GERMINATION OF SEEDS OF WILDLAND PLANTS James A. Young, Jerry D. Budy and Raymond A. Evans

ABSTRACT: Germination of wildland seeds is often dependent on proper seed collection and storage. Timing, seed collection, and the moisture content of seeds in storage often influences germination. A systematic approach to germination testing often will pinpoint the type of dormancy of seeds in wildland species and lead to germination enhancement.

INTRODUCTION

Successful germination of seeds of plants collected from wildlands starts with proper collection of the seeds. Both the timing of collection and the handling of the freshly harvested seeds are important.

TIMING THE COLLECTION OF WILDLAND SEEDS

Many wildland plant species have indeterminate type inflorescences where flowering and maturity are continuous for extended periods. This means that seeds are ripe and falling from the inflorescences at the same time blooming is still occurring at other locations on the inflorescence. It is difficult to avoid collecting immature seeds in this situation. For determinate species that mature at one time there is the danger of the seeds suddenly being dehisced and lost unless they are collected slightly before maturity.

Slightly immature seeds are not necessarily poor germinators. The propagator has to determine the influence of maturity on germination through trials To conduct meaningful trials, it is necessary to label the seed collection with some detail of the phenological stage of development, where the seed lot was collected, and to maintain the identity of the seed lot through germination trials.

Various maturity classes of seeds can be collected by separating collections made on the same plant, moving from early maturing south to north slope communities, or by collecting at higher elevation within the range of the species.

-------James A. Young and Raymond A. Evans are range scientists for the USDA Agricultural Research Service, Reno, Nev. Jerry D. Budy is Assistant Professor of Forestry, University of Nevada, Reno, Nev.

HANDLING FRESHLY HARVESTED SEEDS

A seed is a living organism in a resting stage, but it is most important to remember that it is alive! Freshly harvested seeds have too high a moisture content for safe storage. The moisture content of the seed must be allowed to reach equilibrium with the atmosphere. In the Intermountain area this is usually simple because the relative humidity of our air during the summer and fall is usually quite low.

For freshly harvested seeds to reach a moisture equilibrium they must be stored in such a manner to allow for free aeration. Uncoated paper or mesh bags make good storage containers for initial drying. Never use plastic bags for storage of freshly harvested seeds!

Artificial drying, especially at high temperatures,. is usually not necessary, and often not desirable. Screen freshly harvested material to remove high moisture content trash. This will reduce drying time.

Fleshy fruits require prompt treatment to remove the fleshy material to avoid spoilage or mummification of the fruits.

The seeds of species collected from marsh or wetland environments often require special handling. The technique used depends on the species involved; but often it is necessary to keep the seeds in a cool, wet environment or actually stored in water to avoid acquiring dormancy or loss of viability.

SEED CLEANING

Generally the sooner the seeds are cleaned and placed in storage after they reach moisture equilibrium, the less chance of predation from birds or small mammals or contamination from insects.

Avoid rough handling of seeds during cleaning. Remember the seed is alive and the embryo can be very fragile. Never use a hammer mill in seed processing unless you have first determined by careful testing that seed viability is not being adversely affected by the process.

Proper seed cleaning makes subsequent handling of the seeds in the germination process much simpler. Especially if the seed lot contains trash or empty or obviously immature seeds, much time may be wasted sorting the material to find germinable seeds.

SEED STORAGE

To avoid problems with storage insects, start with clean, insect-free storage conditions. Do not introduce pests with the seeds to be stored. Cool storage conditions lessen the chances of insect problems.

The key to seed storage is maintaining proper moisture conditions so that the seeds remain alive, but ungerminated. Remember that the amount of water that the storage atmosphere will hold as a vapor is directly related to temperature. If you decrease the storage temperature of a sealed container, moisture condensation will occur.

Storage in paper or mesh bags in a cool, dry location is satisfactory for most seeds. Once the seeds have reached moisture equilibrium, storage in glass jars or plastic boxes is possible to avoid insect or mold contamination. Some seeds can be stored easily in small lots, but suffer losses in viability when quantities of seeds are stored together. Some seeds have inherently very short storage lives and seed stocks of these species must be removed annually.

