ACTIVITIES THAT INCREASE GERMINATION AND ESTABLISHMENT OF LONGLEAF PINE SEEDLINGS IN CONTAINERS

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ABSTRACT—Critical to the successful production of longleaf pine (*Pinus palustris* Mill.) container stock is use of high quality seeds that are properly prepared and sown. Uniformity in germination and establishment in containers makes nursery production easier and more profitable for the grower. Activities that affect seedling performance include: time of seed sowing, sowing techniques, number of seeds sown per cavity, seed covering, and thinning and transplanting germinants. Recommendations for each activity are provided.

INTRODUCTION

Obtaining a uniform seedling crop is essential in producing consistently high quality longleaf pine (*Pinus palustris* Mill.) seedlings. If variability in seed germination and establishment is significant, the chance of producing a quality seedling is reduced. The first step to obtaining adequate germination (more than 85 percent) and acceptable losses after emergence (less than 10 percent) is the acquisition of quality seedlots. Poor germination and excessive losses prevent high quality crops because seed is wasted on oversowing. Unfortunately, many of the longleaf pine seedlots available to nursery managers do not produce adequate seedling germination or minimal seedling losses. Thus, the nursery manager must take additional steps to maximize germination and establishment in containers. Attention to the timing of seed sowing, sowing techniques, number of seeds sown per cavity, seed covering, and thinning and transplanting of germinants is critical to developing the best possible crop and to maintaining an economically viable operation.

TIMING OF SOWING

After obtaining the best available seed and applying appropriate presowing treatments (Barnett and McGilvray 1997), time of sowing is the next critical step in assuring good seed performance. Longleaf pine seeds are adapted in nature to fall germination, so the optimum germination temperatures are somewhat lower than those for the other southern pines (Barnett 1979). It is important, then, to avoid consistently high temperatures during seed germination. The optimum temperature range for longleaf seeds is 65 to 75 °F. Depending somewhat upon geographic location, the recommended sowing dates are April through early May. Sowing early, when temperatures of the medium are cooler, slows germination and exposes seeds over a longer period to damping-off fungi that may kill germinating seeds. Sowing late, when temperatures are routinely above 85 °F, reduces total germination.

SOWING TECHNIQUES

The scale of the operation determines whether the seeds are sown by hand, by simple templates, or by elaborate seeding machines. When production is within a few hundred thousand, hand seeding is completely feasible. When production expands into the millions, some sort of more automated seeder is needed. Even mechanical seeders must be visually checked after sowing to ensure that the prescribed seeding rate has been met. Because longleaf seeds have large wing stubs, uniform sowing is difficult.

NUMBER SOWN PER CAVITY

For maximum efficiency in nursery production, empty cavities must be avoided because all cavities, with or without seedlings, cost the same to carry through the growing cycle. But seed germination seldom approaches 100 percent, and some empty cavities will occur after germination is completed if only one seed is sown per cavity. Seed germination, labor costs, and possible long-term effects on field performance determine planting strategies. These include multiple-sow and thin or transplant, single-sow and transplant from germination flats, or to single or multiple sow and accept initial stocking levels. When a current germination test is 80 percent or more, the general recommendation is to sow one seed per cavity.

Situations also may arise when sowing of one seed per cavity is the best option; even when seed quality is low. An example is an inadequate seed supply—a frequent occurrence with longleaf pine. Another possible situation occurs when the labor force is inadequate for thinning or transplanting. If viability of the seedlot is in the 65 to 80 percent range (typical for many lots of longleaf pine), two seeds per cavity should be sown (Barnett and McGilvray 1997).

Balmer and Space (1976) prepared tables that use sowing rates and expected germination to predict the number of vacant and stocked cavities. These tables are useful when selecting sowing rates and estimating how much thinning will be required. For example, if germination tests show that

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expected germination is 70 percent, sowing two seeds per cavity can reduce the percentage of vacant cavities from 30 to 9 percent, but also will increase doubles to 49 percent. Sowing three seeds per cavity will further reduce vacant cavities to 3 percent, but will increase doubles and triples to 78 percent. To help minimize these problems, Pepper and Barnett (1982) suggest a mixed-sowing scheme. For instance; 30 percent of the containers could receive three seeds; 20 percent could receive two seeds, and the remaining 50 percent could receive one seed. Mixed-sowing schemes are generally more cost-efficient than the standard constant number approach, and vacuum seeders can usually be adjusted to seed the desired mix. However, mixed sowing will still require some thinning and transplanting of germinants to reach one seedling per cavity.

SEED COVERING

After filling and seeding the containers, most growers cover the seeds with a light layer of medium, vermiculite, or grit. This covering tends to restrict the development of moss and algae on the surface of the potting mix and improves the moisture relationships around the seeds, thus improving or hastening germination. Seeds should be covered by no more that 1/8 in. of material. Deep covering slows germination and increases the chance of damping-off and other disease problems (Barnett 1988).

The need to cover varies with the type of watering system. Germination is usually most complete and rapid when seeds remain uncovered and receive water by a misting system (Brissette and others 1991). If seeds are watered less frequently, which is usually the case, a light seed covering facilitates germination by mulching that retains moisture near the seeds and accelerates germination.

THINNING

If cavities are multiple-sown, the nursery manager must decide whether to thin. Thinning should be completed by the time seed coats are shed to minimize the effects on seedling development.

The short-term effects of leaving multiple seedlings in container cavities have been evaluated with longleaf, loblolly, and slash pine (fig. 1). The most marked effect was on seedling development—where multiple seeding reduced seedling dry weights by one-half or more at the end of a 14-week greenhouse-growing period. The smaller, multiple-grown seedlings also showed poorer survival after 3 years when compared to those grown with only one seedling per cavity (Barnett and Brissette 1986).

