Made in the United States of America
Reprinted from FOREST SCIENCE
Vol. 19, No. 2, June 1973
pp. 135–138

Bedding and Fertilization Influence on Slash Pine Development in the Florida Sandhills

Note by James B. Baker

Abstract. A field study on the infertile and droughty Lakeland sands of west Florida indicated that bedding or fertilization (134 kg P/ha as ordinary superphosphate and 90 kg N/ha as ammonium nitrate) or both increased early growth of planted slash pine (*Pinus elliottii* Engelm.). Throughout the 6-year study, best growth was obtained when the treatments were combined, resulting in 6-year-old trees averaging 3.0 m in height, 4.3 cm in diameter (dbh), and containing 2690 cc of stemwood volume. These values represent increases in the respective parameters of 31, 54, and 76 percent over the control. Bedding + fertilization was also responsible for a significant shift in height class distribution, which was reflected in a greater number of larger trees per unit area. Foliar P levels were higher for trees on fertilized plots for the first 3 years after treatment, while foliar K levels were higher on bedded plots the first 2 years but lower the third year. Foliar N levels were not influenced by treatments. ***Forest Sci. 19:135–138.***

Additional key words. *Pinus elliottii* Engelm., intensive culture, height class distribution, nutrient status, foliar analysis.

SLASH PINE (*Pinus elliotti* Engelm.) planted on west Florida sandhill soils usually grows about 0.3 m in height per year for the first 15 years. Increased growth has occasionally been observed in the sandhills when seedlings were planted on fertilized beds that had been previously used to grow watermelons, but the causal relationships were unknown. This study investigated the single and combined effects of bedding and fertilization on slash pine growth.

Methods

The study was established on a sandhill site in Calhoun County, Florida, in 1965. The soil

---

At the time of this study, the author was Associate Silviculturist with the Southeastern Forest Exp. Stn., USDA Forest Service, at Marianna, Fla. The author is now Soil Scientist with the Southern Forest Exp. Stn., USDA Forest Service, at Stoneville, Miss. Manuscript received April 5, 1972.

was Lakeland sand, which is a member of the siliceous, thermic family of Typic Quartzipsamments. These excessively drained sands are inherently low in available nutrients, especially nitrogen (N) and phosphorus (P) (Gammon *et al.* 1953). The study area had been prepared for planting by chopping with a duplex brush cutter during the fall of 1963 and again during the fall of 1964. Slash pine seedlings (1-0) were machine-planted in February 1965.

The following four treatments were replicated three times in a randomized complete block design:

(1) Control—No treatment.

(2) Bedding—Prior to planting, beds (1.5 m wide and 0.3 m high) were constructed on 2.7-m centers with a disk harrow by throwing the surface soil from middle or furrow areas into adjacent bed areas. Seedlings were planted at a 2.7-m spacing down the center of the beds.

(3) Fertilization—Prior to planting, ordinary superphosphate (134 kg P/ha) was applied on the soil surface in 1.5-m-wide strips on 2.7-m centers, and seedlings were planted at a 2.7-m spacing down the center of the fertilized strips. One and 2 years after planting, ammonium nitrate (45 kg N/ha/yr) was applied in 0.8-m strips on each side of the rows of trees. Fertilizer rates were based on entire area of the plot.

(4) Bedding + Fertilization—Prior to planting, fertilizer P was applied as in (3), and beds were constructed as in (2) to coincide with strips of fertilizer. Seedlings were planted down the center of the beds. Nitrogen was applied 1 and 2 years later as in (3).

Each treatment plot was 18.3 m × 33.5 m and contained about 100 trees, all of which were measured. Tree heights were obtained at the end of each growing season from 1965 through 1970; diameters (dbh) were measured in 1970. Tree volumes were estimated from volume tables prepared by Schmitt and Bower (1970). Foliar samples were collected from the first flush of previous year's growth during the winter of each year and analyzed for total N, P, and K concentrations. Total foliar N was determined by the Kjeldahl procedure; P and K were determined from needle tissue dry-ashed at 490°C for 4 hours and then taken up in 10 ml of 8*N* HCl. Foliar P was determined colorimetrically by the vanadate-molybdate procedure, and K by flame spectrophotometry.

