Seed Handling and Propagation of Hardwood Trees and Shrubs at Oklahoma Forestry Services' Forest Regeneration Center

Gregory R. Huffman[1]

Huffman, G.R. 1996. Seed Handling and Propagation of Hardwood Trees and Shrubs at Oklahoma Forestry Services' Forest Regeneration Center. In: Landis, T.D.; South, D.B., tech. coords. National Proceedings, Forest and Conservation Nursery Associations. Gen. Tech. Rep. PNW-GTR-389. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station: 43-48. Available at: http://www.fcanet.org/proceedings/1996/huffman.pdf

Abstract-The information presented in this paper describes some of the seed handling and propagation procedures used at the Oklahoma Forestry Services' Forest Regeneration Center. Specific pregermination treatments are stressed as important techniques to evaluate and adapt to local needs. Modifications to the Oyjord seeder are also discussed and are aimed at increasing the versatility and effectiveness of this sower.

INTRODUCTION

The Oklahoma Department of Agriculture - Forestry Services has had an ongoing regeneration program since 1926. The Forest Regeneration Center (FRC in Washington, Oklahoma has been in continuous seedling production since 1946. This paper will review some of the most recent advances in techniques used at the FRC particularly in regards to seed treatments and sowing.

Approximately 40 species of bareroot trees and shrubs are grown at the FRC. Since Oklahoma is centrally located, the species grown range from southern pines and oaks to Great Plains species, and extending to western tree types. This wide diversity of species dictates the development of seed handling techniques that are often not in the mainstream of forest tree nursery research and publications. The techniques and results reviewed here were developed over time in response to specific problems encountered at the FRC. Our findings are based on field trials and operational observations made at the Center. Personnel at other nurseries should use our experience as a general guide, but are encouraged to experiment in their environment before committing to operational programs involving the techniques presented.

It is vital to apply the proper handling and pregermination treatments to each species being propagated. In particular, the techniques used in stratification, aeration, and ripening can have significant impacts on propagation efforts.

STRATIFICATION FOR *PRUNUS* SPECIES

Heat stratification is a technique that has been very successful in treatment of several *Prunus* species at the FRC, including American plum (*Prunus americana*), chokecherry (*Prunus virginiana*), and sand plum (*Prunus angustifolia*). Early work with *Prunus* suggests that the seeds have embryo dormancy and require a period of after-ripening in the presence of moisture and oxygen in order to overcome it (Grisez 1974). *Prunus* species are not truly hard seeded, but do have a hard endocarp. The Woody Plant Seed Manual does not recommend heat stratification for the *Prunus* species in question, but our experience has shown a significant improvement in seed germination by utilizing this treatment.

The techniques employed are as follows.

1. Seed is mixed on a 2:1 volume basis with course vermiculite with American and sand plum and 4:1 with fine vermiculite on chokecherry. The vermiculite should be moistened to the point that you can barely squeeze a small amount of free water from the media. Generally, this can be approximated by 8 parts vermiculite: 4 parts seed: 2.25 parts water.

2. The seed/vermiculite mixture is placed in polypropylene bags which are fairly tight woven, but are not air or water tight. These bags are permeable enough to allow for "adequate" air exchange without excessive drying of the vermiculite. The bags can be ordered from Forestry Suppliers (item #58066).

3. The bags of seed/vermiculite are placed on a pallet with the bags stacked no more than 2.5 feet in height. Additional pallets are used to separate layers ensuring the bags are not stacked too deep. The palleted piles of bags are then covered with 4 mil plastic sheeting. The bags are totally enclosed by the plastic covering, but no effort is made to make a tight seal. The covering is simply used to retard moisture loss from the bags.

4. The bags are kept in our seed extractory which normally is in the temperature range of 60 to 90 degrees F. No attempt has ever been made to precisely control temperatures that the heat stratifying seed are being subjected to.

Our experience with chokecherry exemplifies the integration of heat and cold stratification strategies. The standard procedure was to heat stratify the seed for 30 days, and then to plant in the late fall. This technique gave variable results often with inadequate germination. For example in 1991, this technique yielded very poor results. In 1992, chokecherry received the standard 30 day heat stratification, but poor soil conditions prevented sowing so the seed received a cold, moist (34-36 degrees F) stratification for 45 days. The crop was then sown in early winter. Germination of this crop was quite satisfactory. Based on these field observations, it was concluded that mild and/or dry winter conditions lacked the needed elements to provide a "good" cold stratification for the chokecherry.

