

Seed Source, Seed Size, and Seedling Grade Relationships In South Florida Slash Pine

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Abstract. Differences in survival, growth, and pest resistance of planted South Florida slash pine (*Pinus elliottii* Engelm. var. *densa* Little and Dorman) from two sources, two seed sizes, and three seedling grades are reported. Seedlings from the northerly source had morphological characteristics more closely resembling typical slash pine than did those from the southerly source. Six years after outplanting, the northerly source, medium size seeds, and large seedling grade had survived best. The northerly source and large seedling grade grew fastest. Seedlings infected by the fungus *Scirrhia acicola* were smaller and had greater mortality than noninfected seedlings. These findings indicate the possibility of improvement in survival and early growth of planted South Florida slash pine by careful selection of seed source and seedling grade.

SOUTH FLORIDA slash pine (*Pinus elliottii* Engelm. var. *densa* Little and Dorman), the only native pine in much of southern Florida, possesses a unique combination of desirable characteristics. It is fire resistant (7), its wood is the densest of the southern pines (10), and it is relatively resistant to insect and disease attack (3, 4).

These desirable features are often offset by poor survival and erratic growth of planted stock, but identification of seed and seedling characteristics related to the large variation in survival and growth would help eliminate these disadvantages. Here is a study designed to determine effects of seed source, seed size, and seedling grade on survival and early growth of South Florida slash pine.¹

Past Work

Little and Dorman (10) described South Florida slash pine as a variety of slash pine, and delineated its range. Langdon (8) and Ward (17) also published range maps. The concept of South Florida slash pine as a discrete genetic entity was questioned by Squillace (13), who found a transition zone characterized by clinal variation in some traits between the two varieties.

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The importance of geographic origin of seed on survival, growth, and disease resistance of southern pines is well established (14). Although typical slash pine is apparently subject to less racial variation than some other southern pines (5), differences in survival and growth related to differences in seed source have been demonstrated (12, 15). No previous studies of variation by geographic source within this variety have been published.

Seed size affects survival and early size of a number of pine species (6, 11). Langdon (9) found significant differences in survival of outplanted South Florida slash pine seedlings from different sizes of seed. Seed size did not significantly affect height growth.

Wakeley (16) established morphological seedling grades for southern pines. Morphological grade did not always express survival potential. Transplanting difficulties often resulted in lower survival of larger seedlings than of average-size seedlings (2). Slash pine seedlings of the typical variety selected for fast growth in the nurserybed also grew faster after outplanting (1, 2). Larger South Florida slash pine seedlings survived and grew better than small or medium size seedlings during the first year after outplanting (9).

Nursery Phase

In the fall of 1956 South Florida slash pine seeds were collected at two locations: Hendry County, in

the south-central portion of the variety's range; and Polk County, near the variety's northern limit of natural distribution (Fig. 1) as defined by Langdon (8). The two locations are about 90 miles apart. South Florida slash occurs in pure stands in Hendry County, where it is the only native pine (10). Polk County has been recognized as the southern limit of natural distribution of typical slash pine (8).

Two sizes of seed from each source were retained, those larger than 4.00 mm and those between 4.00 mm and 3.36 mm. Seed that passed through the 3.36 mm sieve were discarded.

Seed of different source and size were sown in separate nurserybeds in March 1957. One bed of each class was randomly chosen for study. Five, 1-square-foot sampling units were randomly located in each bed. Stem diameter at the root collar to the nearest $\frac{1}{16}$ inch and total stem height to the nearest $\frac{1}{10}$ inch were recorded for all seedlings in each sampling unit in November 1957. In addition seedlings were divided into two seedling types (Fig. 2).

1. Seedlings with inconspicuous winter buds, many crowded needles, and thick tap roots. These are commonly accepted criteria for identifying South Florida slash pine seedlings.

2. Seedlings with prominent winter buds or lack of secondary needles. These characteristics are more closely associated with the typical slash pine variety.

The seedlings were root pruned in December 1957, and lifted the following month. Seedlings from each source and seed-size class were graded into small, medium, and large seedling grades on the basis of stem diameter as tabulated below.

Seedling grade	Stem diameter	
	Hendry County Source	Polk County Source
	— Inches —	
Small	1/16-3/16	1/16-1/8
Medium	3/16-1/4	1/8 -3/16
Large	1/4+	3/16+

Trees were handplanted on a 6 x 7-foot spacing in a randomized block design with four replications in Charlotte County, southwest Florida (Fig. 1). Treatments included the two seed sources, two seed sizes, and three seedling grades in a factorial arrangement. Each of the twelve treatment plots per block contained 7 rows by 7 rows of trees.²

Eighteen percent of the seedlings from the Polk County source had characteristics usually associated with typical slash pine seedlings, i.e., conspicuous winter bud or absence of secondary needles. No seedlings from Hendry County possessed these characteristics.

