Simulated Cattle Injury to Planted Slash Pine: Girdling

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Abstract

Animals are known to girdle, or partially girdle, trees and shrubs by eating the bark or by knocking off the bark with their hooves. Since girdling has been observed in slash pine plantations being grazed by cattle, this form of injury was simulated on three ages of slash pine. Survival and growth were observed for 6 years after removal of a 5.1-cm-wide band of bark from around 50, 75, and 100% of the stem near groundline. Mortality was negligible except after complete girdling; even then, some seedlings lived. Height growth was reduced by the 75% girdle, primarily on seedlings treated within 6 months after planting. Two side tests on 100% girdles helped explain how trees can survive this severe injury.

The cloven hooves of cattle, deer, and sheep can scrape off a portion of the bark from young trees. Also, mammals sometimes eat the bark from around the stems of trees and shrubs which results in high mortality. Although animals inflict various forms of damage to pines (Williston 1974), Wahlenberg et al. (1939) reported that damage to bark by cattle was rare. Wakeley (1935), Cassady et al. (1955), and Williston (1974) found that trampling injuries primarily occurred on young trees. Yet, Cassady et al. (1955) reported that injury by cattle caused no serious or permanent damage and concluded that slash pine (*Pine elliottii* Engelm.) and loblolly pine (*Pinus taeda* L.) have a remarkable capacity to recover.

Information is lacking on how such injuries affect pine survival and growth. The study reported here was designed to measure the effects of simulated animal girdling on survival and growth of planted slash pine.

Methods

Study Location

The study was conducted on typical Lower Coastal Plain flatwoods at the Apalaha Experimental Range, Berrien County, Georgia. Seedlings were planted in 1958 through 1962. Some plots contained native pine-wiregrass vegetation, but most were on an old field uniformly covered with carpetgrass (*Axonopus affinis* Chase).

All study plots were on soils which are very wet, acid, and light-textured with moderately free movement of water through the upper horizons. Natural fertility is low.

Experimental Design

A randomized complete-block design was employed. Treatments were replicated during each of 3 years, and applied to three ages of seedlings; each age-at-treatment was considered a separate experiment. The number of blocks within years varied from 1 to 4 because of insufficient land and seedlings in some years and because of losses to wildfire in other years. Usually four blocks

were used. A treatment plot usually consisted of a transect of 10 trees, but limited availability of seedlings sometimes reduced the number to 5.

Treatments

Treatments consisted of removing a 5.1-cm-wide band of bark near groundline from 0, 50, 75, or 100% of the circumference of the seedlings. A sharp knife was used to cut radially to wood in order to remove the specified portion of outer bark, inner bark, and cambium. Bark was removed in mid-May from 1960 through 1962 from seedlings at 6, 18, and 30 months after planting (Fig. 1).

Two additional side tests of 100% girdles were conducted (1) to determine the effects of width and season of girdling on slash pine and (2) to examine more closely in both slash and loblolly pines any healing and bridging of 100% girdles. In the first test, full girdles that were 1.3, 2.5, and 5.1 cm wide were applied to 6- and 18-month-old seedlings in April, August, and December. In the second test, 5.1-cm-wide girdles were applied on May 17 and May 24 to both slash and loblolly pines planted the previous January; 25 trees of each species were girdled on each date and the exposed wood was rubbed with a cloth to ensure a dry face.

All trees were sprayed monthly during the year of treatment to prevent insect attacks from confounding the results. The spray¹ was a 0.5% solution of benzene hexachloride in water plus Kelthane to control spider mites (*Oligonychus* sp.).

Measurements

Heights of individual trees were measured before treatment and during October for 6 years thereafter. Survival was determined from records of living trees in each transect at the time of height measurements.

Statistical Analyses

Data on survival, height, and height growth for each age-at-treatment were subjected to an analysis of variance. Analyses of percentage survival were performed on arc sine transformations of the data. Since so few trees survived the 100% girdle, this treatment was omitted from the analyses of growth. Tukey's *w* procedure at the 0.05 level was used to test differences between means when the analysis of variance indicated that significant differences were present (Steel and Torrie 1960).

