Seed Treatments To Overcome Dormancy

Seeds of most horticultural crops have been genetically selected to germinate immediately after sowing. This is not the case for many forest and conservation species, however, whose seeds become dormant after they mature. **Seed dormancy** refers to a physiological state in which otherwise viable seeds will not germinate, even when placed in growth conducive environments. Although seed dormancy is an annoyance to growers, it is actually a fascinating ecological adaptation that works to spread germination out over time and space. Some types of dormancy insure that seeds will only germinate when weather conditions, especially moisture and temperature, are favorable to the survival of the seedling. Other seeds need to pass through the digestive tract of a bird or animal before they can germinate, which means that they will be carried away from the mother plant.

The **type** of dormancy is genetically controlled, and is usually the same for a given species, or even genus. As with most things in nature, however, there are always exceptions, and the genus *Quercus* is a good example. Most species in the red oak group have immature embryos that benefit from stratification, whereas most species in the white oak group do not. Even within each group, however, there are oak species that are exceptions to this rule. The **degree** of dormancy varies between ecotypes of a species, seedlots collected in different years, or even between individual seeds from a given plant. This variation is an adaptation that insures that all seeds will not germinate at the same time, but that germination will be spread over several years.

Seed dormancy can be caused by several different factors, and there is no universal agreement on the best terminology. For it to be relevant to nursery managers, a dormancy classification system should be both logical and operationally useful; six different types of seed dormancy have been proposed (Table 3). The major types of dormancy can be overcome with seed treatments. In the case of secondary dormancy, however, the best solution is preventing the condition in the first place by proper seed handling and storage.

Seedcoat dormancy

This condition is often called "external dormancy" because the restricting factor is the tissue surrounding the embryo (Table 3). The degree of seed coat hardness varies between species, but also depends on the ecotype and weather conditions during the seed ripening process. Several treatments can be used to soften the seedcoat, but keep in mind that the objective is to just increase its permeability to water and gases. Overly severe treatments may injure the embryo, so start with the gentlest

Table 3. Seed dormancy can be caused by several different factors

Dormancy Class	Causal Factors	Examples
Seedcoat (External)	1. Seed is impermeable to water or oxygen	1. Many legumes: *Acacia* spp.; *Robinia* spp.
	2. Seedcoat physically restricts developing embryo	2. *Pinus* spp.; *Quercus* spp.
Embryo (Internal)	1. Inhibiting substances within the embryo or surrounding tissue	1. *Betula* spp.; *Magnolia* spp.
	2. Physiological immaturity	2. *Juniperus virginiana.*
Morphological	Embryo is not completely developed	*Fraxinus* spp.; *Pinus* spp.
Double	Embryo dormancy in both the radicle and epicotyl	*Prunus* spp.; *Quercus* spp.
Combined	Results from 2 or more primary dormancy factors	*Tilia* spp. have a very hard seedcoat plus embryo dormancy; *Crataegus* spp.
Secondary	Results from poor seed collection, handling, or storage	*Pinus taeda* after exposure to high temperatures and moisture during storage

method, then increase the severity of the treatment until the seedcoat is permeable. *Be sure to keep good notes on the treatment method and timing, so that you can develop a seed treatment guide for each species or ecotype.*

Hot water soaks—This is the traditional treatment for hard-seeded species such as legumes, or seeds with waxy seed coats. Prepare a container with a volume of water that is approximately 4 to 6 times the volume of dry seeds. Bring the water to a boil, immerse the seeds, and then remove the container from the heat and allow it to cool. The embryo of some seeds can be damaged by high temperatures, so for these species, the water should be heated to only 65 °C to 70 °C (149 °F to 158 °F). The seeds can be removed and dried when they swell and become gelatinous to the touch. With some species (e.g. *Tilia* spp.), the imbibed seeds sink to the bottom of the container and the floaters must be removed and retreated. Although some growers use a standard treatment period for the hot water soak, it is better to experiment with each species and seedlot because of variations in seed coat thickness. Treated seed is subject to bacteria and fungus infection, and should be sown within a few days. One problem with hot-water treated seeds is that they stick together, making them difficult to use in mechanical seeders. One remedy for this is to place the treated seeds in moist peat moss for a few days.

Dry Heat—Fire treatments have been used on the seeds of some woody shrubs (e.g. *Arctostaphylos* spp.) from fire-dependent plant communities, and for some species of Eucalyptus spp. Dry heat treatments are not recommended, however, because the amount and duration of the heat that reaches the seed cannot be accurately controlled.

