

Plant Propagation: Basic Principles and Methodology

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Where, why and how do bedding plant, pot crop, foliage, and perennial seedlings or cuttings originate? In order for plants to reproduce, the process of either sexual or asexual propagation needs to occur. These forms of regeneration or replication have been labeled as both an art and a science, and producers must learn both facets so that their product is successful. This handout covers the basic principles of annual and perennial propagation and can serve as a general reference for herbaceous propagation.

Annuals: Seed Propagation

Seeds are the product of sexual propagation and represent an entire embryonic plant that is covered by protective tissue. Seeds are considered dormant until they are exposed to favorable environmental factors such as moisture, warm temperatures, and light that encourage germination. There are many important factors that propagators must consider about seeds before germination.

There are two main ways to handle young plants. Traditionally, growers would “**open sow**” **seeds in flats** and achieve clumps or rows of seedlings. These seedlings would then be transplanted by hand into final containers. Not only did this method require a large amount of labor, but it results in slower growing plants which sometimes flower later and are more susceptible to disease and poor cultural practices (Figure 1).

Plugs have become the chosen method for the production of young plants from seed. Basically, a plug is a seedling that is produced in its own individual container or cell (Figure 2). A plug tray contains many cells (72 to 800) and these trays are commercially produced by specialists. Plugs have many advantages: less labor inputs, faster growing times, less root shock and plant stress, and uniform growth of plants in the final container.

Growers interested in plug production must also consider the disadvantages: higher costs per seedling, greater space requirements during



Figure 1. These newly transplanted vinca seedlings are susceptible to poor cultural practices.



Figure 2. A plug is a containerized seedling.

plug production, specialized equipment, techniques, and personnel. Growers that are new to the business may want to initially purchase plugs to become familiar with the quality, handling, and cost issues that surround this strategy in seedling production.

The issue of **seed quality** plays a major role in the success of a germinating seed. Growers should purchase seed from a reputable seed salesman, and all seed purchased should be labeled as certified with a seed lot number and germination percentage on the package. The large seed suppliers have their own testing labs for vigor and viability, and it is recommended that purchases be made with these firms.

Seeds should be stored at a temperature between 40 to 70°F, with a relative humidity between 20 to 40%. These ranges have been established so that seeds do not lose their vigor and viability. Most growers **store seeds** in a cool chamber such as a refrigerator with low relative humidity. Properly stored seeds should have a moisture content between 5 to 8%.

The type of **substrate** or medium used for germination is important to seedling establishment. In general, a substrate should be light and porous to provide adequate oxygen, yet retain moisture and allow for proper drainage. Most commercial germination mixes contain a blend of peat moss, vermiculite, perlite, and sometimes sand (Figure 3). The germination mix

should be free of weed seeds and pests (insects and disease organisms), low in nutrients, and have a pH between 5.4 to 6.4.

The **temperature of the propagation medium** should be high, and a general range for floricultural crops would be 68 to 86°F. Most seeds will germinate at 75°F, but one should always check the germination requirements of specific seed. Not only do specific species require an optimum germination temperature, but some seeds may or may not require light. There are a number of excellent publications which contain the germination requirements of herbaceous plants (Nau, 1999; Styer and Koranski, 1997). If seeds are to be covered, a general rule of thumb is to cover the seed by a layer of loose propagation substrate (coarse vermiculite or perlite is often used) as thick as 1/4 the length of the seed. Along with a light covering of mix or a mix component, some growers will cover the flats with white or black plastic to keep moisture levels high and prevent rapid drying of the germination substrate. The plastic is then removed after the seedling protrudes from the substrate surface.

