Producing High-Quality Slash Pine Seeds

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Abstract

Slash pine is a desirable species. It serves many purposes and is well adapted to poorly drained flatwoods and seasonally flooded areas along the lower Coastal Plain of the Southeastern US. The use of high-quality seeds has been shown to produce uniform seedlings for outplanting, which is key to silvicultural success along the Coastal Plain and elsewhere. We present information for nursery managers who collect, process, and treat slash pine seeds.

Key Words

Pinus elliottii, *P. taeda*, *P. palustris*, *P. echinata*, seed storage, seed processing, stratification, seed pathogens

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Introduction

Slash pine (*Pinus elliottii* Engelm. var. *elliottii*) is an excellent timber tree and one of the premier pine species in the Southern US. Many prefer the species because of its fast growth and excellent utility for fiber, lumber, poles, and gum naval stores. The habitat and preferred sites within its natural range include poorly drained flatwoods and stream edges, as well as seasonally flooded areas such as bays and swamps.

The ease and success of planting slash pine has resulted in a significant increase in its range. Extensive planting and natural regeneration of open agricultural and forest land led to a sharp rise in acreage of slash pine between 1952 and 1970 (Sheffield and others 1983). Although its range now includes coastal areas from South Carolina to eastern Texas, almost 80% of slash pine ecosystem acreage occurs in Florida and Georgia (Barnett and Sheffield 2003).

Nursery practices for slash pine are similar to those for loblolly pine (*P. taeda* L.), and relatively little seed and seedling research has focused on the species. There are, however, some distinct differences between slash pine cone and seed maturation and performance and that of the other southern pines. The purpose of this paper is to review important aspects of producing high-quality slash pine seeds.

Collecting and Processing Cones and Seeds

Cone and Seed Maturity

Date of collection and length of cone storage significantly influence yields and germination of slash pine seed. As indicated in table 1, the number of recovered seeds per cone generally increases with later collection dates (McLemore 1975; Barnett 1976a). Yields from each collection increase with length of cone storage. One week of storage was unsatisfactory for all dates of collection; 3 weeks increased yields, but 5 weeks proved best. Even cones with a specific gravity of 0.86 yielded only half as much seed after 3 weeks as they did after 5.

Storage for 5 weeks also increased germination in most cases. Seeds in cones that are immature continue to ripen and improve in quality with cone storage, and seed viability in mature cones also continues to improve with cone storage (table 1). In this respect, slash seeds respond differently than those of longleaf (*P. palustris* Mill.) and loblolly pine. Studies indicate that loblolly seeds mature before the cones; as soon as the cones open the seeds are mature (will germinate at the maximum level) (McLemore 1975; Barnett 1976a). However, longleaf pine seed quality normally does not continue to increase during cone storage (table 1). In fact, it typically decreases in storage. So, longleaf cone collection should be delayed until the cones are fully mature.

Cone Storage

Although cone storage is important in maximizing seed recovery, there are no sound recommendations for conditions under which cones should be stored. Typically cones are stored in 1-bushel (35 l) burlap bags, 20-bushel (105 l) wooden crates, or large plastic-mesh bags and either in open or covered conditions. Early studies have indicated no significant differences between burlap bag or crate storage if the cones are handled properly (Barnett 1979a; Bonner 1987). There seems to be benefit in holding loblolly pine cones in the open, where cyclic wetting and drying improves seed extraction (Bonner 1987). Providing cyclic wetting to eastern white pine (*P. strobus* L.) cones during storage, however, reduced germination (Barnett 1988). Storing both slash and longleaf pine cones in the open under rainy, high-humidity conditions causes mold development, which potentially reduces germination of these more sensitive seeds both initially and during seed storage. Seeds from slash pine cones sampled from the center of crates held in the open germinated markedly less than those from the outer portions of the crate (Barnett 1979a). Tests with shortleaf pine (*P. echinata* Mill.) indicate that, although seeds from cones in open storage germinated better initially, they deteriorated significantly during 1 year of storage (Barnett 1979a). It is thought that the open cone storage provided a stratification effect that hastened initial germination, but lowered seed quality. This effect probably occurs in other species as well as slash pine.

