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Soil Properties and Pine Growth Affected by Site Preparation after Clearcutting

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ABSTRACT. A pine-hardwood sawtimber stand in southeast Texas was clearcut in September 1972. Random plots were burned, chopped, KG-bladed, or left untreated. In the spring of 1974, 1-0 loblolly pine seedlings (Pinus taeda L.) *were handplanted at 8 by 10 foot spacing. Data from soil samples, taken from the 0–5 inch depth before clearcutting and 1, 3, and 5 years after site preparation showed that burning appeared to have changed soil nutrient levels the least. Of the two mechanical treatments, KG-blading altered the chemical composition of the soil most, probably because topsoil organic matter was removed. Planted pines survived and grew best on mechanically prepared areas, producing 1.5 to 3.3 times more cubic-foot volume per acre than either of the other treatments by the end of the eighth year.*

Clearcutting, followed by various site preparation treatments prior to planting, is an efficient method on suitable sites for harvesting and artificially regenerating southern pines. After the timber is harvested, the site is customarily prepared for planting by burning, chopping, or KG-blading. The effects of individual site treatment methods (burning, chopping, or KG-blading) on pine growth have been reported by several workers (Haines et al. 1975, Stone 1971, Stransky 1981, Stransky et al. 1983). Considerable information has also been gathered on the impact of burning on soil fertility (McKee 1982).

This report documents the effects of clearcutting and four site preparation treatments on soil properties and the growth of planted loblolly pines on a loblolly-shortleaf pine-hardwood forest area in southeastern Texas. Data presented compare the

influence of these treatments on soil properties 1, 3, and 5 years after site preparation, and on the survival and development of planted pines 8 years after site treatment.

MATERIALS AND METHODS

Study Site

The study site is located on a nearly level to gently sloping terrace of the Angelina River in Jasper County, Texas. The tract, owned by Temple-Eastex Incorporated, had never been cleared for agriculture, although it probably had been grazed by livestock.

The area, part of the Gulf Coastal Plain Quaternary deposits, is underlain by sands, sandstones, and clays of the Oligocene period (Dumble 1918). Soils belong to the Bernaldo-Elysian complex and to the Sacul series. The moundy Bernaldo-Elysian soils occur in such patterns that separation is difficult. Bernaldo soils (Glossic Paleudalfs, fine-loamy, siliceous, thermic family) occupy the lower part of the mounds and most of the adjoining low areas, about 50% of the area. Elysian soils (Haplic Glossudalfs, coarse-loamy, siliceous, thermic family) occupy most of the large mounds and make up about 40% of the area. The major difference between these soils is that the Elysian has a sandy surface layer more than 20 in. thick, while on the Bernaldo, it is thinner. With slopes ranging from 0 to 3%, these well-drained, moderately permeable soils have slow surface runoff.

Sacul soils (Aquic Hapludalfs, clayey, mixed thermic family) occur at the heads of drains and normally are associated with a concave topography. They occupy slopes from 1 to 6%, are moderately well-drained, and have slow permeability.

The region has hot humid summers, mild winters, and a growing season of about 240 days. Annual rainfall averages 51 in., but in 1972, 1973, and 1974 it was 54, 86, and 70 in. Such high precipitation often interfered with site preparation, burning, and planting schedules.

Prior to clearcutting, loblolly pines accompanied by an occasional shortleaf pine (*P. echinata*) occurred on the experimental site in mixture with southern red oak (*Quercus falcata*), post oak (*Q. stellata*), water oak (*Q. nigra*), sweetgum (*Liquidambar styraciflua*), and blackgum (*Nyssa sylvatica*). The pine sawtimber's age averaged 45 years.

Treatments and Design

Twelve 1.5-acre plots representing three replications of four treatments, were established in a randomized block design. The area was clearcut and the merchantable timber removed in the fall of 1972. The following site preparation treatments were applied during early spring of 1974:

- Control—all remaining woody stems greater than 1 in. dbh were cut and left in place.
- Burn—all stems greater than 1 in. dbh were cut and burned with the logging slash by headfires in early March 1974.
- Chop—logging slash and all stems were cut with a chopper and burned in the fall of 1972 and again in the spring of 1974. The burn was spotty and of low intensity as it did not carry well over the chopped ground.
- KG—all stems were cut with a KG blade and the logging slash raked off the plots and burned.