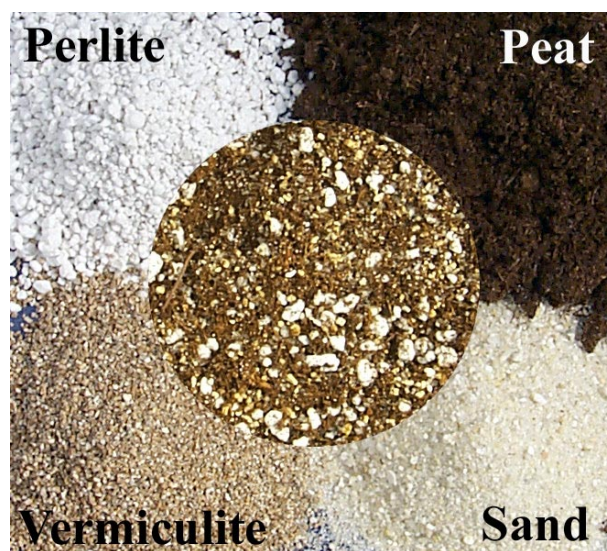


Figure 3. When propagation substrate components are combined, a lightweight porous moisture holding soilless mix is produced.

After the seedling has developed its **first true leaves**, a mild fertilizer solution can be applied. Nitrogen concentrations of 50 to 75 ppm are recommended. Plugs are usually transplantable 3 to 6 weeks after sowing, and a general rule of thumb is when leaves begin to touch one another, the plants are ready to transplant (Figure 4).

Annuals: Vegetative Propagation

Asexual propagation is a process where a new plant is produced from plant parts: leaves, stems, buds, or roots. This form of replication produces plants or clones that are genetically identical to the mother plant, from where the plant part was taken. Asexual propagation of floricultural crops has become a means of producing many plants which were traditionally grown from seed. Examples include coleus, impatiens, strawflower, and verbena. Crops like poinsettias (Figure 5) and chrysanthemums have traditionally been propagated vegetatively.



Figure 4. Ornamental cabbage seedlings are ready to be transplanted in this 72-cell plug tray.

Knowing how the **vegetative propagation industry** has evolved is just as important as the principles behind vegetative propagation. The increasing use of vegetative cuttings for hanging baskets, color bowls, and pots has led to an integrated production and supply system today that involves plant breeders, stock plant managers, propagators, brokers, and growers.

Breeders are the first to develop a new plant line by conducting massive evaluation trials for selection of premium genetic material. After a plant has been selected for replication, its numbers are increased through stock plant or mother plant production. Offshore production of stock plants, mainly in Central America, has been the strategy in which to take advantage of ideal environmental conditions and low labor costs. Cuttings are harvested from these plants and are shipped to the U.S. to either rooting stations or grower locations. Propagation firms have established networks of specialized propagators who root cuttings and ship to clients either regionally or nationally.

Because new lines of plants are being developed every year, most of the recently introduced **vegetatively propagated species are patented** or protected, where the average grower cannot replicate these plants without permission.



Figure 5. Poinsettia stock plants are grown in large containers.

Propagation firms charge royalty fees for patented material and some firms may charge more to growers who propagate unrooted material. Today the industry is carefully monitored for plant quality and business integrity, because the amount of investment for clean (virus and disease free) plants is very expensive.

How do the firms **ensure quality plant material**? One method is the technique called culture indexing. Plant viruses cannot keep up with the rapid growth in the shoot tips of plants, therefore scientists grow new plants from these shoot tips on sterile media, then culture test them over several months to ensure clean stock plants. The technique is also used to eliminate bacteria or fungi from plants. Other control measures include insect screening (Figure 6) and attentive stock plant management.

The **propagation environment** for leaf or stem tip cuttings changes over time because the needs of the tissue change as it develops roots and becomes a functional plant. A good rule to remember for successful propagation of cuttings is the “warm bottoms”, “misty middles”, and “cool tops” principle.

Cuttings need warm bottoms for proper cell division and growth of newly forming adventitious roots. Propagators supply **bottom**

heat to cuttings to accelerate rooting, with a preferred temperature range between 68 to 77°F. Bottom heat can be supplied in many ways. Common strategies for providing bottom heat include propagation mats which have electrically heated wires encased in rubber, heating tubes on benches which carry warm water, and steam pipes under benches. The air temperature also effects growth and should be maintained between 65 to 75°F.

Keeping the **humidity** high is important for propagating herbaceous plants. Newly “stuck” cuttings require a water source to remain turgid. Providing the cuttings with intermittent mist or fog keeps the substrate moist and prevents the cuttings from wilting (Figure 7). Monitoring root growth and development overtime and observing the ability of the cutting to remain turgid with less mist helps the propagator regulate the amount of water supplied to the plant. If the water source is not regulated and the cuttings are continually rooting in saturated conditions, slow root growth and development will occur because of low oxygen levels in the substrate.

