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SUCCESS OF SCARIFICATION AND SEEDING IN CLEARWATER-ROCKY FOREST - ALBERTA

by

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INTRODUCTION

Since 1959, the Alberta Department of Lands and Forests has scarified yearly about 10,000 acres of land in partially cut mixedwood stands and in young aspen stands. The authors conducted a survey during the summer of 1966 to determine the success of natural and artificial seeding of white spruce (Picea glauca Moench Voss) and lodgepole pine (Pinus contorta Dougl. var. latifolia Engelm) on treated areas in Clearwater-Rocky Forest.

Seeding was used successfully in European forestry several centuries ago, long before planting became an accepted method in reforestation. It is easier and faster than conventional planting and generally less costly. On the other hand, it requires better site preparation and the success of properly executed seeding depends almost entirely on the weather during seed germination.

Considerable research in proper regeneration after logging, either by natural or direct seeding, has been conducted in Canada.

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Researchers working in Alberta (Crossley, 1955; Quaite, 1956; Ackerman, 1957; Lees, 1963), agree that mineral soil is the most favorable seedbed for the establishment and survival of both white spruce and lodgepole pine. The removal of vegetation and duff to expose the mineral soil introduced the practice of scarification.

Scarification may not be necessary on dry sites where the vegetation is not heavy and the depth of organic material is shallow. The exposure of mineral soil seedbeds should be restricted to fresh-to-moist sites only; scarification should be avoided on wet sites because it would be ineffective (Rowe, 1955; Ackerman, 1957; Horton, 1962).

Large scarified spots are recommended instead of small scarified spots because the former remain receptive for about five years even under partially cut stands (Lees, 1963).

Seeding should be carried out in the late fall or early spring to secure spring germination which provides maximum opportunity for seedling survival (Cayford, 1959). Seeding in late summer and early fall should be avoided because seedlings would not harden off and early frosts would cause high mortality (Waldron, 1966).

DESCRIPTION OF STUDY AREAS

The study areas are situated in the Lower Foothills Section (B.19a), which is a transitional zone between Boreal and Subalpine Regions (Rowe, 1959). This area has moderately warm summers and cold winters. The mean summer temperature is 50 F and January is the coldest month with a mean average of 10 F. The average annual precipitation is

slightly under 20 inches, and about 60 per cent of total precipitation falls during the growing season. The average frost-free period is only 50 days.

The most common soil parent-material is glacial till with occurrence of alluvial, lacustrine and aeolian deposits. Scarification was carried out in two different forest types: 1) Partially cut mixedwood stands where natural seeding was expected after mineral soil exposure, and 2) Young aspen stands where scarified areas were spot-seeded with spruce or lodgepole pine.

