Demonstrate the application of basic hygienic techniques in nursery

Application of basic hygienic techniques in nursery

Healthy plants are the goal of every nursery manager. This is not restricted to research nurseries but applies to nurseries of all sizes and levels of sophistication. Nursery hygiene does not necessarily mean using expensive or toxic chemicals. It can be achieved by a healthy nursery with ecologically sound management practices.

These are some examples of hygienic practices:

Facility

- Keep the nursery area itself free of weeds. Many plant species can be alternate hosts of important nursery pests. This precaution includes a sensible selection of ornamentals, shade, hedge and windbreak plants in and around the nursery, as they can be hosts for pests such as nematodes.
- Treat all wooden supports with old engine oil or chemicals against termite attack
- Keep tools, work surfaces and containers clean at all times.
- Take particular care with proper sterilization of containers, especially when these are reusable ones. Root diseases such as Fusarium root rot can be transmitted.

Material

- Plant material from other nurseries (seed, cuttings, scion wood and rootstock) can harbor nursery pests. Wherever possible, accept propagation material from nurseries only if it has a plant inspection certificate.
- Surface sterilization should be carried out on all new and unknown material.
- Diseased plants in a nursery should be discarded and burnt rather than composted.
- Composting diseased material can only be recommended if the compost temperatures are high enough to kill pests (above 60°C), and can be maintained at this level for several days.

Shoes and clothing

Quite often, diseases are brought into a nursery inadvertently on shoes (soil-borne diseases and nematodes) or clothing (weed seeds). This is very difficult to control. The best way is probably

to issue to staff, boots and work clothes to wear during work in the nursery and to install a dip basin with 10%household bleach solution at the entrance of the nursery through which staff and visitors have to walk to disinfect their shoes, especially when they come from fields where soil-borne diseases or nematodes are present.

PC (e) Demonstrate the application of cultural practices in nursery.

Better understanding and implementation of nursery cultural practices helps to improve seedling quality.

Cultural practices are what you do to create an ideal growing environment for your plants. The following are basic cultural practices in nursery:

i. Weed control
ii. Pests and disease control
iii. Provision of shade
iv. Watering
v. Arrangement of pottering bags
vi. Pruning of branches
vii. Application of soil amendment

Self-assessment

Planting of citrus seedlings is one of the major activities in citrus farming. Using your school garden, perform the following activities.

PC (a)

1. Explain the reasons for selecting a type of media for planting.

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PC (b)

1. Using the appropriate materials, tools and equipment, show how to bag a media.

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PC (c)

1. Using the appropriate tools and equipment, state the procedure for pruning the off-shoots from rootstock.

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PC (d)

1. State the hygienic measures to be observed in nursery.

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PC (e)

1. Explain why daily cultural practices are necessary in the activity performed.

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