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Shading Reduces Growth of Longleaf and Loblolly Pine Seedlings in Containers

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Development of longleaf (Pinus palustris *Mill.) and loblolly* (P. taeda *L.) pine seedlings growing under three light conditions—full sunlight, 30% shade, and 50% shade—was evaluated. Although there was little difference between development of seedlings in 30% and 50% shade, those grown in full sunlight were significantly larger than shaded seedlings in diameter and in top and root dry weight after 20 weeks. Longleaf pine responded better than loblolly pine in both root and shoot growth under full sunlight. The greatest response to higher levels of light was in root growth. These results have major applications to the culture of longleaf pine seedlings in containers.* Tree Planters' Notes 40(1):23-26; 1989.

One of the problems in producing southern pine seedlings in greenhouse facilities is controlling excessive temperatures, particularly in the late spring and summer. Shadecloth can be used to help control high temperatures by reducing incoming solar radiation. Greenhouse temperatures can be lowered 5 °C or more. Recommended levels of shading range from 30 to 55% *(2)*. Although it is generally known that shading can result in etiolated seedling development, its effect on the growth of greenhouse-grown southern pine seedlings has been generally ignored.

The recent interest in producing longleaf pine *(Pinus palustris* Mill.) seedlings in containers has reaffirmed the sensitivity of this species to competition. Current recommendations for producing longleaf pine in containers include the use of larger containers, which results in a smaller number of seedlings per unit area. *(1)*. To develop quality stock, no more than 550 longleaf pine seedlings should be grown per square meter (50 per square foot). Other southern species can be grown at up to 1,000 seedlings per square meter (100 per square foot). The greater sensitivity of longleaf pine is undoubtedly related to its massive needle development, because epicotyl elongation does not occur for 2 or 3 years.

Preliminary evaluations have indicated that shading longleaf pine seedlings may reduce seedling quality. The purpose of this study was to evaluate the development of longleaf pine seedlings grown in containers at different levels of shade and to compare their performance with that of loblolly pine seedlings *(P. taeda* L.).

Methods

Longleaf and loblolly pine seedlings were grown in Ray Leach Stubby® containers filled with a 1:1 peat–vermiculite medium. Untreated longleaf pine seeds and loblolly pine seeds that had been stratified for 30 days were sown and germinated under uniform greenhouse conditions (30% shade). When germinants dropped their seed coats, seedlings of each species were divided into three groups and grown under the following conditions:

1. no shade (grown outdoors).
2. 30% shade (greenhouse with shadecloth).
3. 50% shade (trusshouse with shadecloth).

A standard cultural regimen was used to grow seedlings in each treatment *(1)*. Efforts were made to maintain uniform growing conditions among facilities. However, there were some differences in growing temperatures (± 5 °C). Although such differences can influence development, the effects of shade were expected to be of much greater magnitude.

Seedlings from four replications were sampled at monthly intervals beginning at 8 weeks of age. Height was measured in centimeters, diameter in millimeters, and dry weights in milligrams. Measurements continued through age 20 weeks.

Differences in seedling responses were tested for statistical significance at the 0.05 level by analyses of variance. Separate analyses were run for each species, and differences in treatment means were evaluated by

orthogonal polynomial comparisons.

Results

Differences in development of both longleaf pine and loblolly pine seedlings due to age, shading treatments, and their interaction were statistically significant. There were major differences in all variables measured due to shading of seedlings. However, there were only minor differences due to the levels of shade (30 or 50%). Consequently, data for these two levels were averaged to simplify presentation.

A 55% increase in stem diameter of longleaf pine seedlings was seen when seedlings were grown in full sunlight (table 1). Increases in top and root weights with exposure to full sunlight were 68 and 210%, respectively. The percentages of increase in diameter and top weight were relatively constant with seedling age. However, the percentage of increase in root weight was high at 8 weeks and decreased steadily as the seedlings grew to 20 weeks of age. There were no differences in longleaf pine development due to different amounts of shade.

Loblolly pine seedlings followed the same trends as those for longleaf pine, but differences between sun and shade exposures were not as great. Increases in seedling height resulting from full sunlight ranged from 7% at 8 weeks to 33% at 20 weeks. Increases in seedling diameter and top weight were fairly constant with age, averaging 18 and 40%, respectively, with exposure to higher light levels (table 1). The trends for root weight agreed with those for longleaf pine, that is, the percentage of difference due to shade decreased with age (118 to 79%).

Seedling development in response to shading varied greatly by species (fig. 1). Both stem diameter and weight were greater for longleaf pine than for loblolly pine when seedlings were grown in shade, but the differences were not as great when seedlings were grown in full sunlight. This suggests the greater intolerance of longleaf pine to shade. Root development was about the same for both species when seedlings were grown in shade, but the root systems of longleaf pine were 65% larger than those of

Table 1—*Effects of shade and full sunlight on development of longleaf and loblolly pine seedlings at 8 to 20 weeks*

Developmental characteristics	8 wk	12 wk	16 wk	20 wk
Stem diameter (mm)				
Longleaf pine				
Shade	2.2	2.8	3.2	4.1
Sun	3.2	4.3	5.2	6.3
% Increase	49	56	62	54
Loblolly pine				
Shade	1.6	2.2	2.4	2.7
Sun	2.0	2.5	2.8	3.2
% Increase	25	14	14	19
Top weight (mg)				
Longleaf pine				
Shade	382	807	1,285	1,870
Sun	613	1,530	2,148	2,936
% Increase	60	90	67	57
Loblolly pine				
Shade	323	716	1,158	1,499
Sun	451	1,040	1,589	2,043
% Increase	40	45	37	36
Root weight (mg)				
Longleaf pine				
Shade	62	161	218	334
Sun	224	493	706	836
% Increase	261	206	224	150
Loblolly pine				
Shade	76	161	241	282
Sun	166	337	469	505
% Increase	118	109	94	79

