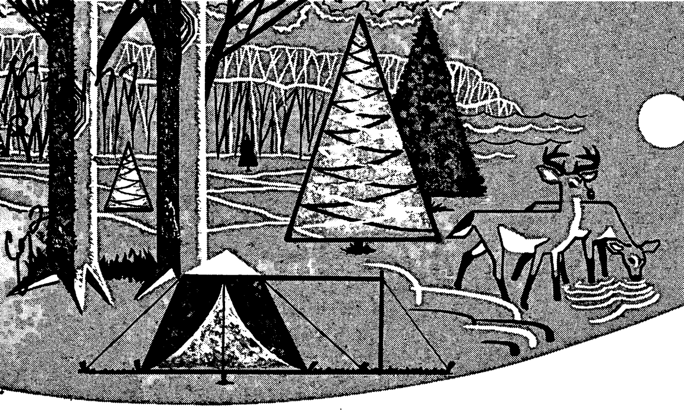



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# SURVIVAL AND GROWTH OF NORTHERN RED OAK SEEDLINGS FOLLOWING A PRESCRIBED BURN

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ABSTRACT.--Mortality of northern red oak seedlings in a spring prescribed burn was related to temperature near the root collar. Most of the 42 percent of seedlings that survived the burn developed new shoots from the root collar.

OXFORD: 232.324:181.65:231.322:176.1 *Quercus rubra*. KEY WORDS: *Quercus rubra* L., seedling sprouts, sprouting, fire, fire temperature, graded temperature indicators, Thermotubes.

Prescribed burning has been suggested as a method for encouraging advance oak regeneration on sites where succession favors less desirable species (Curtis 1959, Rogers 1959). Results from a case study in southwestern Wisconsin, however, show that a single spring fire may kill many young oak seedlings and fail to control competing vegetation.

## METHODS

A prescribed burn was made in mid-April 1971 in a 102-yr-old northern red oak (*Quercus rubra* L.) stand on the Hardies Creek Timber Harvest Forest in Trempealeau County, Wisconsin.[1] The stand is located on a 10- to 35-percent, north-to-east facing slope where the site index for red oak is 70 (Gevorkiantz 1957). The area was divided into two parts, a burn plot and a nonburn (control) plot, each about 4 acres.

Although the stand had been thinned from 120 to 80 ft$^2$ of basal area/acre 1 1/2 years before the burn, logging slash was minimal. Major fuels consisted of the previous year's leaf litter and dead fronds of interrupted fern (*Osmunda claytoniana* L.) and lady fern (*Athyrium felix-femina* L.). Other understory vegetation included American hazel (*Corylus americana* Walt.) and briars (*Rubus* spp.).

A bumper red oak acorn crop during the fall of 1969 produced about 7,000 seedlings/acre on the study area. Immediately preceding the burn, 25 of these seedlings were staked and measured on each of eight transects; four in the burn plot and four in the control plot.

Seven graded, sealed-in-glass, temperature indicators (Thermotubes)[2] were placed around the root collar of each staked seedling on the burn plots. The temperature-sensitive elements inside the Thermotubes were tapped to one end of the 2 1/2-in.-long Thermotube glass cylinders, and this end placed within 1/8-in. of the root collar of

[1] *A State-owned tract where demonstration and research projects are being carried on cooperatively by the Wisconsin Department of Natural Resources, the office of the Extension Forester at the University of Wisconsin, the North Central Forest Experiment Station, and Northeastern Area, State and Private Forestry of the USDA Forest Service.*

[2] *Mention of trade names does not constitute endorsement of the products by the USDA Forest Service.*

the seedling. Because root collars were at various depths in the forest floor, some sets of Thermotubes were near the top of the leaf litter, while others were an inch or more below the litter surface. After the Thermotubes were installed the forest floor fuels were replaced to their original position around each seedling.

