

**Response of Slash Pine to
BEDDING AND PHOSPHORUS APPLICATION
In Southeastern Flatwoods**

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Response of Slash Pine to Bedding and Phosphorus Application in Southeastern Flatwoods

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Slash pine (*Pinus elliottii* var. *elliottii* Engelm.) grows slowly on many poorly drained, sandy soils in the Southeast. During much of the year the water table is so high that growth is retarded. Some stands never reach merchantable size. Drainage, bedding, and fertilization—alone and in combination—are often used to boost the productivity of these sites (2, 3, 4, 5, 6).

Bedding, in which large disks are used to make ridges 5 to 6 inches high, is the most common practice. Bed height is governed by available equipment, and not by information about effects on tree growth. In the study reported here, a major purpose was to compare standard beds with ones about twice as high. Fertilization with phosphorus was also tested, since other investigators have reported substantial growth responses to this nutrient on similar soils (3). All treatments were installed on one prevalent soil type, but sites varied in wetness.

METHODS

The study area is in northwest Florida, about 15 miles northwest of Port St. Joe, in the low, flat area of the Lower Coastal Plain. The soil is a Plummer fine sand—relatively deep, and with about 2 percent of silt

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and clay in the upper 4 feet (1). Phosphorus and nitrogen contents are low. Total phosphorus is about 30 ppm and total nitrogen varies from 20 to 430 ppm at depths to 42 inches. The carbon-nitrogen ratio is approximately 18:1 (1).

Elevation varies 1 or 2 feet with a gradual gradient to a shallow drain. On the lower portion, water stands on or near the surface for 8 to 10 months of the year. The drier part, on higher ground, is free of surface water during all but 2 or 3 months in spring. Vegetation was primarily native grasses intermixed with small stems of gallberry (*Ilex glabra* (L.) Gray) that sometimes occurred in clumps.

Three areas were selected for study: a wet, a dry, and an intermediate site that are within 1,000 feet of each other. Twelve plots, each measuring 50 by 200 feet and 20 feet apart, were established on each area. All were burned in January 1965, and the mechanical site treatments were installed soon thereafter. Treatments, replicated three times on each site, included:

Burn only.

Flat-disk strips twice to measure effects of competition control.

Four strips, each 7.5 feet wide, were prepared on a plot (fig. 1).

With a disk, elevate beds 5 to 6 inches high and 7.5 feet wide, edge-to-edge. Four such beds were made on each plot.

Prepare beds about 10 to 12 inches high and 7.5 feet wide—4 beds per plot (fig. 2). A road grader was used on the dry site and a small dragline on the wet and intermediate sites.



Figure 1.—Flat-disked strips gave excellent temporary control of competing grasses.



Figure 2.—*High beds on intermediate site were elevated about 10 to 12 inches with a small dragline. Natural pines in background are stunted, and few will reach merchantable size.*

Plots were sown with repellent-coated slash pine seed in March 1965. Seed was broadcast on the burned plots, while on disked and bedded plots it was dropped in a line on top of beds or in the center of a strip. Germination was excellent, and in the second and third years stands were thinned to one seedling per 10-foot linear segment. On burned plots, four rows of trees were reserved with a deviation of ± 2 feet from the centerline. Subsequent mortality resulted in some unstocked segments, especially on unbedded plots of the wet site.

In March 1967, end 50-foot segments of beds were selected at random and broadcast with 100 pounds of elemental phosphorus per acre in the form of triple superphosphate.

Five plots on the wet area—three burned and two with standard beds—were destroyed by wildfire in the spring of 1968.

Total height has been measured annually on the two interior rows of each plot. Sample trees were flagged initially and used throughout the study. Where substitution was necessary, it was usually possible to find a replacement of about the same vigor and size as the original pine.

RESPONSE TO SEEDBED PREPARATIONS

Data in figure 3 were collected on 150-foot, unfertilized segments of plots. Seedbed preparations had a significant (0.05 level) effect on heights every year from age 2 to 8 on all sites, but rankings of treatments were not the same on all sites.