Results and Discussion

Effect of Treatments on Tree Growth. Bedding and fertilization, singly and in combination, influenced growth considerably throughout the 6-year study (Table 1). However, bedding + fertilization resulted in the greatest increases in growth. These increases are probably related not only to the fertilizer and bedding effects, but also to a P fertilizer placement response as reported by Brendemuehl (1970).

Bedding, either alone or in combination with fertilization, was responsible for the greatest increases in tree height growth during the first 2 years after plantation establishment (Fig. 1). This short-term response was probably a reflection of temporarily improved soil water-holding capacity and nutrient relations brought about by the incorporation and concentration of organic matter and topsoil in the restricted bed area. At plantation age 3, however, both single or combined treatments of fertilization and bedding had produced taller trees than the control. The response to fertil-

TABLE 1. Effect of bedding and fertilization on growth of slash pine at plantation age 6.[a]

Treatment	Mean height	Mean dbh	Mean volume	Percentage increase over control		
				Height	Diameter	Volume
	m	cm	cc			
Control	2.3d	2.8d	1529d	—	—	—
Bedding (B)	2.7c	3.6c	2095cd	17	29	37
Fertilization (F)	2.8c	3.8c	2492bc	22	36	63
B + F	3.0b	4.3b	2690b	31	54	76

[a] Each value represents the mean of about 300 trees on three replications. Means in the same vertical column not followed by the same letter are significantly different at the 5-percent level.

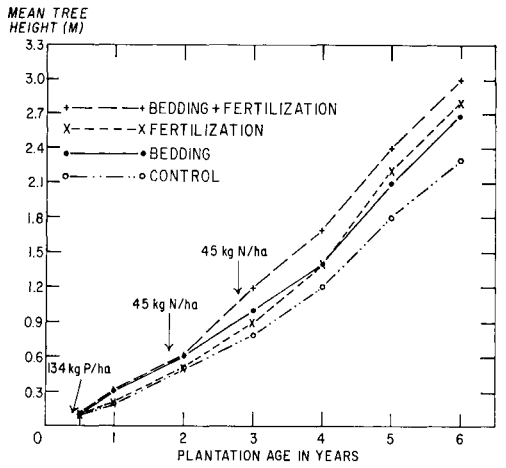

FIGURE 1. *Effect of bedding and fertilization on height growth of planted slash pine.*

ization did not occur until the third growing season, or until after the N fertilizer had been applied.

Treatments had no effect on tree survival. At the close of the 6-year study about 90 percent of the trees on all plots were living.

Effect of Treatments on Height Class Distribution. Treatments were also responsible for changes or shifts in the height class distribution. All treatments caused a greater proportion of trees to fall in the larger height classes. Figure 2 illustrates this for trees of the control versus the bedding + fertilization treatment.

Tests of symmetry (Snedecor 1956, p. 199–202) of distribution curves for all plots indicated that treatments affected both skewness and kurtosis of the distribution curves. The curves for the control and the fertilized plots were significantly (5-percent level) flattened (platykurtic), indicating abnormal variability in the population. However, the curve for the bedding + fertilization plots was significantly (1-percent level) skewed, indicating an alteration in the height class distribution of the population.

Effect of Treatments on the Nutrient Status of the Trees. Of the three nutrients analyzed from needle samples collected each year, only P and K concentrations were significantly affected by treatments, and these effects were often variable and inconsistent. For example, foliar K concentrations were significantly higher (0.47 percent) for trees on bedded plots than for the controls (0.40 percent) in 1966 but lower for trees on these same plots (0.40 percent) than for the controls (0.47 percent) in 1968.