GERMINATION TESTING

Two common determinations are made from seed tests: viability and germinability. Viability simply means the seed is alive. It does not indicate if the seed will germinate. Viability tests may be as simple as cutting a seed or fruit with a knife blade to determine if an embryo is present. More complex viability tests involve the use of the chemical, tetrazolium. This chemical, after proper sectioning and preparation of the seed, has the property to accept hydrogen atoms from dehydrogentate enzymes during the respiration process in viable seeds. Essentially, respiring or living tissue in the seeds is evidenced by a red color change.

The fact that the seeds or fruits contain living tissue does not mean the embryo will germinate. This is a common misinterpretation. For seeds of the major crop species, standards have been developed that relate the tetrazolium reaction to potential germination. These standards have not been developed for the seeds of most wildland species.

Germinability is a much more meaningful statistic for individuals interested in propagating plants from seeds. To obtain an estimate of germinability, the seeds must be subjected to a germination test. The Association of Official Analysis (AOSA) prescribes the rules for testing seeds of specific species. For example, seeds of Canada bluegrass (Poa compressa) are tested on germination paper, at 15/25 or 15/30°C (15°C for 8 hours/30°C for 16 hours daily), with light during the 8-hour period and potassium nitrate (KNO_3) added to the substrate. Unfortunately, for the seeds of most wildland species, no standard germination tests exist. The AOSA has draft standards for about 100 wildland species. Until the standards are accepted and/or developed for the seeds of important wildland species, germination figures as given on seed tags are meaningless.

DETERMINING GERMINABILITY OF WILDLAND SPECIES

Afterripening

The seeds of many species will not germinate soon after they are harvested. As time passes, germinability of these seeds gradually increases until they may be highly germinable.

This time period that must pass before the seeds will germinate has been termed the afterripening requirement. These requirements are not responsive to external stimuli. One cannot do anything about them but wait.

This type of dormancy has been attributed to immature embryos that require post-harvest time to mature.

A variant of this type of dormancy is called temperature-dependent afterripening. In this case, seeds will not germinate at one incubation temperature (usually moderate to high incubation temperatures), but will germinate at other temperatures (usually cold incubation temperatures).

Practically, this means the nurseryman has to wait to obtain germination with the seeds of certain species. Do not confuse afterripening with stratification requirements where the dormancy does respond to external stimuli. Stratification requirements will be discussed later.

Hard Seed Coats

If seeds do not initially germinate or fail to germinate after a reasonable afterripening period, the first germination factor to check is to see if the seeds imbibe water. This can be done by pressing the seed with a thumbnail or by cutting. If the interior of the seed appears chalky and hard, water has not been imbibed through the seed coat. Imbibed seeds should be soft and easily squashed with the thumb.

Seeds with coats that do not freely allow the passage of water are termed hard seeds.

Scarification

To break the hard seed coats some form of scarification is required. This scarification can be accomplished with mechanical, thermal, or chemical treatments. If the seeds are large enough, scarification may be accomplished by filing a notch in the coat or clipping so as not to injure the embryo. Smaller seeds can be scarified by mechanically abrading them in some manner. This may be as simple as rubbing the seeds between sheets of sandpaper.

Mechanical scarifiers have been developed with abrasive lined drums in which the seeds are rotated. Virtually any mechanical scarification that results in increased germinability results in decreased viability. In other words, you pay the price for getting some seeds to germinate by fatally injuring other seeds. Hammer mills are used for scarifying seeds. Great care must be taken to not excessively injure seeds with these treatments. Minimum clearance between concave bars in threshing machines can be used to crack the seeds of legumes to obtain increased germinability, but again, with some reduction in viability.

Thermal scarification is obtained by dropping seeds into boiling water and then allowing the water to cool. Such treatment may have many other influences such as thermal shock to the embryo or leaching soluble inhibitors. Thermal cracking of seed coats is facilitated by fall seeding at shallow depths with exposure to freezing temperatures.

Concentrated sulfuric acid is used to remove hard seed coats. This treatment is difficult to control and may have many side effects. The duration of treatment has to be determined for individual seed lots. Heating from the acid reaction with rinse water and hydrolysis of the seed tissue may induce germination other than through the intended increased imbibition of water.

Always try to control the temperature of the acidtreated seeds in a water bath, rinse a small amount of acid and seeds in a large volume of water, and use a neutralizing solution after the treatment.

