Cultural Practices to Improve Survival and Growth of Loblolly and White Pine Seedlings

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Dierauf, T. 1996. Cultural Practices to Improve Survival and Growth of Loblolly and White Pine Seedlings. In: Landis, T.D.; South, D.B., tech. coords. National Proceedings, Forest and Conservation Nursery Associations. Gen. Tech. Rep. PNW-GTR-389. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station: 53-58. Available at: http://www.fcanet.org/proceedings/1996/dierauf.pdf

INTRODUCTION

This is a broad subject for thirty minutes, so to save time I will skip the routine cultural practices that all nurseries do and spend my time on a few optional cultural practices that some nurseries do and some don't. By routine practices, I mean such things as good so] I management, accurate seeding, and insect and disease control. I will discuss top-clipping, root pruning, and irrigation rates. All three of these affect growth in the seedbed, and can also affect survival and growth in the field. Many nurseries use top-clipping and/or root pruning to control seedling size, especially top length. My comments will be based on research I was involved in over a thirty year period. I want to offer a couple of precautions about the applicability of this research. First, things that work in Virginia may not work in the deep South. There is risk in extrapolating to areas of different climate. Second, things that work in one nursery may not work in another, even in the same geographic area. Soil differences, in particular, and also differences in cultural practices may result in different responses to a treatment.

SEEDLING SIZE

Because the practices I will discuss all affect seedling size, I want to discuss first how seedling size is related to survival and growth in the field, and what size seedlings, consequently, we should be trying to produce. We installed 14 different studies over a period of more than twenty years that were either exclusively seedling grade studies, or included seedling size as a treatment. From these studies we have concluded that in Virginia we prefer Grade 2 seedlings over Grade 1 seedlings, at least the larger Grade 1 seedlings (larger than about 7/32 inch root-collar-diameter). Grade 1 seedlings are larger than 6/32 inch root collar diameter. This is an example of a geographic difference I just cautioned about, because in much of the deep South, large, Grade 1 seedlings are preferred. In our studies, Grade 1 seedlings have usually not survived as well as Grade 2 and have not exhibited enough growth advantage to justify the added expense of growing, lifting, handling, and planting them.

At the other end of the scale, we don't want Grade 3 seedlings either (seedlings below 4/32 root-collar-diameter). They don't survive as well as Grade 2 seedlings, especially when planted early (in December and January).

Larger seedlings grow faster than smaller seedlings, at least for the first few years after planting. Of the 14 Studies I've mentioned, 9 were measured between 17 and 26 years after planting. It seems that in Virginia, most of the height growth advantage of large seedlings

occurs in about the first five years. After that, differences increase very little, or may even decrease.

Our earliest grade studies were installed in 1966 and 1977. They were planted in March, the safest time to plant in Virginia, and survival was excellent, even for 2/32 and 3/32 inch seedlings. The largest size, 7/32 inch, didn't survive as well (Figure 1). These studies were planted at a 3 by 3 foot spacing, because we planned to measure them for only 3 years. However, they were still in good shape at age 25 and 26 - there had been no problems with ice, wind, bark beetles, etc. - so we remeasured them. Competition- induced mortality had been heavy, but about equal in all seedling diameter classes (Figure 1). At age three the larger seedlings were about a foot taller, larger in diameter, and considerably more robust, but by age 25 and 26 the early height differences had disappeared (Figure 2), and larger seedlings were no larger in diameter at breast height.

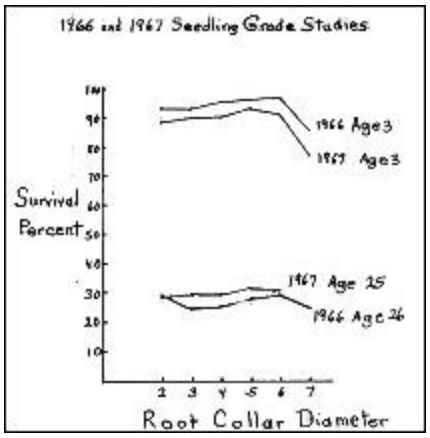

Figure 1. Survival by initial root-collar diameter, at age 3 and 25 or 26.

