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Seed Handling Practices for Southern Pines Grown in Containers

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ABSTRACT. Costs of producing container-grown seedlings increase when containers are not fully stocked. Best use of containers requires high seed viability and low losses of newly germinated seedlings. Seed handling practices before and after sowing affect germination and seedling survival. This is a summary of seed preparation, sowing rates, disease control, and seed germination for container-grown southern pines.

About 5 million containerized seedlings are produced annually in the South (Balmer 1977). Containers are most commonly used to grow southern pines or species which are difficult to plant and usually planted on dry sites or sites unsuited for machine planting. Containerization allows maximum utilization of genetically improved seed and can reduce by a year or more the time required to establish progeny tests.

High-quality seeds that permit maximum utilization of containers are necessary to justify the cost of containerization. Empty containers increase seedling costs and keep production goals from being reached. How seed is handled from extraction through sowing influences germination and early seedling growth.

PROCESSING AND STORING SEED

The high-quality seed necessary for efficient container-grown seedling production results from carefully controlled collection and processing. At the time of purchase, vendors should be required to remove unsound seed. When seed lots are small, as in progeny tests, it is often convenient to use flotation in water or organic solvents to separate unsound seed. In the appropriate liquid sound seeds sink, while unsound seeds float and can easily be skimmed off. Water is appropriate for loblolly pine (*Pinus taeda* L.); a 1:1 water-ethyl alcohol mixture for slash pine (*P. elliottii* Engelm.); n-pentane for longleaf pine (*P. palustris* Mill.); and 95-percent ethyl alcohol for shortleaf (*P. echinata* mill.), sand (*P. clausa* [Chapm.] Vasey), and spruce pines (*P. glabra* Walt.) (Barnett and McLemore 1970). To maintain seed quality, flotation in ethyl alcohol should be delayed until just before seeds are used, because unless the alcohol is thoroughly removed by drying, seeds so treated rapidly lose viability in storage (Barnett 1971b).

Seed to be stored should be dried to below 10-percent moisture content and sealed in airtight containers. Although seeds with moisture content above 10 percent will remain viable for several years if stored at temperatures below freezing, a combination of moisture content below 10 percent and temperature below 32° F is recommended for safe storage. Under these conditions, seeds of most pine species will remain viable for as long as 40 years (Barnett 1972).

STRATIFICATION

Although seeds usually germinate quickly if sown a few months after collection, dormancy often increases during storage (less at low than high moisture content). Stratification overcomes dormancy and makes germination quicker and more uniform. Seeds of such species as longleaf and slash pine require little or no stratification, while others usually benefit from treatment. The number of days of stratification needed depends on the species and how long the seeds have been stored. More specific recommendations are given in Table 1.

Seeds to be stratified are placed in water to soak overnight. Seeds are then drained, put in polyethylene bags, and held at temperatures between 33–41° F. Temperatures below freezing may injure stratified seeds and temperatures above 41° F may cause germination. However, higher temperatures can be used to stratify seeds in aerated water soaks (Barnett 1971a). Aerated water soaks are particularly effective when the time available for stratification is limited.

Table 1. Recommended cold stratification periods for southern pine seed.[1]

Pine species	Stratification period	
	Fresh seed	Stored seed
	----------*Days*----------	
Loblolly	30–60	30–60
Longleaf	0	0
Pitch	0	0
Pond	0	0–30
Sand		
var. Choctowhatchee	0–15	0–21
var. Ocala	0	0
Shortleaf	0–15	15–60
Slash	0	0–30
var. So. Florida	30	30
Spruce	30	30
Table mt.	0	0
Virginia	0–30	30

[1]*Adapted from Krugman and Jenkinson (1974)*

DISEASE PROBLEMS AND CONTROL

Some of the fungi present on pine seeds can infect germinating seeds (Urosevic 1961). In the past, seed fungi on sound southern pine seeds have not been considered a problem because most observations indicated the fungi were saprophytic and did not affect germination (Belcher and Waldrip 1972). However, Pawuk and Barnett (1974) associated *Fusarium* infection of container-grown longleaf pine seedlings with retention of infested seedcoats. Symptoms appeared first on cotyledons of seedlings with uncast seedcoats, and infections eventually spread to the stem, resulting in mortality.

