HRT 504: PROPAGATION OF HORTICULTURAL CROPS
INSTRUCTORS: DR M.A.O. OKELANA
DR L.A. HAMMED

SEXUAL PROPAGATION

Introduction

Plant propagation is the increase in number of individuals of a species, usually accompanied by their spread over a given area. We also noted that propagation may be accomplished by either sexual or asexual means. Up to this point, we have focused our attention on asexual, that is vegetative, means of crop propagation. Beginning in today's lecture and in following lectures, we will turn our attention to basic principles of sexual propagation of crop plants. For the purposes of this class, we will put most of our time and effort into more practical aspects of sexual propagation, specifically dealing with topics such as seed testing, seed quality, and the development of hybrid crop varieties.

Note: In the sexual propagation of crop plants, a seed is produced in a flower. The formation of a seed is a complex process involving a number of steps as shown in the diagram provided. In the lecture, fill in the blanks in the questions, as well as the appropriate blanks in the diagrams provided.

1. Sexual propagation of crop plants involves sexual reproductive structures known as flowers, as shown in the diagram provided. The stem bearing the flower is called the *pedicel*. The tip of the *pedicel* which bears the floral organs is called the *receptacle*.

2. On the center of the receptacle are found one or more organs known as *carpels*. Each *carpel* has at it's base a structure known as the *ovary*, generally considered to be the female organ of the flower. The *ovary* contains small structures known as *ovules*. (Sometimes there is only one *ovule*, as in strawberry). Inside each *ovule* is found a single female gamete or egg. Above the ovary is a stalk like structure known as the *style*. On top of the *style* is a sticky, somewhat enlarged region called the *stigma*.

3. Around the carpels are arranged the *stamens*, generally referred to as the male organs of the flower, because they produce the male gametes, known as *pollen grains*. Each *stamen* consists of a slender stalk called the *filament*. On top of the *filament* is the *anther*, which contains the pollen grains.

4. In sexual reproduction in flowering plants (angiosperms), a male gamete, commonly known as the pollen grain fertilizes the female gamete, known as the egg, to form the *zygote*. The *zygote* eventually develops into an embryo, which is a potential new plant. Over time, a seed coat develops to cover and protect the embryo, and a seed is formed. The seed then becomes the means of propagation of the species.

5. In the stage of flowering known as full bloom or *anthesis*, the anthers, the structures containing the pollen, ruptures, and pollen is shed.

6. One of the important events that precedes the fertilization of the egg is the transfer of pollen from the male organ, specifically from the *anther*, to the female organ, specifically to the *stigma*. This transfer of pollen from the anther to the stigma is known as *pollination*.

7. If the transfer of pollen, pollination, takes place from the anther to a stigma in the same flower, or between flowers on the same plant, it is known as *self-pollination*. Examples of crops that normally *self-pollinate* are *citrus fruits, wheat, barley, oats, and peas*. If the transfer of pollen is between different flowers on different plants of different cultivars, it is known as *cross-pollination*. Examples of crops that usually require *cross pollination* are *apple, blueberries, some grapes*.

8. A plant that is able to use it's own pollen to fertilize it's own eggs is known as a *self-fertile* plant. If it cannot produce seed with it's own pollen it is known as a *self-sterile* plant. In some plants that are *self-sterile* the plants' own pollen has some kind of incompatibility factor that prevents it from reaching the egg.

Note: An interesting, and to some people irritating, side effect of some pollen grains is that produce an allergenic response which can be quite objectionable.

9. How is pollen transferred from the anther to the stigma?

Note: In crop production, or more specifically in crop breeding, breeders manipulate the processes leading to seed production, such as pollination, to produce plants with desired characteristics. As with other fields of science and technology, in the field of crop breeding a specialized terminology has developed. It is important for people working with crop to know some of the specialized 'language' of the crop breeder.

10. One term commonly used in referring to crop plants is the term *cultivar*. In many instances this term is used synonymously with the term variety. In giving the complete scientific name for a crop, it is sometimes necessary to include the *cultivar* or variety name, if there is one. For example, the name for a *cultivar* of corn known as Golden Wonder, would be *Zea mays* var. Golden Wonder. Give a definition for cultivar or variety.

Guiding Questions

1. There are two main categories of cultivars, *clones* and *lines*.

2. What is a clone?

3. What is a line?

4. Crop producers and home gardeners will commonly use terms like inbred, hybrid, hybridizing, and hybrid vigor, and F1 hybrid. Give a brief definition of each of these terms.