Both stem diameter and height varied by seed source. Seedlings from Hendry County tended to have thicker, shorter stems than those from Polk County. The Hendry County seedlings averaged 0.22 inches in root collar diameter and 3.0 inches tall at the end of the first growing season, compared to 0.15 inches in diameter and 5.1 inches tall for the Polk County seedlings.

A comparison of the percentage distribution of the two seed sources by diameter and height classes illustrates the size differences between sources (Fig. 3). The largest proportion of Hendry County seedlings fell in the 3/16- to 1/4-inch diameter class, whereas the largest proportion of Polk County seedlings was in the 1/8- to 3/16-inch class. If the midpoint of the

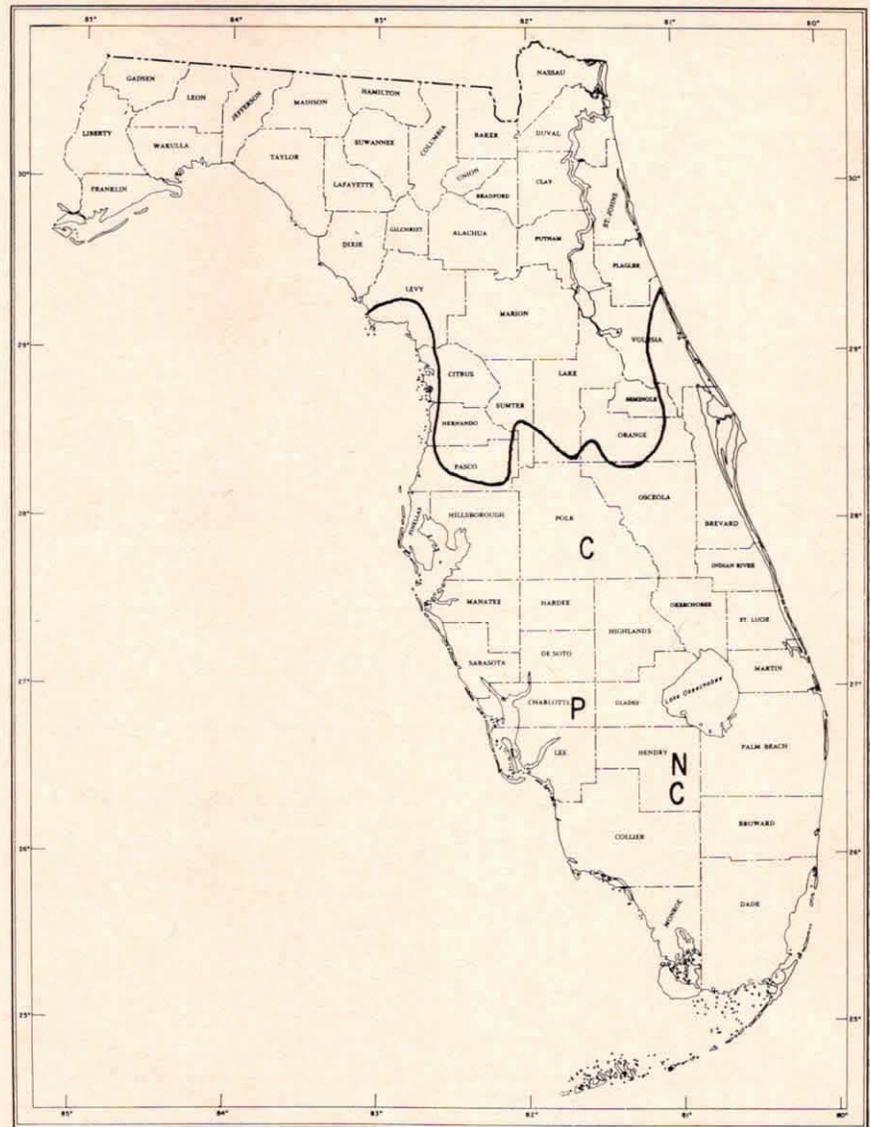


Fig. 1.—Florida, showing northern limit of South Florida slash pine, seed collection areas (C), nursery location (N), and planting location (P).