Seed Processing

Seeds are normally extracted from pine cones in forced-draft kilns where temperatures are maintained between 95 °F and 105 °F (35 °C and 40.5 °C). After extraction from the cones, they must be dewinged, cleaned, and dried. The wings of slash pine and the other southern pines (except longleaf) are completely removed by brushing and tumbling in mechanical dewingers. The dewinging process is hastened and improved by moistening dry seeds, but excess moisture should be removed before storage. Dewinging that is done in a manner that does not damage the seed coats has no effect on seed storability (Belcher and King 1968; Barnett 1969).

Table 1. Seed yields and germination of three southern pines affected by date of collection and length of cone storage (from McLemore 1975).

Date of collection		Specific gravity	Seed yields per cone when stored for:			Germination when stored for:		
			1 week	3 weeks	5 weeks	1 week	3 weeks	5 weeks
			- - - - - - - - - No. - - - - - - - - -			- - - - - - - - - - % - - - - - - - - - -		
				Slash				
Aug	19	0.95	0	8	58	37	52	68
	26	.95	0	41	63	76	46	63
Sep	3	.91	22	37	89	38	38	70
	9	.86	26	40	75	69	46	90
	16	.77	27	75	82	49	63	98
				Loblolly				
Sep	9	.98	0	27	25	96	98	100
	17	.92	11	26	38	92	98	95
	23	.90	19	31	20	97	98	98
	30	.85	21	37	32	100	99	99
Oct	7	.77	41	34	54	98	99	99
				Longleaf				
Sep	9	.99	0	38	46	83	58	31
	17	.95	0	10	61	76	59	48
	23	.93	3	30	50	80	60	49
	30	.92	2	70	72	84	70	72
Oct	7	.88	4	40	72	86	85	83
	14	.83	52	77	77	87	92	90

Seed Treating and Storing

Storing Seeds

Careful control of seed moisture content and storage temperature is essential to maintain viability, and the recommendations are to dry below 10% moisture and store at temperatures below freezing (Barnett and McLemore 1970). Slash pine seeds maintained 66% viability when stored for 50 years at temperatures just above freezing and moisture content of 9% (Barnett and Vozzo 1985). Donald and Jacobs (1990) have shown that lower storage temperatures are better. Under their storage temperatures of 36 °F and 4 °F (2 °C and –15.5 °C), slash pine seeds germinated at 77% and 92%, respectively, after 25 years.

Seed-coat Pathogens

Southern pine seed coats are host to significant populations of pathogenic fungi (Pawuk 1978; Barnett and Pesacreta 1993). Treating with sterilants, such as hydrogen peroxide (Barnett 1976b), or applying fungicidal drenches improves germination of less-vigorous seeds (Barnett and Pesacreta 1993). Pathogens carried on the seed coats also provide a source of infestations that can result in early seedling mortality. Studies show that removing fungal contamination from the seed coats will markedly improve seed germination and seedling establishment in the nursery (Barnett and others 1999).

Tests also indicate that there are important differences among pine species on the degree of seed-coat contamination. Slash pine seeds have high levels of *Penicillium* fungi on their coats, with low levels of *Fusarium*, a primary pathogen on pine seeds (table 2). Longleaf seeds carry the greatest load of fungi, with much greater amounts of *Fusarium* (table 3). By contrast, loblolly seeds have a lower level of contamination (table 4). Contamination among species is related to the different levels of seed-coat density. Loblolly has a very hard coat and longleaf a softer, fibrous one, with slash coats being intermediate in hardness.

Table 2. Levels of seed coat contamination and germination of slash pine seeds following treatment with fungicides[1].

Seed coat treatment	Fungus infestation: *Penicillium*	*Collototrichum*	*Fusarium*	Germination
	%			
Untreated control	100	2	4	33
Thiram™ 42S with Colorant	0	0	0	67
Thiram™ 42S, ABG-3035, Colorant	0	0	0	39
Thiram™ 42S, Vitavax® PC	0	0	0	58
Thiram™ 42S, ABG-3035, Vitavax® PC	0	0	0	54
Vitavax® PC	0	0	0	46

[1] Testing was conducted at Gustafson's Research and Development Center. Two replications of 50 seeds each were used for all treatment evaluations.

