GERMINATION SPEED AFFECTS NURSERY SEEDLING GROWTH[1]

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Abstract. Studies conducted at southeastern and western pine nurseries determined time-of-emergence effects on seedling growth. *Pinus taeda* (southeast) was sown in April, and *P. ponderosa* (western) was sown in August. Seedlings were lifted 8 and 15 months after sowing, respectively. Seedling biomass decreased 5% per day from initial emergence. That is, seedlings that emerged 10 days after germination began were 50% smaller at harvest than those emerging first. Late germinants produced significantly more cull seedlings than early germinants. Findings suggest the germination period should not exceed 5 days and emphasize the need for close supervision of biological and operational factors affecting emergence.

INTRODUCTION

Germination characteristics and subsequent growth characteristics of germinants are not completely understood for coniferous nursery crops. Rapid, complete emergence is generally perceived as important (Dunlap and Barnett, 1984). However, little beyond the stratification requirements of seed is described (McLemore, 1969). Logan and Pollard (1979) reported early-emerged seedlings of Japanese larch were larger than those emerging later. Venator (1973) reported a 10-day delay in emergence resulted in 40% reduction in height of 150-day-old containerized *Pinus caribaea* seedlings. Boyer et al. (1985) reported a similar caliper response of southern pines. However, Griffin (1975) showed that the emergence rate had little effect on dry weight of 214-day-old *P. radiata* seedlings.

Slow or delayed emergence can exacerbate the scheduling of crop management prescriptions. Irregular growth can confound timing of practices such as top pruning or undercutting. Large delays can increase grading costs and variable bag counts. These operations contribute to increased production costs and decreased seed efficiency. Futhermore, slow emergence could carry over to poorer plantation performance of the smaller seedlings (Fisher and Mexal, 1984). This study examined the effects of timing of emergence on seedling size and yield in conifer bareroot nurseries.

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MATERIALS AND METHODS

Pinus taeda L.

Stratified seeds of loblolly pine were sown April 1977 in the Ft. Towson, OK and Magnolia, AR nurseries of Weyerhaeuser Co. The StanHay Precision Seeder was used to sow seed at a target density of about 300/m^2. Seedlings were tagged with 20 mm color-coded plastic rings as the hypocotyl crook emerged from the soil. Emerged seedlings were tagged on alternate days beginning at 10% emergence. The emergence period spanned 9-10 days.

In December 1977, seedlings were hand lifted and sorted by emergence day. Height, root collar diameter, and shoot fresh weight were recorded. The proportion of plantable seedlings (caliper 3 mm) was determined.

Pinus ponderosa Laws

Ponderosa pine seeds were sown August 1984 in the USFS Albuquerque Forest Nursery using a Ojyord seeder at a target density of 430/m^2. Emerging seedlings were tagged over 11-day period as described for the loblolly pine study. Seedlings were lifted, sorted and measured November 1985.

RESULTS

Emergence. The first seedlings were tagged 7 days after sowing at Ft. Towson, OK and emergence was complete after 16 days. At Magnolia, AR, emergence began on day 8 and was complete by day 16. Emergence for ponderosa pine at the USFS Nursery began on day 10 and was complete by day 20 (Fig. 1). The first two dates (days 10 and 12) suffered mortality from washing rains. By December 1984, mortality averaged 16% for these dates. Mortality for later dates averaged 20% with mortality increasing as emergence was delayed. The greatest mortality (30%) occurred on day 20.

Ponderosa pine mortality 16 months after seeding, was related to emergence date. Total mortality for the first two emergence dates averaged 28% (Fig. 1), but mortality for later dates averaged 50%. Seedlings germinating on day 14 had the highest total mortality (55%) suffering 12% early-season mortality and 43% over the following 11 months. In total, 43% of all seedlings died before lifting.