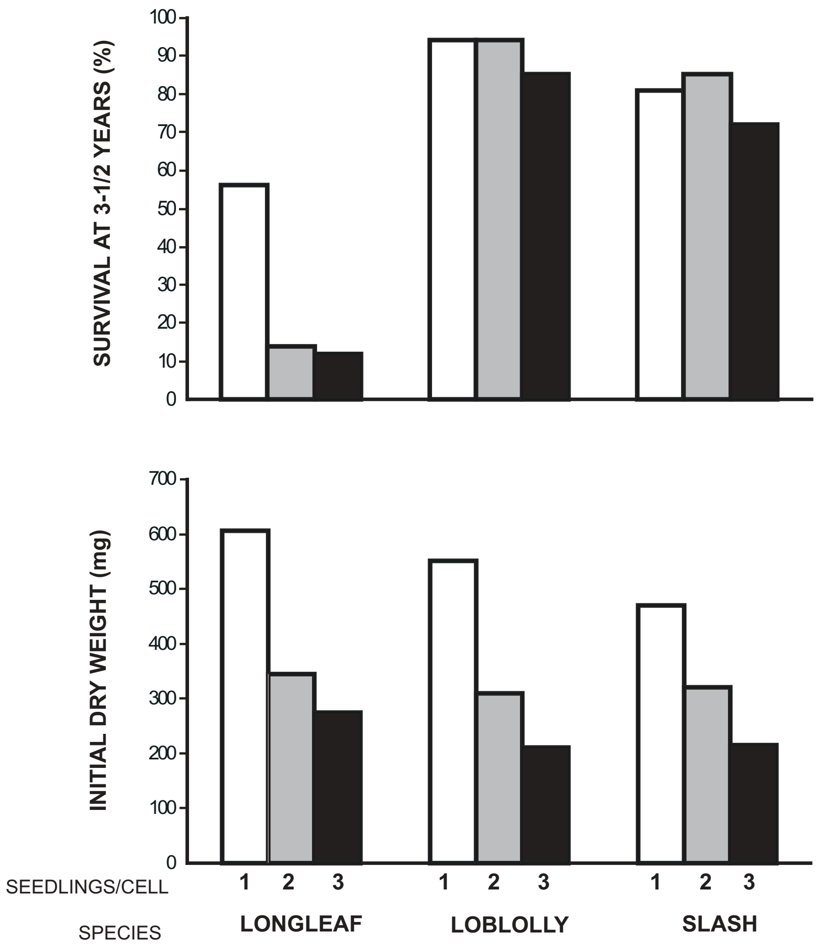

Figure 1—Initial seedling development 14 weeks after sowing in Styroblock 4 containers and field performance after 3.5 years.

TRANSPLANTING

If the percentage of cavities with ungerminated seeds is between 5 and 15 percent, transplanting germinants from cavities with multiple germinants or from germination flats is feasible but unnecessary. However, the absence of germination in up to 5 percent of the cavities will have little practical effect on costs. If more than 15 percent of the cavities are empty, the short fall should be made up by sowing additional containers.

Pawuk (1982) studied the effect of transplanting on initial seedling growth and development. His evaluations involved transplanting germinants with different lengths of radicle development: 0.6 to 0.8 in., 1.2 to 1.4 in., and 1.8 to 2.0 in. The germinants were transplanted carefully to avoid injury to tender radicles. Earlier observations have shown that damage to the radicle, such as breaking the tip, would slow root development and seedling growth. Transplanting longleaf pine germinants, regardless of their radicle length, was detrimental to subsequent diameter growth compared to nontransplanted controls (table 1). Total dry weight was directly related to radicle length when transplanted.

The importance of careful timing when replacement seedlings are transplanted into empty cavities is clear. Transplanting of a vigorous germinant should be done as soon as an empty cavity becomes evident, generally about 10 to 14 days after sowing. Replacements with short radicles are easier to transplant without damage than those with long radicles. If transplanting is delayed, germinants with longer radicles should be used because smaller seedlings are quickly suppressed at dense stockings. However, transplanting is best done before the seed coats drop and radicle elongation exceeds about 2 inches.

CONCLUSIONS

Uniform seedlings in fully stocked containers reflect successful nursery management. Because initial seed quality is often beyond the control of the manager, a number of sowing related activities under the control of the manager can improve the quality of the crop. Time of sowing and amount of seed covering have a significant impact on the development of uniform germination. These activities affect the optimum temperature and light requirements for germination. Decisions on sowing rates (based on seedlot quality) greatly influence a time-consuming and costly part of nursery production. If multiple sowing is required, thinning, transplanting, or both must be evaluated because only one longleaf seedling should remain in each cavity. The timing of thinning and transplanting is critical to obtaining quality seedlings that will survive and promptly grow taller. Nursery managers who pay attention to the activities described will increase germination and establishment of longleaf pine seedlings in containers.

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Table 1—Effect of radicle length at time of transplanting of longleaf pine and shortleaf pine seedlings after 15 weeks (adapted from Pawuk 1982)

	Longleaf pine		Shortleaf pine	
Radicle length	Root-collar diameter	Dry weight	Height	Dry weight
cm	*mm*	*mg*	*cm*	*mg*
1.5–2.0	1.12a	168a	6.61a	137a
3.0–3.5	1.20a	210b	9.36b	173b
4.5–5.0	1.28a	237c	9.48b	188b
Seeded (control)	1.48a	342d	9.93b	280c