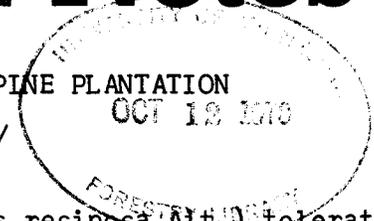


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FIRE DEFOLIATION AND SURVIVAL IN A 47-YEAR OLD RED PINE PLANTATION

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How much fire-produced needle-kill can red pine (*Pinus resinosa* Ait.) tolerate and still survive? This question was asked after a fire burned 5 acres of a 47-year old red pine plantation, near Lake Vadnais, a St. Paul City Water Department Reservoir. The fire started at 1:30 p.m. on April 12, 1966, with northeast winds at 15 to 20 m.p.h., air temperature at 53° F., and relative humidity at 32%. There had been no rain in the previous three weeks and the litter was dry. Suppression crews, which arrived within 10 minutes with truck mounted water tanks, took 35 minutes to control the spread. The fire, while not crowning, charred the trunks 10 to 20 feet high on the lee side and 3 to 8 feet on the windward. Within a week needles began to brown and drop. Some trees, particularly those on the windward side of two cleared strips, lost most of their needles; other trees lost less than 10% of their needles. The 1966 shoots were still in the buds when the stand burned.

At the time of the fire the trees were 50 to 60 feet tall and the top 10 to 15 feet contained live crown. The range in d.b.h. was 4 to 13 inches with most trees 6 to 11 inches. There were 380 trees per acre with basal area of 150 square feet per acre. A 1964 thinning had removed most intermediate and suppressed trees.

On June 8, tags were placed on 196 trees with four classes of needle-kill (Table I). Percent needle-kill was estimated by observing needle color and defoliation. The classification is most accurate at the extremes of high and little kill. At time of tagging the shoot was just emerging from the bud.

In July and October, 1966, and again in June and October, 1967, the tagged trees were observed (Table I). Tagged trees still alive in October, 1967 appeared vigorous. In February and July, 1967, all dead trees and untagged trees of low vigor were removed by the Water Department. The mortality and low vigor were attributable to the fire. In 1966, 9.3 inches of rain fell from April through July, which is 4 inches below normal. During 1967, rainfall was very low in May and July and very high in April and June.

The results as of October, 1967, show that red pines with higher needle-kill have less chance to survive (Table I). Mortality was particularly high - 40% - in those pines which had 95% or more of their needles killed. In contrast, 2-year mortality was only 14% in trees with 80% to 95% of their needles killed and 8% or less among trees losing 75% or less of their needles.

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The highly-damaged trees lived because terminal buds survived on many branches, all of whose needles were killed. These buds, containing all of the year's needles, had elongated into vigorous shoots during June 1966. The mortality was apparently caused by defoliation, but cambial killing may have played a part. Bark beetles were involved in the mortality which occurred after October, 1966. The beetles would work more damage in trees of poor nutrition, i.e., high needle-kill, as well as in trees with damaged cambiums.

The relatively low mortality may be typical for red pine defoliated between October and May. These sparsely foliated pines, unlike the suppressed trees which they resemble, have large buds containing many needles. They also have reserve foods and a well developed phloem to transport food unless basal scorch has been severe. Had the fire occurred between May and September, after the bud had opened and before next year's bud was mostly formed, mortality would have been much higher. In these summer burns no bud would be left to start new shoots on branches bared of needles.

Table I. Effect of needle-kill by fire on survival of red pine

Approximation of Percent Needles Killed	Trees Observed (number)	Trees Still Alive (percent) (1)				
		6-8-66	7-9-66	10-18-66	6-20-67	10-6-67
95 to 100	42	100	79	71	64	60
75 to 95	36	100	100	93	86	86
50 to 75	58	100	100	97	92	92
5 to 20	60	100	100	100	95	95

(1) adjusted for trees not located on reobservation