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GROWTH OF RED PINE PLANTED ON A NORTHERN HARDWOOD SITE

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ABSTRACT.--A red pine conversion planting was established on a cutover northern hardwood site in 1929. Competing hardwoods were controlled on half the area by cleaning during the first 10 years after planting. After 46 growing seasons pine survival was 70 percent on the cleaned plot, and 25 percent on that not cleaned; mean annual increment was 2.37 cords (190 ft^3), and 0.91 cords (73 ft^3) per acre respectively. Merchantable volume of pine was 109 and 42 cords per acre. These data demonstrate the inability of red pine to compete with maple on medium textured soils, and illustrate the growth potential of the species if hardwood competition is controlled during plantation establishment. Results indicate that merchantable volume production on some well drained northern hardwood sites could be doubled by intensive management of red pine.

OXFORD: 562.21:815:174.7 *Pinus resinosa*.
KEY WORDS: red pine, species conversion, cleaning, hardwood competition, intensive silviculture, site quality.

In the Lake States, natural stands of red pine (*Pinus resinosa* Ait.) typically occur on dry, sandy soils (Braun 1950). The species occurs only rarely on heavier soils, probably because it cannot compete successfully with more aggressive species (USDA For. Serv. 1965). The inability of planted red pine to endure inadequate aeration encountered on poorly drained, heavy soils is well established (Stone *et al.* 1954, Dreisinger *et al.* 1956).

This paper documents the performance and competitive ability of red pine planted on a well drained northern hardwood site.

METHODS

Stand and Site

The plantation is located on the Upper Peninsula Experimental Forest near Marquette, Michigan, 10 miles (16 km) south of Lake Superior. The area was originally occupied by virgin northern hardwoods, chiefly hard maple (*Acer saccharum* Marsh.) averaging about 14,000 board feet per acre (35,000 per ha). The original forest was commercially clearcut in 1920. In 1928 the area was described as "a very open stand of sugar maple and brush."[1] There is no evidence that the area had been burned.

The soil is a Munising sandy-loam, a weakly developed spodosol (Alfic Fragiorthod) formed in well drained acid till of Valders age. Most of the roots occur in the upper 15 inches (38 cm) of soil; pH averages 4.8. A fragipan 6 to 16 inches (15 to 40 cm) thick occurs at a depth of about 18 inches (46 cm). Nutrients in the upper 10 inches (25 cm) of soil average approximately 0.12 percent total N, 35 lb/acre (40 kg/ha) P (Bray P_1 extractable), 90 lb/acre (100 kg/ha) K, 960 lb/acre (1,075 kg/ha) Ca, and 112 lb/acre (125 kg/ha) Mg (NH_4OAc extractable). This is a medium site

[1] *Unpublished data on file at the Northern Hardwoods Laboratory, Marquette, Michigan.*

for growth of northern hardwoods: site index averages about 60 feet (18 m) at 50 years for sugar maple and 80 feet (24 m) for red pine.

Plantation Establishment

Concern over the lack of adequate hardwood regeneration following clearcutting of the old growth timber prompted a series of trials "to test the possibilities of underplanting and conversion plantings on cutover hardwood lands."[1] The objective of the underplanting and supplementary plantings was to develop fully stocked, conifer-hardwood stands. The aim of the red pine conversion planting was to develop a pure pine stand by cleaning as necessary to free the pine from competing hardwoods. Significantly, only the conversion planting with the planned cleaning treatments has shown any degree of success.

The red pine was planted in May 1929 at a spacing of about 7 by 8 feet (2.1 by 2.4 m) "on open hardwood land covered with brush, grass, weeds, and scattered young hardwoods"[1] (fig. 1). Planting stock was 2-1-2 transplants from the Higgins Lake Nursery in northern Lower Michigan. The plantation was first cleaned in August 1929. The subsequent records are fragmentary: as far as can be determined, the east half of the plantation was cleaned again the 3rd, 4th, and 6th years, and probably about the 10th year. The west half either was never cleaned, or was cleaned only the year it was planted.