Plant cloning

Advantages

Cloning can leaf to selected crops, with perfect size and nutritious value; maximum output in every harvest; DNA combination in order to select specific features of different plants (color, shape, vitamins, and minerals). Cloning can produce high yielding crops. A cloned plant can yield a thousand new plants from one parent plant. This means that farmers can produce more crops without a lot of seeds.

However, it promotes homozygocity in the absence of linkage, as in sexual reproduction. Can lead to either desirable or undesirable effects, e.g., production of rice enhancement resulting in plants more susceptible to disease and less successful materials in the evolution ladder. For example, cloning can produce drought and pest resistance crops.
Cloning can also be very much welcome, producing crops with higher nutrition in them, for instance, Philippines' *Golden Rice*, material which has high vitamin A content).
Cloning can lead to selected crops with perfect size and high nutritious value; maximum output in every harvest. DNA material can be manipulated in order to select specific features of different plants (color, shape, vitamins, and minerals).

Cloning a plant means you can choose the best plants to clone. An entire crop of healthy, prosperous plants can be cloned from one strong parent plant.
Cloned plants grow at the same rate, so harvesting can become streamlined.

So far, the FDA has stated that cloned food would be perfectly safe for humans to eat. They have not, however, finalized a ruling to allow cloned food on the market.

I have deliberately emphasized the advantages. You can deduce the undesirable, negative effects of cloning!

Advantages of Budding/Grafting

Change varieties or cultivars. An older established orchard of fruiting trees may become obsolete as newer varieties or cultivars are developed. The newer varieties may offer improved insect or disease resistance, better drought tolerance, or higher yields. As long as the scion is compatible with the rootstock, the older orchard may be top worked using the improved variety or cultivar.

Optimize cross-pollination and pollination. Certain fruit trees are not self-pollinating; they require pollination by a second fruit tree, usually of another variety. This process is known as cross-pollination. Portions of a tree or entire trees may be pollinated with the second variety to ensure fruit set.

Take advantage of particular rootstocks. Compared to the selected scion, certain rootstocks have superior growth habits, disease and insect resistance, and drought tolerance.

Benefit from interstocks. An interstock can be particularly valuable when the scion and rootstock are incompatible. In such cases, an interstock that is compatible with both rootstock and scion is used.

Perpetuate clones. Clones of numerous species of conifers cannot be economically reproduced from vegetative cuttings because the percentage of cuttings that root successfully is low. Many can be grafted, however, onto seedling rootstocks.

Produce certain plant forms. Numerous horticultural plants owe their beauty to the fact that they are grafted or budded onto a standard, especially those that have a weeping or cascading form.

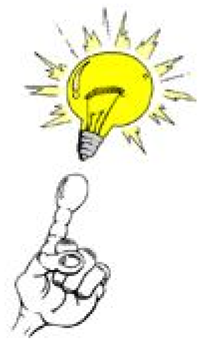
Increase the growth rate of seedlings. The seedling progeny of many fruit and nut breeding programs, if left to develop naturally, may require 8 to 12 years to become fruitful. However, if these progeny are grafted onto established plants, the time required for them to flower and fruit is reduced dramatically. Another way to increase the growth rate of seedlings is to graft more than one seedling onto a mature plant. Using this procedure as a breeding tool saves time, space, and money.

Plant Growth Factors: Photosynthesis, Respiration, and Transpiration

Print this *CMG GardenNotes*

Outline

- Photosynthesis
- Respiration
- Transpiration



Thought Questions

Explain the science behind the following gardening questions:

1. What's the impact on air temperatures when restrictions in landscape irrigation create droughty urban landscapes?

The three major functions that are basic to plant growth and development are:

- **Photosynthesis –** the process of capturing light energy and converting it to sugar energy, in the presence of chlorophyll using carbon dioxide and water.
- **Respiration –** the process of metabolizing (burning) sugars to yield energy for growth, reproduction**,** and other life processes.
- **Transpiration –** the loss of water vapor through the stomata of leaves.

Photosynthesis

A primary difference between plants and animals is the plant's ability to manufacture its own food. In ***photosynthesis,***carbon dioxide from the air and water from the soil react with the sun's energy to form ***photosynthates*** (sugars, starches, carbohydrates, and proteins) and release oxygen as a byproduct. [Figure 1]

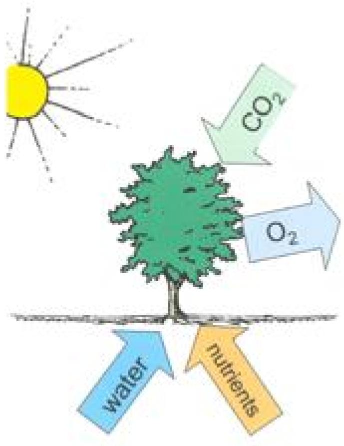


Figure 1. In photosynthesis, the plant used water and nutrients from the soil, carbon dioxide from the air with the sun's energy to create photosynthates. Oxygen is releases as a byproduct.