Many seed lots contain infested seeds. For example, 8 to 20 percent of the seeds from five longleaf seed lots tested for *Fusarium* were found to be infested, and all five species of *Fusarium* recovered were pathogenic on longleaf seedlings (Pawuk 1978). *Fusarium* has since been isolated from seedcoats of shortleaf, slash, and loblolly pine seeds.[1] Recent studies show that pathogens may be present within pine seeds (Miller 1976). Infected seeds germinate poorly and damping-off is increased.

Microorganisms infesting conifer seedcoats can be controlled by sterilizing seedcoats or coating them with fungicides. However, since many fungicides evaluated for forestry use are phytotoxic (Cayford and Waldron 1967), and sterilants inhibit germination of some species (Neal

[1]W. H. Pawuk, unpublished data.

et al. 1967), both methods have been reevaluated with southern pine seeds.

Sterilants

Hydrogen peroxide sterilizes seedcoats (Trappe 1961) and also increases germination of some pine seeds (Barnett and McLemore 1967). Barnett (1976) found that a 3-percent solution of hydrogen peroxide reduced infesting organisms on loblolly pine seeds but not on slash, shortleaf, or longleaf seeds. A 30-percent solution virtually eliminated infesting organisms from seedcoats of all four species, but germination was affected (Table 2).

Table 2. Germination of southern pine seeds soaked in two concentrations of hydrogen peroxide for varying lengths of time.[1]

Hydrogen peroxide treatment	Species			
	Loblolly	Slash	Shortleaf	Longleaf
	---------- *percent* ----------			
None	91		76	53
3-percent				
4 hr	87	82	82	36
8 hr	93	79	80	26
24 hr	93	50	67	27
48 hr	94	43	73	3
30-percent				
¼ hr	88	83	82	49
½ hr	89	85	75	63
1 hr	90	84	48	77
3 hr	44	75	7	54

[1]*Data from Barnett (1976)*

Table 3. Maximum fungicide dosages that did not inhibit seed germination of four southern pines.[1]

Fungicide	Slash	Loblolly	Shortleaf	Longleaf
	------ *Oz ai/100 lb of seed* ------			
Captan 50 WP[2]	16	16	16	16
Arasan 42-S	16	16	16	16
Terraclor 75WP	4	16	16	8
Demosan 65 WP	4	16	16	8
Truban 30WP	2	8	16	16
Banrot 40 WP	2	4	2	4
Dexon 35 WP	2	4	2	8
Terra-Coat SD-205, 25 WP	2	8	4	16
Mertect 42 F	1	8	4	4
Benlate 50 WP	1	4	2	2
Busan® 72 60 EC	0	4	2	4
Terra-Coat L-205, 30 L	0	4	2	4
		Percent		
Control germination	90	86	78	58

[1]*William H. Pawuk, unpublished data*

[2]*Common names and chemical names for the fungicides can be found in Fungicide and Nematicide Tests, 1977. American Phytopathological Society 32:240–251*

Short soaks in 30-percent hydrogen peroxide best controlled infestations without reducing germination. Shortleaf seeds should not be soaked longer than 15 minutes. Loblolly seeds can be soaked for 30 minutes to an hour, and slash and longleaf seeds can be soaked for an hour. Germination of some longleaf seed lots (particularly low-viability lots) can be increased by 30- to 60-minute soaks. Before soaking an entire lot longer than recommended, a preliminary test should be run.

Fungicide coatings

Fungicides applied as seed coatings provide a chemical barrier between germinating seeds and soil fungi. Stratified shortleaf pine seed germination and post-emergence damping-off were reduced by dusting seeds with 50-percent Arasan[2] before sowing (Hamilton and Jackson 1951). The amount of fungicide adhering to seeds can be increased with such adhesive as methyl cellulose or latex. But while fungicides may reduce damping-off (Carlson and Belcher 1969), heavy dosages often reduce germination (Carlson and Belcher 1969, Peterson 1970).