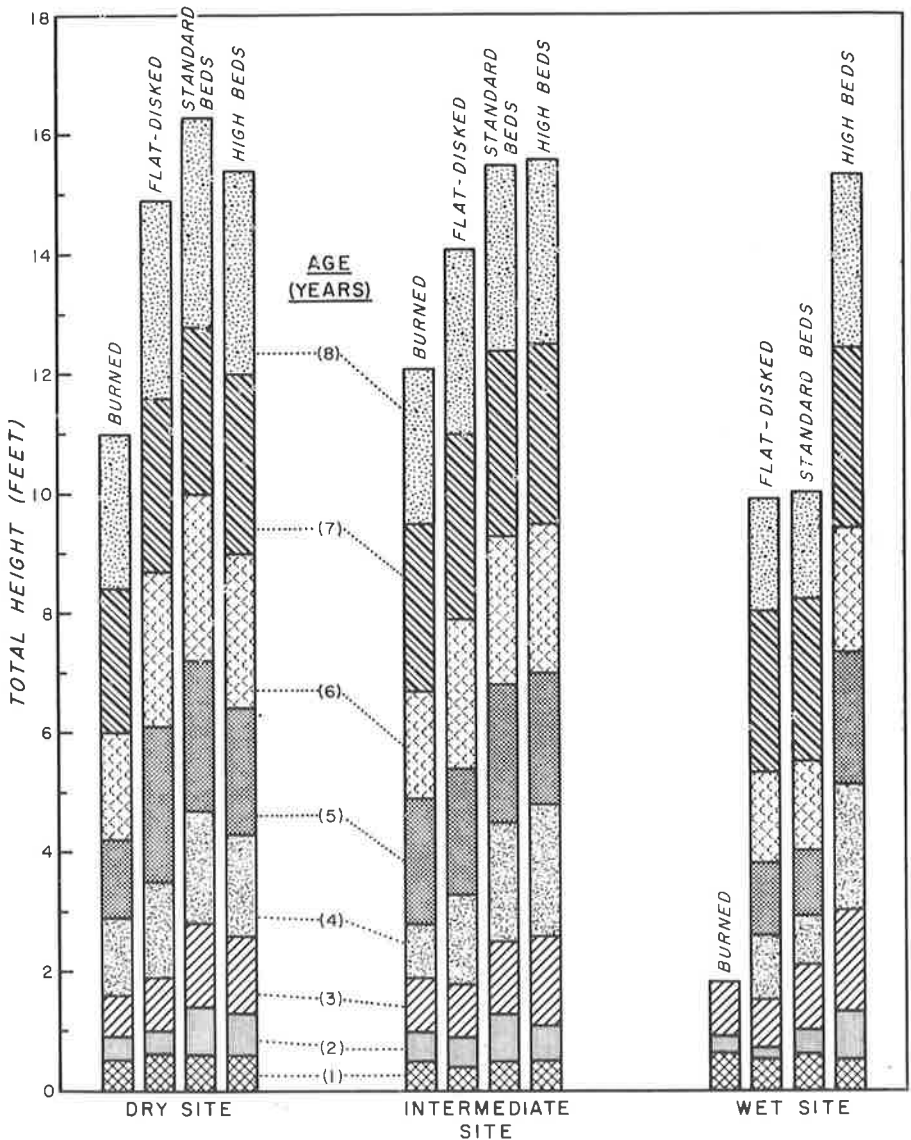


Figure 3.—Heights of pines at ages 1 through 8 years, by seedbed treatments.

Dry Site

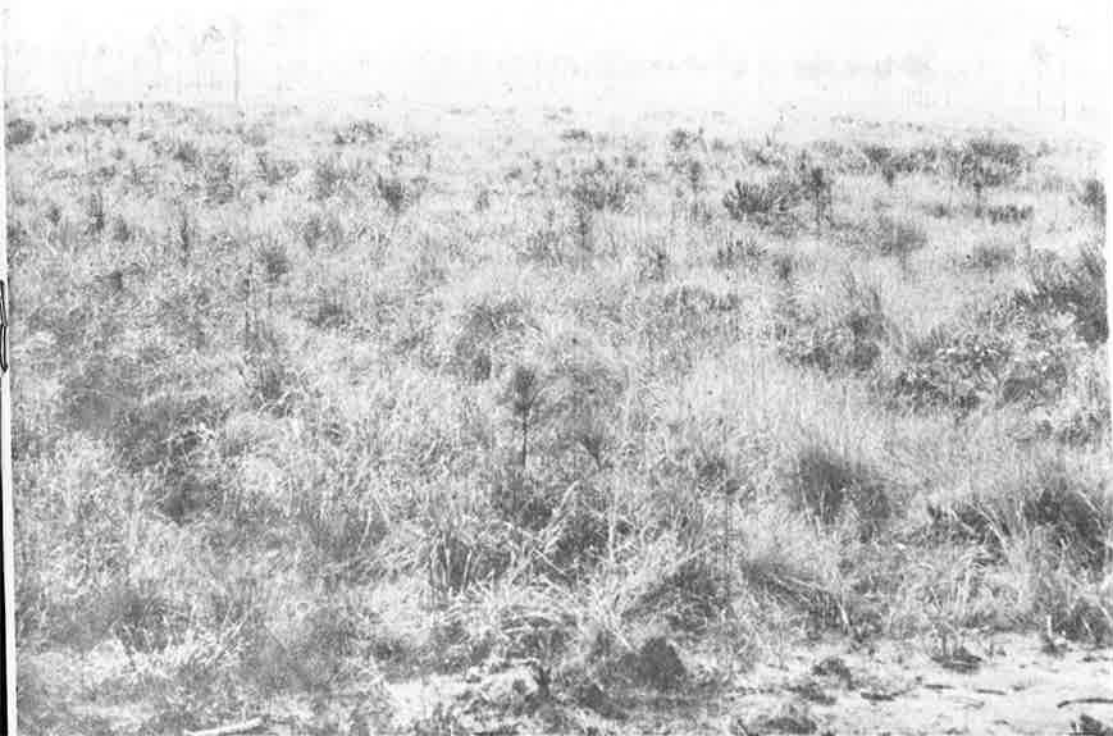
After eight growing seasons on the dry site, heights on flat-disked, standard-bedded, and high-bedded plots did not differ significantly. Heights averaged 15.5 feet, and the maximum variation was 1.4 feet. On burned seedbeds, by contrast, heights averaged only 11.0 feet.