Similar observations were made with American plum. Sand plum appears to be less sensitive to mild winter conditions, but for simplicity purposes, we now subject all three *Prunus*_species to 30 days heat and 30-45 days cold stratification prior to early winter sowing.

Caution should be exercised when utilizing a heat/ cold stratification followed by early winter sowing. Although all of our comparisons have shown the treatment to be beneficial, there is one potential drawback. Our experience has shown that chokecherry seed receiving both a heat and cold stratification will generally germinate about 10-14 days earlier than seed receiving only a heat treatment followed by immediate sowing. We desire the more complete and rapid germination with the heat/cold treated seed, but hard spring freezes can kill these germinants easily. Seed that has not had the artificial cold stratification is slower to germinate, and can potentially "miss" a spring freeze due to the germination delay.

In Oklahoma, we have seen either method get caught in tile freeze. One year the heat/cold treatment germinated early in February and was sufficiently large and hardened before any extreme freezes occurred. A couple weeks later the seed that was only heat stratified germinated, and was shortly thereafter severely damaged by freezing conditions. The heat/cold treatment had sufficient time to develop hardier stems and leaves, and showed much less freeze damage. The advantage of the heat/cold treatment appear to outweigh potential freeze problems since either method can result in seed germinating during dangerous cold periods. Under an optimal "safe" strategy, it might be best to use both treatments and risk only one-half of the crop to any one treatment. We tried this one year and had no spring freezes affect either treatment.

An alternative that we have not tried is to heat stratify the seed for 30 days, and then "hold" in cold stratification until the danger of late spring freezes has passed. At least three potential problems would be associated with this strategy, including:

1. Soil conditions often prevent sowing when desired and the seed may "miss" the best germination and early growing conditions.

2. It can be difficult to accurately predict when the danger of late spring freezes has passed.

3. The totally artificial stratification strategy could be used as a backup to sow in the event that the winter sown crop was a failure. An experiment would need to be initiated to ascertain if the seed would tolerate redrying and subsequent sowing the following year, if the backup seed was not used.

In summary, we have found heat stratification to be very useful particularly with *Prunus* species. This technique allows for a slow breakdown of the seedcoat within an environment promoting moisture absorption and ample air exchange. When used in conjunction with artificial cold stratification followed by early winter sowing, chokecherry, American and sand plum germinate more completely and rapidly in comparison to either treatment when used alone.

AERATION

Seed needs to breathe, and this is particularly important during pregermination treatments. Common suggestions with cold stratified seed are to periodically turn the bags, use poly bags that hold moisture but allow some air exchange, fold the bag opening but do not seal tight (oaks), etc. These concerns are greatly dependent on the initial quality of the seed, species, quantity of seed being treated, duration of treatment, and many other factors. In Oklahoma, our experience has shown that aeration control can have significant impacts on seed germination and crop development.

The air exchange requirements for tree seeds in various stages of pregermination treatments is not well defined. Our limited research in this area has led to one conclusion--namely that various aeration treatments appear to hasten physiological processes that promote germination. Discussions citing examples in this area follow.

The goal of every nursery manager is to have very rapid and complete germination. Steve Hallgren with Oklahoma State University has utilized osmotic seed priming in several pine species (Hallgren 1987). In general, his studies showed that priming significantly increased speed of germination particularly for loblolly and shortleaf pine. A tendency to increase the final germination of unstratified loblolly seed was also observed. These results have led us to the postulation that the primary benefit of priming may simply be increased air exchange. This concomitant increase in seed metabolism may allow the hastening of physiological processes that are needed to help break dormancy, or otherwise "pull the germination trigger."

In the spring of 1992 a hard freeze killed most of the germinating hackberry crop. This is a fall sown species at the FRC, and generally would require a 60 to 90 day cold stratification if sown in the spring. Faced with a freeze killed crop and no stratified seed, we decided to try a short, cold stratification (30 days) followed by several treatments including aeration in cold and room temperature water, and polyethylene glycol. Aeration treatments continued for approximately 15 days.

Germination was similar for all treatments with lab germination ranging from 36 to 41%. Approximately 75% of this germination occurred in the first 31 days following sowing. Similar results were seen in the field plots. Although the germination was poor in comparison to normal hackberry germination, the aeration treatments did produce marginally acceptable germination in a situation where there was insufficient time to undergo a full cold stratification. No non-aerated comparisons were made as our goal was to maximize germination as quickly as possible. It was felt that a short, cold stratification without aeration would be futile. From an experimental view, this presents a problem as we can not claim that aeration was better than simply extending the cold stratification 15 days (vs. aeration for 15 days). In any event, all aeration treatments "worked" and resulted in an acceptable crop in a situation that looked rather hopeless.