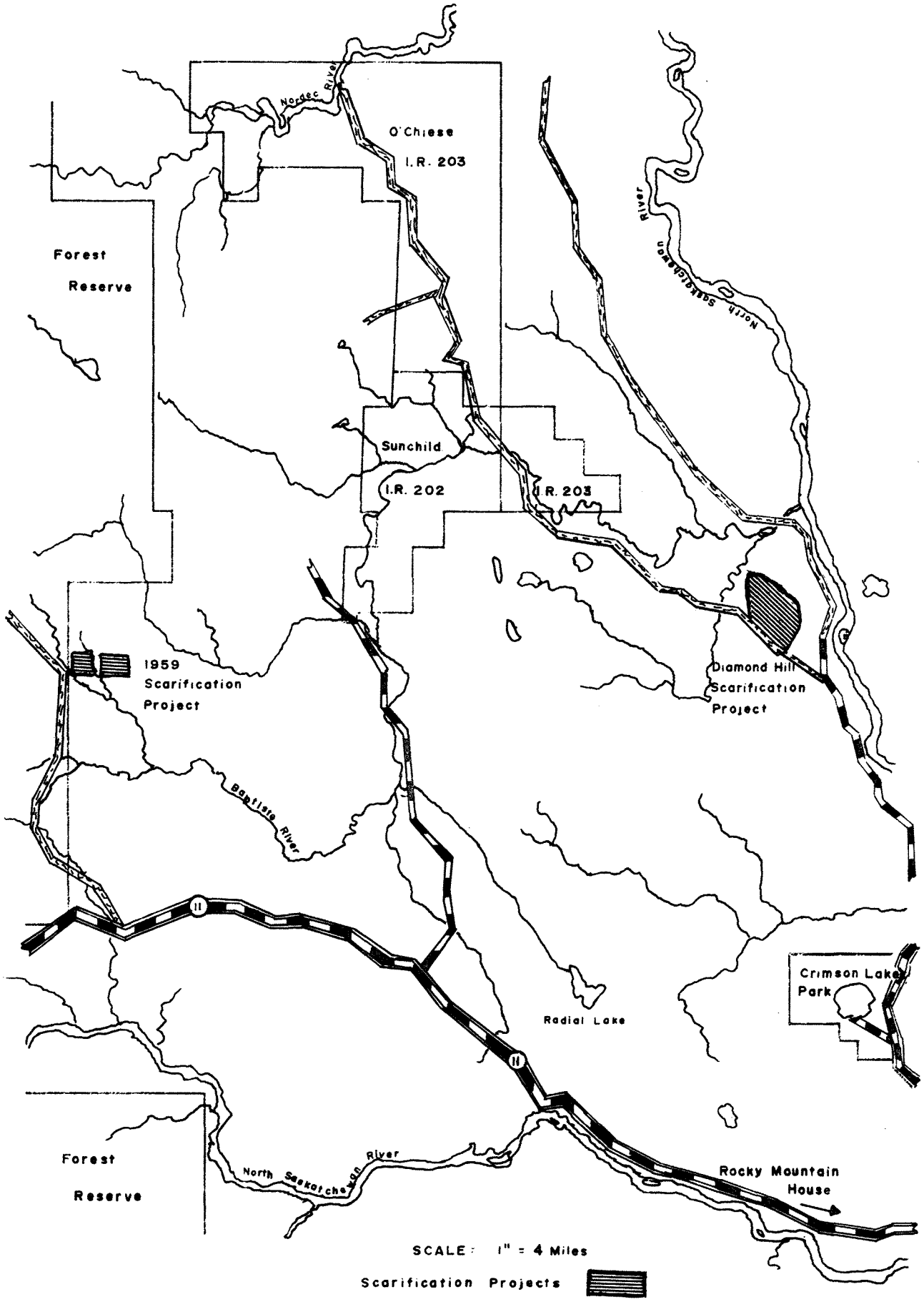
Partially Cut Mixedwood Stands

Three stands partially logged between 1950-1952 were scarified in 1959. These stands are located in Township 42, Range 11 west of 5th Meridian near Jackfish Lake, approximately 40 miles northwest of Rocky Mountain House (Fig. 1). The average stand age was 80 years. A total area of 60 acres was scarified with a John Deere 420 tractor equipped with hydraulic dozer. The average cost of scarification was $10 per acre. A cone crop was present at the time of scarification, so artificial seeding was omitted.

Conversion of Young Aspen Stands

The general area is located in Township 42, Range 9 west of the 5th Meridian near Sunchild Indian Reservation, 22 miles north of Rocky Mountain House (Fig. 1).

Fig. 1. Location of scarification projects



After being logged in the early part of this century, the area was swept by several fires and as a result dense, vigorously growing aspen stands were established. The average age of these stands was 17 years and the stocking consisted of 1200 to 2500 stems per acre. Strips varying between 13 and 17 ft in width were cleared of aspen by bulldozers and residual aspen strips about 9 ft wide were retained. The cleared strips were scarified and seeded during the fall of 1960 and the fall and winter of 1961.

1960 Fall Scarification and Seeding

A D-4 caterpillar with dozer blade was used to clear strips in a 17-year-old aspen stand. Fifty-eight acres were subsequently spot-scarified by dozer blade and 42 acres were prepared for seeding with an Athens plow. The average cost of scarification was $10 per acre including the cost of seeding. About 3 oz of spruce seed per acre was sown during late fall of 1960.

1961 Fall Scarification and Seeding

Two D-7 caterpillars were used to scarify a total area of 260 acres at an average cost of $9.08 per acre. One-hundred acres were seeded with lodgepole pine and 160 acres with white spruce seed. The amount of seed sown per acre was not recorded. The blade of the D-7 caterpillar was angled and kept continuously in the ground, which resulted in good mineral soil exposure.

1961 Winter Scarification and Seeding

A total of 125 acres was scarified with D-7 and D-8 caterpillars in December, 1961. Owing to heavy frost, the caterpillars had to make two passes before the area was satisfactorily scarified. The average cost of scarification and seeding per acre was $10.34. The amount of seed sown per acre was not noted.

SURVEY METHODS

All areas scarified and seeded between 1959 and 1962 were surveyed during the summer of 1966. Sampling was done on 1-milacre quadrats in groups of eight, arranged in a double row of four. Each milacre quadrat was examined for degree of scarification, presence of regeneration and advance growth, height of seedlings, growing medium of seedlings, vegetative competition, and moisture regime.

Only those quadrats with at least 1 sq ft of mineral soil exposed were considered scarified. All seedlings established before scarification were recorded as advance growth. The height of the tallest seedling originating after scarification was measured to the nearest 1/10 inch. Five seedbed media were recognized: 1) Mineral soil, 2) Rotten wood, 3) Duff, 4) Humus, 5) Mixture (any combination of previously listed media). Four classes were used to describe the existing vegetative competition: nil, light, medium, and heavy.

Three moisture-regime classes were established: 1) Normal. This is the most common for the general area. 2) Drier than normal. 3) Wetter than normal.

The normal moisture-regime class was identified for both areas, partially cut mixedwood stands and young aspen stands, as somewhat moist (3).

