SLASH BURNING INCREASES SURVIVAL AND GROWTH OF PLANTED LOBLOLLY PINE IN THE PIEDMONT

W. Henry McNab and Edward E. Ach
Associate Forest Fuels Specialist and forestry technician, Southeastern Forest Experiment Station, Forest Service, U.S. Department of Agriculture

After 1 year, loblolly pine seedlings planted in ashes of burned logging slash had five times greater survival than those planted in surface drainage from those ashes or away from the ashes and drainage. After 2 years, seedlings in the ashes or drainage were taller than those away from the drainage.

Piled logging slash is often burned before southern pines are planted. When ignited, the large piles of fuel may burn for several days, exposing the underlying soil to high temperatures. After the piles burn out, large quantities of alkaline ashes remain concentrated in small areas. If such burning is hazardous to survival and growth of young seedlings, then the advantages of burning are lost.

Most accounts of soil conditions and seedling growth after slash burning in the Southeast are from the Coastal Plains (*2, 5, 10*). In this region of sandy soils, high temperatures from burning apparently do not harm the physical structure of the seedbed, and concentrated salts are rapidly leached from the ashes. In the Piedmont, however, heavy clay soils retard leaching, and concentrations of fresh ashes may cause mortality by drying out seedling roots (*1*). Studies have also shown that prolonged heating causes loss of organic matter in clay soils, although it can also improve aeration and water movement by altering the soil's crystalline structure (*8*).

Although broadcast burning has been studied in the Piedmont (*4*), no reports have focused on the response of pine seedlings planted in clay soils previously subjected to intense heat from slash burning. Such data are presented here for 1- and 2-year-old seedlings of loblolly pine *(Pinus taeda* L.) in the Piedmont.

Methods

The study was conducted on a 40-acre demonstration woodlot of the Hitchiti Experimental Forest near Macon, Ga. Each year, a 1-acre tract of loblolly pine in this woodlot is systematically harvested for pulpwood during early winter and subsequently replanted. Limbs, tops, and other unmerchantable materials are placed by hand in six to eight large piles, allowed to dry, and then burned.

The slash piles usually burn actively for 4 to 6 hours and produce beds of embers which smolder through the night. These embers leave piles of white ash and charcoal 2 to 4 inches deep and 5 to 7 feet in diameter. Soil temperature at the 1-inch depth reaches about 550° F during the fire (*3*).

One-year-old loblolly pine seedlings are then planted at 6- by 8-foot spacing on the tract, with some rows extending through the ash piles. At least one and sometimes two seedlings are planted in each pile. If planting is done before rainfall settles and compacts the ashes, the seedlings are planted deeper to ensure that the root systems extend into mineral soil.

For this study, seedlings on two adjacent tracts were measured. Both tracts were on upper slopes with eroded Lloyd clay loam, which is common throughout the lower Georgia Piedmont. On each tract, data were collected according to planting position of the seedlings.

Tract 1 was prepared and planted in March, which was unusually late for planting in this region. Prior to planting, the seedlings had been stored for over 2 months without refrigeration. During the November after planting, survival and height of 10 adjacent seedlings in each of 16 row segments were recorded. Each row segment had been planted through an ash pile and included 1 or 2 seedlings planted in or near the ashes as well as seedlings in the surface water drainage from the ashes and others not in the drainage.

Seedlings in tract 2 were 2 years old when measured. These seedlings were stored without refrigeration for a week, and were planted at the normal time in January. The method of sampling was slightly different from that used in tract 1, because fewer ash piles were present. All seedlings growing within a radius of 12 feet from five ash piles were measured for both height and distance from the edge of the ashes. These seedlings were also classified according to the planting positions used for the 1-year-old seedlings. Six seedlings had been planted in the ashes, 23 in the drainage from the ashes, and 52 out of the drainage.

Results

1-Year-Old Seedlings

Because of the late planting date and the reduced vigor resulting from unrefrigerated storage, overall survival was very low among seedlings on tract 1. Analysis of the data revealed that seedlings planted in the ashes or in the drainage from the ashes had significantly greater survival and height than those not in the drainage:

	Survival (percent)	*Height* (feet)
In ashes	87.5	1.5
In drainage	77.3	1.0
Not in drainage	17.7	0.7

2-Year-Old Seedlings

Survival of 2-year-old seedlings

averaged about 85 percent—typical of other tracts established during the normal planting season in January. There were no significant differences in survival among the seedlings in the three planting positions.

The effect of the residual ashes on height growth extended into the second year. The average height of seedlings planted in the ashes was over twice that of seedlings not in the drainage from the ashes (table 1). Disregarding distance from the ashes, the average height of all seedlings planted in the drainage was slightly greater than the height of those not in the drainage.

The effect of distance from the ashes on seedling height is shown in figure 1. Seedlings nearest the ash piles were tallest, but the height advantage was quickly lost as planting distance from the ashes increased. Beyond 6 feet from the ash piles, the seedlings growing in the path of drainage averaged about the same height as those not in the drainage.

Table 1.—*Height of 2 year-old loblolly pine seedlings according to planting position in relation to ash piles*

Ash pile (No.)	Planting position		
	Ashes	Drainage	Not in drainage
		Feet	
1	3.9	2.6	2.4
2	5.1	2.0	1.7
3	4.6	2.6	2.2
4	5.1	2.2	1.9
5	[1]	2.9	1.9
Mean[2]	4.7a	2.4b	2.0c

[1] None planted.

