SCARIFYING FOR JACK PINE
REGENERATION IN MANITOBA

by

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Scarifying for Jack Pine Regeneration in Manitoba

by

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INTRODUCTION

Jack pine is one of the most important commercial species in Manitoba. It occurs on extensive areas throughout the province and is utilized for a variety of products including pulpwood, lumber, railway ties, posts, and poles.

Although the species is particularly adapted to regenerating after fire, it has often failed to re-establish itself after logging. Several reasons have been suggested for these regeneration failures, including inadequate available seed supply, unfavourable seedbed conditions, and unfavourable climatic conditions after germination.

The serotinous character of jack pine cones plus the fact that mineral soil provides the best germinating medium (LeBarron, 1944) has led investigators to believe that scarification in conjunction with lopping and scattering of cone-bearing slash could provide adequate natural jack pine regeneration after logging. In the Lake States, Ralston (1951) has reported the 10-year results of trials on the Chippewa National Forest. Scarification was done with an Athens plough and cone-bearing slash was scattered over the mineral soil. Four hundred and fifty acres were treated and in 1951 there were between 3,000 and 3,200 seedlings per acre. Stocking, based on an examination of milacre quadrats, averaged 70 per cent. Scarification of cut-over areas has also increased the abundance of jack pine regeneration in Ontario and in Saskatchewan (Farrar, Gray, and Avery, 1954; Kabzems and Kirby, 1956).

In Manitoba the Forestry Branch has conducted two experiments to study various techniques of reproducing stands of jack pine. On sandy soils on the Sandilands Forest Reserve three methods of cutting were carried out: clear cutting, clear cutting in strips, and seed-tree cutting. After logging, scarification was carried out on portions of each treatment area, in some instances before scattering of slash and in other instances after scattering of slash. On clay soils on the Riding Mountain National Park the effects of scarification on jack pine regeneration were investigated in stands which had been clear cut. Scarification was done both before and after the slash was scattered.

SCARIFICATION ON SANDY SOILS

The experiment was carried out in moderately stocked, pure, jack pine stands located on the Sandilands Forest Reserve. Number of trees per acre varied from 250 to 350; their ages were between 50 and 60 years at breast height.

The stands were located on well-drained sandy podzolic soils. Topography varies from flat to gently undulating and slopes seldom exceed five per cent. The minor vegetation was dominated by ericaceous shrubs, particularly bearberry, wintergreen, and blueberry.
Experimental Techniques

The investigation commenced in 1952 when three ten-acre blocks were established in each of two stands. Three logging methods were tested in conjunction with scarification on portions of each cut-over block using an Athens plough. Table 1 lists the method and date of logging and also the scarification treatment carried out on each experimental block.

Table 1.—Methods of Logging and Scarification, Sandilands Forest Reserve

<table>
<thead>
<tr>
<th>Block</th>
<th>Method of cutting</th>
<th>Date of cutting</th>
<th>Method and date of scarification</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Seed-tree cutting</td>
<td>Summer of 1952 to summer of 1953</td>
<td>Scarified August 1953 after slash was scattered</td>
</tr>
<tr>
<td>2</td>
<td>Clear cutting</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Clear cutting in strips</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Clear cutting in strips</td>
<td></td>
<td>Scarified July 1954. Slash windrowed before scarification and then scattered by hand on mineral soil.</td>
</tr>
<tr>
<td>5</td>
<td>Seed-tree cutting</td>
<td>Winter 1953-54</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Clear cutting</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Regeneration was examined on both scarified and unscarified areas. The sampling units were plots, 13.2 feet by 33 feet, divided into ten milacre quadrats each of which was recorded as stocked or not-stocked. Plots were not established on Block 1 (seed-tree cutting) as a severe windstorm in 1954 destroyed nearly all the seed trees. Annual examinations of plots established on Blocks 2 and 3
were made from 1954 to 1956. On Blocks 4 to 6, unscarified plots were examined in 1954, and in 1955 all plots were examined. A forest fire in September 1955 burned Blocks 4 to 6.

**Results**

The per cent of quadrats stocked with jack pine on both scarified and unscarified areas on each of the blocks examined is shown in Table 2.