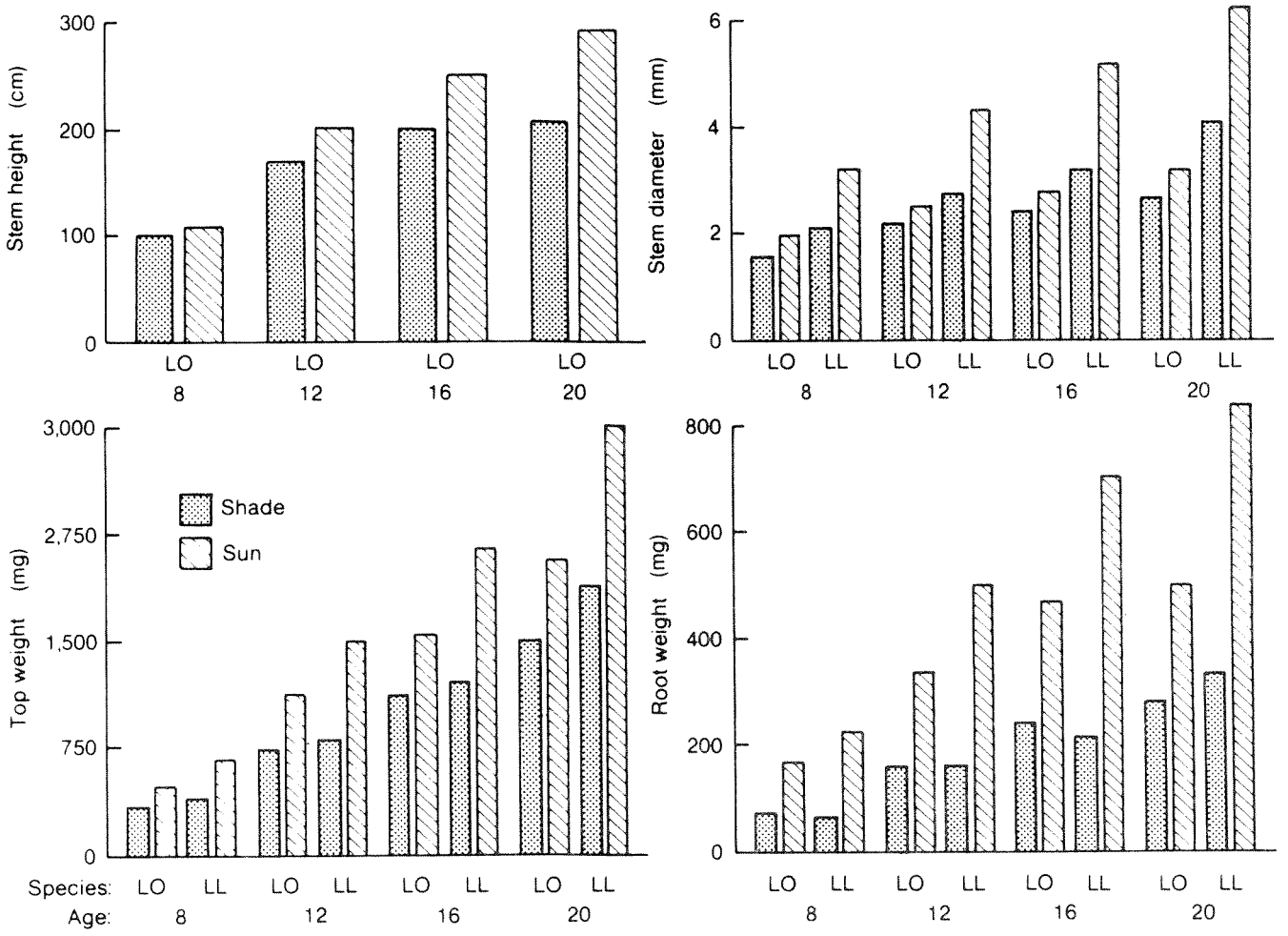

Figure 1—*Response of longleaf* **(LL)** *and loblolly* **(LO)** *pine seedlings to different levels of light. Stem heights were measured for loblolly pines only.*

loblolly pine at 20 weeks of age when grown in full sunlight.

Discussion

These results have immediate application for the production of longleaf pine in containers. Previous research with bareroot longleaf pine seedlings has demonstrated the need to plant seedlings when root-collar diameters are near 1.25 cm (½ inch) for successful initiation of height growth. This same response occurs in container-grown longleaf pine. Therefore, cultural practices that speed stem development must be utilized. Growing longleaf pine seedlings in full sunlight is highly desirable. Based on the results of this study, seeds should be sown in containers in late spring or early summer (May or early June) and the seedlings grown in the open throughout the summer. High-quality (larger diameter and greater root system) seedlings are then available for planting in the late summer or fall. Not only are better quality seedlings produced, they are produced more economically because a greenhouse structure is not required.

Although this technology is most appropriate for longleaf pine, it also applies to loblolly and other southern pines as well. It is important to note that root development was the seedling characteristic that responded most to increased light; this may result in improved field performance.

There was little difference in seedling development between the 30% and 50% levels of shade. Some of this lack of difference may have been due to the variations in environmental conditions among the growing facilities. However, these variations were not great enough to mask the differences between shade and full sunlight.

Literature Cited

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