Morphology. Seedling shoot fresh weight decreased with delayed emergence (Fig. 2). Shoot fresh weight decreased more than 5%/day for loblolly and ponderosa pine. That is biomass decreased over 50% over the emergence period. A linear model was significant (α=.01) for each trial. Furthermore, shoot fresh weight reliably predicted yield for both species (Fig. 3). A minimum cull standard of 3 mm caliper was selected for both species. Operationally, the standard for ponderosa pine is 4.8 mm. Ponderosa pine required a shoot fresh weight of about 4 g to meet minimum size, and loblolly required about 10 g. Late emerging seedlings contributed disproportionately to the cull level. For example, ponderosa pine seedlings emerging last had 70% culls, but the early seedlings averaged only 30%. A similar relationship held for loblolly pine.

Figure 1. Emergence and mortality of ponderosa pine seeds sown August 1984 in the Albuquerque Forest Nursery.

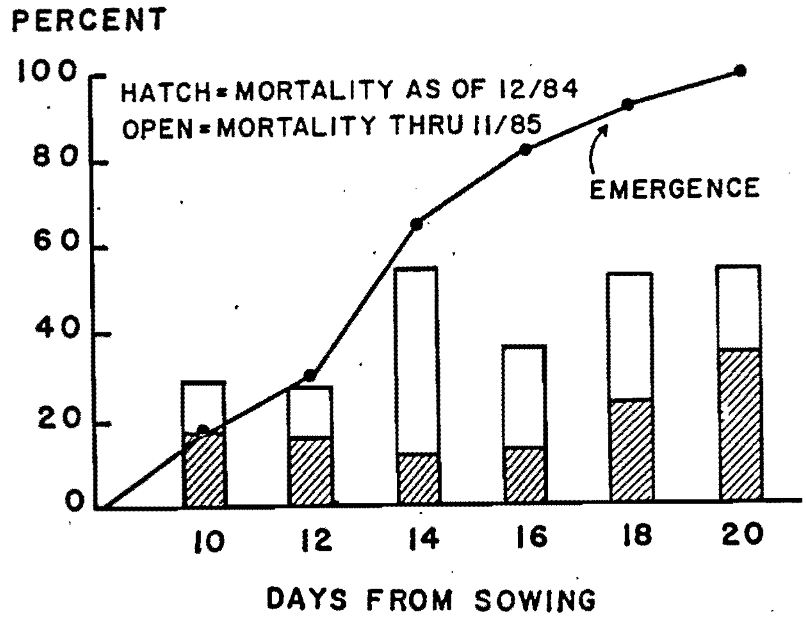


Figure 2. Effect of emergence day on shoot fresh weight of loblolly pine (0,□) and ponderosa pine (●).

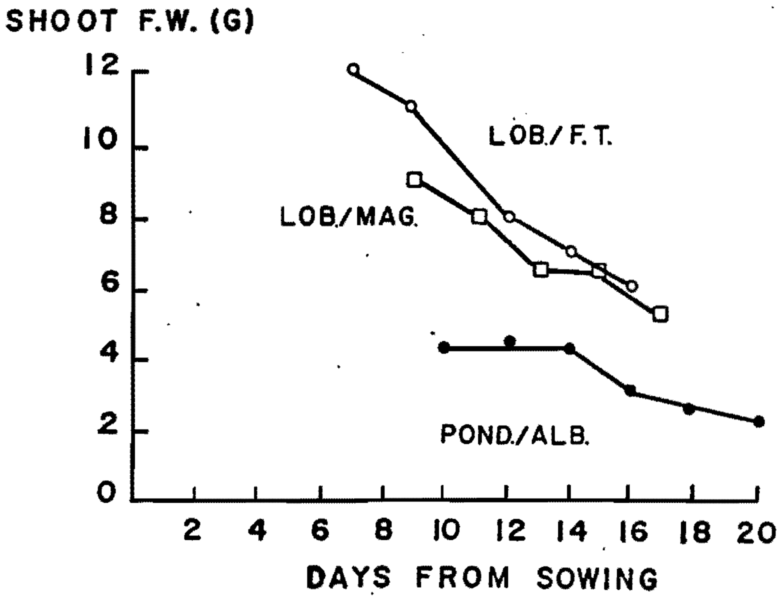
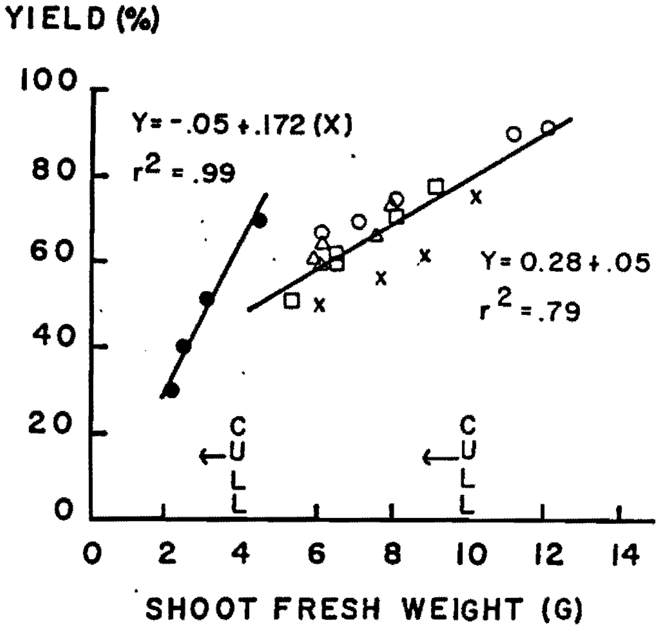


