

DIAMETER DISTRIBUTIONS AND BASAL AREA OF PINES AND HARDWOODS 12 YEARS FOLLOWING VARIOUS METHODS AND INTENSITIES OF SITE PREPARATION IN THE GEORGIA PIEDMONT

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Abstract—Twelve years after various methods and intensities of site preparation in the Georgia Piedmont, diameter distributions and basal area (BA) of pines and hardwoods varied considerably among treatments. Site preparation reduced hardwood basal area to 36 percent of that observed in clearcut-only plots. As a result, planted-pine BA in the presence of site preparation was 2.7 times that observed in its absence. Site preparation by manual cutting of residual trees resulted in a volunteer-pine BA of over three times that observed in mechanically prepared plots. We inferred that **tillage** treatments increased planted-pine BA through improvements in soil characteristics. In treatments in which the planted pines were under severe competition from hardwoods or volunteer pines, their diameter distributions were positively skewed (many small and few large individuals). In treatments of greater site-preparation intensity, diameter distributions approached a normal distribution.

INTRODUCTION

Silviculture often mimics natural disturbances to create desirable stand structures (Smith and others 1997). Specifically, silvicultural treatments select for the growth form, size, or species of trees that have the greatest competitive advantage during specific stages of stand development (Oliver and Larson 1996). An appropriate time for manipulating stand structure of pine plantations is after crown closure and during stand differentiation, when potential crop trees can be identified and recruited into the upper crown classes.

In this paper, we compare diameter distributions and basal area of pines and hardwoods among various methods and intensities of site preparation in the Georgia Piedmont. The results we describe supplement the findings of a previous paper on these data (Harrington and Edwards 1996).

METHODS

Study Site and Treatments

The study was conducted at an existing site-preparation experiment in the lower Piedmont of Georgia located on the Hitchiti Experimental Forest, 18 miles north of Macon. In spring 1980, the previous old-field stand of loblolly pine (*Pinus taeda* L.) was **clearcut** and nonmerchantable trees (primarily hardwoods) were left standing. Thirty 2-acre plots were located, and one of the following treatments was randomly assigned to each:

- (1) **Clearcut** only: absence of site preparation; residual (nonmerchantable) trees retained.
- (2) Manual cutting: residual trees of d.b.h. (diameter at breast height, 4.5 feet above ground) > 1 inch were cut with a chainsaw (August 1981).
- (3) Shear-chop: residual trees were sheared with a KG blade, and debris was masticated with a rotary chopper (September and November 1981).

- (4) Shear-chop-hexazinone: treatment 3 plus application of hexazinone herbicide (Velpar (TM) **Gridball** pellets) at 2.5 pounds of active ingredient per acre (March 1982). Heavy rains soon after application accelerated herbicide spread and uptake, resulting in subsequent first-year mortality of approximately 35 percent of the planted pines and an 80 percent reduction in first-year cover of associated woody and herbaceous species (Edwards 1994).
- (5) Shear-root rake-burn-disk: residual trees were sheared, rootstocks were raked into **windrows** and burned, remaining debris was scattered with a bulldozer blade, and plots were **disked** with an offset harrow to a depth of 6-8 inches (September and October 1981).
- (6) Shear-root rake-burn-disk-fertilize-sulfometuron: treatment 5 plus a broadcast application of ammonium-nitrate fertilizer at 102 pounds of elemental nitrogen per acre and a banded application of sulfometuron (Oust (TM)) herbicide at 6 ounces of active ingredient per acre (March and April 1983).

Each treatment was replicated five times in a randomized complete-block design. In January and February 1982, 1-0 **bareroot** seedlings of loblolly pine were hand planted at a spacing of 6 ft x 10 ft. Pines that had died in treatment 4 were replanted with new seedlings of the same stocktype in January and February 1983.

Vegetation Measurements and Statistical Analysis

At the center of each treatment plot, a 0.2-acre measurement plot was located. In fall 1993, 12 years after treatment, d.b.h. (nearest 0.1 inch) and species of hardwood and pine trees were recorded for each stem of d.b.h. > 1 inch rooted within a given measurement plot. Data were separated into categories of planted pines (tagged at planting), volunteer pines (not tagged), and hardwoods. Measurement plot values of stand basal area (BA, square feet per acre) were calculated for each category of trees.