Similar experiences have been observed in the treatment of honeysuckle (*Lonicera maackii*) and euonymous (*Euonymous bungeanus*). These species, like hackberry, generally exhibit moderate seed dormancy, and require up to 90 days of cold stratification for adequate germination. These species respond rapidly to aeration treatments when used in conjunction with shorter cold stratification.

In 1995, after spring freezes damaged these fall sown crops, the seed was stratified for 60 days and then put into aeration. Surprisingly, the euonymous began germinating in the aeration chambers within one day. Honeysuckle was germinating the same day as aeration began. Apparently, 60 days of cold stratification was sufficient, and the favorable conditions of aeration quickly promoted the seed to begin to germinate.

Although it appears that the aeration treatment did nothing in terms of helping meet stratification requirements, it did demonstrate how quickly the treatment could aid in the initiation of germination. Bringing seed to a state that it is ready to "hit the ground running" is a very desirable quality. The basic premise of osmotic priming is to bring seed to the point that it is ready to germinate, but is held back due to the effect of the negative water potential osmotic solutions. Our aeration treatments were in water so negative osmotic potentials were not present to prevent radical emergence. Perhaps, we could have brought the seed to a greater state of "germination readiness" if polyethylene glycol had been used. In any event, aeration in water resulted in very rapid germination. The seed was immediately sown and approximately sixteen trees per square foot was realized for both species. This compares to about two trees per square foot in the fall sown freeze damaged beds. The seed was not sown until April 27 for species that normally germinate in early to mid March. Our concern was the loss of about 45 days of potential growing days. However, with rapid germination and a little luck (cool weather in May), the crop developed well. The aeration treatment provided the extra "push" that was needed to grow an acceptable crop.

RIPENING

For many species, well documented procedures are available to guide seed collection and processing efforts. Also, in many instances considerable latitude is allowed in collection timing, after-ripening, etc. However, for some species more exact procedures need to be followed. Often, as nursery managers, we assume that we are performing collection and processing procedures in the "correct" manner each year. This was the case in our experience with red mulberry (*Morus rubra*). Unfortunately, seed germination in recent years began showing poor results.

Mulberry seed handling procedures were suspected as possible problem areas due to a lack of well defined handling parameters. The standard procedure was to collect fruits as they fell onto tarps spread below target trees. "Occasionally," the fruits would be gathered from the tarp and soaked for a "day or so." It is very apparent that these procedures were quite loose, and needed to be better defined.

A study to evaluate the impact of various treatments confirmed the importance of proper handling procedures. Seed germination was best (89%) for seed collected within 4 to 5 days after failing. Waiting for 1 to 2 weeks reduced germination to 73% and lower. Germination was further reduced for seed fermented in water for 48 hours (56%) and 72 hours (33%). We now make sure that fruits are promptly removed from tarps (by the third day) and ferment the fruit for no longer than 24 hours.

STRATIFICATION MEDIUM

Stratification techniques usually employ either a medium such as sand, peat moss, vermiculite, etc., or may be done without media (naked). The naked method is generally more desirable due to its' ease of technique. However, naked methods are not universally applicable to all species.

I have previously described the use of vermiculite in heat stratification techniques. We also use vermiculite for cold stratification treatments with several species including autumn olive (*Elaegnus umbellata*), Cotoneaster (*Cotoneaster acutifolia*), soapberry (*Sapindus drummondii*), and Vitex (*Vitex agnus-caslus*).

General observations of various seeds during naked cold stratification have led us to use vermiculite media in several situations. The most obvious benefit of using media is the "forgiving" nature of this method. It is difficult to get the seed too wet or too dry as the vermiculite has very good moisture holding capacity with a wide range of acceptable moisture regimes. This allows for a much better moisture balance. In short, use of the medium allows for good aeration while still providing ample moisture for seed uptake. This lessens mold problems on seed during stratification. Ultimately, utilizing a medium can provide a safer, more uniform stratification environment. Nursery managers should evaluate the technique on species which are not giving satisfactory results with naked methodology.