Figure 3. Relationship between fresh weight and yield (Caliper 3 mm) of ponderosa (•) and loblolly pines (o ,Δ ,□ , x).



DISCUSSION

Tests at the three nurseries were sown with unimproved seed from a local provenance. As such, these lots probably contained seed from several open-pollinated trees. Genetic variability may have contributed to morphological variability. Likewise, imprecise seed placement may have confounded test results. Results from another test (Mexal, unpublished) indicate genetic effects or sowing pattern may be relatively minor (Fig. 4). Seed from two half-sib seed lots were precision sown at two densities. Seedlings from both families suffered a decline in caliper with delayed emergence, regardless of growing density. The effects of delayed emergence were dampened somewhat by the lower bed density.

Assuming delayed emergence is the principal cause of seedling morphological variability, two models might be considered as possible responses to treatments affecting emergence rate (Fig. 5). Model A illustrates a decrease in the time from sowing to emergence, but no change in population variability. The average seedling size of the population is increased due to earlier emergence. This is tantamount to sowing earlier to increase size (Mexal, 1982). Model B illustrates the opportunity to produce larger more uniform seedlings through practices promoting rapid emergence. For example, Model B may apply when stratification (McLemore, 1969) is used to speed emergence.

Figure 4. Effect of day of emergence and growing density on caliper of two loblolly pine improved seed lots.