Photosynthesis literally means *to put together with light.* It occurs only in the ***chloroplasts***, tiny sub-cellular structures contained in the cells of leaves and green stems. A simple chemical equation for photosynthesis is given in Figure 2.

Photosynthesis

carbon dioxide + water + light energy = glucose + oxygen

$6CO_2 + 6H_2O +$ light energy $= C_6H_{12}O_6 + 6O_2$

Figure 2. Simple chemical equation for photosynthesis.

This process is directly dependent on the supply of water, light**,** and carbon dioxide. Limiting any **one** of the factors on the left side of the equation (carbon dioxide, water, or light) can limit photosynthesis regardless of the availability of the other factors. An implication of drought or severe restrictions on landscape irrigation is a reduction in photosynthesis and thus a decrease in plant vigor and growth.

In a tightly closed greenhouse there can be very little fresh air infiltration and CO2 levels can become limiting, thus limiting plant growth. In the winter, many large commercial greenhouses provide supplemental CO2 to stimulate plant growth.

The rate of photosynthesis is somewhat temperature dependent. For example, with tomatoes, when temperatures rise above 96o F the rate of food used by respiration rises above the rate of which food is manufactured by photosynthesis. Plant growth comes to a stop and produce loses its sweetness. Most other plants are similar. [Figure 3]

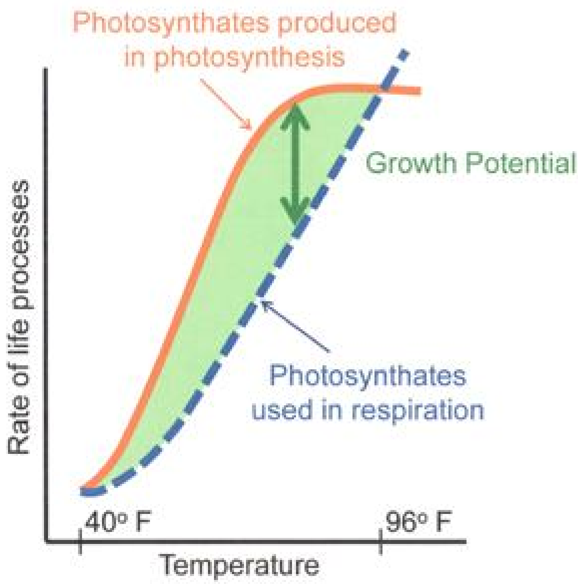


Figure 3. For the tomato plant, rates of photosynthesis and respiration both increase with increasing temperatures. As the temperature approaches 96o, the rate of photosynthesis levels off, while the rate of respiration continues to rise.

Respiration

In ***respiration***, plants (and animals) convert the sugars (photosynthates) back into energy for growth and other life processes (metabolic processes). The chemical equation for respiration shows that the photosynthates are combined with oxygen releasing energy, carbon dioxide, and water. Notice that the equation for respiration is the opposite of that for photosynthesis. [Figure 4.]

Respiration

glucose + oxygen = energy + carbon dioxide + water

$C_6H_{12}O_6 + 6O_2 = \text{energy} + 6CO_2 + 6H_2O$

Figure 4. Simple equation for respiration.

Chemically speaking, the process is similar to the **oxidation** that occurs as wood is burned, producing heat. When compounds combine with oxygen, the process is often referred to as “burning”, for example, athlete’s “burn” energy (sugars) as they exercise. The harder they exercise, the more sugars they burn so the more oxygen they need. That is why at full speed, they are breathing very fast. Athletes take up oxygen through their lungs. Plants take up oxygen through the stomata in their leaves and through their roots.

Again, respiration is the burning of photosynthates for energy to grow and to do the internal "work" of living. It is very important to understand that both plants and animals (including microorganisms) need oxygen for respiration. This is why overly wet or saturated soils are detrimental to root growth and function, as well as the decomposition processes carried out by microorganisms in the soil.

The same principles regarding limiting factors are valid for both photosynthesis and respiration.

Table 1.
Comparison of photosynthesis and respiration

Photosynthesis	**Respiration**
Produces sugars from light energy	Burns sugars for energy
Stores energy	Releases energy
Occurs only in cells with chloroplasts	Occurs in most cells
Releases oxygen	Uses oxygen
Uses water	Produces water
Uses carbon dioxide	Produces carbon dioxide
Requires light	Occurs in dark and light

Transpiration

Water in the roots is pulled through the plant by **transpiration** (loss of water vapor through the stomata of the leaves). Transpiration uses about 90% of the water that enters the plant. The other ten percent is an ingredient in photosynthesis and cell growth.

