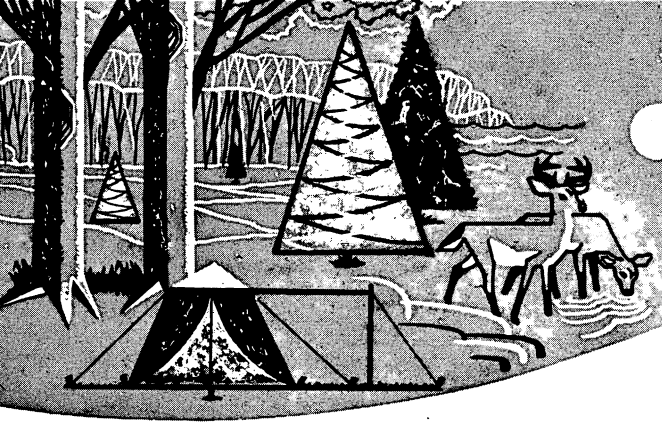

USDA FOREST SERVICE

RESEARCH NOTE NC-224

NORTH CENTRAL FOREST EXPERIMENT STATION, FOREST SERVICE—U.S. DEPARTMENT OF AGRICULTURE

Folwell Avenue, St. Paul, Minnesota 55101 1977

RED PINE SEEDLING ESTABLISHMENT AFTER SHELTERWOOD-STRIP HARVESTING

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ABSTRACT.—Shelterwood-strip harvesting in a mature red pine stand provided favorable growing conditions for red pine seedlings established by planting nursery stock, by planting 10-week-old to 1-year-old tubelings, and by direct seeding. How long the shelterwood-strips can be left standing before they seriously affect seedling development remains to be determined.

OXFORD: 221.223:232:174.7(77) *Pinus resinosa.*
KEY WORDS: regeneration, planting, seeding, tubelings, visual quality.

A shelterwood-strip harvesting method was tested in 1970 in a 100-year-old red pine (*Pinus resinosa* Ait.) stand on the Cutfoot Experimental Forest in north-central Minnesota (Benzie and Zasada 1972). The method was designed to harvest mature timber, prepare the site for regeneration, provide environmental conditions to favor tree growth, and maintain the visual quality of the landscape.

The shelterwood-strip method resulted in a pattern of clearcut strips 50 feet wide and uncut shelterwood-strips 16 feet wide (fig. 1). Some strips were oriented north-south and some east-west; all led to a common landing. Full-tree harvesting was used—trees were felled into the cut strips and skidding was confined to the cut strips. Limbing was done at the landing and the slash was piled and burned. Unmerchantable trees were cut, skidded, and burned with the slash to prepare the area for establishing a new red pine stand.

Figure 1. — *Shelterwood-strip harvesting in red pine provided good environmental conditions for seedling establishment.*

ESTABLISHING REGENERATION

During good seed years the trees left in the shelterwood-strips could supply up to a quarter of a million seeds per acre, but 1970 was a poor seed year and less than a thousand seeds per acre were produced. The 1-year-old conelets that would produce the 1971 seed crop were also poor. Therefore, 3-0 red pine seedlings, three age classes of red pine tubelings,[1] and untreated red pine seed were planted in the spring of 1971. At the time of planting the tubelings were 10 weeks, 16 weeks, and 1 year from date of seeding. The bare-root seedling stock was hand-planted without additional site preparation but tubeling and direct seeding planting sites were hand-scalped.

A row of nursery stock seedlings, tubelings, and a direct-seeded plot were established along each long edge and in the center of four north-south strips and four east-west strips. Each row had 10 nursery-grown seedlings, 10 tubeling seedlings from each of the 3 age classes, and 1 direct-seeded plot. This planting scheme resulted in a total of 240 nursery stock seedlings, 240 tubelings of each age class, and 24 seeded plots. Most of the seeded plots failed the first year and were reseeded the following spring.

SURVIVAL AND HEIGHT OF REGENERATION

Mean survival on the north-south strips was higher than on the east-west strips after 6 years, but the differences were not significant (table 1). Conversely, height growth was slightly greater on the east-west strips than on the north-south strips but again the differences were not significant.

