CIR725

Landscape Plant Propagation Workbook: Unit III. Propagation by Seed[1]

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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 using seed for plant propagation in the landscape plant industry. This workbook and the video-taped presentation have been divided into two parts. Part A deals with the basic characteristics of seed and proper collection and handling. Part B emphasizes environmental modifications and considerations for seeding.

There is more detailed information in this publication than can be covered in the video presentation, and additional sources of information are listed. Study questions designed to provide a review of important points are presented.

OBJECTIVES FOR THIS UNIT

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

- **Part A**

1. Present advantages and disadvantages of propagation by seed.
2. Present considerations for seed collection, handling and storage.
3. Describe the stages of seed germination.
4. Define the causes of seed dormancy.
5. Explain methods of breaking seed dormancy.

- **Part B**

1. Present considerations for sowing seeds.
2. Describe environmental modifications for seed germination and seedling development.

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PART A

Sexual (seed) propagation is an important means of reproducing crop plants, including landscape plants. Many seeds can usually be harvested from a plant; thus, many plants can be propagated from a single mature plant. An orchid seed pod can contain over 3 million seeds but 500,000 to 1 million seeds per pod is common in many plant species. Annuals and biennials are most commonly propagated from seed. Sometimes seedage is the only practical means of propagating a plant, because vegetative means have not been explored or have been unsuccessful.

Seed propagation offers genetic variability; thus, the offspring may not have the exact characteristics of the parent plant. This allows for the selection of plants with unique features and systematic breeding for identified characteristics. Genetic variability is a disadvantage if the goal of the producer is to grow a uniform crop. Seedling variation is quite high in some plants, while other plants are more true to type. Techniques using genetically stable lines or line hybrids are used to produce many of the flowering annuals and vegetables with minimal variability.

Growers find that it takes longer to produce some plants from seed than from cuttings. Seedlings may remain in a juvenile stage of growth for a longer period of time. Juvenile growth does not produce flowers or fruit and such growth often has a different appearance than mature growth.

Description of Seed

A seed is composed of three basic parts: the embryo, food storage tissue and the seed covering. The embryo is a new plant resulting from union of male and female gamete during fertilization. Cotyledons, or seed leaves, are attached to the embryo. Seeds are classified by the number of cotyledons attached. Monocotyledons (monocots) such as grasses and palms have one cotyledon, while dicotyledons (dicots) such as bean and peach have two. Plants such as pines are gymnosperms and their seeds may contain as many as 15 cotyledons.

A mature viable seed contains enough stored food or energy source for seed germination and early seedling growth. The cotyledons of dicots usually contain this food reserve, while some seeds have a mass of food reserve called endosperm surrounding or in contact with the embryo (e.g., corn).

Seed coverings can consist of the seed coat and parts of the fruit or seed pod. These structures protect the embryo and food reserve inside the seed. They can also inhibit germination until conditions are suitable for germination and seedling development.

Seed Collection

Seeds should be collected when ripe and just before they fall to the ground. When seeds are on the ground, the likelihood of disease and insect infestation is greatly increased. Some seeds loose viability (ability to germinate) soon after they are ripe and should not be collected from the ground. Several of the tropical plants have seeds with short periods of viability. Generally, palm seeds fit into this category.

Seed maturity is often difficult to determine. Generally there is a color change of the fruit from a green to an orange, black, purple or red, and the fruit may become soft. Winged seed, seed pods or fruit without fleshy pulp may turn a brownish color as they mature and become drier. This water loss or drying coincides with seed maturity and is a state in which the seed may be stored or distributed by wind or water.

Seed Cleaning

The pulp from a fleshy fruit may contain germination inhibitors and should be removed before seeds are sown. The seed would probably germinate after the fruit decomposes, but the propagator may not want to wait several weeks and the process may reduce germination. Seeds are usually removed from dried capsules before treated or germinated.

Seeds may be cleaned individually or in bulk. Seeds may be harvested from dried capsules, or the capsules can be crushed, if the seed is sufficiently hard, and sown with the seeds. The flesh around a seed can be removed by hand or by some mechanical means. A procedure for cleaning several seeds at one time has been developed by Dr. Bijan Dehgan in the Department of Environmental Horticulture at the

University of Florida. The procedure was developed for cleaning cycad seeds but will work with many seeds. The general procedure is as follows: The fleshy coat is removed by using a long-stemmed, circular wire brush attached to a variable speed drill. First, seeds should be soaked in water for 24 hours. Next, place seeds in large wide-mouth jar or a large coffee can with a plastic top in place, through which the stem of the wire brush is passed. Add a small amount of 20 mesh sand to the seeds and enough water to cover the sand and seeds. Turn on the drill at a slow speed and gradually increase the speed until all seed coats are removed. Wash the seeds thoroughly. A lot of 300 to 400 seeds can be cleaned in approximately 10 to 15 minutes.