At age 46 (from planting), diameter and merchantable height of all surviving pine were measured on a 0.1-acre (0.04 ha) plot in each half of the plantation (table 1).

RESULTS

First-year survival of planted seedlings was 99 percent and height growth averaged 7 inches (17.8 cm). After five growing seasons survival was 94 percent, total height ranged up to 7.2 feet (2.2 m) and averaged 4.1 feet (1.25 m). At 9 years the largest pines measured 14 feet (4.3 m) and averaged 8.8 feet (2.7 m) in height, but survival had dropped to about 80 percent.

Over the next 37 years, adjacent hardwoods, primarily sugar maple, completely

Figure 1.--*One of several experimental conifer plantations established on cutover hardwood land on the Upper Peninsula Experimental Forest; September 1929.*

Table 1.--*Stand conditions and merchantable volume of red pine on a northern hardwood site, 46 years after planting (per acre)*

	Cleaned	Not cleaned
NUMBER OF TREES		
Red pine	540	190
Hardwoods	100	290
Total	640	480
MEAN DBH (INCHES)		
Red pine	10.0	10.4
Hardwoods	5.8	6.2
BASAL AREA (FT^2)		
Red pine	305	115
Hardwoods	20	83
Total	325	198
MERCHANTABLE VOLUME[1]		
Rough cords[2]	109	42
Cubic feet[3]	8,720	3,360
ANNUAL YIELD		
Rough cords	2.37	0.91
Cubic feet	190	73

[1] Bruno Lindfors, Munising Ranger District, Hiawatha National Forest, determined the merchantable volume of pine.

[2] Gross volume from composite volume table 6 (Gevorkiantz and Olson 1955).

[3] Net volume calculated at 80 cubic feet per rough cord.

replaced the planted pine on the south 33 feet (10 m) of the plantation, across both the cleaned and noncleaned portions. Hardwood encroachment also was severe along the west 20 feet (6 m) of the original planting. On the east side and along most of the north side of the plantation encroachment was negligible and pine survival was good. By 1974, 38 percent of the red pine in the cleaned half of the plantation were alive, but only 13 percent on the noncleaned portion. Based on the two sample plots located in the areas of highest pine stocking, survival averaged about 70 percent in the cleaned portion, and 25 percent in that not cleaned. The larger dominant pines averaged 79 feet (24 m) at age 46.

DISCUSSION

Early survival and growth were excellent for this region, probably due to a combination of site quality, careful planting, and use of large, vigorous planting stock. The transplants used in this study were older and presumably larger than the 3-0 red pine stock commonly used today. Unfortunately, no records are available on survival and growth after the 9th year. Apparently, most of the mortality occurred fairly early in the life of the stand because height growth of the surviving pines has exceeded that of the adjacent hardwoods for many years and there is little evidence of recent mortality on the plots (fig. 2).

Despite good early survival and growth, many of the pines could not compete with the encroaching hardwoods. Survival probably would have been greater with an additional cleaning at a later age, particularly along the south side of the planting where the hardwood encroachment was most severe. Even in the interior of the plantation where survival was 70 percent, the cleaned plot contains 100 maple stems per acre (250/ha) 2.0 inches (5.0 cm) dbh and larger, and an understory of maple saplings 5 to 10 feet (1.5 to 3.0 m) in height persists. The pine probably cannot be regenerated naturally; even if the maple were eliminated by thorough site preparation, the development of grass, brush, and herbaceous competition on this site would undoubtedly preclude the establishment of red pine from seed (fig. 1).