Differences in survival and height by locations within the strips varied but generally survival was lower and height greater on portions of the strips that received longest exposure to midday sun. Survival was generally higher on the west edges of north-south strips and on the south edges of east-west strips. Height growth was generally greater on the north edge of east-west strips and on the east edge of north-south strips (table 2). The center plots had good height growth for both east-west and north-south strips.

Highest survival was obtained with 1-year-old tubelings. It was significantly higher than survival of the 3-0 nursery seedlings but not significantly higher than that of the 16-week-old tubelings. The survival of the 10-week-old tubelings was significantly lower than any of the other regeneration methods except direct seeding. The differences in survival between tubeling age classes are similar to those previously found after three growing seasons (Alm 1974). The recommended 16-week minimum cultural period for red pine tubelings is still valid after six growing seasons.

Direct seeding tree percent (number of surviving seedlings per 100 viable seeds sown) was lower than the expected 5 to 10 percent.[2] So, under these conditions about 39,000 seeds (approximately 3/4 pound) would be required to establish 1,000 6-year-old seedlings per acre.

The majority (62 to 68 percent) of the trees died during the first winter and the first two growing seasons

[1] *Seedlings were grown in 9/16-inch diameter, 3-inch long plastic tubes (Ontario tubes).*

[2] *Benzie, John W. 1965. Small plot direct seeding trials. Unpublished report on file at North Central Forest Experiment Station, Grand Rapids, Minnesota.*

Table 1. – *Mean survival and height of red pine after 6 years by regeneration method and strip orientation*

Regeneration method	North-south strips		East-west strips	
	Survival	Height	Survival	Height
	percent	*feet*	*percent*	*feet*
3-0 seedlings	61	2.1	54	2.3
1-year tubelings	78	1.1	75	1.4
16-week tubelings	72	0.8	62	1.1
10-week tubelings	47	0.6	35	0.8
Direct seeding[1]	3	0.5	2	0.5

[1] Direct seeding survival is tree percent (seedlings per 100 live seeds sown). Seven plots in the north-south strip and eleven plots in the east-west strips had tree percents less than 3 the first year and were reseeded the spring of the second year.

Table 2. – *Mean survival and height of red pine after 6 years by regeneration method and location within strip*

Location	Regeneration method									
	3-0 seedlings		Tubelings						Direct seeding	
			1-year		16-week		10-week			
	Percent	*Feet*	*Percent*	*Feet*	*Percent*	*Feet*	*Percent*	*Feet*	*Percent*[2]	*Feet*
West Edge[1]	55	1.8	90	0.9	88	0.7	50	0.6	3	0.4
East Edge	70	2.2	80	1.0	72	1.0	48	.7	4	.4
South Edge	62	1.9	75	1.2	82	.8	38	.6	3	.4
North Edge	42	2.2	72	1.3	50	1.1	28	1.1	1	.4
Center	58	2.5	72	1.4	52	1.2	42	.6	4	.7
Mean[3]	58b	2.2e	78a	1.2f	69ab	1.0f	41c	.7g	3d	.5g

[1]East and west edges are on north-south strips, north and south edges are on east-west strips and the center plots include both strip directions.

[2]Direct seeding survival is tree percent (seedlings per 100 viable seeds sown).

[3]Means followed by the same letter do not differ significantly at the 0.01 level.

(1971-72). The major cause of death was smothering by leaves and other vegetation. Also, many seedlings were killed as a result of heavy deer activity in the cut strips.

Differences in height between regeneration methods were significant. As expected, the 3-0 seedlings were taller than all others. The next largest seedlings were the 1-year-old tubelings followed closely by those 16 weeks old. The 10-week-old tubelings and the direct-seeded seedlings were the smallest.

Red pine seedling establishment and early growth after harvesting by the shelterwood-strip method indicates generally favorable growing conditions within both north-south and east-west strips for all regeneration methods tested. Therefore use of the shelterwood-strip method need not be limited to a particular orientation of the strips. How long the shelterwood-strips can be left before they seriously affect seedling development remains to be determined.

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