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Stand basal area data were subjected to analysis of variance and the following orthogonal contrasts (95 percent significance level):

- I. Absence versus presence of site preparation: treatment 1 versus the mean of treatments 2-6.
- II. Manual cutting versus mechanical site preparation: treatment 2 versus the mean of treatments 3-6.
- III. Absence versus presence of hexazinone: treatment 3 versus treatment 4.
- IV. Absence versus presence of **tillage** (i.e., root raking and disking): the mean of treatments 3 and 4 versus the mean of treatments 5 and 6.

Stem frequencies (trees per acre) were plotted against 1-inch d.b.h. classes to illustrate the effects of the site preparation treatments on diameter distributions for each of planted pines, volunteer pines, and hardwoods.

RESULTS AND DISCUSSION

Absence versus Presence of Site Preparation

By removing aboveground portions of residual trees, site preparation reduced hardwood BA to about 36 percent of that observed in clearcut-only plots (fig. 1A). Although some of the site-preparation treatments caused abundant sprouting of the hardwood rootstocks (Harrington and Edwards 1996), planted-pine BA in the presence of site preparation (77 square feet per acre) was about 2.7 times that found in the absence of site preparation (28 square feet per acre). Diameter distributions reveal that, in the absence of site preparation, a relatively low density of large, residual hardwoods (31 stems per acre of d.b.h. 6 inches and greater) appear to have limited planted-pine BA (figs. 1 B-I C).

Manual Cutting versus Mechanical Site Preparation

Volunteer-pine BA following manual cutting (96 square feet per acre) was over three times the mean value observed for mechanical treatments (30 square feet per acre) (fig. 2A). Apparently in response to severe competition from volunteer pines, planted-pine BA following manual cutting (35 square feet per acre) was about 40 percent of that observed for mechanical treatments (87 square feet per acre). We hypothesized that manual cutting released an abundance of volunteer pines that had germinated the year before pine planting (Harrington and Edwards 1996). Because of overstocking, 91 percent of the volunteer pines in the manual-cutting treatment had a d.b.h. less than 6 inches (987 trees per acre) (fig. 2B). As a result of differences in method of site preparation, diameter distributions for planted pines were either positively-skewed (manual cutting) or relatively normal (mechanical site preparation) (figs. 2B-2C).

Absence versus Presence of Hexazinone

The application of hexazinone during site preparation reduced volunteer-pine BA by half, although it did not result

