CIR723

Landscape Plant Propagation Workbook: Unit I. General Principles of Plant Propagation[1]

Dewayne L. Ingram[2]

This is one in a series of educational units presenting the basic principles of landscape plant propagation. This workbook is intended to be used in conjunction with a video-taped presentation on the general principles of propagation in the landscape plant industry. There is more detailed information in this publication than can be covered in the video presentation and additional sources of information are identified. Study questions designed to provide a review of important points are included.

OBJECTIVES FOR THIS UNIT

At the conclusion of this unit you should be able to do the following:

1. Describe the two methods of propagation: sexual and asexual.
2. Describe advantages and disadvantages of the methods of plant propagation.
3. List and describe types of asexual propagation.
4. Outline and describe procedures involved in sexual and asexual propagation.
5. Explain environmental considerations during propagation.
6. Define terms related to plant propagation.

The ornamental plant industry is a substantial portion of agricultural production in the southern United States and constitutes over a half billion dollars in gross sales in Florida. Many plants must be multiplied or propagated to achieve the numbers of starter plants required for production. Therefore, the size and importance of the propagation phase of the landscape plant industry is evident.

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2. Dewayne L. Ingram, former Professor, Environmental Horticulture, Cooperative Extension Service, Institute of Food and Agricultural Sciences, University of Florida, Gainesville FL 32611.

Most production nurseries propagate the majority of plants produced, although many nurseries purchase at least some liners from other nurseries. The term "liner" is used to describe a plant that has been propagated and is mature enough to move into the production phase. The word "liner" is used in this context because when plants were grown primarily in the field, the liners were "lined-out" in the field in rows. Liners may be transplanted into container, the field nursery row or directly into the landscape in some cases.

There are opportunities in the landscape plant industry for small to medium-sized nurseries specializing in propagation. Larger nurseries are generally willing to purchase liners of plants that are in demand and somewhat difficult to propagate. It is imperative that liners offered for sale be of acceptable quality. Nurseries will not purchase liners with a weak appearance and will not purchase additional liners from firms whose liners did not perform well after being transplanted. Repeat business is important to a nursery enterprise. Quality salable plants are best achieved when quality is the primary concern in the propagation phase.

PROPAGATION METHODS

Plants are propagated by sexual or asexual means. Sexual propagation is multiplication of plants from seed, and asexual, or vegetative, propagation involves starting a new plant from some vegetative part of a parent plant. Both methods are important in the landscape plant industry, but asexual propagation is most common.

Sexual Propagation

Many plants normally propagated from seed produce an abundance of seed per plant; therefore, a large number of seedlings can be produced from a single mature plant. Seed also provide a means of long-term storage. This is obviously important in the production of annual plants such as petunia, marigold and corn, which complete their life cycle in one year. Annuals grow from seed, produce seed and die in one year or growing season. Some herbaceous (not woody) plants grow vegetatively the first year and produce seed the second year of their life cycle. These plants are called biennial.

Woody plants are perennial, meaning their life extends over several years, and woody plants that produce seed usually do so every year after they mature and the environmental factors are favorable. Seed from many plants germinate readily and require no treatments to break dormancy. Feijoa, citrus and bougainvillea are examples of those requiring no pretreatment. Some seed require a postharvest treatment such as cold temperatures, which allow for the development of an immature embryo or degradation of chemical inhibitors. Hollies, junipers, magnolia, pines and dogwood seeds are examples of those requiring a cold pretreatment before germination.

Propagation by seed results in seedling variability. Although genetic variability is necessary if one is searching for a plant with improved or different characteristics, it is an extreme disadvantage for a nursery operator trying to produce a uniform crop containing chosen desirable characteristics.

Seedlings of some plants grow relatively slow and remain in a juvenile stage for a long period of time. Plants in a juvenile stage of growth may have leaf and growth habits different from desirable characteristics in a mature form of the plant. Juvenile plants do not usually produce flowers and fruit.