Table 3. Levels of seed coat contamination and germination of longleaf pine seeds following treatment with fungicides[1].

Seed coat treatment	Fungus infestation: *Penicillium*	*Collototrichum*	*Fusarium*	*Rhizopus*	Germination
	%				
Untreated control	58	2	32	10	33
Thiram™ 42S with Colorant	2	0	12	0	67
Thiram™ 42S, ABG-3035, Colorant	4	0	10	0	39
Thiram™ 42S, Vitavax® PC	0	0	2	0	58
Thiram™ 42S, ABG-3035, Vitavax® PC	0	0	8	0	54
Vitavax® PC	0	0	16	0	46

[1] Testing was conducted at Gustafson's Research and Development Center. Two replications of 50 seeds each were used for all treatment evaluations.

Table 4. Levels of seed coat contamination and germination of loblolly pine seeds following treatment with fungicides[1].

Seed coat treatment	Fungus infestation		
	Penicillium	*Aspergillus*	Germination
	- - - - - - - - - - - - - - - - % - - - - - - - - - - - - - - - -		
Untreated control	70	6	20
Thiram ™ 42S with Colorant	0	0	42
Thiram ™ 42S, ABG-3035, Colorant	0	0	39
Thiram ™ 42S, Vitavax® PC	0	0	32
Thiram ™ 42S, ABG-3035, Vitavax® PC	0	0	34
Vitavax® PC	0	0	33

[1] Testing was conducted at Gustafson's Research and Development Center. Two replications of 50 seeds each were used for all treatment evaluations.

Because Thiram™ 42-S is a labeled seed treatment, tests were installed to evaluate it, and two other fungicides (ABG-3035 and Vitavax® PC) in combination, for effectiveness in reducing seed-coat contamination. Gustafson's Research and Development Center treated the seeds and conducted both pathological and germination evaluations. Germination of seed samples from the same treatments was tested at the Pineville Seed Testing facility. Results from the 2 facilities were similar, so only the Gustafson's results are shown in tables 2 through 4.

All treatments eliminated fungi from slash and loblolly pine seeds that had low levels of microorganisms on the coats (tables 2 to 4). However, germination was improved in both species with all fungicidal applications. For these species, the Thiram™ 42-S treatment singly was as good or better that any combination of treatments. Longleaf pine seeds had much higher levels of infestation and the treatments reduced, but did not eliminate, seedborne fungi. In the case of longleaf, the combination of Thiram™ 42-S and Vitavax® PC was the most effective. Thiram™ 42-S alone resulted in greatly improved germination—an increase of from 53% for the control to 72% for the treatment.

These results suggest that the Thiram™ 42-S seed treatment significantly reduces seed-coat contamination, and the process improves germination of low-quality seed lots.

Prechilling Needs

Generally, slash pine seeds require little prechilling or stratification to overcome dormancy. If germination conditions in the nursery are near 75 °F (24 °C), most lots will germinate well without prechilling. However, if nursery seedbed temperatures are below 65 °F (18 °C), a short period of prechilling will improve seed germination and early establishment (Barnett 1979b).

Seed Sowing and Performance

The presence of fungi on the seed coat may reduce germination and seed establishment under normal conditions in container nurseries. Covering of germinating seed may contribute to additional mortality. When the container medium is kept continuously moist and the seeds are covered, germination can be adversely affected due to damping off as the infested seeds germinate (table 5). These results reaffirm the benefit of reducing seedborne pathogens. If the surface of the container medium dries between watering, seed covering speeds and enhances germination.

Table 5. Effects of seed covering on slash pine seed germination (from Barnett 1978).

Watering method	Depth of cover (inches)	Total Germination	Proportation at 15 days
		- - - - - - - - % - - - - - - - -	
Mist	0	96	95
	0.25	69	72
	0.50	26	38
Hand	0	60	0
	0.25	80	58
	0.50	67	46

Conclusions

Slash pine seeds are more sensitive to injury during collection, processing, storage, and treatment than loblolly pine seeds. To obtain seedling uniformity in the nursery, particular attention should be paid to cone maturity and storage, presence of seed-coat pathogens, and application of treatments that may enhance performance.

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