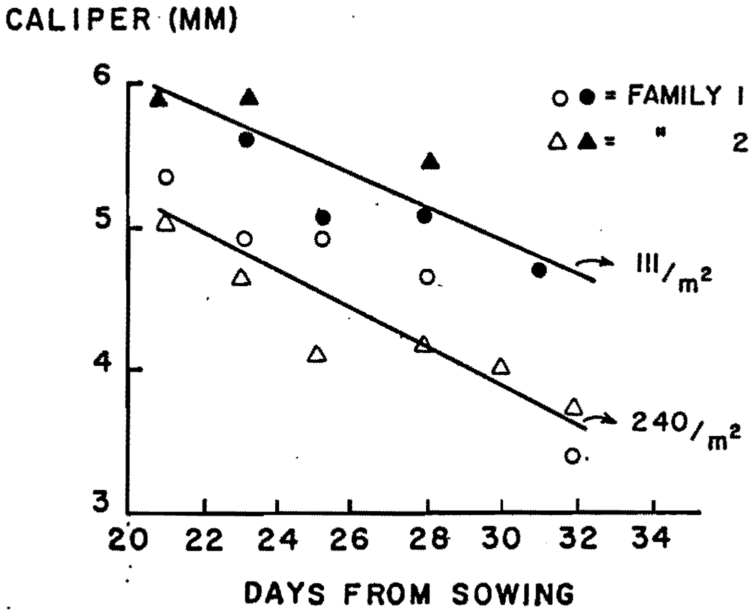
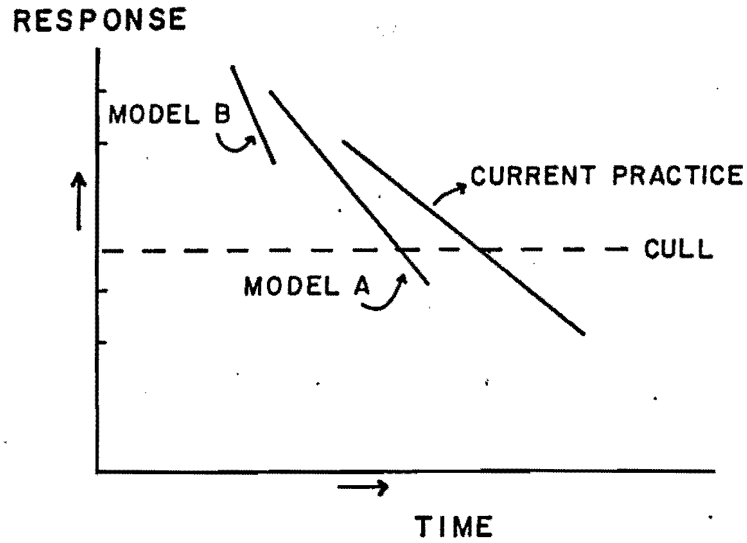
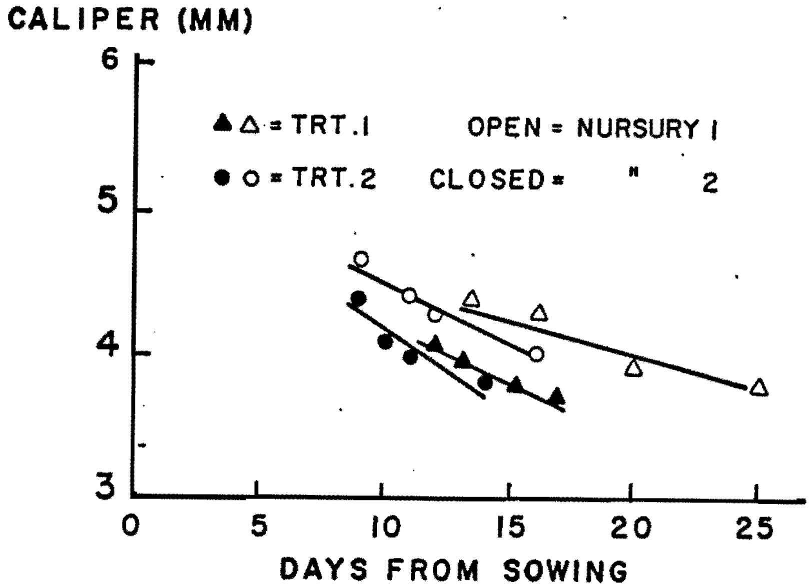


Figure 5. Proposed responses to treatments speeding emergence.



Boyer et al. (1985) indicate that Model A may be the more common response (Fig. 6), because treatments improve the speed of emergence result in little improvement in crop uniformity. In fact, promoting earlier emergence at 'nursery 2' resulted in greater variability than the treatment delaying emergence. At 'nursery 1', emergence began 4 days earlier with the better treatment and ended 9 days earlier, but with little concomittant reduction in seedling variability. Overall earlier emergence improved seedling size. Furthermore, seed and new germinants are more susceptible to heavy rains than are seedlings anchored by the developed radicles. Consequently, faster emergence reduces the risk of loss from rain. These two factors, increased size and decreased risk, justify investigating methods of implementing Model B.

Figure 6. Effect of seed treatments on speed of emergence and caliper of loblolly pine seedlings (after Boyer, et al. 1985).



Model B is attractive because it facilitates effective nursery management and field performance. Improved seedling uniformity would allow more precise scheduling of cultural practices to meet the physiological needs of the crop. Practices such as irrigation, top pruning and undercutting could be timed to maximize field performance rather than nursery production.

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