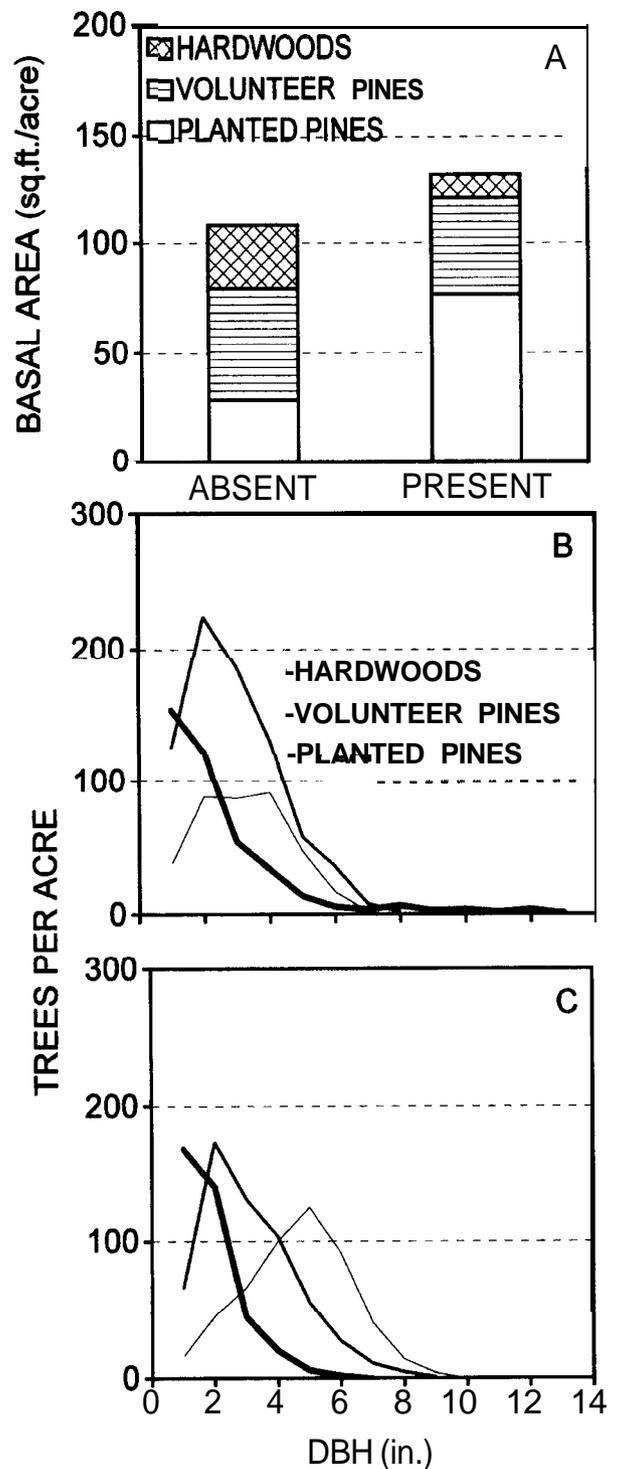


Figure 1-Basal area (A) and diameter distributions of pines and hardwoods 12 years following absence (B) versus presence (C) of site preparation.

in statistically significant effects on BA of planted pines or hardwoods (fig. 3A). Stem density of hardwoods in the presence of hexazinone (192 trees per acre) was about 38 percent of that observed in its absence (511 trees per acre) (figs. 3B-3C). Replanting of pines that died from hexazinone may have resulted in a diameter distribution that was relatively flat and positively skewed, because it

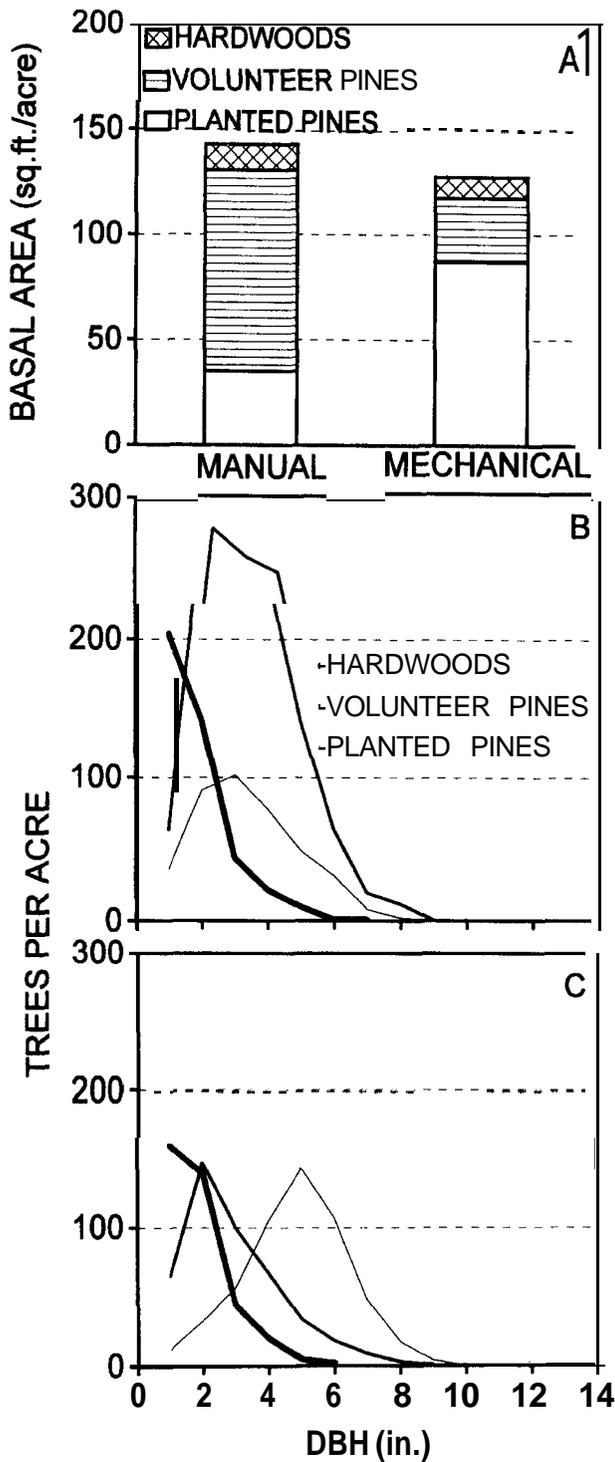


Figure 2-Basal area (A) and diameter distributions of pines and hardwoods 12 years following manual cutting (B) versus mechanical (C) site preparation.

introduced a cohort of seedlings that were a year younger than those of the original planting.