Transpiration serves three essential roles:

- **Movement of minerals** up from the root (in the xylem) and sugars (products of photosynthesis) throughout the plant (in the phloem). Water serves as both the solvent and the avenue of transport.
- **Cooling** – 80% of the cooling effect of a shade tree is from the evaporative cooling effects of transpiration. This benefits both plants and humans.
- **Turgor pressure** – Water maintains the turgor pressure in cells much like air inflates a balloon, giving the non-woody plant parts form. Turgidity is important so the plant can remain stiff and upright and gain a competitive advantage when it comes to light. Turgidity is also important for the functioning of the guard cells, which surround the stomata and regulate

water loss and carbon dioxide uptake. Turgidity also is the force that pushes roots through the soil.

Water movement in plants is also a factor of osmotic pressure and capillary action. **Osmotic pressure** is defined as water flowing through a permeable membrane in the direction of higher salt concentrations. Water will continue to flow in the direction of the highest salt concentration until the salts have been diluted to the point that the concentrations on both sides of the membrane are equal.

A classic example is pouring salt on a slug. Because the salt concentration outside the slug is highest, the water from inside the slug's body crosses the membrane that is his "skin". The poor slug becomes dehydrated and dies. Envision this same scenario the next time you gargle with salt water to kill the bacteria that are causing your sore throat.

Fertilizer burn and dog urine spots in a lawn are examples of salt problems. The salt level in the soil's water becomes higher than in the roots, and water flows from the roots into the soil's water in an effort to dilute the concentration. So what should you do if you accidentally over apply fertilizer to your lawn?

Capillary action refers to the chemical forces that move water as a continuous film rather than as individual molecules. Water molecules in the soil and in the plant cling to one another and are reluctant to let go. You have observed this as water forms a meniscus on a coin or the lip of a glass. Thus when one molecule is drawn up the plant stem, it pulls another one along with it. These forces that link water molecules together can be overcome by gravity.

Additional Information

CMG GardensNotes on how plants grow (botany)

- **Horticulture Classification**, #121
- **Taxonomic Classification**, #122

- **Plant Structures: Cells, Tissues, and Structures**, #131
- **Plant Structures: Roots**, #132
- **Plant Structures: Stems**, #133
- **Plant Structures: Leaves**, #134
- **Plant Structures: Flowers**, #135
- **Plant Structures: Fruit**, #136
- **Plant Structures: Seeds**, #137

- **Plant Growth Factors: Photosynthesis, Respiration and Transpiration**, #141
- **Plant Growth Factors: Light**, #142
- **Plant Growth Factors: Temperature**, #143
- **Plant Growth Factors: Water**, #144
- **Plant Growth Factors: Hormones**, #145

- Homework: How Plants Grow. #147
- References and Review Questions: How Plants Grow, #120
- Worksheet: Plant Structures, #146

Authors: **David Whiting** (CSU Extension) with Michael Roll and Larry Vickerman (former CSU Extension employees). Artwork by David Whiting.

- CMG GardenNotes are available online at www.cmg.colostate.edu
- Colorado Master Gardener/Colorado Gardener Certificate Training is made possible by a grant from the Colorado Garden Show, Inc.
- Colorado State University, U.S. Department of Agriculture, and Colorado counties cooperating

Revised August 2010

Propagate by Plant Cuttings

Vegetative propagation using plant cuttings applies to many crops. This method allows the production of clones or plants which are considered “duplicates” of the parent plants genotypically, and usually also phenotypically. Just like other vegetative propagation methods, it is advantageous where a plant does not produce seeds, the seeds are sterile, or whenever seeds are not available.

With crops that can be easily propagated using plant cuttings, this method has numerous advantages. Many new plants can be produced in a limited space from a few stock plants. It is simple and can be easily applied without having to learn the special techniques in grafting or budding. It is rapid because there is no need to produce rootstocks.

Plant cuttings may consist of segments of the root or whole leaves or portions of leaves, or segments of stems which are used as planting materials. Depending on the plant part used, these propagules are called by special terms such as root cuttings, leaf cuttings, leaf-bud cuttings or stem cuttings. In sugarcane, the stem cutting is called **cane cutting** while in bamboo, it is **culm cutting**. Culm is the technical term for the main stem of plants belonging to the grass family **Gramineae** (alternatively named **Poaceae**).