RESULTS

Partially Cut Mixedwood Stands

A total of 664 milacres were sampled and were evenly distributed throughout the entire area. Table 1 shows that 41 per cent of the total area was scarified. The wetter sites supported the most regeneration after scarification. The drier sites were not regenerated to spruce; only lodgepole pine advance growth was present when the survey was conducted. Only 14 per cent of the total area was stocked with spruce regeneration and the total stocking amounted to 22 per cent including advance growth. Figure 2 shows that approximately 2/3 of stocked quadrats were found on areas with normal moisture regime. The total height of spruce seedlings was greater on normal than on wetter sites, probably due to the cooler soil temperatures of the latter.

Stocked quadrats occurred only on sites with heavy and moderate vegetative competition. Although the difference in total height between moderate and heavy vegetative classes was not striking, seedlings growing under heavy competition were taller (Fig. 3).

The most common soil media on treated areas were mineral soil, humus, rotten wood, and mixtures. The tallest seedlings were found on humus, rotten wood, and mineral soil, and the smallest on the duff and mixture (Fig. 4).

Table 1. Success of spruce regeneration in partially cut mixedwood stands.

Moisture regime	Area scarified (%)	Percentage of regeneration		Advance growth (%)	Total stocking (%)
		Scarified area	Unscarified area		
Normal	35	24	4	8	18
Wetter than normal	76	52	6	3	44
Drier than normal	76	-	-	*29	29
TOTAL for area	41	27	4	8	22

* Advance growth consisted of lodgepole pine only.

Fig. 2. Average height of tallest spruce seedlings under various moisture conditions.

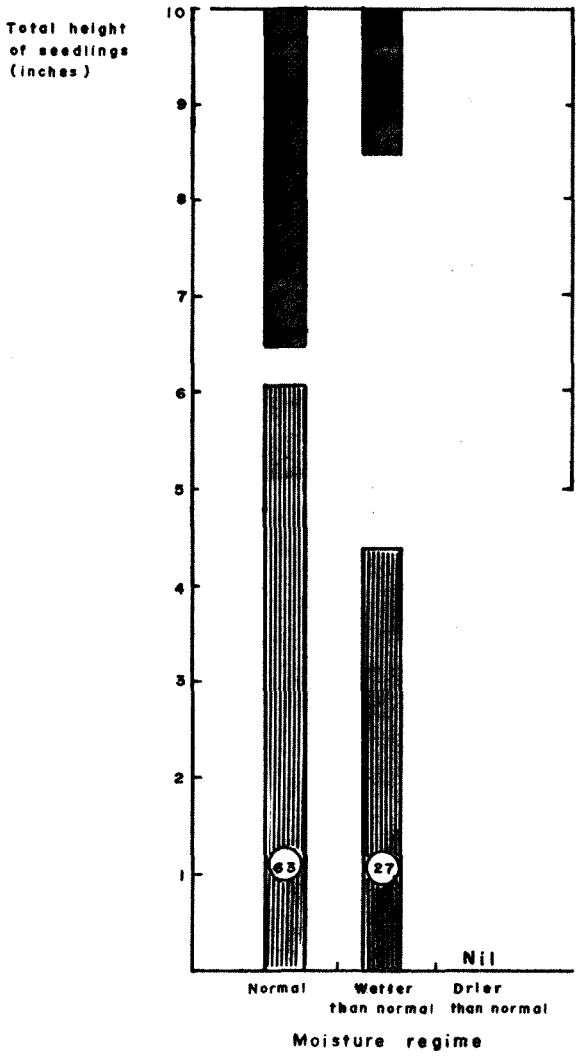


Fig. 3. Average height of tallest spruce seedlings under various vegetative competition.