### TABLE 2.—REGENERATION OF JACK PINE—PERCENT STOCKING BY MILIACRE QUADRATS, SCARIFIED AND UNSCARIFIED AREAS

<table>
<thead>
<tr>
<th>Block</th>
<th>Treatment</th>
<th>Scarified areas</th>
<th>Unscarified areas</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Scarification after slash scattered</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Clear cut</td>
<td>8.0</td>
<td>4.7</td>
</tr>
<tr>
<td>3</td>
<td>Strip cut</td>
<td>16.5</td>
<td>19.0</td>
</tr>
<tr>
<td></td>
<td>Scarification before slash scattered</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Strip cut</td>
<td></td>
<td>45.5</td>
</tr>
<tr>
<td>5</td>
<td>Seed-tree cut</td>
<td></td>
<td>59.0</td>
</tr>
<tr>
<td>6</td>
<td>Clear cut</td>
<td></td>
<td>71.0</td>
</tr>
</tbody>
</table>

1 All seedlings which germinated after logging are included.

2 Per cent stocking for each treatment based on between 170 and 200 quadrats.

Stocking on Blocks 2 and 3 was unsatisfactory regardless of treatment in all of the three years in which regeneration was examined. Scarification did not increase stocking; in fact, the unscarified areas were better stocked than the scarified areas. These blocks, which were cut over between the summer of 1952 and the summer of 1953, were not scarified until August 1953. Scarification was carried out after the slash had been scattered. At the time of scarification, cones were opening and some seedlings had germinated. An examination of 168 seedlings on unscarified areas indicated that more than 60 per cent of the seedlings were 1952 and 1953 germinants. Scarification would have destroyed most of these seedlings and this may be largely the reason why the unscarified areas were better stocked than scarified areas.

Blocks 4 to 6 were cut over during the winter of 1953-54 and scarified in July 1954. Slash was windrowed prior to scarification and then scattered on mineral soil. Scarification greatly increased the stocking with jack pine on all three blocks. Initial stocking was highest on clear-cut areas, intermediate on seed-tree areas, and lowest on strip-cut areas. However, there were indications that mortality would be greatest on the clear-cut areas and least on strip-cut areas, because of seedbed exposure to solar radiation.
On one milacre quadrat per plot, on the scarified areas on Blocks 4 to 6, where scarification preceded scattering of slash, the total number of seedlings and the total number of cones were counted. A regression was calculated for the relationship (Figure 2), using methods described by Schumacher and Chapman (1942). The calculated equation was $Y = 0.213 + 0.053X$, where $Y$ is the number of seedlings, and $X$ the number of cones, both on a milacre basis. The data indicate that quadrats having more than 15 cones present were usually stocked with jack pine cotyledons, although in a few instances even a larger number of cones failed to produce a single seedling. In 1943, Zehngraaff reported that on the Chippewa National Forest in Minnesota, “it requires from 10 to 15 cones per milacre scattered on scarified soil to produce one good seedling.” Jack pine cones among slash which has been lopped and scattered will disseminate approximately 30 seeds each (Eyre, 1936; LeBarron and Eyre, 1939). Thus, at least 400 to 500 seeds may be required to produce a single one-year-old seedling on the Sandilands Forest Reserve.
SCARIFICATION ON CLAY SOILS

On the Riding Mountain National Park an experiment was carried out in mature jack pine stands growing on till soils of clay loam to clay texture. Before logging the stands averaged 150 trees per acre of which 85 per cent were jack pine, 12 per cent white spruce, and 3 per cent trembling aspen. The site is somewhat moist; topography is gently rolling and small wet, treeless depressions occur.

The minor vegetation, prior to logging, consisted of a profuse growth of green alder, dwarf birch, and reed grass. After logging an invasion of grasses occurred (Figure 3).

![Invasion of grass after logging jack pine on the Riding Mountain National Park.](image)

**Experimental Techniques**

In the spring of 1951 four areas which varied in size from two to six acres, and which had been clear cut in December 1950, were scarified with an Athens plough. The slash on Areas 1 and 2 had been lopped and piled during the logging operation. Both areas were completely scarified and slash was then scattered by hand over the exposed mineral soil. Slash was lopped and scattered on Areas 3 and 4 during logging, and narrow strips, located approximately one chain apart, were subsequently scarified on these areas (Figure 4).