Asexual Propagation

Asexual propagation is the multiplication of a plant from some vegetative part such as a shoot tip. A proper environment must be provided for root development. The propagator may start with a piece of root and encourage the development of shoots and roots. Types of asexual or vegetative plant propagation include cuttage, layering, division, budding, grafting, and specialized organs such as corms, bulbs and tubers.

Most plants in the landscape plant industry are grown because of certain characteristics such as size, form, color and/or growth habit. Most asexual propagation techniques ensure that plants being propagated will have the same characteristics as the parent plant. Plants propagated from a single plant are called "clones". Clonal propagation constitutes much of the propagation in the landscape plant industry. *Ilex crenata 'Helleri'* is an example of a clone.

Although the advantages of clonal propagation are numerous, one disadvantage is the lack of genetic variability. In a monoculture, production of a single crop with limited genetic variability, there is more threat of rapid spread of disease and insect infestations.

Asexual propagation is the only way to multiply plants that do not produce seed. *Ilex crenata* 'Helleri', *Ilex vomitoria* 'Schellings' and several of the junipers are examples of plants in the industry that do not normally produce seed. *Ilex* species are also dioecious, which means male and female flowers are borne on different plants. Therefore, even with *Ilex* species that produce seed, the plant one wishes to propagate may be a male plant that will not produce seed.

In a similar amount of time, a plant produced by asexual propagation can be larger than a plant produced by sexual propagation. This is especially true for propagation by cuttings, which is by far the most common means of asexual propagation in the nursery industry. Cuttings can be taken from the branch tips, canes, leaves, or roots. However, plants produced from root cuttings may not remain true to the characteristics of the parent plant. Large cuttings from some plants such as *Ficus sp.* or *Photinia* can be rooted successfully. This results in a salable plant in a shorter production time.

Many ground covers such as liriope and mondograss are propagated by clump division. The clump is divided into several pieces containing adequate leaves, stems and roots for transplanting. Specialized organs such as bulbs, corms and tubers can also be separated or divided to yield multiple plants from a single plant.

Budding and grafting is used to join a desirable scion, the top portion of a plant, to a selected rootstock. The scion is usually selected for form, leaf color, flower color, size, branching habit, fruit characteristics, or disease or insect resistance. The root stock selection is based upon growth rate, tolerance to environmental stress such as cold, or resistance to important pests. More details of budding and grafting are covered in another workbook accompanying a video-taped presentation on that subject.

Layering permits the development of a liner while it is attached to the parent plant. The branch receives water and nutrients from the parent plant while roots develop. This method of asexual propagation yields a large plant while roots develop. This method of asexual propagation yields a large plant in a relatively short time, but only a limited number of layers can be made on the parent plant without disfiguring the plant form. Air, tip, trench, mound and serpentine layering will be described in more detail in another video-taped presentation and workbook.

ENVIRONMENTAL CONSIDERATIONS

An environment that limits stress on the developing propagule, (cutting, seedling, etc.) is essential for successful propagation. High or low temperatures, excessive water loss and light levels out of the desired range can limit the rate of development and can result in death of the propagule. The propagator may modify the propagation medium, relative humidity at the leaf surface, air and soil temperature, and light intensity and daylength to optimize development and growth of liners.

Propagation Media

The ideal propagation medium supplies the proper balance of air and water for the developing root system, anchors the propagule and holds nutrients for plant uptake. The medium should be free of disease organisms, insects and weed seed. The exact characteristics of the ideal medium will vary with container size, environmental conditions such as watering regime and temperature, and the plant species or cultivar. Common components of propagation media include pine bark, peat, perlite, vermiculite and coarse sand. Choice of components and combination of components are based on particle size, weight or bulk density, durability of the particles over time, availability and cost.