Height differences became evident in the early years, and the ranking at 8 years was the same as 2. In the last 4 years total growth in the three best treatments has been almost identical. Growth on the burned plots has been less in every year than on the other seedbeds, so that differences are still increasing.

Intermediate Site

Growth on standard and high beds on the intermediate site has been nearly the same throughout the study, with heights totaling 15.5 at 8 years. The greatest difference at any time was 0.3 foot, and growth in a single year never varied by more than this amount. At 8 years, pines on flat-disked plots averaged about 1.5 feet less than on both bedded plots. Most of this difference occurred in the first 4 years. Figure 4 shows 2-year-old trees on standard beds.

Figure 4.—*Two-year-old slash pines on standard beds on intermediate sites. Native grasses have reinvaded the area.*



Growth on burned and flat-disked seedbeds was nearly the same for the first 3 years, but in each year thereafter the trees on disked plots excelled. Disking is usually considered an aid to early growth. Thus, the delayed response was surprising, especially as the reduction of grass competition lasted no more than 2 years. At age 8, heights on burned plots averaged 2.0 to 3.5 feet less than on disked and bedded plots—differences that were significant and important.

Wet Site

The loss of five plots by fire after the third growing season complicates comparisons of seedbeds on the wet site.

As on the other sites, differences in height developed early. At age 3, pines were significantly taller on high beds than in all other treatments, exceeding heights on standard beds, the second-ranked treatment, by 43 percent. Heights on burned and flat-disked plots ranked third. Here as on the intermediate sites, disking was not better than burning alone.

Beginning with the fourth year, after two plots had been destroyed by fire, data for standard beds are based on one replication. It is noteworthy that at age 3 trees on the undamaged plot were shorter than in the other two replications—1.7 versus 2.1 and 2.4 feet. If all replications had remained intact, 8-year heights for the standard beds might have averaged between 12 and 14 feet instead of 10 feet. Foresters in this region know that bedding is essential on wet areas and that flat disking is not enough. What cannot be resolved, however, is whether high beds are superior to standard beds and, if so, what is the magnitude of the difference.

EFFECTS OF FERTILIZATION

The information on response to seedbed preparation was from 150-foot, unfertilized segments of plots. As data on the effects of fertilization were collected on 50-foot segments, subplots for comparisons are unequal in size.

On the dry site, fertilization with phosphorus had no significant effect on heights at 8 years on any of the seedbeds.

By the end of the fourth year fertilization had significantly increased heights on all seedbeds on the intermediate site (fig. 5). While differences were in the range from 0.3 to 1.0 foot, it is important to note that pines responded quickly to the phosphorus applied as a top dressing.

The fertilized trees continued to gain each year after age 4. By age 8 they were from 2.5 to 5.4 feet taller than the unfertilized, with no indications that gains were diminishing. It seems likely that phosphorus will promote growth for at least a few more years.

