Racial Variation in Sand Pine Seedlings[1/]

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Interest in sandhills reforestation has substantially increased the economic importance of sand pine (**P.** clause (Engelm.) Sarg.). This species has demonstrated superior growth compared to longleaf (**P.** palustris, Mill.) and slash pines (**P.** elliottii Engelm.) on certain sandhills sites (Florida Forestry Reporter 1963). Its kraft pulp properties of overall strength and brightness compare favorably to those of longleaf pine (Martin 1962).

Sand pine is geographically confined to the excessively or moderately well drained and infertile sands of Florida and the southern tip of Baldwin County, Alabama (fig. 1). The major concentration is a 280,000 acre block in north central Florida. The only other extensive area is in western Florida, between Panama City and Pensacola.

Sand pines are typically small, poorly formed and short-lived. The average stand attains a height of about 65 feet and a maximum diameter of 18 inches. Stands usually deteriorate after 50 to 60 years (Cooper 1957). Sand pine is related genetically to Virginia pine (**P. virginiana** Mill.).

Two races of sand pine are recognized. The Ocala race has serotinous cones, grows in even-aged stands, and is phenotypically of poorer form than the open-coned and uneven-aged western race. Ward (1963) has named the western race **immuginata.**

Relatively little research has been conducted on sand pine. This increasingly important species may facilitate sandhills reforestation and should, therefore, be evaluated more thoroughly. The objective of this study was to investigate possible racial variation of certain seedling characteristics, especially growth rate and response to fertilization.

PROCEDURE:

In the fall of 1965, fresh cones were collected from eight average dominant trees in each of five Florida counties; Walton, Franklin, Levy, Marion and Hernando (fig. 1). At each location the randomly selected trees were within the same soil series and a minimum of 300 feet apart. The soil series at Franklin, Levy and Hernando counties was St. Lucie. The Marion and Walton County soils were better sites; Kershaw and Lakeland sands, respectively.

The seedlings were kept separate by individual mother-tree and grown five to a pot (one line from each origin) in a ventilated and shaded greenhouse for eight months. The Marion County Kershaw soil was treated with a factorial combination of 0 to 100 ppm of nitrogen and 0 to 300 ppm of phosphorus.

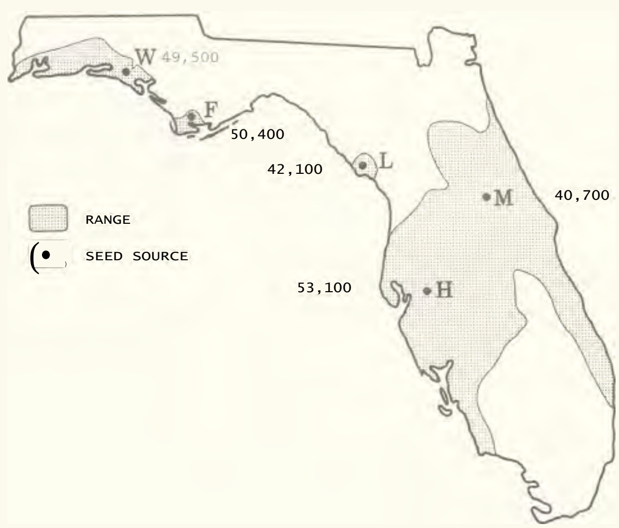

FIG. 1. RANGE, SEED SOURCE, AND SEED SIZE (SEEDS L/B.).

RESULTS AND DISCUSSION:

Seed **Color and Seed Size:** Seed color darkened and seed size increased from west to east (fig. 1). These trends were reported previously by Barnett and McLemore (1966) in a comparison of Walton and Franklin seeds. The small size of the Hernando seeds was an exception. Walton and Franklin seed

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were significantly smaller than Levy, Marion and Hernando seed and the Marion seed were significantly larger than the Levy and Hernando seed; Hernando seed were significantly smaller than Levy seeds (table 1).