Circular one-quarter milacre quadrats were established in 1951 to observe regeneration. All quadrats were examined annually from 1951 until 1954, and in 1956 scarified quadrats were again examined. During each examination all seedlings were tallied in one-year age classes. In 1956, circular milacre quadrats, established concentrically around the one-quarter milacre quadrats on Areas 1 and 2, were recorded as stocked or not-stocked.
Results

Table 3 illustrates the superiority of regeneration on the areas which were completely scarified before slash was scattered (Areas 1 and 2) as compared with regeneration on areas where narrow strips were scarified after slash was scattered (Areas 3 and 4). In 1956, five years after scarification, stocking on Areas 1 and 2 averaged 31.2 per cent, on the basis of one-quarter milacre quadrats, or 40.3 per cent by milacre quadrats. On Areas 3 and 4, the stocking averaged only 6.0 per cent, and on undisturbed litter, regeneration was a failure. It is obvious that complete scarification followed by scattering of slash on mineral soil was a more successful technique than strip scarification after the slash had been scattered.
TABLE 3.—REGENERATION OF JACK PINE—PER CENT STOCKING BY ONE-QUARTER MILACRE QUADRATS, SCARIFIED AND UNSCARIFIED AREAS

<table>
<thead>
<tr>
<th>Area</th>
<th>Year</th>
<th>Basis1 (number of quadrats)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1951</td>
<td>1952</td>
</tr>
<tr>
<td>3</td>
<td>13.8</td>
<td>17.4</td>
</tr>
<tr>
<td>4</td>
<td>21.5</td>
<td>30.5</td>
</tr>
<tr>
<td>Average</td>
<td>19.1</td>
<td>26.4</td>
</tr>
</tbody>
</table>

Strip scarification after slash scattered

<table>
<thead>
<tr>
<th>Year</th>
<th>Basis1 (number of quadrats)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1951</td>
<td>53.1</td>
</tr>
<tr>
<td>1952</td>
<td>30.6</td>
</tr>
<tr>
<td>Average</td>
<td>45.0</td>
</tr>
</tbody>
</table>

Complete scarification before slash scattered

<table>
<thead>
<tr>
<th>Year</th>
<th>Basis1 (number of quadrats)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1951</td>
<td>16.9</td>
</tr>
<tr>
<td>1952</td>
<td>9.7</td>
</tr>
<tr>
<td>Average</td>
<td>12.0</td>
</tr>
</tbody>
</table>

Unscarified

1 All seedlings which germinated after logging are included.
2 Variation in numbers of quadrats examined is due to inability to relocate all quadrats each year.

Seedling survival was higher on the areas which were completely scarified before slash was scattered (Table 4). Slash scattered after scarification provided the seedlings with protection from direct solar radiation and probably retarded the evaporation of moisture from the soil surface. In addition, competition from encroaching vegetation was not as severe where scarification was complete as where only strips were scarified, and this factor aided seedling survival on completely scarified areas.

TABLE 4.—EFFECT OF SCARIFICATION AND SLASH TREATMENT ON SURVIVAL OF JACK PINE SEEDLINGS

<table>
<thead>
<tr>
<th>Year of germination</th>
<th>Strip scarification after slash scattered</th>
<th>Complete scarification before slash scattered</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Number of quadrats stocked with first-year seedlings</td>
<td>Number of quadrats stocked with the same seedlings in 1956</td>
</tr>
<tr>
<td>1951</td>
<td>40</td>
<td>3</td>
</tr>
<tr>
<td>1952</td>
<td>47</td>
<td>10</td>
</tr>
<tr>
<td>1953</td>
<td>12</td>
<td>2</td>
</tr>
<tr>
<td>Total</td>
<td>99</td>
<td>15</td>
</tr>
</tbody>
</table>
DISCUSSION

The results indicate that scarification when carried out carefully using a tractor-drawn Athens plough may be an effective technique of regenerating cut-over jack pine stands. On both the Sandilands Forest Reserve and the Riding Mountain National Park scarification before scattering of slash proved to be a more successful technique for inducing jack pine regeneration than scarification after slash had been scattered.