[2] Treatment means followed by different letters are significantly different at the 5-percent probability level.

Discussion

The fertilization effect of wood ashes on vegetation is well known; such ashes were probably one of the first soil amendments used in early agriculture. In forestry, the benefits of burning piled debris to the establishment and growth of pine seedlings have also been reported. However, the reason for the beneficial response is unclear. Bruce (*5*) concluded that the main growth response of longleaf pine seedlings planted in ashes resulted not from the residues but rather from reduced root competition after grasses were killed by the fire. Working in Louisiana, Applequist (*2*) found increased growth of loblolly pine planted in burned windrows of hardwood brush. However, he was not able to distinguish the fertilization effects from the effects of topsoil concentration and improved drainage in the slightly elevated windrows.

Chemical analysis of the soil after burning was beyond the scope of this study. However, other studies have established that burning causes certain soil reactions. Concentrations of phosphorus, potassium, calcium, and magnesium are increased; these increases, in turn, cause soil pH to rise (*10, 11*). In soils deficient in one or more of these nutrients, even a slight increase may have a positive effect on seedling growth. The higher soil pH also makes soil nutrients more readily available for seedling utilization.

In this study, the seedlings growing in the ashes and drainage were larger than those not in the drainage, but their foliage was not

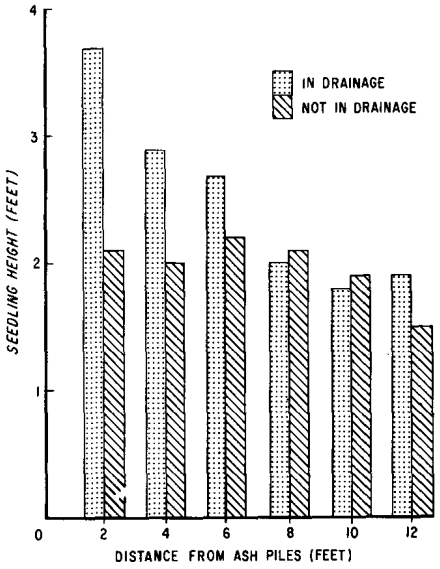

Figure 1.—*Height of 2-year-old loblolly pine seedlings according to planting position and distance from ash piles.*

noticeably greener. This response indicates that soil nitrogen levels were not directly increased by the ashes, a finding consistent with results of DeBell and Ralston (*6*). Rowe and Hagel (*9*) reported that certain ions in ashes (calcium, potassium, sodium, and sulfates) are very susceptible to leaching. Lewis (*7*) found little surface movement of ions during heavy rainfalls in the Coastal Plains, but he suggested that considerable ion transport might occur on Piedmont clay soils after fires.

High concentrations of fresh ashes and the effects of intense heat on this clay soil had no harmful effect on the establishment of planted loblolly pine. On the contrary, survival and growth were markedly improved after burning. In contrast to the findings of Bruce (*5*), nutrients in the ashes themselves appear to be the main stimulus to growth; seedlings in the path of drainage from the ashes also showed growth increases.

These results indicate that burning of windrowed logging slash is beneficial to pine seedlings in Piedmont soils. Not only will such burning increase soil fertility, but it will allow more complete utilization of the tract and provide improved access to the mature stand for fire control and management activities.

Literature Cited

1. Ahlgren, Clifford E.
   1959. Some effects of fire on forest reproduction in northeastern Minnesota. J. For. 57: 194-200.
2. Applequist, M.F.
   1960. Effects of cleared and burned hardwood slash on growth of loblolly pine in Livingston Parish, Louisiana. J. For. 58: 899-900.
3. Bentley, J.R., and R.L. Fenner.
   1958. Soil temperature during burning related to postfire seedbeds on woodland range. J. For. 56: 737-740.
4. Brender, E.V., and R.W. Cooper.
   1968. Prescribed burning in Georgia's Piedmont loblolly pine stands. J. For. 66: 31-36.
5. Bruce, David.
   1950. It isn't the ashes. USDA For. Serv., South. For. Exp. Stn. South. For. Notes 66, p. 3-4.
6. DeBell, D.S., and C.W. Ralston.
   1970. Release of nitrogen by burning light forest fuel. Soil Sci. Soc. Am. Proc. 34: 936-938.
7. Lewis, William M., Jr.
   1974. Effects of fire on nutrient movement in a South Carolina pine forest. Ecology 55: 1120-1127.
8. Ralston, Charles W., and Glyndon E. Hatchell.
   1971. Effects of prescribed burning on physical properties of soil, p. 68-84. *In* Prescribed burning symposium proceedings. USDA For. Serv., Southeast. For. Exp. Stn.
9. Rowe, R.K., and V. Hagel.
   1972. Leaching of plant nutrient ions from burned forest litter. Aust. For. 36: 154-163.
10. Thielges, Bart A., Norwin E. Linnartz, and Craig P. Leach.
    1974. Burning logging residue improves site for cottonwood plantations. USDA For. Serv. Tree Plant. Notes 24(4): 4-5.
11. Wells, Carol G.
    1971. Effects of prescribed burning on soil chemical properties and nutrient availability, p. 86-97. *In* Prescribed burning symposium proceedings, USDA For. Serv., Southeast. For. Exp. St