

14 Reasons Why Bareroot Loblolly Pine Seedlings Die

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There is no universal answer to why newly planted seedlings die, but many died last year because of human mistakes. When rainfall and survival are adequate, some of these mistakes may go unnoticed but when an “exceptional drought” occurs (Figure 1), these mistakes cause seedling mortality. However, on wet sites where seedlings with large roots were planted “deep” in the fall, moisture stress at planting was avoided and seedlings survived. The following is a partial list of mistakes that can lower initial survival of loblolly pine and slash pine.

1 INADEQUATE SUPERVISION

During the 1980’s, planting quality checks were carried out while crews were planting. These “preventative” inspections allowed errors to be quickly corrected. However, federal laws, company downsizing and contracting of services have increased. As a result, planting quality checks are often conducted after the crew is gone. These inspections might identify why trees died, but they do not prevent pruning of roots, pulling up seedlings, or making shallow holes.

2 A SHALLOW HOLE

Some planting guides provide instructions which result in a shallow planting hole. For example, a 2006 publication said that bareroot seedlings “need a 6-8 inch deep planting hole” but I say this is too shallow. Even in a good year, planting roots in shallow holes increases seedling mortality! Some tree planters will use this to justify making 6-inch planting holes. In contrast, I recommend a 10 to 12-inch hole since this allows the roots to be 2 to 6 inches closer to moist soil. Making a 12-inch hole is relatively easy to do with either a ripper (i.e. a subsoiler that makes a continuous furrow several months prior to planting) or with a planting machine. However, making a 10 to 12-inch hole does require more time and effort when using a planting bar, dibble, hoedad or shovel. Since hand-planters often get paid by how many seedlings they can plant in a day, taking the time to make an 11-inch hole will cost hand-planters money. For this reason, I prefer machine planting (when the terrain permits). The hole depth is more consistent with planting machines. Survival from machine planting is higher (Figure 2) because the average planting depth (i.e. distance between root-collar and ground-line) is greater than with hand planting. Another reason survival of machine planted trees is greater is due to no root pruning by the tree planter. The popularity of machine planting in Louisiana has increased from 16% in 1997 to 42% of the acres planted in 2004.

3 INADEQUATE PLANTING DEPTH

I recommend planting loblolly and slash pine with the root-collar about 5 or 6 inches below ground (with about 5 to 8 inches of shoot above ground). However, this will require a 10 to 12-inch deep hole. On well drained sites, this method will increase survival (especially when rainfall is limited). Planting deep will reduce seedling exposure, reduce transpirational loss of

water, and in dry soils, the roots will be closer to moisture deep in the mineral soil. For example, on old-field sites in South Carolina this planting method increased survival by 10%.

Another benefit of deep planting is that roots are protected from a hard freeze. In some cases, low survival results because seedlings become deacclimated due to warm weather. Since roots are more sensitive to freezing temperatures than shoots, roots planted near the surface can be injured by a sudden 20° F freeze. New root growth is reduced and seedlings either die or exhibit little shoot growth. Planting bareroots deeper in the soil will provide seedlings with some protection from a sudden freeze event.

Planting the root-collar at the soil surface is appropriate for some species or when soils are poorly drained and have low oxygen levels. Low soil oxygen reduces new root growth and this can kill seedlings. For example, on two poorly drained sites in Mississippi, survival was reduced by 17 % to 58% by planting half of the shoot below ground.

4 PULLING THE SEEDLING UP

Some outdated planting guides say that a “curled root will kill the seedling.” Therefore, a 1989 planting guide says to push the roots “deep into the planting hole. Pull the seedling back to the correct planting depth.” This “pull-up” technique results in pulling the roots up several inches. However, there are no studies to show that, when planted deeply, a curled taproot will kill a pine seedling. Therefore, the “pull-up” method may actually reduce seedling performance. Higher survival from machine planting (which typically plants roots in an L-shape) may be in part due to not using the “pull up” method.