Light, in particular light level, has a tremendous effect on the success of rooting cuttings. Cuttings should be protected with shade cloth during parts of the year with high light



Figure 6. Insect screening is required for the prevention of Western flower thrips and other insect pests that can infest stock plants and rooting cuttings.



Figure 7. Intermittent mist prevents cuttings from desiccation.

levels and if light levels are too low in the winter, propagators should provide supplemental light. A general light level range for the propagation of floricultural crops is 1,000 to 2,000 footcandles.

Several **substrates** are used to root cuttings. Overall propagators want a substrate that retains moisture, but provides adequate oxygen and will support a cutting upright. Not only do propagators use perlite, vermiculite, and peat, but foam is also used to root cuttings. A common type of foam product used is the Smithers-Oasis Root Cube or Wedge®.

In general, cuttings root 3 to 5 weeks within the propagation environment. Propagators remove cuttings from bottom heat after roots reach the bottom of the tray and typically apply a moderate amount of fertilizer (75 to 200 ppm nitrogen) to the cuttings because leaching of nutrients from the substrate and plant tissue has occurred. It is important to fertilize recently propagated material because this nutrient treatment affects the growth and development of the plant once placed in its final container.

Perennials

Perennials have become an important component of a greenhouse grower's production list. The nature of the plant has made gardeners appreciate its repeating lifecycle (Figure 8), and through its popularity has come an increased demand for production information. Perennial propagation involves a tremendous amount of skill and because there are thousands of species with specific germination requirements, many growers purchase plugs from specialty propagators.

One of the most common means of propagating perennials is by **division**. Most mail order perennial suppliers propagate by division where large tracts of land are required to produce field-grown perennials. The plants are normally divided in the fall or early spring. Propagators who divide in the spring allow for 3 to 5 inches of growth from the crown of the plant and segment

the plant with a sharp spade or serrated knife.

Because most perennials do not flower the first year, propagators sow seed during the summer months and transplant into larger containers in the late summer and early fall. This strategy is also conducted before winter because a large majority of perennials require a cold period or a **vernalization** treatment for spring or summer flowering. Even before germination is to occur, some perennial seeds may require **special treatments** to break dormancy. Certain species of perennial seed require a period of moist chilling or warm stratification. Other types of seed may require a treatment known as scarification. Scarification involves breaking or weakening the seed coat for the penetration of oxygen and water to the embryo through chemical or physical means. Uniform germination is rarely achieved with perennials and it may be more economically feasible to root vegetative cuttings.

Vegetative propagation is a fairly new approach to replicating perennials, with a large amount of production information still unknown. Research is now focussing on manipulating the plants through modifying the daylength and production temperatures in order to condition the plants to flower. Propagation by tip cuttings allows for more uniform growth in the rooting tray and the plants are more true to type than seed



Figure 8. The blackberry lily is a seed propagated perennial which is also propagated by division.

propagated perennials. Successful propagation by cuttings can be achieved by following the same guidelines established with vegetative annuals.

Sanitation and Pest Control

Because temperature and humidity are normally higher in propagation houses, the incidence of disease is greater. Diseases thrive in environments which allow for easy survival and transmittance of fungi and bacteria. Propagators should establish strict sanitation measures to prevent diseases so production is optimized and profits always exceed losses. All containers should be sterilized before reuse in the propagation area and workers should wash their hands thoroughly before handling unrooted material. It is recommended that a 10% sodium hypochlorite solution be in the propagation area at all times (Figure 9). Disinfectants labeled for greenhouses should be applied to benches, flats, pots, knives, walls, and floors before initiating any propagation activity. Not only are diseases economically devastating in propagation (Figure 10), but insects can cause loss of profits. Greenhouses should be monitored for pests routinely with yellow and blue sticky cards, while growers should periodically check vegetation for signs of insects or insect damage.

Propagation References

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Figure 9. Sodium hypochlorite is used to sterilize cutting tools.

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Figure 10. Soft rot in poinsettia cuttings is a devastating bacterial disease.