Table 1
Analysis of Variance

Variable	Source of Variation	df	Level of Significance
Cotyledon Number	Origins	4	
	W+F vs L+M+H		ns
	W vs F		ns
	M vs L+H		ns
	L vs H		ns
	Lines in Origins	35	**
Seed Size	Origins	4	
	W+F vs L+M+H		**
	W vs		ns
	M vs L+H		**
	L vs		**
	Lines in Origins	35	**
Seed Color	Origins	4	
	W+F vs L+M+H		**
	W vs F		ns
	M vs L+H		ns
	L vs H		ns
Deficiency Symptom (Yellow Tipping)	Origins	4	
	W+F vs L+M+H		**
	W vs F		ns
	M vs L+H		ns
	L vs H		ns

Cotyledon Number: No differences by seedling origin were observed in the number of cotyledons. The most frequent number of cotyledons was five. The range by individual seedlings was from three to seven. The range by lines was 4.30 to 5.70 and was statistically significant (table 1),

Deficiency Symptoms: Significant differences in deficiency symptoms occurred both by seedling origin and by treatment. The nitrogen alone treatment resulted in stunted growth and purp I i s h needles, a typical phosphorus deficiency. This effect was uniform for all origins. Seedlings with yellow tips which later turned brown were present only in the NP treatment. These symptoms are similar to the magnesium deficiency symptoms of Virginia pine reported by Sucoff (1961). The Walton and Franklin seedlings exhibited such symptoms to a significantly less degree than did the Levy, Marion and Hernando seedlings (table 1).

Mycorrhizae: Ectotrophic mycorrhizae were completely absent in the presence of 100 ppm of nitrogen. However, the proportionii of infection was unaffected by 300 ppm of phosphorus. Walton and Franklin origins showed significantly more mycorrhizal infection than those from Levy, Marion, and Hernando (table 2). -

Although the overall root infection of Walton seedlings was greater than that of Franklin seedlings the latter exceeded the Walton seedlings in

1/ Each seedling was subjectively evaluated for root infection and placed in the following categories --none, very low, low, medium, high.

proportion of infection in the phosphorus alone treatment.

The absence of mycorrhizae may have led to the deficiency symptoms mentioned above. The

Shoot Weight: Shoot weights were significantly different by seedling origin, by fertilizer, and by the origin x fertilizer interaction (fig. 2, table 2). All shoot weights were severely decreased in the

TABLE 2
Analysis of Variance

Source of Variation	df		Mycorrhizal Infection	Shoot Weight
			Level of Significance	Level of Significance
Fertilizer	3			
N		1	**	ns
P		1	ns	**
NP		1	ns	**
Origin	4			
a) W+F vs L+M+H		1	*	**
b) W vs F		1	ns	**
c) M vs L+H		1	ns	ns
d) H vs L		1	ns	*
Fertilizer x Origin	12			
N x a		1	ns	ns
N x b		1	ns	**
N x c		1	ns	ns
N x d		1	ns	ns
P x a		1	ns	**
P x b		1		**
P x c		1	ns	ns
P x d		1	ns	ns
NP x a		1	ns	ns
NP x b		1	ns	ns
NP x c		1	ns	ns
NP x d		1	ns	ns

nitrogen alone treatment resulted in no mycorrhizal infection, and phosphorus deficiency symptoms were evident. These stunted and purplish seedlings fit the description of Virginia pine seedlings grown in the absence of mycorrhizae (McComb 1938). The nitrogen plus phosphorus treatment resulted in yellow tipping, a possible magnesium deficiency. These observations further substantiate the importance of mycorrhizae in absorption of nutrients.

It seems reasonable that in the absence of mycorrhizae, the most unavailable nutrient, phosphorus, would indicate a deficiency symptom first. Upon the addition of phosphorus, the next most unavailable nutrient, possibly magnesium, may indicate a deficiency symptom.

nitrogen alone treatment and mortality was high (15%). All shoot weights, with the exception of the Walton seedlings, were positively affected by the phosphorus alone treatment. Interestingly, it was found that all origins responded synergistically to the NP treatment (table 2). The nitrogen x the Walton and Franklin comparison was significant; the nitrogen main effect was positive for Franklin and negative for Walton shoots.

The interactions of nitrogen and phosphorus with the Walton and Franklin comparison are of considerable practical significance as this relationship reduces the importance of the main effects of the fertilizer. It follows that seed origin must be considered before response to fertilizer can be predicted with any degree of confidence.