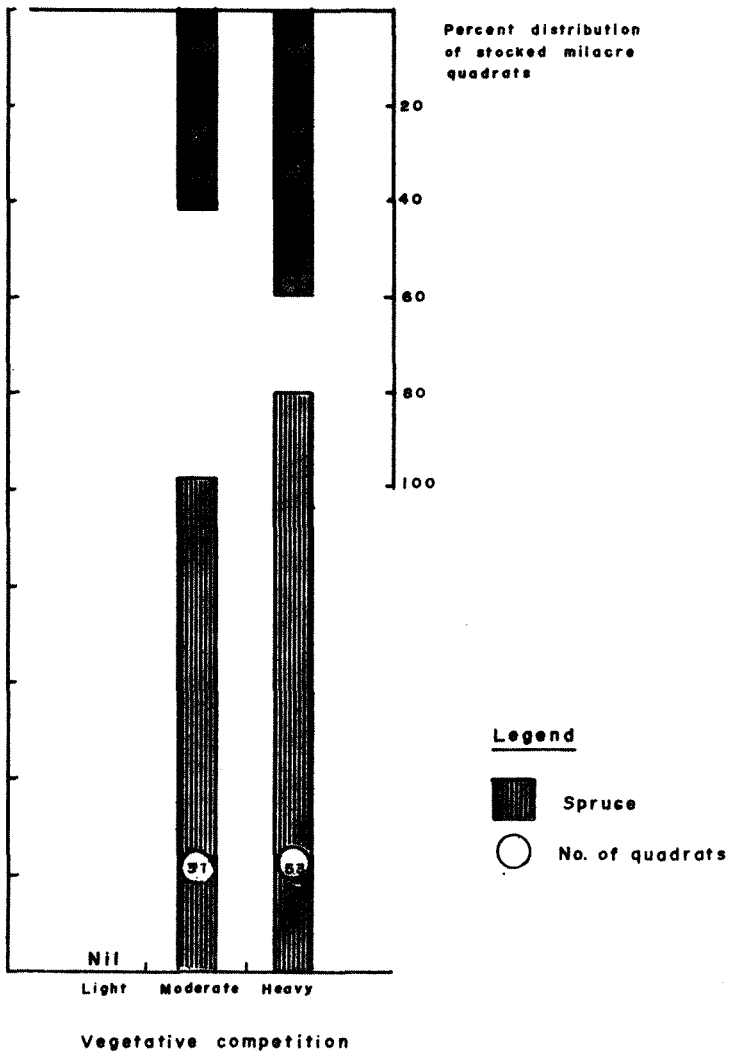
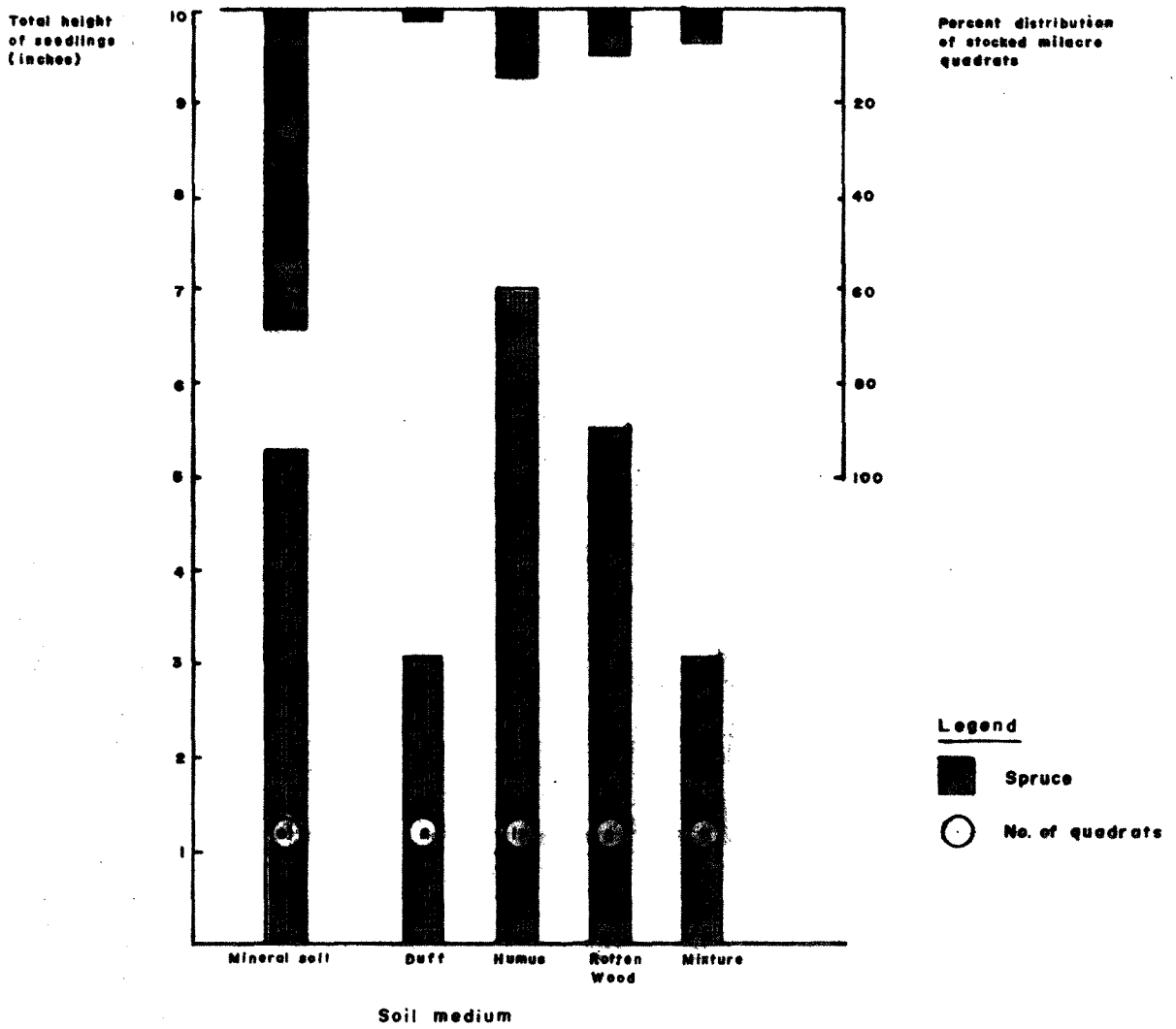


Fig. 4. Average height of tallest spruce seedlings in various soil media.