On the other hand, fertilization treatments resulted in significantly higher concentrations of P (0.11 percent *vs.* 0.09 for control) in needle tissue in all years except 1969. On the

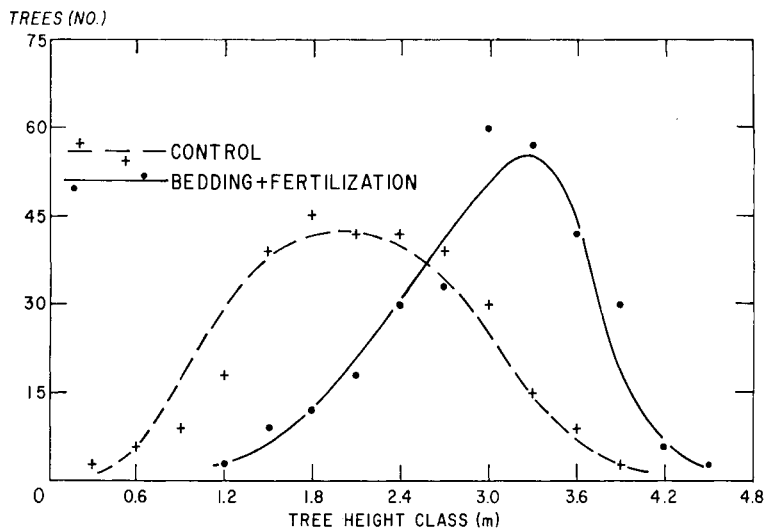

FIGURE 2. *Effect of bedding and fertilization on height class distribution in a 6-year-old slash pine plantation.*

basis of the "critical foliar P level" for slash pine (about 0.10 percent P) as reported by Pritchett (1968), trees on the control and bedded plots were in short supply of P (<0.10 percent) from 1968 through 1970, whereas trees on the fertilized plots maintained tissue P levels of 0.10 percent or greater through 1970, indicating that adequate P absorption was occurring.

Conclusions

Bedding or fertilization or both improved the growth of the young slash pine plantation throughout the course of this investigation. However, growth was best when the treatments were combined. After 6 years, bedding + fertilization had resulted in increases of 31 percent in tree height, 54 percent in dbh, and 76 percent in volume over the controls. This treatment was also responsible for a significant shift in the height class distribution of the plantation, which was reflected in a greater number of larger trees per unit area. If these growth trends continue, slash pine planted on fertilized beds will reach merchantable size sooner and thus allow for a shorter rotation or larger trees at a predetermined rotation age. It is too early to conclude, however, whether the increase in tree size or the decrease in rotation age will provide a suitable return on the fertilizer and bedding costs.

Literature Cited

BRENDEMUEHL, R. H. 1970. The phosphorus placement problem in forest fertilization, p. 43–50. *In* C. T. Youngberg and C. B. Davey (ed) Tree growth and forest soils. Third North Amer Forest Soils Conf Proc 1968. Oregon State Univ Press, Corvallis.

GAMMON, NATHAN, JR., J. R. HENDERSON, R. A. CARRIGAN, R. E. CALDWELL, R. G. LEIGHTY, and F. B. SMITH. 1953. Physical, spectrographic, and chemical analysis of some virgin Florida soils. Univ Fla Agr Exp Stn Bull 524, 130 p.

PRITCHETT, W. L. 1968. Progress in the development of techniques and standards for soil and foliar diagnosis of phosphorus deficiency in slash pine, p. 81–87. *In* Forest fertilization theory and practice symposium 1967. Tenn Val Auth, Muscle Shoals, Ala.

SCHMITT, D., and D. BOWER. 1970. Volume tables for young loblolly, slash, and longleaf pines in plantations in south Mississippi. USDA Forest Serv Res Note SO-102, 6 p. South Forest Exp Stn, New Orleans, La.

SNEDECOR, G. W. 1956. Statistical methods. Iowa State Univ Press, Ames, 534 p.