Absence versus Presence of Tillage

Planted-pine BA in the presence of tillage (99 square feet per acre) was about 30 percent greater than that observed in its absence (76 square feet per acre) (fig. 4A). However,

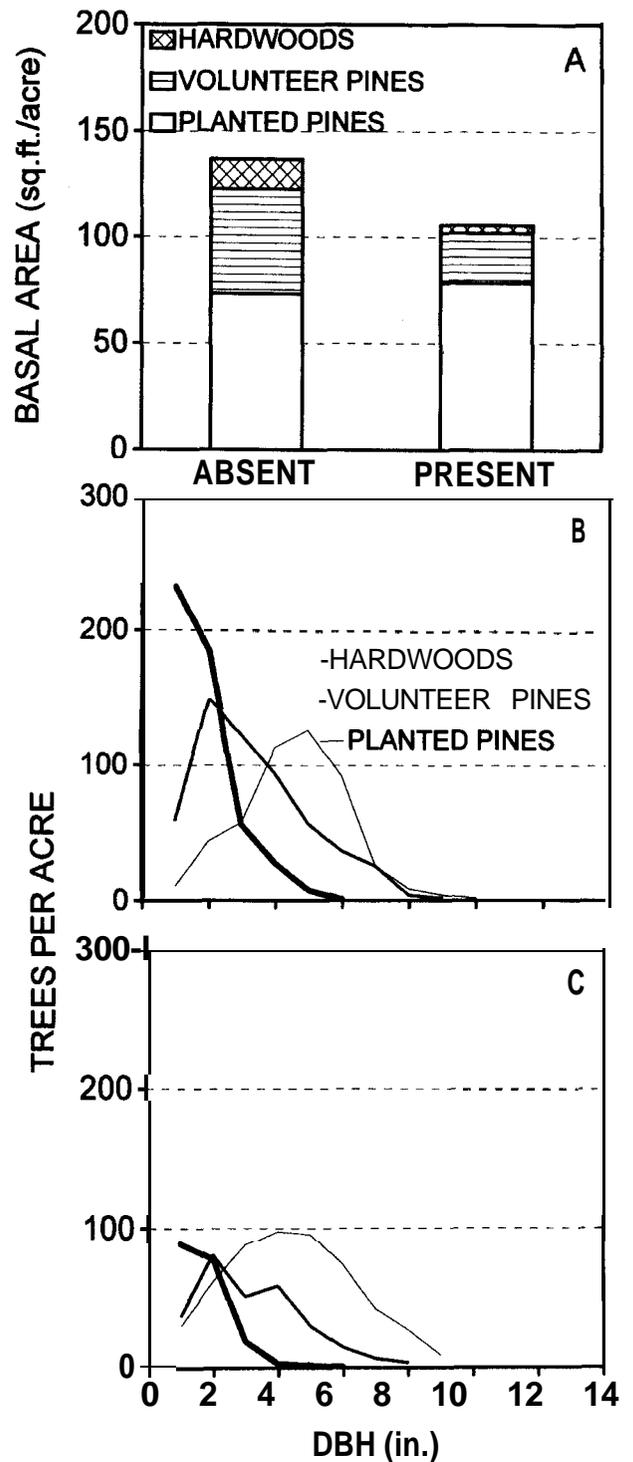


Figure 3-Basal area (A) and diameter distributions of pines and hardwoods 12 years following absence (B) versus presence (C) of hexazinone during site preparation.

basal area of volunteer pines and hardwoods did not differ significantly in the absence versus presence of tillage. From these results, we inferred that increases in planted-pine BA from tillage resulted from improvements in soil characteristics, rather than from a reduction in competing vegetation abundance (Harrington and Edwards 1996). In the second year of the study, Miller and Edwards (1985)

