Priming Treatments to Improve Pine Seed Vigor[1]

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Hallgren, S.W. 1987. Priming Treatments to Improve Pine Seed Vigor. In: Landis, T.D., technical coordinator. Proceedings, Intermountain Forest Nursery Association; 1987 August 10-14; Oklahoma City, OK. General Technical Report RM-151. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station: 33-35. Available at: http://www.fcnanet.org/proceedings/1987/hallgren1.pdf

Abstract.--Osmotic priming improved both final germination and rapidity of germination in loblolly pine and showed a detrimental effect or no effect on slash pine seeds. The beneficial effects of priming were lowest for stratified seeds and greatest at a low germination temperature.

INTRODUCTION

Nursery managers prefer to work with high-vigor seed lots that show rapid uniform germination and produce vigorous seedlings under a wide range of conditions. Seedling costs are lower because there are fewer culls and uniform stands of seedlings are easier to manage. Thus, there is a strong incentive to improve techniques for controlling and manipulating seed vigor.

Seed priming has shown promise as a technique for improving seed vigor in numerous agricultural and horticultural species (Heydecker and Coolbear 1977, Heydecker et al. 1973). The technique has been used to improve germination in cold soils (O'Sullivan and Bouw 1984, Sachs 1977), to alleviate thermodormancy (Valdes et al. 1985, Guedes and Cantliffe 1980) and to increase rate and uniformity of crop emergence (Heydecker and Coolbear 1977, Heydecker et al. 1973, Holley et al. 1984). Seeds are imbibed in an osmoticum that allows all the processes of germination to proceed to completion except radical emergence. The treatment is long enough to bring all the seeds to the same point, poised just before the last step in germination. Upon termination of the treatment, seeds are introduced to water and the germination process proceeds rapidly to completion (Bewley and Black 1985).

Previous work on priming required rather cumbersome techniques for bringing the seed in contact with the osmoticum that worked well for small quantities of seed (Heydecker and Coolbear 1977). Recently, a seed priming system was developed at Oklahoma State University that proved to be effective in priming vegetable seeds and could be upgraded to handle large quantities of seed. Basically, seeds are primed in columns of osmoticum that are vigorously aerated to insure adequate gas exchange for the seeds (Akers and Holley 1986, Akers et al. 1984, Holley et al. 1984).

This system was tested with loblolly (Pinus taeda L.) and slash pine (Pinus elliottii Engelm. seed and the results were promising. Some of the preliminary results are presented here. A more complete evaluation of the technique is being prepared for publication in a scientific journal.

MATERIALS AND METHODS

Seeds used in the study were from single bulk lots of improved loblolly pine and slash pine collected in 1985 and supplied by the Texas Forest Service. Prior to priming the seeds were divided into two equal groups, one to remain in cold storage and one to receive a cold moist stratification treatment for 53 days.

The seeds were primed in transparent columns of vigorously aerated priming solution at 25°C (Akers and Holley 1986). The solutions were prepared from polyethylene glycol, molecular weight 8000, and water to have a water potential of -1.0 MPa. Each column contained 300 ml of solution and 400 seeds. Solutions were changed daily at first and every other day later in the 11 day treatment period. Light was not excluded from the priming columns. One

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[1]Paper presented at the Intermountain Nursery Association meeting [Oklahoma City, August 10-14, 1987]. Professional paper No. P-2539 of the Agriculture Experiment Station, Oklahoma State University.

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group of seeds was not primed and was given an additional 11 days of stratification for a total of 64 days.

Following 11 days of priming the seeds were washed and divided into groups to be placed in two germinators, one at constant 25°C and another at 15°C. At 25°C the temperature is near optimum for germination of the southern pines and 15°C is considered stressful (Association of Official Seed Analysts 1981, Dunlap and Barnett 1984). The seeds received natural lighting during germination. The seeds were arranged in 4 replicates of 50 seeds on moist filter paper and the layout was a randomized complete block design in each incubator.

Germination was counted for 37 days, everyday at first and less frequently as germination slowed. A seed was considered germinated when the growing radical began to show geotropic curvature (Dunlap and Barnett 1984). Analysis of variance and the Least Significant Difference were used to determine the significance of treatment effects on final percent germination and the number of days to reach 50 percent of the final total germination (Steel and Torrie 1980).