OYJORD SOWING TECHNIQUES

The Oyjord seed sower by Love Industries is the mainstay at the FRC. Though designed for smaller seeds, we have found it to be a very versatile sower, needing only minor modifications to sow larger seed. Modifications we have employed are discussed.

The spokes (vanes) in the seed metering wheel are too close together to allow larger seed to drop clear. As we attempted to sow larger seed, they would get crushed or would bend or break a spoke. Removing every other spoke eliminated this problem. We now use two metering wheels. One is kept in original condition with all spokes intact. This configuration is used for small seeded species (> 5000 seed per pound). For larger seeds, the alternate wheel is used.

When sowing large seed, larger drop tubes are needed. We have installed clear tubes which are approximately 1.25 inches in diameter. The use of clear tubes is very helpful in order to view seed movement. This allows rapid recognition of seed bridging. Using large drop tubes also dictates that the drop tubes be positioned further to the rear between the seed furrow coulters. This change in drop tube position can be done very quickly, and can be attached easily using standard cable ties. When sowing larger seed, replace the small nozzle (part # S10109) with the larger orifice nozzle (part # S10110).

We have successfully sowed seed as large as 540 seed per pound. This year we attempted to sow willow oak (415 seed per pound) via the large seed setup. Although we did not achieve the sowing density that was desired, it may be possible to achieve higher densities if very slow tractor speeds can be tolerated.

Lastly, we have begun experimenting with fine tuning the seed distribution pattern via the Oyjord seeder. The seed spinner within the distribution chamber is normally controlled by the ground speed of the tractor. We wanted to see if independent speed control of the spinner could be used to increase the uniformity between the number of seed applied per drill row.

A hydraulically operated motor was mounted on the Oyjord to allow independent control of the spinner. RPMs were measured at the spinner driveshaft. Actual spinner RPMs are approximately 25% greater than the driveshaft readings which are presented and discussed. Seven spinner speeds (driveshaft readings) were tested ranging from 350 to 1850 RPMs at 250 RPM ntervals. Tests were successfully run on two species. Lespedeza bicolor at 55,996 seed per pound and Redbud (*Cercis canadensis)* at 10,933 seed per pound were evaluated. Larger seeded Soapberry (*Sapindus drummondii*) was also tested, but at 728 seed per pound all spinner speeds produced unacceptable results.

The results appear fairly consistent, but we are not sure if the differences seen are biologically significant in terms of increasing seed density uniformity. The best results for Lespedeza were obtained at 600 RPMs. At this spinner speed the coefficient of variation between drill rows ranged from 2.35 to 4.18 percent (mean 3.42). This compares to the worst variation at 1600 RPMs with 4.33 to 5.63 coefficient of variation values (mean 5.04). The tractor speed still slightly the pattern as the upper seed distribution wheel directly works in tandem with ground speed and primarily impacts the quantity of seed dumped into the distribution chamber.

Note that our intent was to increase the uniformity of seed dropped between drill rows. The theory was that any increase in uniformity of distribution within the chamber would result in increased uniformity between drill rows and possibly within drill rows (better equidistance between seeds). Our preliminary results indicate that some improvement can be gained between drill rows. The next step Is to evaluate the impact of spinner speed control on uniformity within a drill row. Although we never expect the Oyjord to be a "precision" sower, we do want to optimize its' performance.

SUMMARY

Nursery managers desire maximum efficiency from each species sown. Experiences at Oklahoma's Forest Regeneration Center help exemplify the importance of several pregermination treatments. In particular, the role of heat stratification, seed aeration, ripening, and stratification media can greatly impact the ability of seed to promptly germinate and grow. Seed handlers should realize that seemingly small variations in seed treatment technique can potentially impact success in significant ways. A review of Oyjord seeder modifications shows that this machine can handle considerably larger seed with fairly simple changes. The uniformity of seed sown between drill rows can also be improved and is dependent on the species in question, particularly as related to seed size. Where applicable, future efforts to increase seed efficiency should include evaluation of the techniques presented.

---

[1]*Oklahoma Department of Agriculture-Forestry Services, Forest Regeneration Center, Route 1, Box 44, Washington, OK 73093; Tel: 405/288-2385, Fax: 405/288-6326.*

LITERATURE CITED

Grisez, T.J. 1974. Prunus. In: Seeds of Woody Plants in the U.S. USDA Agric. Handbook 450.
Hallgren, S.W. 1989. Effects of osmotic priming using aerated solutions of polyethylene glycol on germination of pine seeds. Ann. Sci. For. 46, 3 1-37.