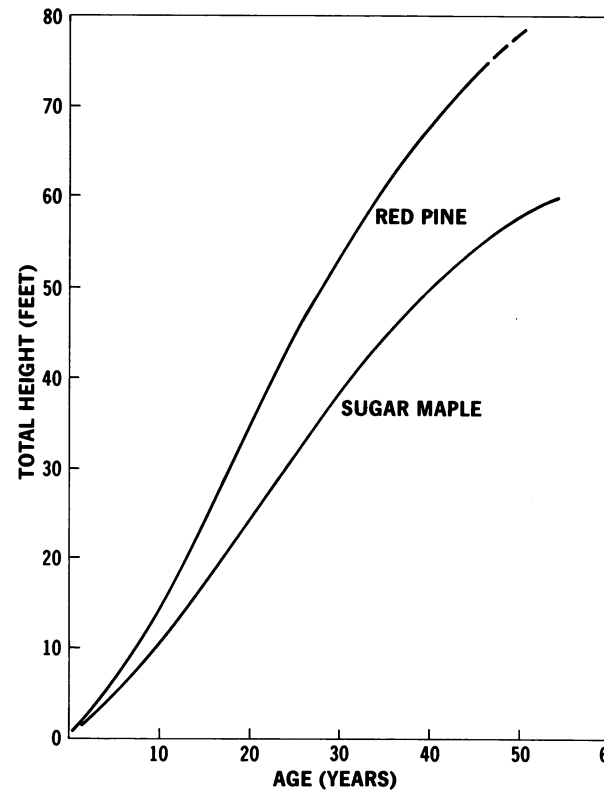

Figure 2.--*Height growth of red pine 46 years after planting on a northern hardwood site, and 54-year-old sugar maple in the adjacent stand. Both curves based on codominant trees; site index (50 years) is about 60 for maple and 80 for red pine.*

The poor survival in the noncleaned portion of the planting confirms the inability of red pine to compete with more aggressive species on medium textured soils (USDA For. Serv. 1965). Without the early cleanings, pine survival was only 13 percent over the entire area and 25 percent on the well stocked plot in the interior of the planting. Although the noncleaned plot contains more than 1½ times as many hardwoods as red pine, the pine has grown faster in both diameter and height than the hardwoods (table 1, fig. 2).

Volume growth of the red pine has been impressive, particularly on the cleaned plot. The mean annual increment of 2.37 cords per acre substantially exceeds published values for the species (Buckman 1962). In fact, growth of over 100 cords per acre in less than 50 years is high for any species in the Lake States (Horton and Bedell 1960, Wilde *et al.* 1965). The slightly lower average diameter of the pine on the cleaned plot reflects the excessively high stand density.

Mean annual growth on the cleaned plot has been 190 ft^3 per acre, more than 2½ times that on the noncleaned plot (table 1). A typical even-age northern hardwood stand nearby had a mean annual merchantable growth of 54 ft^3 per acre for 30 years after a commercial clearcut (Jacobs 1969). However, periodic annual growth from age 25 to 30 was 120 ft^3 per acre. Assuming that growth continues at this rate, at age 46 the hardwood stand will have a mean annual growth of 77 ft^3 per acre, about equal to that of the red pine on the noncleaned plot, but only about 40 percent of that on the cleaned plot.

This conversion planting has illustrated the inability of young red pine to compete with maple on a site where northern hardwoods are the climax vegetation. However, it also indicates the growth potential of red pine on an average, well drained northern hardwood site if maple competition is controlled during the first 10 years after planting.

These results indicate that the performance of red pine needs to be evaluated over a wider range of sites. In general, well stocked northern hardwood stands on medium and better sites contain many high quality stems and should be managed for high value products. However, many northern hardwood stands in the Lake States are below average in stocking, growth, and/or tree quality because of stand history, or occasionally, site quality. The species occupying a given site do not necessarily indicate the maximum yield, in volume or value, attainable on that site. Stevens and Wertz (1971) for example, estimated a potential 60 percent increase in sawtimber yield by coordinating species distribution with soil productivity in northern Wisconsin.

Although it is impossible to extrapolate from a small, nonreplicated study, these data indicate that volume production may be doubled by intensive management of red pine on some well drained northern hardwood sites. If these sites are utilized to produce high value softwood products like poles, piling, and saw logs, rather than poor quality hardwood products, the value yield will be more than doubled.

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