Stratification

Seeds that imbibe water but fail to germinate are good candidates for stratification. Do not confuse this word with scarification. Stratification involves placing seeds in a wet environment at temperatures that are not conducive to germination. For most western plants these are temperatures too cold for germination. Such treatments are termed cool-moist stratification. The duration of stratification requirements can range from a few days to many months. For prolonged stratification a substrate must be furnished for moisture retention. Historically peat has been used. Commonly used materials include sand and vermiculite.

Naked stratification has proven effective for the seeds of some species of conifers. This is accomplished by soaking the seeds overnight in water and then placing the damp seeds in plastic bags that are sealed for the duration of the stratification.

Special stratification conditions include prolonged soaking in refrigerated baths that are saturated with oxygen or by using activated charcoal as a stratification substrate.

Some species require specific stratification temperatures. Their seeds are very difficult to germinate without prolonged experimentation.

Nurserymen have long solved stratification problems by fall planting seeds and allowing nature to supply the treatment. In cold areas where snow cover is prolonged, such practices can be quite effective. The interface between continuous snow cover and the surface of the seedbed usually is near 0°C, a near-ideal stratification environment. Any interruption of temperature or moisture conditions during the stratification period results in prolonging the stratification requirement. Covering seeds in flats and covering them with sand and placing the flats outdoors on the northside of a greenhouse can provide a test environment
for the stratification of seeds whose requirements are not known.

The seeds of several eastern hardwoods require periods of warm-moist stratification for germination. Some species require warm-moist stratification followed by cold-moist stratification.

Nitrate Ion

The most influential factor in enhancing germination of seeds is often enrichment of the germination substrate with nitrate ions. The nitrate is usually supplied as potassium nitrate (KNO3) at concentrations ranging from 10(-1) to 10(-3) mmoles (1.0 to 0.01 g per litter of water). In the field or nursery bed, flushes of spring germination may be associated with nitrification and the availability of nitrate nitrogen in the seedbed.

Gibberellic Acid

The mode of action of gibberellic acid in seed germination is not known, but very low concentrations of this growth regulator can greatly enhance germination. Concentrations of from 1 to 250 parts per million (p/m) are commonly used in germination enhancement. Combinations of gibberellic acid and potassium nitrate are often more effective than either material alone. Both of these materials can be obtained from chemical supply houses. The potassium nitrate is more easily obtained than gibberellin.

A good balance is needed for preparing the minute concentrations of gibberellic acid. A solution with a concentration of 1 p/m of gibberellic acid consists of 0.001 grams of gibberellic acid dissolved in 1,000 milliliters of water. Gibberellic acid is sold as a 10-percent active ingredient preparation, which makes the weighing simpler.
One alternative is to prepare higher concentrations than needed and dilute to the desired concentration. For example, 1,000 p/m would be 1 g in 1,000 ml; however, gibberellic acid is relatively expensive and breaks down very rapidly under warm temperatures

Hydrogen Peroxide

Seeds of several species, especially members of the rose family, have their germination enhanced by soaking in hydrogen peroxide solutions. Dramatic germination enhancement has been obtained with seeds of bitterbrush (Purshia tridentata) and curlleaf mountain mahogany (Cercocarpus ledifolius).

A wide range of concentrations from 1 to 30 percent is effective. Generally, the higher the concentration, the shorter the soaking time, but the greater the risk of damaging the seed. Hydrogen peroxide is a very reactive chemical. Concentrations greater than 3 percent are particularly dangerous to handle.

Other Chemicals

A large number of other chemicals have been used to enhance germination. These include, among others, ethylene producing compounds and various sulphydryl compounds.

Light

Many seeds are sensitive to light during germination. This light or phytochrome reaction involves germination stimulation by near red light and dormancy inductions by far red light. Generally coolwhite florescent light enhances germination and incandescent light should be avoided.

Practically, seeds that require light for germination have to placed virtually on the surface of the seedbed. The seeds should be pressed into the seedbed for optimum moisture transfer.

SEEDBED REQUIREMENTS

Seeds have to take moisture up from the germination substrate faster than they lose it to the atmosphere. In a well-firmed seedbed, optimum germination conditions can occur with proper water management. Planting small seeds on the surface of a firmed seedbed and covering them with vermiculite can produce a quality germination environment.

Generally only seeds with external mucilage can germinate on the surface of seedbeds. Exceptions are seeds such as Russian thistle (Salsola iberica) with extremely rapid germination.

Even seeds with extremely low percentage germination can give satisfactory establishment if sufficient seeds are planted in a quality seedbed.

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