Conversion of Young Aspen Stands

1960 Fall Scarification and Seeding

Four-hundred milacres were systematically distributed over the cleared strips. All information obtained pertain to the strips rather than the entire area. Table 2 indicates that 58 per cent of strips were scarified and the best regeneration occurred on relatively dry sites. The total stocking derived from scarification and seeding is low at 20 per cent.

Most of the stocked quadrats were found on sites in the normal and wetter-than-normal classes and only a few were on drier-than-normal sites. The tallest seedlings were observed on dry sites and the smallest on normal sites (Fig. 5).

Most of the stocked quadrats had moderate and heavy vegetative competition, and the total height of seedlings appeared to be similar under variable vegetative competition (Fig. 6).

The most common growing medium was mineral soil and only a small percentage of mixture, humus, and rotten wood occurred. The tallest seedlings grew in mineral soil and the poorest in rotten wood (Fig. 7).

1961 Fall Scarification and Seeding

A total of 536 evenly distributed, one-milacre quadrats were sampled on the area that was seeded to both species, spruce and lodgepole pine. Since the blade of the bulldozer was down continuously, excellent mineral soil exposure was achieved, resulting in an average of 88 per cent for spruce and 90 per cent for lodgepole pine. The

Table 2. Success of spruce seeding in young aspen stands

Moisture regime	Area scarified (%)	Percentage of regeneration		Advance growth (%)	Total stocking (%)
		Scarified area	Unscarified area		
Normal	57	31	3	2	21
Wetter than normal	60	31	5	1	21
Drier than normal	83	60	-	-	50
TOTAL for area	58	31	3	1	21

Fig. 5. Average height of tallest spruce seedligs under various moisture conditions.

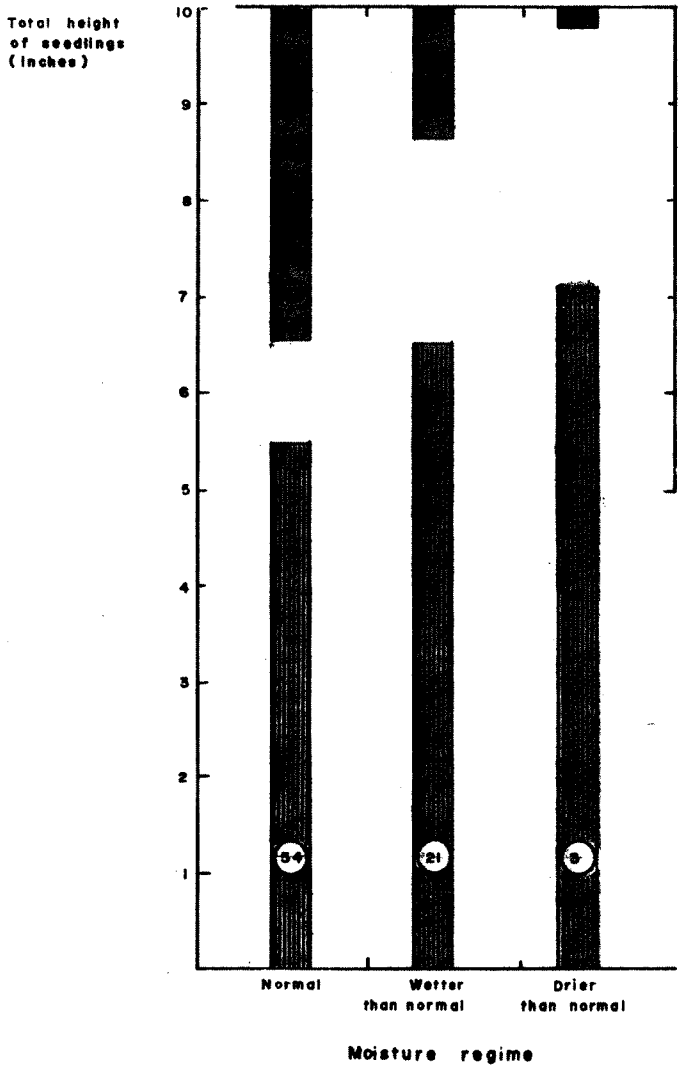


Fig. 6. Average height of tallest spruce seedlings under various vegetative competition.