Seed Viability Tests

It is often difficult to determine from the appearance of a seed if it is alive and would germinate under the proper conditions. There are methods of determining seed viability or potential for seed germination.

Stains can be used to determine if the seed embryo is alive. Living tissue respires in order to maintain its integrity and tetrazolium chloride turns red when it comes into contact with respiring tissue. The seed is cut open and the stain applied to the exposed embryo. If the embryo is alive, it will turn reddish in color.

Viable and dead seeds in some plant species can be separated by floating the seed in water. When the seed is filled with the embryo and endosperm to support germination and early seedling growth, the seed will sink in water. When a seed is empty or contains a relatively large amount of air, the seed will float. This is a good means of identifying dead oak and pindo palm seeds, but it does not work with *Zamia floridana*, *Cycas cercinalis*, coconut, fishpoison tree and several other plants.

Seed Storage

Seeds of many plants can be stored and germinated weeks, months or years later. Factors affecting the viability of seeds during storage include (1) the inherent longevity of the plant species, (2) seed moisture content, (3) the temperature and (4) the relative humidity.

The length of time seeds can be stored differs with the plant species. Magnolia, wax myrtle and elms have short-lived seeds and may be stored only for a few weeks or maybe up to a year without losing viability. Koelreuteria, calendula, petunia and zinnia are examples of seeds that can be stored for 2 to 15 years, and acacia and elaeagnus can be stored for 15 to 20 years. Research is being conducted with freezing techniques that could increase the length of time seeds can be stored.

The moisture content of the seed should be reduced to 20 to 30 percent of seed weight before storage. This can be accomplished by placing them in the sun or in a drying oven. Obviously, if the seed becomes too dry, the embryo will die.

Many seeds will store best if a temperature 35 to 45°F is provided. However, some of the tropical plants will not tolerate temperatures below 40°F. Generally, seeds from tropical plants do not store well.

The relative humidity in the storage container should be 20 to 30 percent. The moisture in the air and the seed will become equal over time in the container; therefore, the environment in the container should be relatively dry and the seeds should be dried somewhat before storage. Plastic bags or bottles work well as storage containers.

Seed Germination

Although the specific characteristics of seeds differ with plant species, the general germination process is the same. Plants can be divided into two large categories: those whose seeds contain one cotyledon (monocot) and those that contain two (dicot).

The germination process can be described in three phases: activation, digestion and cell division, and elongation. The process begins with the imbibition or uptake of water. This may take a few hours or several days, and the seeds will usually swell or enlarge due to the increased volume. Water uptake triggers the activation of certain biochemical processes that result in the synthesis of the building blocks (nucleic acids, amino acids, enzymes, etc.) for growth and development.

The endosperm is digested by enzymes to produce energy-rich compounds and nutrients that are transported to the embryo. Cell division and elongation occurs and the developing embryo expands. The radical or root emerges from the seed by breaking through the seed coat.

Dormancies

Many seeds are ready to germinate when the fruit is ripe or the capsule is dried. Seeds from tropical plants usually are not dormant when mature, but many of the plants from temperate climates are dormant when collected. Dormancies are protective mechanisms that have evolved to allow a seed to germinate at the appropriate time. For example, dogwood seed mature in late fall but are dormant at that time. These seeds require a cold period to satisfy some factor inside each seed before it will germinate. If dogwood seeds were germinated in the fall, the tender seedling would probably not survive the winter. Therefore, the cold requirement facilitates natural germination in the spring at the beginning of the growing season.

Seed dormancy can be caused by a hard seed coat that is impermeable to water or gases, or resistant to embryo expansion. Zamia, camellia and redbud are examples of seed dormancy due to an impermeable seed coat. Seeds from many of the stone fruits, such as peaches, are dormant due to physical restriction of seed expansion.

The fleshy pulp, the endosperm or the seed coat can contain chemical inhibitors of germination. Some of these inhibitors are water soluble and can be leached out of the seed, but many can not be washed out and must be broken down by some chemical process. Okra seeds contain a water-soluble inhibitor that can be leached by soaking the seeds in water for 12 to 24 hours.