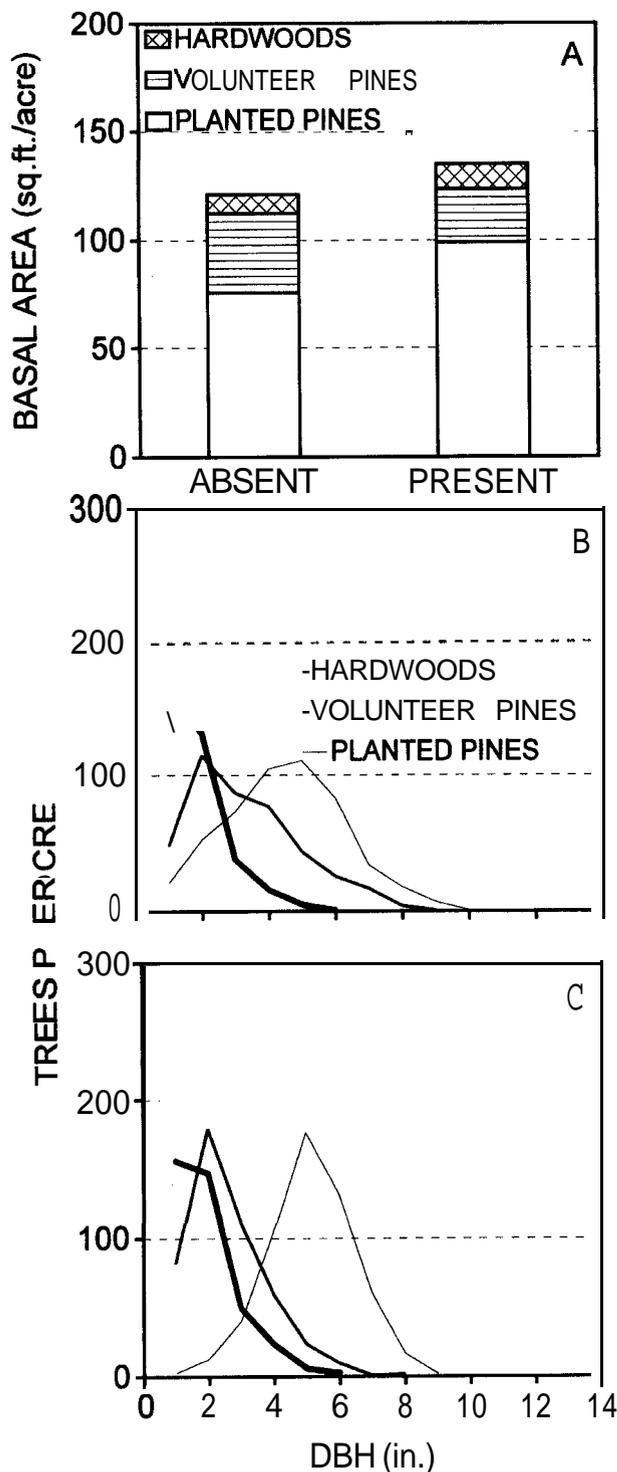


Figure 4-Basal area (A) and diameter distributions of pines and hardwoods 12 years following absence (B) versus presence (C) of tillage during site preparation.

detected reductions in bulk density and increases in pore space following tillage. Presumably because enhanced growing conditions permitted the development of a more uniform stand structure, the normality of the planted-pine diameter distribution was greater in the presence versus absence of tillage (figs. 4B-4C).

CONCLUSIONS

A wide range of stand structures resulted 12 years after various methods and intensities of site preparation. Differences in stand structure resulted because the treatments provided a competitive advantage to either hardwoods, volunteer pines, or planted pines. Absence of site preparation favored residual hardwoods over planted and volunteer pines. Manual cutting released an abundance of volunteer pines from hardwood competition, favoring their dominance over pines planted a year later. Mechanical treatments delayed development of hardwoods and volunteer pines and may have improved soil characteristics-growing conditions that favored the development of productive and uniform stands of planted pine. Results of this research emphasize the importance of understanding how forest disturbances influence subsequent stand development, and how such information can be incorporated into silvicultural systems to better meet stand management objectives.

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