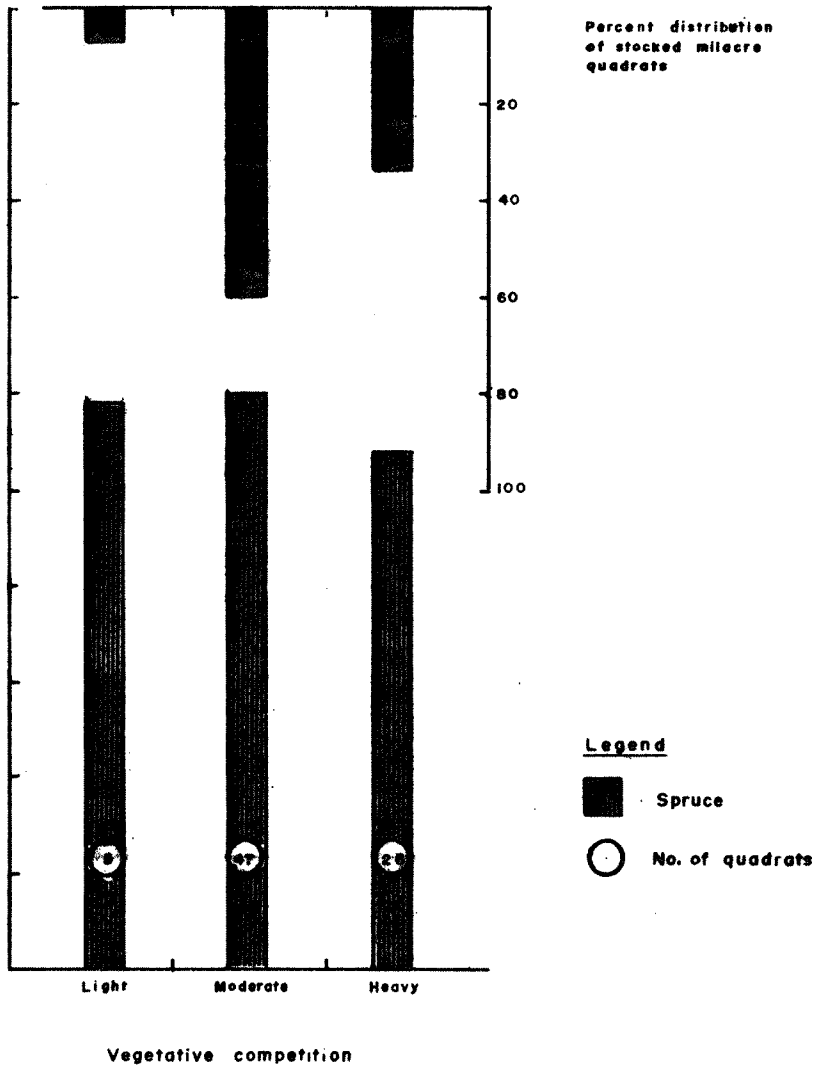
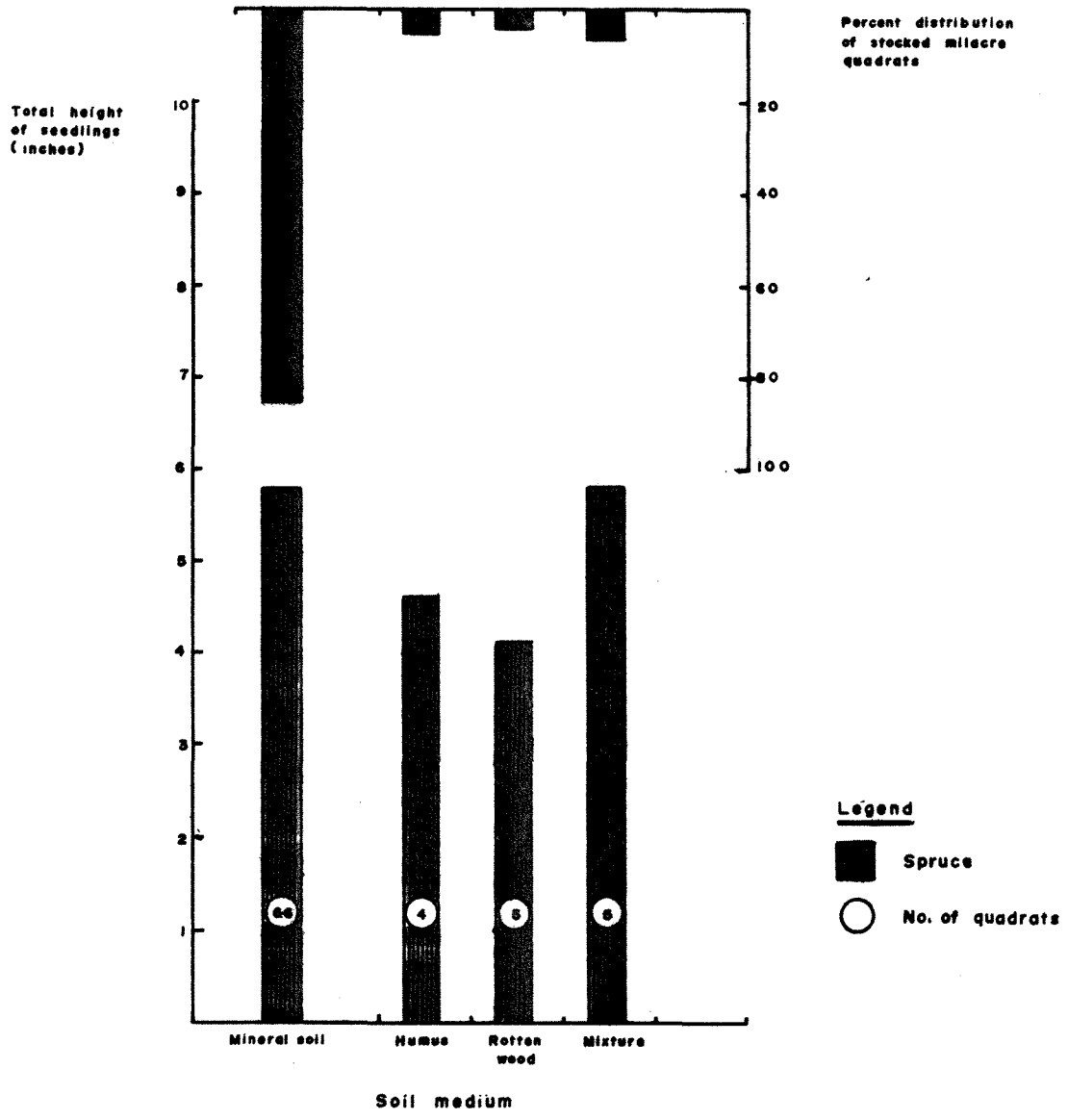