The site was handplanted with 1-0 (1-year-old, nursery-grown) loblolly pine seedlings in mid-March 1974, at 8- by 10-ft. spacing, providing 544 trees/acre.

Sampling procedures

Five 1-in. diameter soil cores were extracted from 20 sampling points spaced on 36.5 × 36.5 ft. centers in the interior 1.0 acre of each 1.5 acre plot. Samples were taken from the 0 to 5 in. depth prior to clearcutting (July 1972), and then at one, three, and five growing seasons after site preparation (December 1974, January 1977, and March 1979). The five individual samples were composited and analyzed for organic matter by loss on ignition, and pH by glass electrode (1 : 1 soil : water). Phosphorus was extracted with 0.002 *N* H_2SO_4 and measured by the sulfomolybdic blue color method, except in 1978 when the Bray and Kurtz #1 method was used. Exchangeable potassium, calcium, and magnesium was extracted with 1.0 *N* ammonium acetate at pH 7 and measured by the atomic absorption method.

Survival of the planted pines, based on a sample of 150 tree-planting spots per treatment (50 per plot), was tallied and tree heights and diameters (dbh) measured in randomly selected rows within each plot's interior 1 acre at the end of the eighth growing season after planting (February 1982). Total pine volume per acre for each site treatment was computed from the number of live trees per acre and the equation of Hasness and Lenhart (1972), for predicting total cu. ft. volume per tree outside bark.

Soil data by site treatments within years and tree data by site treatments were compared by analysis of variance for a randomized block design, and by Duncan's new multiple range test. All testing was at the 0.01% level of probability.

RESULTS AND DISCUSSION

Soil Properties

pH Levels: Changes in pH from preharvest (1972) to after the site preparation (1974) were generally small (Table 1). Soil pH on all treatments declined in the third year (1977) following site treatment and by 1979 rose to the approximate pH levels measured before clearcutting. As there was hardly any variation in pH values between samples, even small differences among the means became statistically significant, even though differences may be of little biological importance. Changes between sampling years have to be interpreted cautiously, as the season of sampling may cause significant differences not just among pH levels but other soil property values too (Haines and Cleveland 1981).

Organic Matter: Organic matter contents between assigned treatments were not significantly different before the sites were clearcut (1972). After the sites were treated, however, the burned plots had the highest percentage of organic matter, while the KG and chopped plots had the lowest. After the third growing season (1977) following treatments, the percentage of organic matter decreased, regardless of site treatment.

Organic matter contents after the fifth growing season (1979) were similar to those of the third season. Control plots ranked high and the mechanically treated plots low on organic matter (Table 1).

Available Phosphorus: Precutting phosphorus (P) levels differed significantly between assigned treatments. As a result of site preparation, available phosphorus increased one growing season (1974) after the site was treated. After the third growing season (1977), phosphorus concentrations fell below the precut levels, and the amount of phosphorus was low on the chopped and KG plots. The fifth growing season (1979) data showed no significant differences among treatments but the values are not comparable to previous phosphorus figures because changed phosphorus extraction procedure resulted in much lower values (Table 1).

Other Soil Elements: Potassium (K), calcium (Ca), and magnesium (Mg) showed a steady increase from the precut (1972) samples through the third growing season (1977). By the fifth year (1979), the amounts of some of these elements in the soil decreased, while others remained at relatively high levels (Table 1). Abundance of these nutrients did not show a consistent pattern among site treatments within years, except for KG plots which almost always had less K, Ca, and Mg than the other treatments.

Burning appeared to be the site treatment that changed nutrient levels in the soil the least. Of the two mechanical treatments tested, KG-blading altered the chemical composition of the soil more. This was probably due to the removal of organic matter from the soil by KG-blading and windrowing.