The embryo may be immature when the fruit is ripe or the capsule is dry. A period of time in the proper environment is required before germination is possible. The embryo will often increase in size during this period and will develop the properties necessary for germination. Orchid seeds are dormant when released by the plant, due to an immature embryo.

Some seeds have double or multiple dormancy: more than one type of dormancy. An immature embryo may prevent germination of a seed, even though a dormancy due to a hard seed coat has been overcome. A seed may require a cold period to break a dormancy due to the seed coat and then require a warm period for development of an immature embryo. Nandina seeds require a cold-warm-cold sequence of temperatures before germination.

Even though some seeds will germinate without a preconditioning period, the germination rate and uniformity might be enhanced by some treatment. This condition is referred to as a physiologically intermediate dormancy.

Overcoming Seed Dormancies

Scarification and stratification are the two most common means of breaking seed dormancy, but hot water soaks and plant growth regulator treatments are also used. Scarification involves the breaking of the impermeable or hard seed coat. This may be accomplished by mechanical means or by acid treatments. Scratching the seed coat with sand paper and cutting the seed coat with a knife are suitable for some seeds. A hammer or pliers can be used to break the seed coat in some cases. Care must be taken in any scarification procedure not to injure the seed embryo. If a specific treatment for a particular plant species is not known, sample seed lots treated with various techniques followed by germination tests is recommended.

Acid scarification has been used successfully in some plants to break the seed coat. Such scarification occurs in nature when the seed coat is partially digested by fungi or bacteria or enzymes in the digestive tract of birds and animals. Sulfuric acid is usually used for scarification. Seeds may be soaked for 5 to 60 minutes, depending upon the toughness of the seed coat and the sensitivity of the embryo. Dry, clean seeds are placed in a nonmetal, noncorrosive, acid-resistant container, and the acid is added slowly in a ratio of one part seed to two parts acid. The mixture should be gently stirred intermittently during the soak to ensure uniform results. Seeds soaked in acid should be washed thoroughly under running water for 10 minutes to dilute the acid in contact or inside the seeds before they are sown.

Acids are extremely dangerous and proper handling procedures must be followed. Never pour water into acids, because tremendous heat can be generated in a violent reaction. Dilute acids by pouring the acid into water very slowly. Acid-resistant clothing including gloves, should be worn when handling acids. Acids should be disposed of properly as hazardous material and should never be poured down the sink.

Stratification is the technique of providing a moist chilling treatment to seeds to overcome a dormancy. This technique has been used to overcome dormancies due to an impermeable seed coat or chemical inhibition. Stratification could reduce the concentration of germination inhibitors or increase the concentration of growth-promoting hormones. Seeds should be soaked for 12 to 24 hours and then placed in a moist medium. Coarse vermiculite, sphagnum peat moss, equal volumes of peat and perlite, and coarse sand have proven to be good stratification media that retain moisture yet allow aeration. Seeds should be mixed with one to three times their volume of medium and stored in a container that provides a barrier to moisture loss, such as a polyethylene bag. Seeds can be stratified naturally by placing them outdoors in an area or container protected from rodents, but the temperatures outdoors may not be uniformly low enough in Florida to provide optimum results.

Seeds are usually stratified at 32 to 40° F (0 to 2° C) for a period of 1 to 4 months. Seeds are then separated from the stratification medium and germinated at 70 to 80° F (17 to 22° C). Germination at higher temperatures (>90° F; >27° C) may induce a secondary dormancy.

Soaking in water will often soften seed coats and leach water-soluble inhibitors from the seed to reduce germination time. Best results are obtained when hot water is used, but the temperature sensitivity of the embryo differs with species. Generally, water at 170 to 212° F (67 to 88° C) is poured over seeds in a ratio of one part seed to four or five parts water and allowed to cover the seed and cool for 12 to 24 hours. Changing the water periodically during prolonged soaking is imperative. Seeds should not be allowed to dry after the treatment but should be sown immediately. (Review Questions for Part A can be found on page 7.)

PART B

Environmental Factors

An ample supply of high quality water must be applied during seed germination and seedling development. There must be a proper balance between water and air in the propagation medium. Waterlogged media cannot supply the oxygen necessary for germination and seedling growth. Monitoring the moisture level in the medium is important. Water with excessive dissolved salts can result in poor seed germination and seedlings growth. Seeds and seedlings differ in their sensitivity to salt levels, but generally the seedlings are less tolerant than mature plants.