A container medium that has been thoroughly irrigated and allowed to drain freely is at "container capacity". When a medium is at container capacity, a saturated water table develops at the bottom of the container. The bottom of the container obviously creates a barrier to free drainage. The particle size of the medium determines the height of this water table. A tighter, less porous medium will result in a higher water table in the container than a porous medium. The height of the propagation container, bed or flat determines what portion of a given medium is saturated after irrigation and drainage. The saturated water table height is affected little by the height of the container. Therefore, if a shorter container has the same medium as a taller container, there will be a greater portion of the medium in the taller container filled with air after irrigation and drainage. This illustrates the importance of propagation medium depth, especially under outdoor conditions where water levels can not be adequately controlled.

A medium with the desired physical properties can be constructed by mixing components of known particle size. The addition of small particles to a medium composed primarily of large particles will increase the waterholding capacity and reduce the air pore space at container capacity. Common propagation media include (1) coarse sand, (2) equal volumes of peat and perlite, (3) equal volumes of vermiculite and perlite, (4) ground pine bark and (5) three parts peat and one part coarse sand.

The ideal medium for outdoor propagation will contain approximately 25 to 35 percent air space at container capacity. It is possible to produce quality liners in media with less air space when a covered greenhouse is used and the irrigation and misting are precisely managed. A porous medium is an excellent buffer during times of excessive rainfall or irrigation. A method of determining the air space at container capacity is outlined in **Extension Circular 556**, *Nursery Laboratory Development and Operation*.

In addition to water and aeration properties, the particle size in relation to seed size should be considered in medium selection. There must be sufficient surface contact between the particles and the seed to maintain proper seed moisture. A small seed in a medium with large particles will not have adequate contact with the medium and will probably dry too much between irrigations. The medium particle size is less critical for larger seeds.

Cost should also be a consideration, but do not buy an inferior medium just because the purchase price is lower. A quality medium is a wise investment and will pay for itself in healthier plants, fewer cull plants and fewer pest problems.

Temperature

The optimum temperature differs with plant species. Generally, air temperature of 70 to 85°F and soil temperatures of 70 to 75°F have proven optimum for many plants commonly grown in temperate climates. (The optimum temperature range for roots is narrow in comparison to that for shoots. The optimum may be slightly higher for some tropical plants and lower for plants commonly grown in colder climates.) Air temperature in enclosed structures must be controlled. Ventilation should be provided in the summer and on winter days with high light intensity. There are many ways to ventilate a structure, including passive and active means. Active means usually involve the use of fans and possible fans pulling air through moistened pads as a means of evaporative cooling. Passive ventilation uses the principle that hot air rises, and the structure is designed to allow the hot air to escape through some type of vent in or near the top of the structure. Structure design dramatically affects the efficiency of passive ventilation. More information on greenhouse ventilation can be found in *Agricultural Engineering Extension Fact Sheet No. AE-10*.

Heat must be added during cold periods to provide optimum temperatures or maybe just to minimize cold injury. The strategies for cold protection differ greatly with the specific crop and the climate in which the plants are grown, but the cost and return ratio is the primary consideration. It may be economically feasible to provide near optimum temperatures in a warmer climate, whereas in colder regions it may only be feasible to keep temperatures above those causing injury.

Heat can be added to the total air volume of the structure or may be strategically placed in relation to the crop. One efficient means is to heat the soil and allow the heat to rise into the crop canopy. The air temperatures 2 feet above the crop may be lower than desired, while the temperature around the plants is in the desired range. Heat can be provided to the root zone by several innovative ways, including below-bench heating and in-bench heating with heating cables or warm (100 to 115°F) water circulating through polybutylene tubing or polyvinylchloride (PVC) pipe. Many different types and arrangements of shields to minimize heat loss from the crop area have been used successfully. An overhead plastic shield in a greenhouse, often called a thermoblanket, will reduce heat loss from the crop zone.

Light

Optimum light is critical for proper plant development. Some plants are photoperiodic, which means they respond to daylength. Growth is encouraged in these plants when the daylength is longer. This can be achieved by extending the light period to 14 to 16 hours per day or by interrupting the dark period with 1 to 3 hours of light near midnight. A relatively low intensity of light is required for daylength extension.