Root cuttings are segments of the root while **leaf cuttings** are either entire leaves, with or without the petiole, or portions of leaf blades. **Leaf-bud cuttings** consist of a leaf with petiole, and a short piece of the stem with axillary bud. **Stem cuttings** are segmented parts of the stem, or entire stems detached from the main branch. Where the stem cutting includes the tip or apex, it is called **tip cutting** .

Special terms are also used to classify stem cuttings such as hardwood or woody cuttings, semi-hardwood or semi-woody cuttings, softwood cuttings and herbaceous cuttings. These are classifications of stem cuttings based on the nature of wood and stage of growth.

Hardwood, semi-hardwood and softwood cuttings are taken from woody trees and shrubs while herbaceous cuttings are made from succulent, herbaceous plants like chrysanthemum, coleus, tomato, eggplant and squash.

Propagation with the use of plant cuttings is common for dicots but there are some monocots that can be rooted by this method like bamboo and sugarcane. Compared to the other methods, propagation by stem cuttings has the widest application.

Plants That Can be Propagated by Root Cuttings

Breadfruit (*Artocarrpus altilis*), blackberry (*Rubus* sp.), fig (*Ficus carica*), garden phlox (*Phlox paniculata*), Japanese pagoda tree (*Sophora japonica*), lilac (*Syringa vulgaris*), *Malus* sp., oriental pear (*Pyrus calleryana*), *Rosa* spp.

Plants That Can be Propagated by Leaf Cuttings

African violet (*Saintpaulia ionantha*), *Begonia* spp., *Bryophyllum* spp.), *Crassula* spp., *Kalanchoe* spp., lily (*Lilium longiflorum* and *L. candidum*), *Oxalis* spp., *Peperomia* spp., *Sedum* spp., snake plant (*Sansevieria trifasciata*), sweet potato, wax plant (*Hoya carnosa*). Generally, these plants have thick leaves.

Jasmine (*Jasminum sambac*) and dracaena (*Dracaena godseffiana*) have also been propagated experimentally by leaf cuttings.

Plants That Can be Propagated by Stem Cuttings

Acerola (*Malpighia glabra*), bamboo, black pepper (*Piper nigrum*), cacao (*Theobroma cacao*), cassava (*Manihot esculenta*), citrus (*Citrus* spp.), coffee (*Coffea* spp.), eggplant (*Solanum melongena*), grape (*Vitis vinifera*), guava (*Psidium guajava*), lagundi (*Vitex negundo*), lanzones (*Lansium domesticum*), makabuhay (*Tinospora orispa*), malunggay (*Moringa oleifera*), molave (*Vitex parviflora*), Norfolk Island Pine (*Araucaria heterophylla*), passion fruit (*Passiflora edulis*), physic nut (*Jatropha curcas*), pili nut (*Canarium ovatum*), pineapple (*Ananas comosus*), rubber (*Hevea brasiliensis*), red mombin (*Spondias purpurea*), sambong (*Blumea balsamifera*), santol (*Sandoricum koetjapi*), sapodilla (*Manilkara zapote*), starapple (*Chrysophullum cainito*), sugarcane (*Saccharum officinale*), tsaang gubat (*Ehretia microphylla*), tomato (*Lycopersicon esculentum*), tubli (*Derris sp.*).

Note: Plant cuttings may not always produce the desired plant characteristic. The use of root cuttings in propagating variegated plants may result to reversion to the normal, evergreen type. This also occur when variegated snake plant (Sansevieria laurenti) is propagated by leaf cutting. This is because these plants are periclinal chimeras in which the inner cross sectional areas of the plant body are normal while the thin outer layers are mutated cells which are responsible for the variegation. With root and leaf cuttings, the new plant regenerate from the inner cells, resulting to normal growth and loss of variegation.

In snake plant, the variegated character can be perpetuated by division of rootstock instead of leaf cutting propagation.

References

Abellanosa, A.L. and H.M. Pava. 1987. An Introduction to Crop Science. CMU, Musuan, Bukidnon: Publications Office. pp. 71-87.

Hartmann, H.T. and D.E. Kester. 1975. Plant Propagation: Principles and Practices. New Jersey: Prentice-Hall, Inc. pp. 211-313.

(Author: Ben G. Bareja. 2010)

Suggested reading related to plant cuttings:

[Sexual Propagation: Orthodox vs. Recalcitrant Seeds]
[Vegetative Propagation of Crop Plants]
[Marcotting Methods in Plant Propagation]

>click to return to cropsreview.com Home page from plant cuttings

Propagate Herbaceous and Woody Plants by Air Layering

Air layering, also called marcotting, marcottage, Chinese layering, pot layerage, circumposition and gootee, is a vegetative method of plant propagation which involves the rooting of aerial stems while attached to the parent plant. It is one among the various special methods of layering which also include tip layering, simple layering, compound or serpentine layering, mound or stool layering, and trench layering.