Except for the surface layer of one or two leaves, the 1-1/4-in. forest floor (L+F layers) was wet and tightly compressed due to an unusually heavy snowpack the previous winter. Consequently, the fire spread at only 13 in./min (estimated from 30 burn-out time measurements) and consumed only the surface litter. The little slash that was on the plots did not contribute significantly to the fire. Ambient air temperature was 70° F and relative humidity 25 percent at the time of burning (1 to 2:30 p.m., cst); winds were out of the south-southwest at 5 mi/h. The temperature of the soil-forest floor interface ($A_1$-F) was 50° F. Although 3 days before the burn the area received 0.15-in. of rain, precipitation for the preceding 26 days totaled only 0.25-in.

## RESULTS AND CONCLUSIONS

Ninety-three percent of the seedlings on the control plot were alive one growing season after the fire, but only 42 percent of the seedlings survived on the burned plots. Of the 42 survivors, all but 8 were top-killed, producing 34 seedling-sprouts with 1 to 3 living stems originating from the root collar. Seven of the eight uninjured seedlings grew where the temperature was less than 120° F; this occurred on 17 percent of the samples. All survivors on the control plot were true seedlings, i.e., their original seedling tops were living.

Mortality in the burned plot was associated with temperature near the root collar. Where temperature was 220° F or more, mortality was 71 percent; mortality was slightly but not significantly lower in the 140 to 219° F class at 64 percent. Mortality was only 19 percent where temperature was less than 140° F.

Seedling height was also affected by the burn: seedlings on the burned plot were significantly shorter (1.4 in. on the average) than on the control plot, even though there was no significant difference in their heights before the burn. Average annual shoot growth, however, was 4 in. greater for the surviving burned-plot seedlings than the control-plot seedlings.

Because much oak reproduction is from basal sprouts of seedlings, predicting temperatures near the root collar is critical in prescribed burning designed to favor oaks. The lethal temperature for plants as a whole is frequently given as 140° F, although there is some variation among species (Hare 1961). Temperature duration and initial temperature of vegetation, however, must also be considered in evaluating effects of heat on living vegetation (Byram 1958). This was apparent in the present study where 29 percent of the seedlings survived where root collars were exposed to temperatures 220° F or higher; and these temperatures occurred on 51 out of 100 samples. The low initial 50° F temperature of the root collar region and the insulating effects of seedling bark may have shielded many dormant buds from heat flashes of short duration.

The limitations of the temperature measurement system, i.e., its inability to measure temperature "at" the root collar, may explain some of the survival at the higher observed temperatures. On the other hand, maximum temperatures may not always have been recorded due to heat transfer lag through the Thermotube glass. Also, some seedling mortality may have resulted from disturbance of litter around the seedlings during the placement of the Thermotubes which in turn may have caused drying of fuels and a higher temperature near the root collar than would have been expected with undisturbed fuels.

With 7,000 seedlings/acre, a 50- to 60-percent reduction in oak seedling population due to fire may be acceptable, provided the fire partially controls competitors. But the spring burn described here had little observable effect on competing vegetation: both fern and shrub growth were rank throughout the burned plot by late June. Nor is it probable that older red oak seedlings growing under the dense fern and shrub cover characteristic of most southwestern Wisconsin stands would be any larger and thus more fire resistant. This is evidenced by an earlier study at the Hardies Creek Forest, which showed that after the fifth growing season red oak seedlings under similar ground cover competition were only 3 to 4 in. taller than they were after the first growing season

(Scholz 1955). The results of this case study thus indicate that a single, low-intensity spring fire may do more harm than good to seedlings about the size of the 1-yr-old red oaks observed, especially where competition after the burn is severe.

However, the limited scope of this study precludes extending the results to all uses of fire in oak management. For example, the response of larger or older oak regeneration may be quite different from the 1-yr-old seedlings studied. In Williams[3] study in southern Indiana only 22 percent of 4-yr-old northern red oak seedlings planted in a clearcut hardwood site were killed by a wildfire described as "extremely hot." Thus, additional research is needed to determine under what conditions prescribed burning might control competing vegetation and at the same time favor established oak reproduction.

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[3] *R. D. Williams. Burned red oak and black walnut stock grades plots at the Georgia Tower. Unpublished report on file at the North Central Forest Experiment, Carbondale, Illinois. 1966.*

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