Fig. 2.—Types of South Florida slash pine seedlings. The two seedlings on the right closely resemble typical slash pine.

²A similar planting was made in south-central Florida, but was destroyed by wildfire one year after planting. The outplanting results reported are from the Charlotte County planting only.

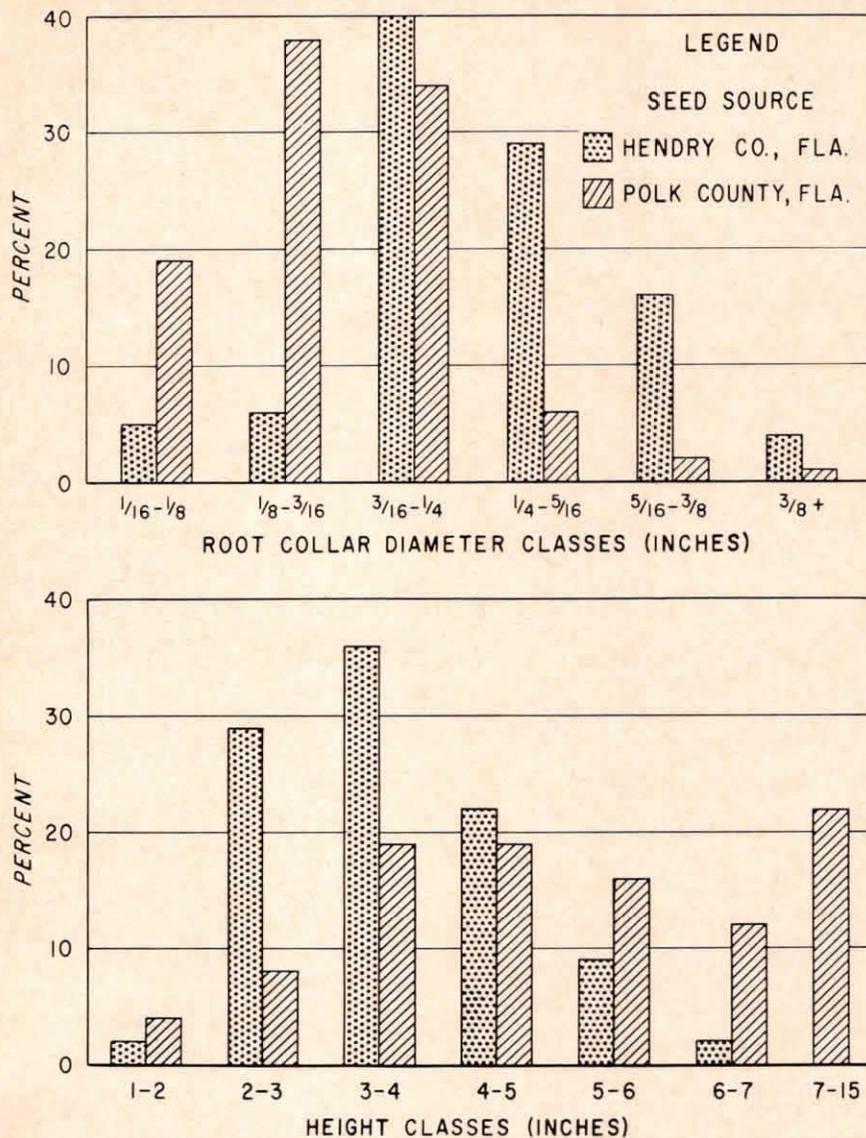


Fig. 3.—Percentage distribution of root-collar diameters and height classes of South Florida slash pine seedlings from two seed sources in the nurserybeds.

3/16- to 1/4-inch class (7/32 inch) is taken as the breaking point, 69 percent of the Hendry County seedlings fell above that point, compared to only 26 percent of the Polk County source.

Eighty-seven percent of the Hendry County seedlings were from 2 to 5 inches tall. Polk County seedling heights varied over a wider range and the shape of the distribution curve was not normal. Fifty-four percent of them were from 3 to 6 inches tall, but 34 percent were taller than 6 inches. Those Polk County seedlings classified as having characteristics resembling typical slash pine seedlings averaged taller (7.3 inches) and slightly larger in diameter (0.19 inch) than the other Polk County seedlings.