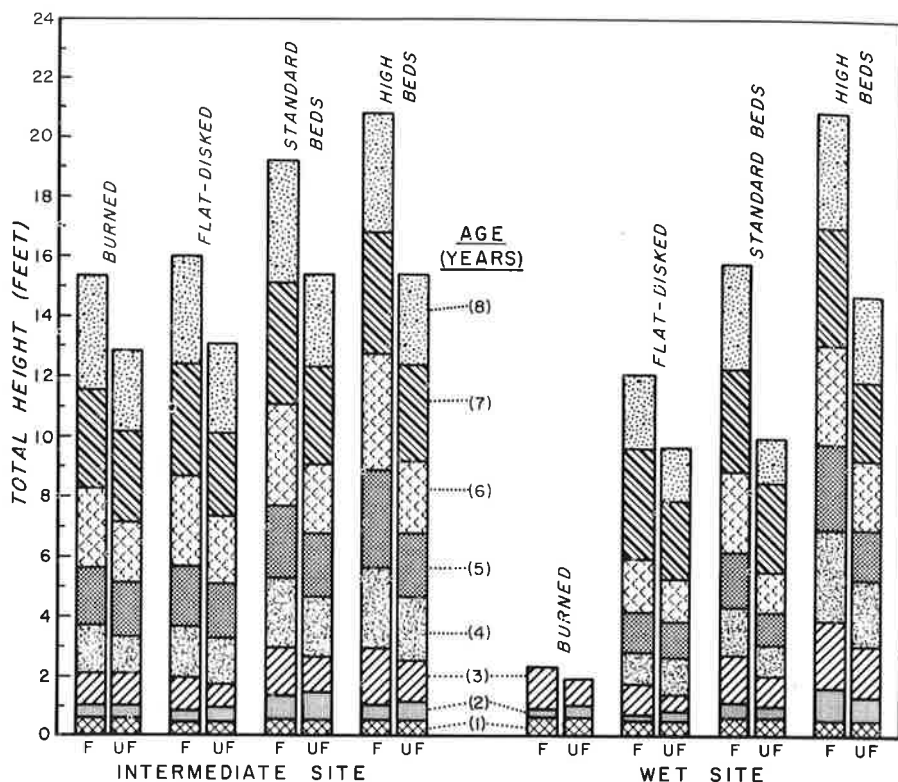


Figure 5.—Heights of fertilized (F) and unfertilized (UF) pines, by seedbed treatments on intermediate and wet sites.

Burning plus fertilization resulted in growth about equal to standard bedding without fertilization, and superior to flat disking without fertilization. Bedding combined with the application of phosphorus, of course, was better than either treatment alone.

On the wet site significant differences were evident 1 year after fertilizer was applied and generally increased in each subsequent year (fig. 6). After the eighth year, accumulated differences ranged from 2.4 to 6.1 feet. The trend for bedded plots to respond most, found in early years, continued to age 8; this interaction of seedbed preparation and fertilization was significant in 3 of 6 years but not at age 8. It is difficult to say if growth on the flat-disked seedbed with fertilization was comparable to that on standard beds without fertilization. Judged by tree height on the existing replication it was not, but if the value is adjusted upwards, as discussed previously, the comparison becomes close.



Figure 6.—*These 4-year-old pines are growing on high beds on the wet site. Those on the man's left were fertilized with phosphorus at age 2, and are obviously taller than unfertilized pines on his right.*

DISCUSSION

Results from small plots such as this are often conservative, especially as to effects of seedbed preparation. Many of the treatments interrupt natural drainage and tend to retard runoff or impound water. On large tracts, for example, beds would be oriented so as to improve surface drainage by channeling water into ditches and natural courses.

High beds, one of the main features of the study, were not more effective than standard beds on dry and intermediate sites. They were probably superior on the wet site, even if 8-year heights on standard beds are adjusted upward to compensate for the loss of the two best replications. But practical and economical equipment to build high beds is not available. Even if an efficient machine were developed, it is doubtful if the increased growth on the wet site was enough to offset the cost of moving so much soil.

Flat disking was as effective as standard bedding on dry and intermediate sites. Early growth was slightly better on the beds during the first 3 or 4 years, but almost identical after that. It is doubtful, then, if differences will increase in the future. Two major factors should enter into the decision on how to treat such sites: (1) difference in cost between flat disking and bedding, and (2) expected problems in managing and cutting timber on bedded tracts.

The inadequacy of flat disking on the wet site has been amply corroborated in commercial operations. Burning alone gave the poorest growth on all sites, and some form of mechanical seedbed preparation is justified even in the driest situation.

Fertilization has not improved growth on any of the seedbeds on the dry site. On the intermediate and wet sites, however, it has stimulated growth appreciably. Responses have become larger each year through the eighth, and some differences are now as great as 6 feet. These are strong indications that phosphorus applications will pay their way.

Phosphorus applied to burned and flat-disked seedbeds on the wet and intermediate sites gave comparable growth to standard bedding without fertilization. For landowners who cannot finance bedding, applications of phosphorus may be a substitute. Of course, bedding and fertilization were superior to either treatment alone on wet and intermediate sites.

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