Scarification—The process of **scarification** involves weakening the hard seed coat just enough to allow imbibition, and several techniques are effective:

> *Mechanical abrasion*—The seedcoats of small quantities of relatively large seeds can be treated by hand: nicked with a triangular file or sharp knife, rubbed against coarse sandpaper, or burned with an electric soldering iron or wood-burning tool. Be sure to scarify the rounded side of the seed to avoid damage to the radicle of the embryo (Figure 4). Workers should always wear protective gloves and small seeds can be held with tweezers. To treat large seedlots, a rotating drum that is lined with sandpaper or a cement mixer filled with gravel has been used. Whatever technique is used, it is important to regularly check the seedcoats to make sure that the treatment has not gone too far.

> *Acid soaks*—Another scarification method is to soak the seeds in a strong acid solution which chemically digests the hard seedcoat. Concentrated sulfuric acid is preferred, but growers must be aware that this is an extremely caustic material, and that safety must always be a foremost consideration. MacDonald (1986) presents an excellent step-by-step procedure. Because the treatment time will vary considerably with species and seedlot, it is a good idea to conduct some small-scale trials first by removing a few seeds at regular time intervals, and cutting them to assess the thickness of the seedcoat. When properly done, acid scarification is a very effective way to soften seedcoats and stimulate quick germination. Although acid-scarified seeds can be stored for a few days, it is best if they are sown immediately.

The best choice of scarification treatment will depend on the biological requirements of the species and the skill and experience of the grower.

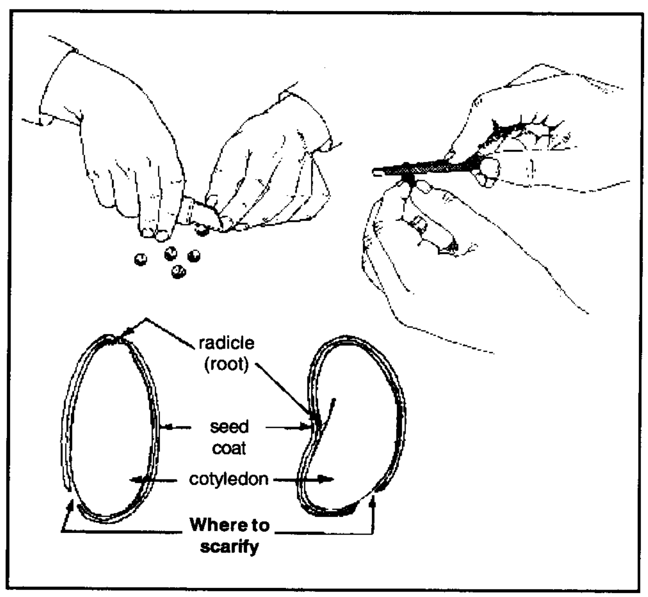

Figure 4. Hard-coated seeds can be hand scarified with a knife or file, but be careful not to damage the embryo.

Embryo or morphological dormancy

These "internal" types of dormancy can have two different causes (Table 3), but in both, the cultural treatment must overcome a physiological or morphological condition within the seed itself. As was the case with seedcoat dormancy, the degree of dormancy can vary considerably from species to species, as well as between ecotypes, again, the need to try different treatments and keep good records cannot be overstressed.

Cold, moist stratification—For commercial forest tree species, stratifying seed under cold and moist conditions is the most common treatment to overcome seed dormancy. Cold, moist stratification originated from the historical practice of placing layers of seeds between alternating layers ("strata") of moist peat or sand. Cold, moist stratification satisfies several important physiological functions, including: activating enzyme systems and converting starches to sugars for quick metabolism. Although the exact mechanism is unknown, stratification also changes the balance between chemical inhibitors and promoters within the seed, acting as a "switch" to chemically stimulate germination. Even species that do not exhibit true dormancy can benefit from cold, moist stratification with faster and more complete germination.

The traditional practice of mixing seeds within a moist medium is still used for some forest and conservation species. Some nurseries mix seeds with damp Sphagnum moss in a plastic bag and place it in a refrigerator. The condition of the seeds is checked weekly and they are sown after the prescribed stratification period, or planted as germinants. Naked stratification involves soaking seed in water to obtain full imbibition, draining off the excess water, and placing the seeds in polyethylene bags in refrigerated storage where the temperature is held slightly above freezing. Running water rinses are preferred to standing soaks because the bubbling water keeps dissolved oxygen levels high, and also cleanses the seedcoat of pathogenic organisms.