Because of container production's high costs, fungicides must control diseases without sacrificing quick, vigorous germination. Tests show the four important southern pine species respond differently to fungicides (Table 3). Loblolly and longleaf seeds are the most tolerant, slash the most sensitive. Shortleaf seed response was intermediate compared to the other species.

Captan and Arasan were the least toxic fungicides. Neither reduced germination of any species, even when applied at 16 oz. ai/100 lb.

SOWING RATES

Seed tests are important because they allow sowing rates to be adjusted for poor seed lots.[3] When seed lots have low germination, multiple seeding can reduce the number of vacant cavities. Cavities with excess seedlings can then be thinned. Tables prepared by Balmer and Space (1976) use sowing rates and expected germination to predict the number of vacant and stocked cavities and are useful both for selecting sowing rates and for estimating how much thinning will be required.

For example, if seed tests show that expected germination is 70 percent, sowing two seeds per cavity can reduce the percentage of vacant cavities from 30 to 9 percent. Sowing three seeds per cavity will further reduce vacancies to 3 percent. Of course, as sowing rates increase, the percentage of cavities with more than one seedling increases and more thinning is required. Trans-

[2]Trade names are used in this publication solely to provide specific information. Mention of a trade name does not constitute a warranty of the product by the U.S. Department of Agriculture or an endorsement by the Department over other products not mentioned.

[3]The Eastern Tree Seed Lab in Macon, Georgia, will test seed lots for a small fee. Germination tests require 600 seeds but a complete analysis that estimates stratification requirements takes 2,500 seeds.

planting germinated seed from trays or containers to vacant cavities, an alternative to multiple sowing, raises production costs and increases the chance of spreading disease organisms.

GERMINATION

Germination depends on adequate light and moisture and favorable temperatures. Because southern pine seeds do not require intense light for germination, enough light is usually available in greenhouses or shade houses. Some growers cover seeds after sowing to conserve soil moisture and prevent seeds from drying, but germination can be reduced if seeds are covered so deeply that light reaching them is markedly reduced. If soil surfaces are kept moist, seeds germinate best uncovered. When intermittent watering is used and periodic surface drying occurs, germination of most species of pine is enhanced by using a 1/4-inch covering of vermiculite. Longleaf seeds can be covered to 1/2 inch.

During germination, waterings should be frequent but just heavy enough to keep the seeds and soil moist. Since temperature, relative humidity, air movement, and sunlight determine the number of waterings needed, fixed watering schedules should be avoided; seeds should be watered only when necessary. Frequent monitoring of soil moisture is essential during germination.

Soil temperatures should also be monitored. Southern pine seeds germinate best when temperatures are between 60° and 80° F. Temperatures below 60° F delay germination while temperatures above 80° F reduce seed vigor and increase the amount of abnormal germination. Stratification broadens the temperature range for satisfactory germination, but germination is better at low temperatures. Unless temperatures can be controlled, seeds should not be sown during either very hot or very cold months. Air in greenhouses may be several degrees warmer than soil cooled by evaporation. During sunny days soil temperatures may be higher than air temperatures. In winter, irrigation water can be cold enough to further reduce already low soil temperatures. Poor germination of longleaf seed has been experienced when soil temperatures dropped shortly after germination. Many seeds cracked but failed to germinate completely. Seed from the same lot germinated well, however, when resown a few weeks later in warmer temperatures.

SUMMARY

Problems many growers encounter when they begin to grow seedlings in containers can be diminished if proper techniques are followed. If the seed vendor does not remove unsound seed, the grower should. After separation, sound seeds should be dried to moisture content below 10 percent and stored at temperatures below 32° F. When seeds are removed from storage, their dormancy can be overcome by stratification. Seeds should either be sterilized with hydrogen peroxide or treated with a fungicide to minimize losses to disease. Sowing rates can be adjusted to reduce the percentage of empty cavities if seed tests are run before sowing. Finally, after sowing, soil moisture and temperature should be carefully monitored to insure good germination.

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