RESULTS

The effect of primping on final germination for loblolly pine at 25°C was an increase of nearly 50 percent for unstratified seeds and no change for stratified seeds (Table 1). Days to 50 percent germination was reduced by more than 50 percent by priming for both stratified and unstratified seeds. Stratification alone increased final germination by 80 percent and reduced days to 50 percent germination by nearly 50 percent.

In contrast, slash pine final germination at 25°C showed a reduction due to priming of 18 and 28 percent for unstratified and stratified seeds. Stratification alone had no effect on percent germination and neither stratification nor priming affected days to 50 percent germination.

At 15°C loblolly pine showed only 2 percent germination when unprimed and unstratified (Table 2). Final germination was increased by stratification to 89 percent and by priming to 35 percent, and priming had no effect on stratified seeds. Days to 50 percent germination for stratified seeds was reduced by 60 percent by priming.

Table 1. Effects of priming on final percent germination and days to 50 percent germination for stratified and unstratified loblolly and slash pine seeds germinated at 25°C.

	Final Percent Germination		Days to 50% Germination	
	Stratified		Stratified	
	No	Yes	No	Yes
Loblolly Pine				
Not Primed	[1]53 b	96 *	8.6 a	4.6 a*
Primed	79 a	96 *	3.1 b	2.0 b
Slash Pine				
Not Primed	88 a	92 a	4.8	3.8
Primed	72 b	66 b	4.4	3.6

[1]For each species and stratification treatment means followed by the same letter are not. different at the 5 percent level; * = stratification treatment significant at the 5 percent level.

Table 2. Effects of priming on final percent germination and days to 50 percent germination for stratified and unstratified loblolly and slash pine seeds germinated at 15°C.

	Final Percent Germination		Days to 50% Germination	
	Stratified		Stratified	
	No	Yes	No	Yes
Loblolly Pine				
Not Primed	[1]2 b	89 *	-	13.4 a
Primed	35 a	93 *	8.1	5.4 b
Slash Pine				
Not Primed	40	88 a *	13.2	11.3
Primed	35	44 b	12.4	13.4

1For each species and stratification treatment means followed by the same letter are not different at the 5 percent level; * = stratification treatment significant at the 5 percent level.

The effect of priming on percent germination for slash pine at 15°C was nil for unstratified seed and a 50 percent reduction for stratified seeds. Stratification alone more than doubled percent germination. Days to 50 percent germination was unaffected by both priming and stratification.

DISCUSSION

The results of this study demonstrated that osmotic priming improves the vigor of loblolly pine seeds (Table 1 and 2). Osmotic priming is known to have beneficial effect on

the vigor of seeds of many agricultural crops (Heydecker and Coolbear 1977). There has been very little work done with tree seeds.

Osmotic priming, like stratification, can improve both final germination and rapidity of germination. The beneficial effects of priming are less if the seeds are stratified before priming, indicating that both treatments may affect some of the same germination processes.

The beneficial effects of priming for loblolly pine were even greater at a low germination temperature than at a nearly optimum temperature (Table 2). These results are consistent with findings for agricultural crops that priming can improve germination at suboptimum temperatures (O'Sullivan and Bouw 1984 and Sachs 1977). Apparently loblolly pine seeds are especially sensitive to low temperature stress during germination (Dunlap and Barnett 1984) and osmotic priming can be a practical option for overcoming the sluggish germination at low temperatures.

The results presented here are inconsistent with the previous findings that osmotic priming improved germination of slash pine seeds (Haridi 1985). The two studies are not entirely comparable since different techniques were employed and the priming treatment ran for nearly twice as long in the current study as in the prior one. There were many ways the techniques used in the current study could be adjusted to meet the needs of different species including changes in temperature, solution concentration, oxygen levels, types of osmoticum and length of treatment.

It is well known that loblolly pine and slash pine have different stratification requirements for removal of dormancy and it is not surprising that they show different responses to the same osmotic priming treatment (Krugman and Jenkinson 1974).

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