The proper light intensity differs with plant. Some plants are quite efficient at lower light levels, while others may require almost full sun for optimum photosynthesis. Inadequate light intensity will result in leggy plants with weak stems that are sparsely foliated. Excessive light will stress the plant, resulting in a short, stubby, weakened plant with light green or yellowish foliage. It is important to maximize photosynthesis during propagation, since the products of photosynthesis are used for growth and development. The light level may have to be a compromise between optimum light for photosynthesis and reduction of heat load on the structure, depending upon air temperatures and the ventilation capabilities.

Moisture

The amount of moisture in the air, or relative humidity, affects the degree of water stress to plants. This is especially critical for cuttings, since they have no roots for water uptake to replenish water lost through transpiration. The higher the water content of the air adjacent to the leaves, the lower the amount of water loss.

Intermittent mist and fog systems are the primary ways to maintain a moisture content on the leaf surface approaching 100 percent relative humidity during the day, when potential evapotranspiration is highest. These mist systems are usually controlled by timeclocks with a preset duration and interval of mist or fog for the plant and the expected environment. Other types of controllers sense some aspect of the environment and provide moisture accordingly. More details will be given on mist control in the workbook accompanying the video presentation on propagation by cuttings.

A high relative humidity near the leaf surfaces can also be provided by a humid chamber technique. This involves confining the crop to a smaller volume of air in which the humidity can be more easily controlled. Disadvantages of this technique are the reduction of light intensity by some type of covering and the encouragement of disease development by reduced air circulation. The material confining the crop plants could be made of a porous material that is kept moist. Such a structure has been called a wet tent. This could allow some air circulation while adding moisture to the environment around the plants during propagation.

The quality of the water applied during propagation is important. The soluble salts level should be well within the acceptable range. Details of soluble salts measurement and interpretation are presented in **Extension Circular 556**, *Nursery Laboratory Development and Operation*. Higher concentration of calcium and/or iron in the water applied through a mist system result in deposits on the leaves. These deposits may not be obvious while the leaves are wet, but a white calcium deposit or a reddish iron deposit can reduce the attractiveness of the finished liner. These deposits probably do not reduce growth or vigor, unless they are extremely thick, but might reduce salability. Calcium and iron can be removed from irrigation water by filtration, but the cost of filtration may be prohibitory when large volumes of water are used.

Fertilization

When roots of developing cuttings or seedling emerge, they can absorb nutrients. However, excessive nutrients result in high levels of soluble salts that can injure tender roots. Controlled-release fertilizers can be used in the propagation medium, but the rate of nutrient release and the period of release must be carefully considered. A controlled-release fertilizer must be predictable over the range of temperatures and moisture conditions possible in a particular propagation system. Soluble fertilizers applied at moderate rates give more control of nutrient levels in the medium but require more intense management. Soluble fertilizer should not be incorporated in the propagation media. Controlled-release fertilizers may be incorporated in the medium during mixing or applied to the surface after cuttings have been stuck or seedlings have been transplanted. Whatever fertilization program is chosen, the routine monitoring of soluble salts and pH is essential. The propagator should be cautious when selecting and managing a fertilization system and should fertilize with moderation during propagation.

REFERENCES

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REVIEW QUESTIONS

- Define the following:

  liner

  clone

  relative humidity

  annual plant

  perennial plant

  biennial plant

- What are three critical environmental factors during propagation?

  1.

  2.

  3.

- What is the optimum soil temperature range for most temperate plants?

- What is the optimum air temperature range for most temperate plants?

- List five types of asexual propagation.

  1.

  2.

  3.

  4.

  5.

- What are the most common means of providing a humid environment for rooting cuttings?

- Propagation media selection is based on:

  1.

  2.

  3.

- What is meant by the statement, "the water status of the propagation medium at container capacity?"