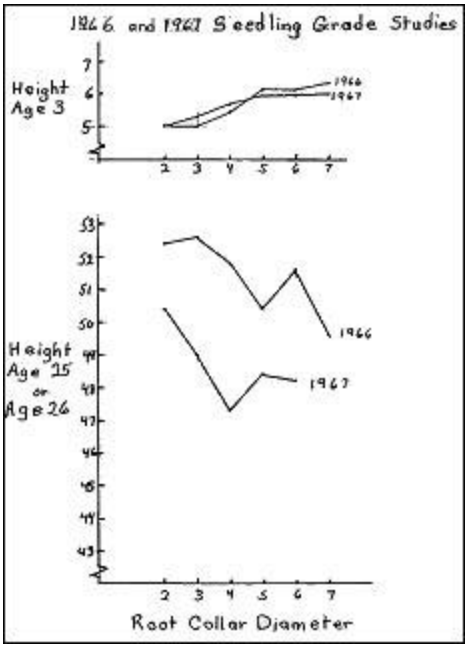

Figure 2. Height by initial root-collar diameter, at age 3 and 25 or 26.

Two additional studies were installed in 1969-70 and 1971-72, planting small (2/32 and 3/32), average (4/32), and large (5/32 and 6/32) seedlings in December, March, and April in 8 different locations. In the 1971-72 study, the small diameter class included only 3/32 inch seedlings. Survival of large seedlings was only slightly better than average seedlings, but small seedlings did not survive nearly as well, especially with December planting (Figure 3).

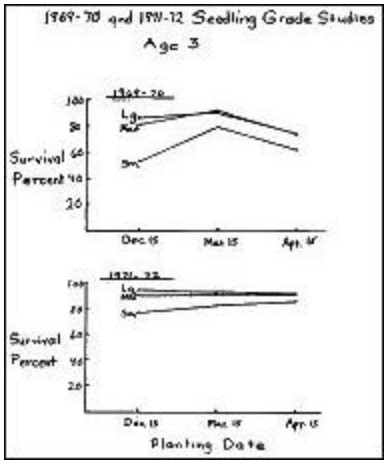

Figure 3. Survival by initial root-collar diameter class and planting date at age 3.

We measured these studies each year for 5 years, and then again at age 20 or 21 for the 1969-70 study and age 18 or 19 for the 1971-72 study. The height growth advantage of large seedlings seemed to peak by or soon after age 5 (Figures 4 and 5).

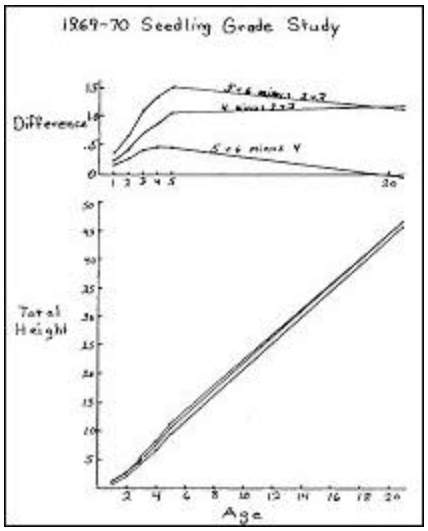

Figure 4. Height differences between initial root-collar diameter classes (above) and total height by initial diameter class (below), at ages 1, 2, 3, 4, 5, and 21 for the 1969-70 study.

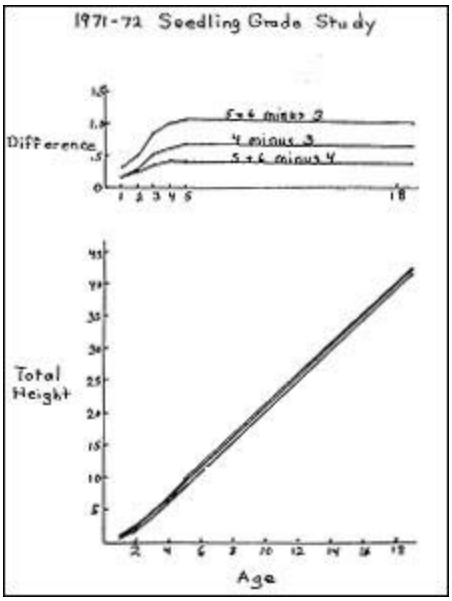

Figure 5. Height differences between initial root-collar diameter classes (above) and total height by initial diameter class (below), at ages 1, 2, 3, 4, 5, and 19 for the 1971-72 study.