Results and Discussion

Survival

Treatments less severe than a full girdle had little effect on seedling survival (Table 1). Only occasional mortality occurred after the year of treatment.

Several fully girdled seedlings survived during the first year treatments were applied. Apparently, some unremoved strings of inner bark or cambium formed a bridge of callus

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¹This publication reports research involving pesticides. It does not contain recommendations for their use, nor does it imply that the uses discussed here have been registered. All uses of pesticides must be registered by appropriate agencies before they can be recommended.

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Fig. 1. Girdles were applied near groundline to 1-, 2-, and 3-year-old slash pine at 6, 18, and 30 months after transplanting.

which rapidly encompassed the stem. In the following years, a special effort to remove all bark and cambium permitted few fully girdled trees to survive.

In the separate test on season and width of 100% girdling, none of the seedlings girdled 6 months after planting survived. However, 10% and 30% of the seedlings treated in April, 18 months after planting, survived the 1.3-cm and 2.5-cm girdles, respectively. About half of the trees treated in December survived, regardless of girdle width. In the other separate test, neither slash pine nor loblolly pine survived girdling in May when the exposed wood was rubbed

dry with a cloth after girdling. The similar response by these species was not surprising. Evidently, a dry face prevents the healing of the wound.

Although it is of little importance to cattle or timber production, the ability of some trees to recover from complete girdling is interesting. The exact mechanism for recovery was not observed in this study, but Claud L. Brown (School of Forest Resources, University of Georgia) suggested such a process in a personal communication. When young, vigorous trees exude enough oleoresin immediately after wounding to seal off the exposed wood, ray and epithelial cells are able to proliferate rapidly and form a callus pad over the wound. New cambium is then formed in the callus tissue, and it begins producing new phloem to the outside and xylem to the inside, as in an undisturbed tree. However, if the ray cells are exposed to the air or fail to proliferate promptly because of poor tree vigor, the wound surface dries and healing must be accomplished by downward growth of tissue from the upper edge of the wound. The present study suggests that conditions enabling pines to survive a full girdle include failure to remove all cambial material and weather that permits the wound to remain wet. Noel (1970) reported that poor girdling technique was frequently the reason that full girdles were able to heal.

Heights and Growth Rates

Treated at 6 Months

Girdling reduced the heights of slash pine, but only the 75% girdled seedlings grew at a slower rate than the controls throughout the study (Fig. 2). After 6 years, however, height differences averaged only 0.5 m. The annual growth rate was significantly reduced only during the first 3 years. Since the 50% girdle never significantly reduced growth after the first year, injury caused by an animal's hoof in partially girdling a tree should have little effect on its productivity.

Table 1. Survival percentages of slash pine following girdling at three ages after planting.¹

Degree of girdling (%)	Growing seasons since treatment		
	1	2	6
Treated at 6 months			
0	99.0a	99.0a	97.0a
50	98.0a	98.0a	98.0a
75	97.0a	94.0a	92.0a
100	7.0b	7.0b	7.0b
Treated at 18 months			
0	99.1b	99.1a	98.2b
50	100.0a	98.2a	97.3a
75	100.0a	98.2a	96.4a
100	0.0c	0.0b	0.0b
Treated at 30 months			
0	100.0a	100.0a	100.0a
50	98.6a	98.6a	98.6a
75	100.0a	100.0a	98.6a
100	22.9b	22.9b	22.9b

¹Within treatment ages in a column, means identified by different letters are significantly different at the 0.05 level according to Tukey's test. Analyses performed on arc sine transformations of the data.

Fig. 2. Initial height at time of treatments (bottom segments of bars), final height, and annual growth for 6 years after girdling a 5.1-cm-wide band around 0, 50, or 75% of each stem of slash pine at three ages after planting. Within treatment ages, bars marked with different letters are significantly different at the 0.05 level. (Detailed tables are available from the author).