5 PRUNED ROOTS

Most tree planting guides place too much emphasis on avoiding bent roots and not enough emphasis on keeping roots. I believe the bent-root myth has actually lowered seedling survival because the fear of a 2-inch bend at the bottom of an 7-inch taproot, (1) encourages the seedling to be planted with the root-collar at the groundline; and (2) encourages the removal of roots. For example, one planting guide states to “prune roots to a uniform length by aligning root collars in bunches before pruning” and goes on to say “do not prune tap or lateral roots of loblolly or white pine seedlings shorter than 5 inches.” These recommendations suggests it would be OK to prune an 8-inch taproot (with 6 lateral roots) so that after pruning, the taproot would be 5-inches long (with 4 lateral roots). Of course pruning roots makes planting easier for hand-planters, but studies show that removing fibrous roots lowers root-growth potential and increases mortality. For example, pruning 3.5 inches off of a 10-inch taproot reduced loblolly pine survival by 4%. However, in some years, a moderate amount of pruning can reduce survival by 19%. For this reason, a few tree planting guides say “do not allow planters to prune roots.”

6 STRIPPED ROOTS

Some hand-planters like to strip roots just before they insert the seedling into the hole. This practice (typically done by moving the root through a closed fist), removes some of the small fibrous roots. As a result, the weight of the root system might be reduced by only 2%. However,

the ability of the seedling to produce new roots can decrease by more than 40% and in some cases, this could result in a 12% reduction in seedling survival.

7 SEEDLINGS WITH SMALL ROOTS

Small seedlings (with a limited amount of roots) do not compete with annual weeds as well as well-balanced seedlings with larger root systems. Therefore, in some cases weed control is required to achieve high survival from small seedlings. However, many hand-planters like to plant small seedlings since they are easy to plant. Therefore, some nursery managers cater to hand planters and produce seedlings with roots that have a dry weigh of about 0.4 to 0.6 grams. In contrast, a few nurseries grow seedling primarily for machine planting and the root mass might be > 1.2 grams. Several research trials have shown that when everything else is equal, seedlings with large roots have a more favorable balance between shoots and roots, a greater potential for new root growth, and a higher chance of survival. For example, survival of machine planted slash pine seedlings with 0.35 g roots was 74% compared to 96% for seedlings with 2.9 g of roots. In this study, those operating the machines preferred to plant seedlings with larger roots.

8 LOW SOIL MOISTURE

Sometimes, seedlings have arrived from the nursery, the tree planters are ready to plant, but the soil is dry. Some landowners will take a chance and plant seedlings even knowing that planting into dry soil is risky. They take this chance because if the tree planters leave, they might not return (especially since they are now in short supply due to a limited number of H2B visas). However, if it does not rain soon after planting, bareroot loblolly pine (especially those that are planted with the root-collar at the ground line) will undergo moisture stress and may die. Container-grown seedlings stand a better chance of survival when the soil is dry but if the drought is extended, even container seedlings will wither.

9 PLANTING IN MARCH

In the Southern US, the planting season for bareroot seedlings can extend from October to March. The amount of seedlings planted by month might be 1% in Oct., 5% in Nov., 15% in Dec., 40% in Jan., 25% in Feb., and 14% in Mar. Of these months, March was by far the worst month for achieving adequate survival (Figure 1). March planting should be avoided since seedlings do not have enough time to establish roots before the hot-dry season. Landowners who plant their wetter sites in October or November are planting prior to the cool-wet season while those who plant in March are planting just prior to the hot (possibly dry) season. Although container seedlings can be stored during the fall, before Dec. 21, bareroot seedlings are typically lifted and planted within 5 days.

10 EXPOSING SEEDLINGS

Sometimes seedlings die because they were mishandled after leaving the nursery. Seedlings should be protected from heat buildup (by not stacking bags more than two deep) or from freezing temperatures. In one case, the landowner picked up seedlings from the nursery, stored

them outside during the coldest day of the year (15° F), and then outplanted them on the following Monday. The landowner then wondered why the seedlings died.

11 TOO MUCH RAINFALL AT THE NURSERY

Occasionally, excessive rainfall amounts in the fall will result in flooded nursery soils. When this occurs, the oxygen level in the soil drops, the physiology of the roots change, lenticles develop on the lower stem and the production of new roots decreases. If these seedlings are outplanted, the “double-stress” can be too much and seedlings will die. When seedlings have developed “lenticels” in the nursery, lifting should be delayed for several weeks.

12 TOO MUCH FERTILIZER IN THE HOLE

Occasionally a landowner will apply fertilizer directly into the planting hole in hopes of improving early growth. However, this practice can kill seedlings due to “burning” of the roots. At one site, every container-grown seedling died after fertilizer was added to the planting hole.