Seed size had no consistent effect on height or diameter of the Hendry County seedlings. The Medium-sized Polk County seeds tended to produce taller seedlings with smaller diameters than did large seeds. Eighty-five percent of the seedlings resembling typical slash were produced by the medium-sized Polk County seed. The effect of seed size on height and diameter of the Polk County seedlings was evident in the seedlings classified as "South Florida type" as well as those classified as "typical slash type." The "South Florida type" Polk County seedling heights and diameters averaged 4.5 inches and 3/16 inch, respectively, for seedlings from large seeds compared to 5.2 and 1/8 inches, respectively, for those from medium seeds.

Outplanting Phase

Survival.—During the critical first months after outplanting and through the first 3 years, survival of the Hendry County seedlings was slightly higher than survival of the seedlings from Polk County (Table 1). But, by age 3 survival percentages of the two sources were closely comparable. A larger percentage of the Hendry seedlings died between the ages of 3 and 6 than during the first 3 years after outplanting. The rate of mortality remained about constant for the Polk County seedlings. By age 6, survival of the Hendry seedlings was consistently lower than survival of the Polk seedlings for all seed sizes and seedling grades.

Seedlings from medium size seeds survived slightly better than those from large seeds throughout the 6-year period. The difference in survival between seed sizes increased slightly during the latter three years. The superior survival of seedlings from medium sized seeds was maintained for all sources and seedling grades.

There was little difference in survival between seedling grades through the first 3 years after outplanting. Between ages 3 and 6, survival differences between seedling grades increased and became statistically significant. Only the difference in survival between the large and small grade seedlings was significant.³ The superiority in survival of large grade seedlings was consistent for both sources and both sizes of seeds.

Height growth.—The superior height growth of seedlings from the Polk County source, first noted in the nurserybeds, persisted through the first 6 years of the study (Table 2). Hendry County seedlings averaged 58 percent as tall as those from Polk County before outplanting. Six years later they were 54 percent as tall (Fig. 4). The superior height growth of Polk seedlings was evident in both seed sizes and all seedling grades.

Seed size had no lasting effect on seedling height growth.

³Comparisons of individual means were made by Duncan's New Multiple Range Test, 5 percent level.



Fig. 4.—Planted South Florida slash pine from a Hendry County source (L) and from a Polk County source (R), Caloosa Experimental Range, Charlotte County, Fla. After 6 years the Hendry County seedlings were only 54 percent as tall as the others.

The large seedling grade was significantly taller than the small grade at every measurement. The differences between large and medium grade, and between medium and small grade seedlings were not significant at age 6. However, differences in average height between seedling grades increased during the 6-year period (Fig. 5).

Disease and insects.—One year after planting, infection by the fungus *Scirrhia acicola* (Dearn.) Siggers, causing brown-spot needle blight was noted on 28 percent of the seedlings. Incidence varied significantly between all main effects (Table 3). By age 3, incidence of brown-spot disease had dropped

sharply, and was negligible at age 6. The decrease was primarily a result of mortality of diseased trees, but some previously infected trees no longer had infected needles.

Differences in brown-spot incidence are correlated with differences in survival and height growth. Only 41 percent of the seedlings infected with brown-spot at age 1 were living at age 6, compared to 84 percent of the noninfected seedlings. The diseased seedlings averaged less than half as tall as those which were disease-free.

Pine needle rust (*Coleosporium* sp.) was the only other disease noted. Its incidence and effect were negligible.

Pine sawflies (*Neodiprion* spp.), scale *Phenacaspis pinifoliae* Fitch), tipmoths (*Rhyacionia* spp.), and pine pitch moths (*Dio-ryctria* spp.) attacked some seedlings. The infestations were light and did not differ by treatment.

Discussion

Typical slash pine seedlings tend to be taller and more slender than South Florida slash pine seedlings. In this study seedlings from the more northerly (Polk County) source were taller and more slender than those from the Hendry County source. Moreover, eighteen percent of the Polk County seedlings had characteristics so closely re-

Table 1.—Average Survival of South Florida Slash Pine Trees by Seed Source, Seed Size, Seedling Grade, and Age from Outplanting

Main effect	Age			
	6 months	1 year	3 years	6 years
	Percent			
Seed source:				
Hendry County	94	94	86	59
Polk County	90*	89*	85*	72*
Seed size:				
Large	90	89	84	62
Medium	93	93	87	69*
Seedling grade:				
Large	92	92	88	78**
Medium	91	90	84	66
Small	93	92	84	53**
Average	92	91	85	65

*Significantly different at 5-percent probability level.
**Significantly different at 1-percent probability level.