The maximum, minimum and optimum temperatures for seed germination and seedling growth differ with plant species and maybe even cultivars within species. If the optimum temperature for a seed is not known, the range of 75 to 80° F would be optimum for many plants and should be considered. Keep in mind that plants native to warmer climates or those that flourish during the warmer months may have higher optimum temperatures than plants that flourish in cooler temperatures. Reducing night temperatures 5 to 10° F (3 to 5° C) has proven beneficial in germination of some plants native to temperate climates.

Seeds can be grouped according to their requirement of light for germination. Many woody plants do not require light for seed germination, but most epiphytes such as mistletoe and strangler fig require light. Other species have a light requirement for germination, but this can be overcome by chilling or chemical treatments as in lettuce, tobacco and many native weed seeds. *Allium, Amaranthus* and *Phlox* are examples of seeds whose germination is inhibited by light. Some species such as *Tsuga* and *Betula* are sensitive to daylength, but sometimes this can be overcome by temperature treatments.

Emerging roots from a seed can absorb nutrients. The presence of nutrients in low to moderate concentrations at this time will result in more rapid seedling growth. Care should be taken to avoid excessive dissolved salt levels which will injure such tender root tissue. Application of soluble fertilizers on a periodic basis is recommended over incorporation of fertilizers in the propagation medium before the seeds are sown.

Seed Sowing

Germinating seeds in a controlled environment such as a greenhouse and in a sterile medium will result in optimum seed germination and early seedling development. Problems with weed seeds, nematodes, insects and diseases can be greatly reduced with such procedures. Plastic, wood or metal flats are common containers for seed germination, although individual containers, celled flats and preformed peat pellets are also used. Seeds may be germinated in a flat and then the most vigorous seedlings can be transplanted to a larger production container, or, under certain circumstances, the seeds may be sown in the production container in which they will be sold.

The germination medium should be well-drained but should hold sufficient moisture to maintain optimum moisture in the seed. The particle size of the propagation medium components is important, because this primarily determines moisture and aeration characteristics of the medium. The particle size must also be considered in relation to the size of the seed to be sown in the medium. There must be sufficient contact between the seed and the particle for exchange of moisture. A large seed can be germinated in a medium with relatively large particles, but a small seed would settle toward the bottom of such a medium. A small seed should be germinated in a medium with relatively small particles to provide an appropriate contact between the seed and the particle.

The proper planting depth differs with seed. Seeds that require light for germination obviously can not be planted deeply or may not be covered at all. Generally, seed should not be planted deeper than two or three times their diameter. Many large seed, especially tropical species like palms, may only be inserted into the medium surface where they will remain moist.

Transplanting Seedlings

Seedlings should be transplanted before they over-grow a container and their growth habit or form is altered. Seedlings produced in flats at a high density must obviously be transplanted earlier than seedlings produced in larger containers at a low density. Seedlings must be hardened before transplanting. Hardening refers to a gradual change in the environment so the seedlings can adapt to withstand more stressful conditions than those provided in the propagation phase. The irrigation frequency is usually reduced and the light level and fertilization may be increased. Proper hardening will ensure that the seedlings are established in the production environment at an optimum rate. (Review Questions for Part B can be found on page 8.)

REFERENCES

Hartmann, H. T. and D.E. Kester. 1983. *Plant propagation principles and practices*. Fourth Edition. Prentice-Hall, Inc.: Englewood Cliffs, NJ.

Seeds of woody plants in the United States. Agricultural Handbook No. 450. 1974. Forest Service, U.S.D.A.: Washington, D.C.

REVIEW QUESTIONS FOR PART A

- What are the advantages and disadvantages of seed propagation?

- How can one know when seeds are ready to be harvested?

- What is the ideal environment for storage of most seed?

  temperature______________________

  humidity__________________

- What are the stages in seed germination?

1.

2.

3.

4.

5.

- List three common causes of seed dormancy.

1.

2.

3.

- Define:

scarification

stratification

- What are two tests of seed viability?

1.

2.

REVIEW QUESTIONS FOR PART B

- What temperature range is best for seed germination for most temperate and subtropical plants?

- Why is the particle size of the seed propagation medium important?

- Do all seed require light to germinate? Yes or no

- Name one seed that requires light to germinate.

- At what stage of development can roots of seedlings absorb nutrients?

- Define:

hardening

spore