13 WASHING ROOTS

Soil often adheres to the roots of bareroot seedlings so a few nurseries once washed roots prior to shipping. However, keeping soil on the roots can be beneficial to retaining seedling vigor. In one study, seedlings that were not washed had 95% survival while root-washed seedlings had 82% survival.

14 WRONG GENETICS

Genetics plays a role in seedling survival especially in terms of response to a hard freeze. For example, some southern Coastal Plain sources of loblolly pine do not survive well when planted in colder regions such as the Cumberland Plateau. Also, since survival is related to genotype, the range in survival observed when planting trees by family will be greater than when planting a mixed lot of the same families. For example, when planting an area using a seed-orchard mix of 30 loblolly pine families, average survival of bareroot seedlings planted in mid-December might be 78%. However, when planting each family separately, survival may range from 61% to 97%. At this site, survival of one family was 17% below the average. When site conditions are favorable, this effect will be masked since survival will be high for all 30 families. However, in droughty years, a range in survival will result because not all genotypes are created equal.

PENNY WISE AND POUND FOOLISH

Some landowners are willing to invest large amounts of money in mechanical site preparation and chemical weed control but are unwilling to invest a small amount for effective planting methods. If making 11-inch holes costs 2 cents more per tree, the cost per acre might increase by \$10. Likewise, penny pinchers might save \$25 per acre by not machine planting an old-field. However, paying more for machine planting, large-diameter seedlings in November can be a good investment, especially in years when droughts occur.

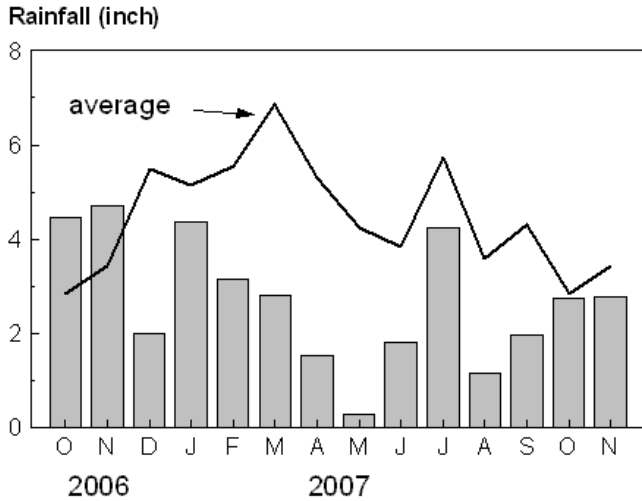


Figure 1. An exceptional drought occurred in Alabama during 2007. The rainfall at Auburn, Alabama (bars) was below average (line) from December 2006 to November 2007. Average yearly rainfall was 56.3 inches but only 28.9 inches fell from December, 2006 to November, 2007.

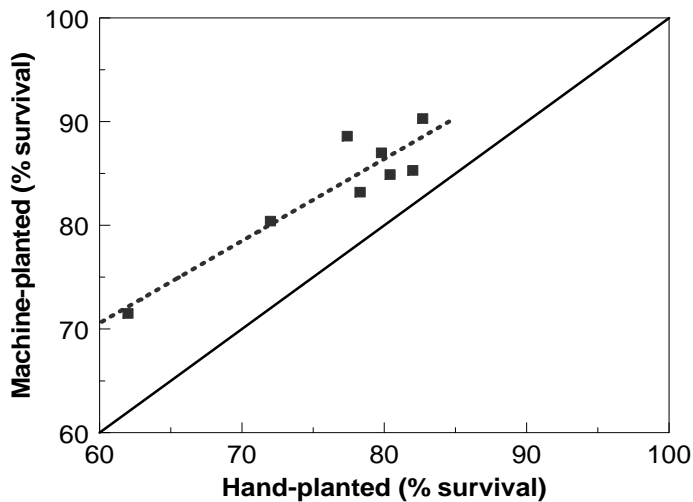


Figure 2. The comparison of hand-planting with machine-planting (Louisiana Forestry Commission planting survival reports). When average survival of hand-planted seedlings was 62% (in 1998), the survival of machine planted seedlings was 71.5%. Overall, survival of machine planted seedlings was 7% greater than for hand-planted seedlings. Better survival (indicated by points above the solid line) is likely due to a deeper planting hole, planting the root-collar about 5 to 6 inches below the ground line, and by root pruning by hand-planters.