Fig. 7. Average height of tallest spruce seedlings in various soil media.



success of seeding was slightly better for spruce than for lodgepole pine, with a stocking of 42 and 33 per cent respectively (Table 3).

Most of the stocked quadrats of both species were found on sites with normal moisture regime (Fig. 8). Considerably more seedlings of spruce than of pine occupied the wetter sites, while the opposite was true on the drier sites. The tallest lodgepole pine seedlings were observed on dry sites and the smallest on wet sites, while a similar trend was not evident for spruce seedlings.

Figure 9 shows that the vegetative competition has little influence on the height growth of spruce and pine seedlings. Most of the spruce seedlings were found on mineral soil although some seedlings were established on humus, rotten wood, and mixtures (Fig. 10). The tallest spruce seedlings were growing on mixtures and mineral soil, while seedlings on rotten wood and humus were slightly smaller.

Pine seedlings were found only on mineral soil and mixtures and the tallest seedlings were growing on mineral soil (Fig. 10).

1961 Winter Scarification and Seeding

A total sample of 464 milacres was distributed evenly throughout the entire area. Owing to heavy frost conditions at the time of scarification, the exposure of mineral soil was much less than was in the fall scarification. Only 47 per cent of the strips were scarified and 21 per cent of the treated area stocked (Table 4). The stocking appeared to be fairly uniform on all sites regardless of moisture regime.

Table 3. Success of seeding in young aspen stands.

Species	Moisture regime	Area scarified (%)	Percentage of regeneration		Advance growth (%)	Total stocking (%)
			Scarified area	Unscarified area		
White spruce	Normal	88	52	8	-	47
	Wetter than normal	93	39	-	1	38
	Drier than normal	67	43	-	-	29
TOTAL for area		88	47	5	1	43
Lodgepole pine	Normal	90	35	8	1	33
	Wetter than normal	75	27	-	-	20
	Drier than normal	97	39	-	-	38
TOTAL for area		90	35	6	1	33

Fig. 8. Average height of tallest spruce and pine seedlings under various moisture conditions.