The only seedling that survived a full girdle in this treatment grew slowly the first year. Thereafter, it grew as fast as or faster than the controls and was 0.5 m taller after 6 years. The vigor that enables an occasional seedling to survive a full girdle, unsurprisingly, continues to be reflected through rapid growth. Reduced competition, as well as vigor, may have contributed to this faster growth. These benefits of vigor and reduced competition were similarly reflected in the test on width and season of girdling.

As with survival, growth of 6-month-old seedlings was reduced more by girdling injury than was true of older seedlings. Not having fully recovered from the stress of transplanting, these young seedlings were less able to overcome the effects of girdling.

Treated at 18 Months

Applying 50% and 75% girdles to 18-month-old slash pine affected neither the height nor growth rate in any year of the study (Fig. 2). Allowing slash pine a year to become fully established after planting resulted in vigorous trees that withstood any treatment less drastic than a full girdle. After 6 years, these trees showed no effects of earlier treatment (Fig. 3).

Treated at 30 Months

After two growing seasons, these seedlings were about 0.6 m tall at time of treatment. Heights and growth rates were unaffected by the girdling treatments (Fig. 2).

Three trees which survived the full girdle generally grew faster each year than the other treatments or the control. After 6 years, these trees were 5.6 m tall, about 1 m taller than the control.

Year of Planting

Survival was less affected by year of planting than by year of treatment. Girdling in 1960 caused less mortality to seedlings treated at 6 and 30 months after planting than to the same-aged seedlings treated in 1961 and 1962. These seed-

lings treated in 1960 were never under stress for moisture during the growing season following treatment. However, July, September, and October of 1961 were drier than usual and 1962 was the study's driest year, especially during the growing season. Seedlings treated at 18 months did not follow this pattern. The initial establishment and vigor of all seedlings for each age-at-treatment seemed to be similar prior to treatment; therefore, weather patterns did not seem to play a major role in the mortality of girdled slash pine.

Height growth of any age group was not consistently affected by either year of planting or year of treatment. No conclusions, therefore, can be drawn about the effects of growing conditions on the response of slash pine to girdling.

Summary and Conclusions

Animals sometimes girdle or partially girdle a tree by scraping off or eating the bark. Various intensities of girdling injury were evaluated by removing a 5.1-cm-wide band of bark from around 50, 75, and 100% of the stem near the groundline on slash pine seedlings of three ages.

Mortality at all ages was negligible except after full girdling. A few fully girdled seedlings bridged their wounds and survived, probably because of poor girdling techniques. When greater care was taken to obtain a clean girdle, mortality was consistently high. Seedlings that initially survived girdling generally lived throughout the 6-year study.

Treating older seedlings was less harmful than girdling within 6 months after planting regardless of season or width of a full girdle. When full girdles were applied 18 months after planting, girdling in December was less harmful than in the spring or summer. Evidently the cooler temperatures and level of humidity allowed the wounds to remain moist, thereby permitting the healing process to take place. Although narrower girdles would be expected to heal better than the 5.1-cm girdles, there was little difference in survival in this study.

Height growth of seedlings treated 6 months after planting was reduced by the 75% girdle for 3 years following girdling but was not affected thereafter. However, the total height reduction averaged only 0.5 m after 6 years. Girdling at lower intensities and on older trees produced practically no harmful effect on height growth. Hughes (1976) reported similar results from South Florida slash pine (*Pinus elliotii* var. *densa* Little and Dorman).

Both the literature and this study indicate that the type of girdling inflicted by livestock would have little harmful effect on either survival or growth of slash pine and, possibly, other southern pines. Indeed, the meticulous care required to kill trees with a full girdle in this study indicates that the scraping action of a hoof would seldom remove enough cambium and phloem to cause death. However, if the seedlings were in a low state of vigor, under extreme stress, or subjected to high temperatures with very low humidity, they could be strongly affected.

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