Successful stratification requires that four conditions be met:

1) proper seed moisture content
2) adequate aeration
3) low temperatures
4) the appropriate treatment time

Moisture and aeration—Operationally, these two factors must be considered together because they can be inversely related in the stratification environment. Effective stratification requires that seeds be fully imbibed and not allowed to dry out for the entire treatment period. Soaking in running water at room temperatures for 24-48 hours is usually adequate. If the seeds are not fully imbibed, the stratification will be less effective, and will be reflected in slow or irregular germination. After imbibition, the seeds are drained and placed in polyethylene bags. The volume of seed per stratification bag should be kept relatively small to insure good aeration throughout, and the bags should be no thicker than 0.102 mm (4 mil). This thickness of plastic allows some oxygen and carbon dioxide exchange-remember the seeds are alive and "breathing"! (Some nurseries insert a hollow tube in the top of the bag to increase aeration.) Placing the bags on wire mesh racks insures air exchange under the bag, and some nurseries hang the stratification bags from hooks. It is also a good practice to have someone move and massage the bags weekly; this moves seeds from the interior to the outside, and insure that no anaerobic conditions exist.

Temperature—The best temperature for cold, moist stratification is dependent on the species and ecotype, but most trees and shrubs from colder climates need temperatures slightly above freezing. The optimum temperature range for most temperate zone species is 1 °C to 5 °C (34 °F to 41 °F). Growers should make certain that their refrigeration units are functioning properly, and that temperature monitoring equipment is accurate, because freezing desiccates the seeds and stops the stratification process.

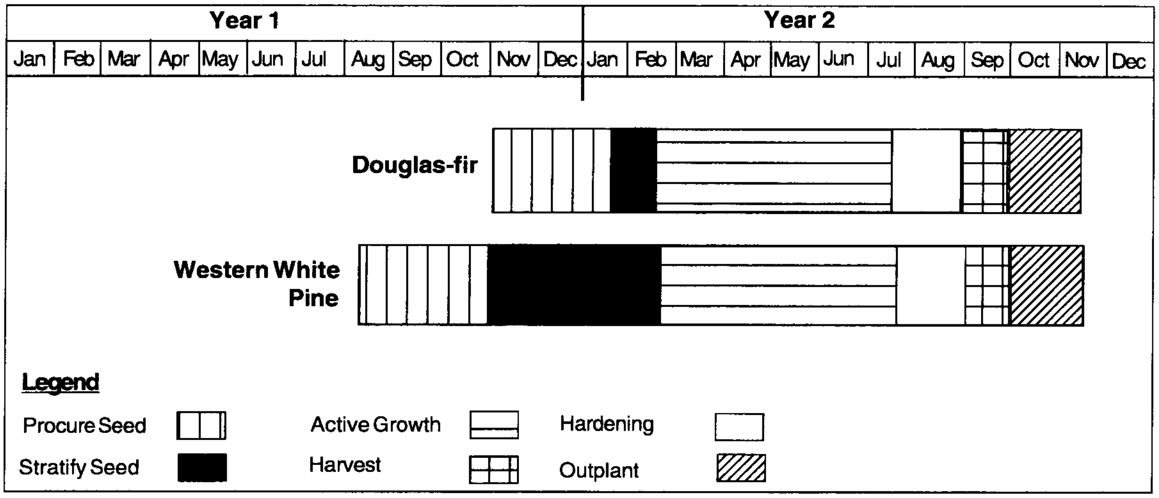

Figure 5. Seedling growing schedules must allow enough time for pre-sowing seed treatments which can take 4 months or even longer.

Duration of treatment—The prescribed length of the cold stratification treatment can vary from 4 to 20 weeks depending on species, variety and ecotype. Longer stratification periods erase the inherent differences within a seedlot, and improve the speed and uniformity of germination, resulting in a more uniform crop of seedlings. This is especially important when germination conditions are not optimum. Nursery managers must allow enough time in their growing schedules so that sowing can proceed on time (Figure 5).

In conclusion, most forest and conservation species have seeds with some sort of dormancy. To assure complete and timely germination, growers must learn the biological requirements of each species. Pre-sowing seed treatments take time, and this time requirement must be worked into the growing schedule so that the crops can be sown on time.

Sources:

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