In conclusion, for a geographically small species sand pine's regional variation is striking. Under the conditions of reproductive isolation and environmental differences, both ecotypic and clinal variations have developed. To capitalize effectively on the probable existence of racial variation of economically important traits, these races must be evaluated genetically in order to secure the most efficacious race for a given site and cultural regime.

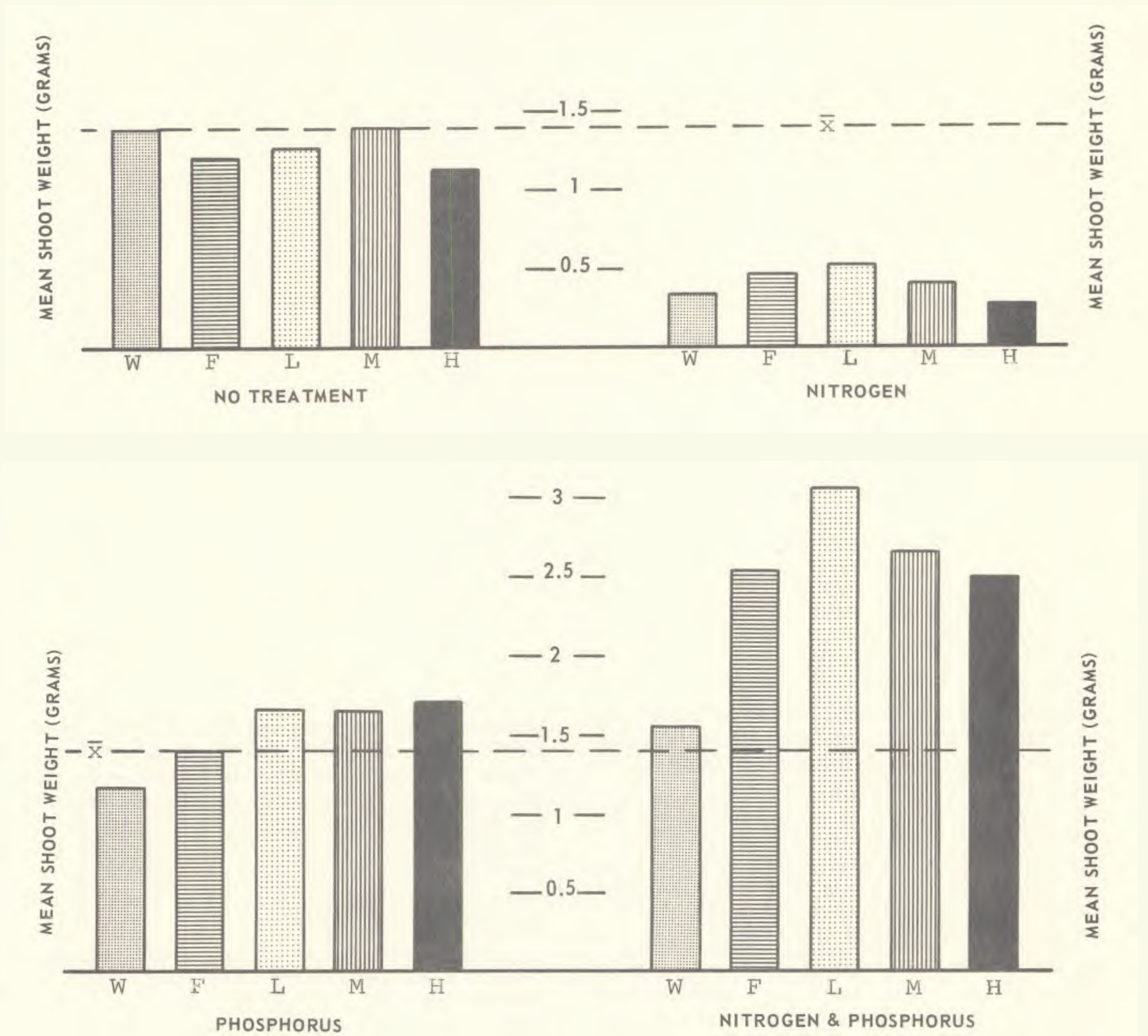

FIGURE 2. SHOOT WEIGHT BY SEED SOURCE AND FERTILIZER TREATMENTS

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