This propagation method applies to many trees, shrubs, bamboo and herbaceous plants. The following fruits and plantation crops have been successfully marcotted:

Bell fruit, water apple (*Syzygium aqueum*), black pepper (*Piper nigrum*), cacao (*Theobroma cacao*), cashew (*Anacardium occidentale*), citrus (*Citrus* spp.), coffee (*Coffea* spp.), grape (*Vitis vinifera*), guava (*Psidium guajava*), jackfruit (*Artocarpus heterophyllus*), lanzones or langsat (*Lansium domesticum*), lychee (*Litchi* sp.), mango (*Mangifera indica*), mangosteen (*Garcinia mangostana*), pili nut (*Canarium ovatum*), sapodilla or chickle tree (*Manilkara zapota*), starapple (*Chrysophyllum cainito*) and tamarind (*Tamarindus indica*).

(Click to find other pages on plant propagation)

Factors Affecting Regeneration

The formation of adventitious roots during air layering is induced by various stem treatments. These generally involve the girdling or wounding of a small part of the stem, resulting to the interruption of the downward movement of organic materials such as carbohydrates, auxin and other growth factors from the leaves and shoot tips. These materials accumulate close to the treated area and rooting occurs.

Continuous moisture, sufficient aeration, and moderate temperatures in the rooting zone affect the formation of roots on layers or marcots. These conditions can be provided by using a loose rooting medium with high water holding capacity such as a sphagnum moss. It has been observed also that the rainy season favors rooting rather than the hot, dry season.

The application of rooting hormone to the injured stem is sometimes effective. This can be applied in powder form, lanolin, or as a dilute solution.

Rooting success likewise depends on the plant species. In general, plants which can be propagated using stem cuttings will also root through air layering. Prostrate stems of some plants which naturally root at the point of contact with the soil indicate that these plants can be easily rooted using this method, as with stem cuttings.

In monocot plants such as bamboo, aglaonema, dieffenbachia and dracaena, the roots emerge from the node.

Advantages Compared to Other Vegetative Propagation Methods

1. Rooting success is more ensured through layering, including clones which will not root easily.

2. Air layering or marcotting is relatively simple to perform. With a small number of plants, it can produce more layers with less skill, effort and equipment.

3. Larger plants which are readily mature can be produced in faster time.

Disadvantages Compared to Other Vegetative Propagation Methods

1. Air layering or marcotting is laborious and therefore expensive.

2. Only a small number of layers can be produced from a parent plant than when the same plant is used as source of cuttings, buds, or scions.

3. A wider area is needed to grow stock plants to be able to produce a greater number of layers.

4. Bigger layers need special care to establish them independently on the potting containers.

References

Abellanosa, A.L. and H.M. Pava. 1987. Introduction to Crop Science. CMU, Musuan, Bukidnon: Publications Office. 245 p.

Hartmann, H.T. and D.E. Kester. 1975. Plant Propagation: Principles and Practices. 3rd ed. Englewood Cliffs, N.J., USA: Prentice Hall, Inc. pp. 455-476.

(Author: Ben G. Bareja. 2010)

Continue reading: Marcotting Methods in Plant Propagation

HRT 504
DEPARTMENT OF HORTICULTURE
UNIVERSITY OF AGRICULTURE ABEOKUTA, NIGERIA.

TOPIC: DEFINITION AND IMPORTANCE OF NURSERY.

What is a nursery?

A nursery is a place where young plants are raised under intensive management for later transplanting into the field. Many horticultural crops can be grown insitu but, experience has shown that raising seedlings in the nursery has a number of advantages. These may include –

1) Economy of propagules
2) Intensive care for the seedlings – protection against animals, diseases, insects and rodents, regular maintenance practices, watering / irrigation and manuring in the nursery.
3) Raising seedlings in the nursery affords selection of vigorous and disease-free seedlings for transplanting into the field.
4) Ease of genetic activities.
5) The nursery allows for a better medium of growth for the plants than when directly seeded on the field.
6) Nursery affords ease of carrying out propagation techniques like, budding, grafting and even marcutting / air-layering.

However, the disadvantages of raising seedlings in the nursery before transplanting into the field include –

1) Increased cost of production of a particular crop.
2) Specialized labour requirements in the nursery, especially skilled budders and grafters.
3) Skilled personnel required for transplanting operations.

Types of nurseries.