Table 2.—Average Height of South Florida Slash Pine Trees by Seed Source, Seed Size, Seedling Grade, and Age from Outplanting

Main effect	Age		
	1 year	3 years	6 years
	Feet		
Seed source:			
Hendry County	0.3	0.6	1.9
Polk County	0.4	1.2	3.5**
Seed size:			
Large	0.3	0.9	2.6
Medium	0.4*	1.0	2.8
Seedling grade:			
Large	0.5	1.3	3.5**
Medium	0.4**	0.9**	2.6
Small	0.2	0.6	2.1**
Average	0.4	0.9	2.7

*Significantly different at 5-percent probability level.
**Significantly different at 1-percent probability level.

Table 3.—Incidence of Brown-Spot Needle Blight on South Florida Slash Pine Seedlings at Age 1 by Seed Source, Seed Size, and Seedling Size

Main effect	Brown-spot incidence
	Percent
Seed source:	
Hendry County	38
Polk County	19**
Seed size:	
Large	38
Medium	24*
Seedling size:	
Large	20**
Medium	25
Small	39**

*Significantly different at 5-percent probability level.

**Significantly different at 1-percent probability level.

sembling typical slash pine that they would have been classified as typical slash had their source been unknown. The variations in morphological characteristics indicate possible racial variation within the variety — possibly clinal and becoming more divergent from typical slash pine characteristics from north to south. Evidence of the validity of this conclusion depends on results of intensive slash pine geographic variation studies currently in progress.

The large variation in adaptability and early growth between the two sources is important to foresters and agencies responsible for management activities in southern Florida. Most south Florida land managers plant typical slash pine because survival and early growth are usually better for this variety. However, most comparisons of the two varieties have been based on South Florida slash originating from a single geographic source—the Keri area of Hendry County. The results presented here indicate that knowledge of the variety may be more limited than has been realized. The large variation raises the possibility of obtaining seedlings with characteristics intermediate between the two varieties, or with the more desirable features of both.

Seed size has had no lasting effects on South Florida slash pine tree size in either of the two studies in which it has been tested. The effect of seed size on survival has been erratic, and differences have been small.

Seedling grade is of prime importance in securing survival and

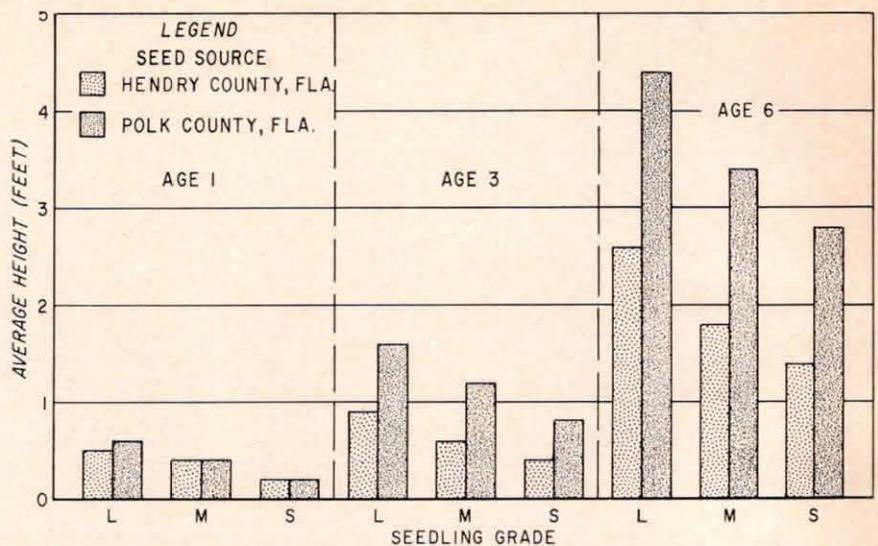


Fig. 5.—Average height of South Florida slash pine trees by seed source, age, and seedling grades large (L), medium (M), and small (S).

growth of South Florida slash pine. Grading by diameter is as effective as grading by diameter-and-height in nursery selection of seedlings. Nurserybeds of South Florida slash should be managed to produce seedlings with root collar diameters of 1/4 inch or larger. Seedlings with root collars less than 3/16 inch should be culled.

Incidence of brown-spot disease was greater among shorter trees, regardless of treatment, and the disease caused continuing high mortality. Wakeley (16) has shown that brown-spot infection on long-leaf pine can reduce growth as much as 95 percent and cause continuing mortality to the 20th year. Elimination of the disease should increase both survival and growth of South Florida slash pine.

Continued research in these and other phases of artificial regeneration techniques is needed if southern Florida is to realize its forest potential.

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