The five other studies, measured at age 17, 18, or 20, had height growth trends similar to the last two studies, with differences between 4/32 inch and larger diameter seedlings of about a foot or less at the final measurement.

All 9 of these studies involved seed bed densities that were high by today's standards - 40 to 50 per square foot. David South recommends densities of about 15 per square foot in order to grow a high proportion of Grade 1 seedlings. More recently, we installed two studies in which the seedlings were grown at lower seedbed densities.

In 1987 the Auburn Nursery Co-op installed a nitrogen rate study at our New Kent Nursery which they later abandoned because the precision seeder malfunctioned. We planted a portion of the study to compare 6/32 and 7/32 inch seedlings that had been grown at a bed density of 18 per square foot. At age seven the results were:

Auburn Study - Results at Age 7

Size	Survival	Height (Feet)	DBH (Inches)
6/32	89.6	20.5	3.9
7/32	87.1	20.6	3.9
DIFF.	2.5	0.1	0.0

In 1988, we installed a top clipping study that compared the full range of Grade I and 2 seedlings that had been grown at a bed density of 27 per square foot. At age 6 the results were:

Top Clipping Study - Results at Age 6

Size	Survival	Height (Feet)	DBH (Inches)
Grade 2	88.2	15.9	3.0
Grade 1	85.0	16.1	3.1
DIFF.	3.2	0.2	0.1

Today we seed for 30 per square foot, which in conjunction with our top-clipping schedule produces about 2/3 Grade 2 seedlings and 1/3 Grade 1 seedlings (with very few larger than 7/32 inch). In addition to having a target root collar diameter distribution, we try to keep seedlings from getting too tall. We prefer seedling tops of 8 inches or less, and not over 10 inches. Our top-clipping schedule does a good jobs of controlling top length.

TOP CLIPPING

Loblolly

Top-clipping works well for us at our two sandy nurseries in Virginia. Between 1971 and 1988, we installed 15 different studies involving top-clipping, which I summarized at the 1990 Nurseryman's Conference:

1. **Clipping improves survival:**

a. The improvement is greater for December planting, a risky time to plant in Virginia, than March planting, usually the safest time. This may be at least partly due to an increase in cold resistance, as David South has reported. However, I think an important reason for this difference is the shorter tops resulting from clipping that probably provide some protection from desiccation during cold winters when soil temperatures are too low for root growth to occur. On the average, we get about a 15 point improvement in December and about a five point improvement in March, although this will vary greatly from year to year depending on the weather.

b. The taller the unclipped seedlings, the greater the improvement from clipping. Short, relatively-stocky seedlings survive better than tall, relatively-spindly seedlings.

c. Improvement is related to bed density spindly seedlings in dense beds respond more to top clipping.

2. **Clipping produces more uniform seedlings:**

a. Seedling heights are much more uniform because "tall tops" are eliminated.

b. Diameter distributions are tightened with slightly fewer small seedlings and considerably fewer large seedlings.

3. **Clipping, following the schedule we have been using for the past 12 years, does not reduce height growth in the field. By age 3, clipped seedlings are as tall as unclipped.**

4. **More uniform seedlings (fewer small and oversized seedlings) may result in a better planting job.**

We have been following this top-clipping procedure for 12 years now:

1. We clip three times, sometimes four times in a rainy year with unusually rapid growth.
2. The first clipping is done about August first, plus or minus a week, when about 10 to 20 percent of the seedlings are tall enough to be cut at a six inch height.
3. The second and third clippings follow at three to four week intervals, at target heights of . seven and eight inches. The third clipping is done about mid-September
4. Only succulent tips are cut, no woody stems, removing usually one to three inches.
5. The first clipping typically cuts about 10 to 1-0 percent of the seedlings, the second clipping perhaps half, and the third clipping perhaps a third, including many of the seedlings clipped the first time. On the average, we think that about twenty percent never

get clipped, and these benefit from the improved growing conditions resulting from clipping their taller neighbors.

Consequently, the fastest growing seedlings are slowed the most, because they are clipped twice, and the slowest growing seedlings, that are never clipped, are enabled to grow faster.