Types of nurseries depend on the size, scope and investments put in place. Therefore, there are 3 types of nursery under 2 groups –

1) Temporary / shifting nurseries –
   a) Peasant nursery: These include spots / places where peasant farmers raise tree crop seedlings like cocoa, kola, coconut, citrus, coffee, mango or vegetables. They are normally located within the compound or along river banks, streams, swamps or

family bathroom sheds or any other place with regular source of water. The site is normally under brushed leaving the trees standing for shade provision. The soil is loosened with hoes, seeds sown and covered with palm fronds. Little care is given to the nursery materials. Such a nursery can be shifted at any time.

b) Intermediate nursery: An improved type of peasant nursery. They are established very close to field in order to avoid the cost and attendant problems on long distant transportation of seedlings. Here, there are no permanent installations and it can be used for one or more seasons. It can also serve as a resting station for transported seedlings.

2) Permanent / Standard / Central nurseries: Permanent nurseries are larger and more intensively managed. Although, proximity to field is important, but centralization with respect to the total area the nursery is expected to serve, nearness to source of labour and supervision minimize transportation cost in the long run and thus bring greater economic benefits.

DEPARTMENT OF HORTICULTURE
UNIVERSITY OF AGRICULTURE ABEOKUTA, NIGERIA.

TOPIC: FACTORS OF NURSERY ESTABLISHMENT.

Selecting a site for permanent nursery is a difficult task. This is because the degree of success achieved in the production of nursery plant materials is largely dependent on careful study and objective judgment on the site. Thus, the following factors must be considered –

1) Water supply: Water is of prime importance in any successful nursery management. The must be sited near an adequate supply of water. Therefore, in selecting a site, the amount and quality of water available during the period of low water table and extreme drought should be ascertained if possible. This is because the highest water demands by seedlings is during these periods and particularly important in the drier agroecological regions.
2) Soil and topographical features of the proposed site: A good soil is a prerequisite to the success and economy in the production of nursery plants. The soil should be deep, with fine to coarse sandy loam texture, underlain by somewhat stiffer but still permeable subsoil. Good drainage is very essential to carry off excess water from the tropical rainstorm. Such soils found on freely-draining flat ground or on a gentle slope sufficient to permit satisfactory drainage are considered the best sites.
3) Source of labour: An adequate supply of labour and proper supervision especially when transplanting, weeding and lifting is essential. Whether in temporary or permanent nurseries, labour must be swift and on schedule to ensure success. The problem of recruiting more labour could be very serious where manpower is scarce or alternative employment exists.
4) Protection against winds: In a savanna ecosystem, protection against wind is very important. Very often, the violent parching winds in the dry season do cause a high rate mortality in nursery stock especially in the exposed part of the nursery. Under such conditions, nursery should be sited preferably in the naturally sheltered areas. When this not possible and the proposed site is exposed to dry winds like harmattan, artificial screens made of mats or coarse cloth are provided round the nursery or screen houses are constructed.
5) Air pollution: This is very important especially in the industrial areas and where there is heavy traffic. Sulphur dioxide, cement dust and dust from dusty roads do settle on leaves and this detrimental to the growing seedlings in the nursery.

Therefore, the final choice of a nursery site is usually a compromise that favours those factors that ultimately permit future development and higher efficiency in the nursery

DEPARTMENT OF HORTICULTURE
UNIVERSITY OF AGRICULTURE ABEOKUTA, NIGERIA.

TOPIC: SELECTION AND PREPARATION OF NURSERY SITES.

Selection of nursery sites:

The size of land to be selected for nursery depends on –

1) Morphological characteristics of the plant species.
2) Size of the stock to be planted
3) The annual production target
4) Method of raising the seedlings
5) The degree of permanence of the site.

For intermediate nursery, the area actually occupied by the seedlings plus the access roads and storage sheds constitute the nursery area. In a permanent nursery, additional room has to be provided for crop rotation in order to maintain the organic matter and nutrient status of the soil. Where mechanical equipment is to used, equipment maintenance and storage centers have to be provided for in the nursery.

Preparation of a nursery site:

Major operations in the preparation of a nursery site include –

1) Land clearing: Clear-fell for permanent nursery, while under-brushing and selective thinning of trees are the required operations in temporary nurseries.
2) Removal of all plant stubbles and / or trash and burn them at a demarcated incinerator. All other debris must be packed off the plot.
3) Leveling the site: This should be carried out before laying out operations. This is majorly, not to give room for erosion.
4) Laying out of the site in accordance with plan.
5) Establishment of windbreaks. These may include leguminous trees because of their immense agricultural advantages. Other shade-providing trees may be used provided such trees can provide required shade density during the dry season / drought outbreaks.
6) Fencing the nursery. The entire nursery may be fenced if compelling factors (like theft or marauders) exist in the area. If raising seedlings with epigeal germination, fencing within

the nursery may be necessary in order to keep off the rodents that may want to feed on the cotyledons of the germinating seedlings.