Where slash was either windrowed or piled prior to scarification a good mineral seedbed was prepared. Slash was subsequently scattered by hand on the mineral soil and moderate jack pine stocking resulted. This treatment was not as successful on the clay loam to clay soils as on the sandy soils because of an exceedingly vigorous growth of grasses which developed following logging on the heavier soils. This rank growth provided intense competition and reduced seedling survival.

On areas where slash was scattered after logging and prior to scarification, accumulations of slash usually occurred adjacent to the tops of the felled trees, whereas between these areas, slash was sparse. Where the accumulations occurred, the Athens plough tended to ride up over the slash and the only areas which were well scarified were those on which there was little slash or seed. It is probable, therefore, that a large portion of the seed supply did not reach a favourable medium for germination. In addition, many cones were likely buried during scarification, and very few of these would open because of lower temperatures below the ground surface. Consequently, regeneration on these areas was little or no better than on unscarified areas.

In Ontario, Holt, Swan and Weetman (1956) have reported the results of a study designed to test soil scarification equipment. It was found that the Athens plough was very poor when operating in slash and in such conditions it seldom succeeded in reaching mineral soil. On the other hand, the Fleco Rock Rake and the Imset scarifier were little hampered by slash.

It is probable that with the use of heavier equipment a satisfactory seedbed could be prepared by scarifying over scattered slash. On the Nisbet Provincial Forest in Saskatchewan, Kabzems and Kirby (1956) have reported that an Athens plough with 200 to 400 pounds weight added was capable of cutting through the slash. In fact, scarification before scattering of jack pine slash did not prove as effective as scarification after the slash had been scattered. The scarification was done in June 1951, and in 1955 the areas which were scarified before slash was scattered were 40.0 per cent stocked while those which were scarified after slash was scattered were 52.8 per cent stocked.

The experiments show that additional research is needed in Manitoba before the problem of securing natural jack pine regeneration after logging is solved. Among the phases which should be investigated are scarification using various types of equipment before clear cutting, and scarification after logging and after scattering of slash. In future regeneration studies, the ecological factors affecting jack pine regeneration on various sites should be investigated more intensively.

SUMMARY

In Manitoba two experiments have been undertaken by the Forestry Branch to study various silvicultural techniques of reproducing jack pine. On the Sandilands Forest Reserve in the southeast corner of the province, an experiment was undertaken on sandy soils in which three methods of cutting were carried out: clear cutting, clear cutting in strips, and seed-tree cutting.
After logging, portions of each treatment were scarified, in some instances before scattering of slash, and in other instances after scattering of slash. On the Riding Mountain National Park in western Manitoba, scarification carried out both before and after scattering of slash was tested in previously clear-cut stands growing on till soils.

The following results were obtained from the two experiments:

1. Scarification followed by scattering of fresh cone-bearing slash resulted in moderate initial stocking on both sandy and clay soils, although better results were obtained on the former. On sandy soils clear-cut areas had the best stocking, seed-tree areas were intermediate, and strip-cut areas the poorest.

2. Scarification after scattering of cone-bearing slash was not a successful silvicultural technique for reproducing jack pine, either on sandy or clay soils. Regeneration on these scarified areas was little or no better than on unscarified areas.

3. At least 15 cones among slash scattered on mineral soil were usually required to produce a single one-year-old jack pine on sandy soil.
REFERENCES


APPENDIX

Common and Botanical Names of Plants Mentioned in Text

Alder, green .................. Alnus crispa (Ait.) Pursh
Aspen, trembling ............... Populus tremuloides Michx.
Bearberry .......................... Arctostaphylos uva-ursi (L.) Spreng.
Birch, dwarf .................. Betula glandulosa Michx.
Blueberry .......................... Vaccinium angustifolium Ait.
Blueberry .......................... Vaccinium myrtilloides Michx.
Grass, reed .................. Calamagrostis canadensis (Michx.) Nutt.
Pine, jack .................. Pinus banksiana Lamb.
Spruce, white .................. Picea glauca (Moench) Voss
Wintergreen .................. Gaultheria procumbens L.