White Pine

We did only one study with white pine, as part of a root pruning study, clipping either once on July 11 or twice on July 11 and September 19 at eight and nine inches. Survival of unclipped, once-clipped and twice-clipped seedlings was identical - 56 percent. Height growth, on the other hand, was significantly reduced b top clipping. At age three, average heights were 2.6, 2.2, and 2.0 feet for unclipped, once-clipped, and twice-clipped seedlings respectively, a 23 percent reduction for two clippings.

ROOT PRUNING

Loblolly We did six studies between 1977 and 1991, which I summarized at the 1994 Nurseryman's Conference. Timing, frequency, and depth of undercutting were varied. Up to four undercuttings were made between late July and late October. Depth of cut was about five inches each time, or increased from 3 inches at the first cut to 5 inches at the final cut. Roots were pruned laterally each time undercutting was done in five of the six studies. In one study, wrenching replaced undercutting after an initial undercutting was done.

There was only one statistically significant difference among pruning treatments in the six studies. Combining root pruning treatments, therefore, and comparing them to unpruned seedlings for each study, the survival increase from pruning was +1, +1, +2, +2, 0, and -1 percentage points in the six studies, averaging overall about one point. This is hard to explain, at least for the more frequent root pruning, which in some years produced dramatic changes in root morphology - much denser root systems due to many more lateral roots.

A problem with all six of these studies is that survival of unpruned seedlings was so high 88, 91, 96, 96, 94, and 97 percent. These high survivals occurred despite the fact that planting was done between December 13 and January 12 in five of the six studies, usually a risky time to plant loblolly seedlings in Virginia. One study was planted on March 22, usually the safest time to plant, but in this study the difference was two points in favor of pruning, 98 versus 96 percent, one of the largest differences.

It seems logical that improvement from root pruning would be greater under more stressful weather conditions. Of all the seedling studies we ever installed over a 30 year period, the 1977 studies experienced the coldest weather. The 1977 root pruning study was planted on December 14 and by late winter all the seedling tops had turned brown. Despite this severe stress, at age 3 average survival was less than one point better for root-pruned seedlings, 88.0 versus 87.5 percent.

Root pruning improved height growth slightly. Combining root pruning treatments, again, and comparing them with unpruned seedlings, average differences were .4, .1, .3, .1, .2, and .2 feet at age three for the six studies, giving an overall average improvement of .2 feet for

seedlings that averaged 6 feet tall at age 3 (about a three percent difference).

Our 6 studies don't provide much support for root pruning. Top-clipping, which is much faster and easier to do than root pruning, improves survival much more than root pruning. Top clipping also does a much better job of controlling top length and produces more uniform seedlings. As already mentioned, top clipping only slows the growth of the taller seedlings that arc growing too fast. The shortest seedlings are never clipped and benefit from the reduced competition when their taller neighbors are clipped. Root pruning, on the other hand, reduces the growth of all seedlings, large and small, which for us has resulted in greater numbers of undersize, Grade 3 seedlings.

White Pine

Root pruning white pine in the same sandy nursery soils improves survival dramatically. Five studies were installed in 1988, 1989, 1990 and 1991. Treatments were similar to the loblolly studies, except that in some studies pruning started earlier and more prunings were done during the season. Overall survival was much lower than for the loblolly studies (done in the same years) and survival of unpruned seedlings was only 58, 58, 45, 48, and 59 percent, leaving plenty of room for improvement. There were no statistically significant differences between different root pruning treatments. Combining root pruning treatments, therefore, and comparing them with unpruned seedlings for each study, survival was improved 20, 20, 13, 16, and 19 percentage points in the five studies.

Based on these studies, root pruning white pine is now standard practice in our two sandy nurseries. We undercut and lateral prune three times, with the first pruning about the time height growth begins in the spring.

IRRIGATION

We studied irrigation for three years, comparing one inch of water per week with irrigating at from 5 to 30 centibars of moisture tension. Increased moisture stress reduced seedling growth and produced more cull seedlings. Irrigating at 20 to 30 centibars resulted in greater mortality, areas of stunted seedlings, and greatly increased summer chlorosis. The driest treatments had a slight tendency to improve survival, but this could be explained by the considerably shorter tops. Shorter seedlings usually survive better than taller seedlings, but top length is much more easily controlled by top-clipping, and without the undesirable effects of high moisture stress. We concluded that applying one inch of water per week works very well in our sandy nursery soils.

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