7) Erection of major installations: These may involve storage sheds, farm house, incinerators, pipes for sprinkler irrigation etc.

DEPARTMENT OF HORTICULTURE
UNIVERSITY OF AGRICULTURE ABEOKUTA, NIGERIA.

Topic: Nursery management techniques.

Nursery crops require a lot of careful management from sowing time to eventual transplanting into the field. On both operations, the y need some shading, adequate watering and freedom from pests. Besides, some species require tending operations like shoot and root pruning, hardening-off, and field storage prior to transplanting into the field.

1) Shading: crop species differ in their requirement for shade in the nursery. Some shade-loving crops like cocoa, kola and some vegetables, require a very good shade in order to keep the soil / growth medium moist and the microenvironment cool. The light-demanding crop species, like cashew germinate and develop into vigorous seedlings without shade. Budded and grafted materials and marcots / air-layers require very good shade in the nursery.
2) Watering: Immediately after sowing the seeds, the medium must be water thoroughly and must be continuously kept moist. Drying up of the sowing medium for a day may result in heavy losses of the sown seeds. During the germination period, it is important to keep the growth medium moist with light application of water at least twice a day. Timing of watering is equally as important as the amount of water to apply. Watering continues until the seedlings' roots are grown enough to tap soil moisture.
3) Weeding: Weeds must be controlled on both germinating and transplanting media if the seedlings are to develop normally. The associated weed species at these stages of growth of the young plants compete for moisture, mineral nutrients and light. If the weeds are left unchecked, they may stunt and even kill a large percentage of nursery stock.
4) Root and shoot pruning: Root pruning is carried out on both bare-rooted and potted seedlings. In bare-rooted seedlings, root pruning is carried out where it is desired to retard shoot growth or to change rooting habit of tap-rooted species by promoting the development of lateral roots. Root pruning involves severing the tap root and / or lateral roots as well. By so doing, greater lateral roots are encouraged. The new root system enables the plants to withstand harsh conditions much better when transplanted. Shoot pruning is also practised in some in some areas as a means of checking the growth of seedlings that tend to grow tall, thin and weak.
5) Nursery soil management: Typical crops of the tropical nursery stock take a lot of nutrients out of the soil, sometimes much more than equivalent field crops. The greater number of seedlings produced per hectare makes the total nutrient requirements per hectare of nursery soils very high. The high rainfall and copious artificial watering required by nursery plants for proper growth and development often leads to additional nutrient losses by leaching. Stable soil structure and proper nutrient supplementation programmes keep soils in the nursery in good physical and chemical conditions to sustain economic production of seedlings in a given piece of land.

6) Maintenance of soil fertility: The nutrient elements lost from the nursery soil by cropping, leaching and some other ways are most economically replaced by adding chemical fertilizers. The primary aim of doing this is to achieve optimum plant response as over-fertilizer application is not only wasteful but dangerous. The excess is subjected to leaching and volatilization and this could be destructive to seedlings as a result of toxic accumulation. Therefore, effective fertilizer application involves finding out what nutrient elements are lacking in the soil and applying them without injuries to the seedlings or soils.
7) Maintenance of good physical condition: Achieving and keeping a good physical conditions of the soil especially in the standard nurseries, is more complicated than maintaining its fertility. This usually requires some systematic increase in organic matter content of the soil and continuous protection of the soil from insolation, erosion and caking-up or crust formation as well as minimization of intermingling of sub-soil and the top-soil layers during bedding, filling of bags and weeding.
8) Soil conservation: Although the productive capacity of the soil may be drastically reduced by destruction of soil structure and excessive loss of nutrient elements, but, the most serious problem may be caused by erosion. Soil nutrients may be easily replaced, soil structure can also be easily replaced by addition of organic matter, but, loss of top-soil cannot be easily and rapidly remedied. Soil conservation measures include the use of cover crops, mulching, minima tillage, proper bed orientation and windbreaks.

DEPARTMENT OF HORTICULTURE
UNIVERSITY OF AGRICULTURE ABEOKUTA, NIGERIA.

Topic: fruit tree propagation

This involves practical exposure of the students to both sexual and asexual methods of propagating fruit trees. This practical exercise takes place at the nursery site of the Department of Horticulture.

Budding, grafting, marcotting / air-layering are practically demonstrated to the students using seedlings of cocoa raised by the students. Matured cashew trees are used for marcotting operations.

Every student does his / her own as a practical component of the course.