Pine Survival and Growth

Average survival, height, and diameter (dbh) of planted pines measured at the end of their eighth growing season in February 1982 were greatest on

Table 1. Soil properties by years and site treatments in the 0-5 in. depth. (1972 data are pretreatment values).

Year and month	Treatment	pH	Organic matter	Phosphorus	Potassium	Calcium	Magnesium
		Percent		*Lbs/ac*			
1972 July	Control	5.3 a[1]	4.3 a	10.1 a	65.5 a	329.0 a	106.8 a
	Burn	5.4 ab	3.9 a	8.9 ab	47.6 b	245.7 ab	73.6 b
	Chop	5.6 b	4.2 a	5.9 c	49.7 b	264.6 ab	59.7 b
	KG	5.3 a	4.5 a	6.7 bc	48.7 b	204.1 b	71.9 b
1974 Dec.	Control	5.3 a	4.0 a	9.9 ab	61.9 a	386.7 a	85.1 a
	Burn	5.5 ab	4.1 a	10.9 ab	56.1 a	301.0 ab	73.9 a
	Chop	5.6 b	3.5 a	8.4 a	54.0 a	314.7 ab	63.5 a
	KG	5.4 ab	2.8 b	11.4 b	52.9 a	191.3 b	59.9 a
1977 Jan.	Control	4.5 a	2.4 a	8.2 a	76.9 a	491.5 a	104.4 a
	Burn	4.3 ab	2.2 ab	7.7 a	47.8 a	539.3 a	88.6 a
	Chop	4.5 ab	2.1 ab	6.5 a	76.6 a	564.8 a	78.9 a
	KG	4.3 b	2.0 b	4.9 a	55.1 a	404.6 b	58.7 a
1979 Mar.	Control	5.0 a	2.6 a	1.7 a[2]	75.1 a	433.8 ab	93.2 a
	Burn	5.1 a	2.3 ab	1.6 a	47.3 a	437.3 ab	72.2 a
	Chop	5.4 b	2.0 b	1.5 a	40.1 a	476.3 a	78.1 a
	KG	5.1 a	2.0 b	1.5 a	45.3 a	323.4 b	63.8 a

[1] Soil property means within a sampling year that are not followed by a common letter are statistically different ($P \leq 0.01$).
[2] Due to change in phosphorus extraction procedure the 1979 data are not comparable with previous data.

Table 2. Average survival and growth of pines eight growing seasons after planting.

Site treatment	Pine survival and growth				
	Survival	Suppressed	Height	Dbh	Volume/acre
	..... *Percent*.....		*Ft.*	*In.*	*Cu. ft.*
Control	56.6 a[1]	18.0 a	18.9 a	2.7 a	173.6 a
Burn	82.0 b	3.7 b	19.8 ab	3.2 b	321.1 a
Chop	89.3 b	0.0 c	22.3 c	4.2 c	566.3 b
KG	95.0 b	1.0 c	20.5 b	3.8 c	496.3 b

[1] Treatment means within any column that are not followed by a common letter are statistically different ($P \leq 0.01$).

the site-prepared plots (Table 2). The mechanical treatments, in particular, successfully controlled both height and density of hardwoods competing with the pines for growing space (Stransky 1981). By contrast, the burned and the control plots had less survival, shorter trees of smaller dbh, and more pines suppressed by hardwood trees and shrubs.

Better survival and growth on the chop and KG plots produced significantly more volume per acre (cu. ft.) than burning or no treatment (Table 2). Thus, despite the generally lower soil nutrient levels, volume per acre on the chopped and KG-bladed plots was 3.3 and 2.9 times greater than that of the control. The volume per acre was 1.5 and 1.8 times greater on mechanical treatments than on the burned plots. Although Haines et al. (1975) implied that effects of certain site preparation treatments decrease with time, several studies reported by Shultz (1975) have shown that initial growth advantages gained through site preparation are maintained for a long time in the life of a young stand of trees. The relatively minor variations in the nutrient status of the surface soil appear to have only little effect on early pine tree growth.

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