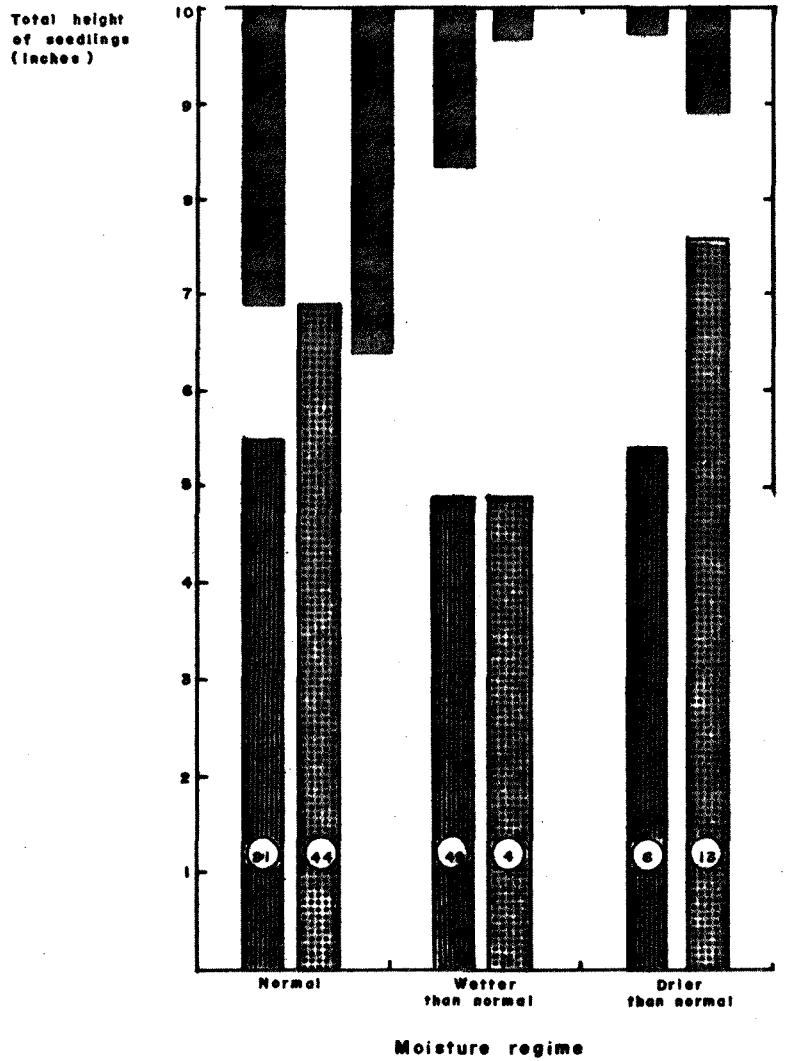
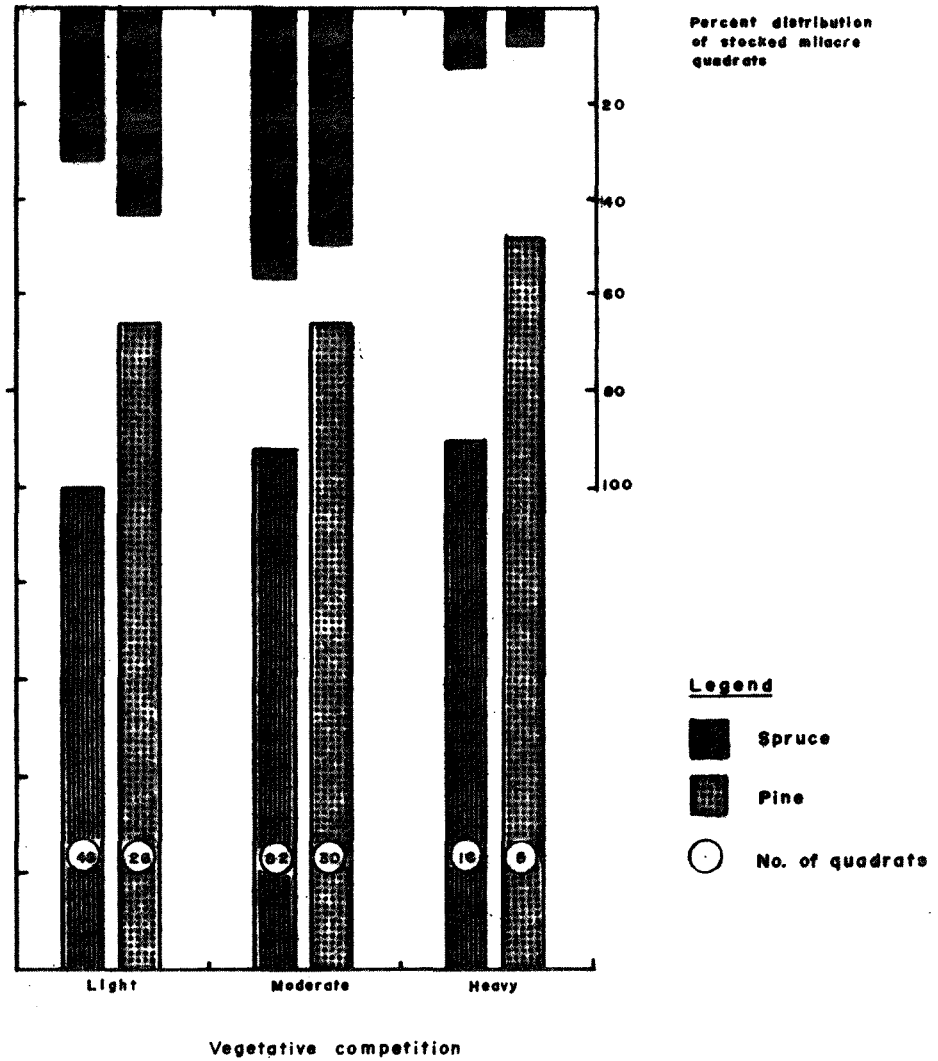


Fig. 9. Average height of tallest spruce and pine seedlings under various vegetative competition.



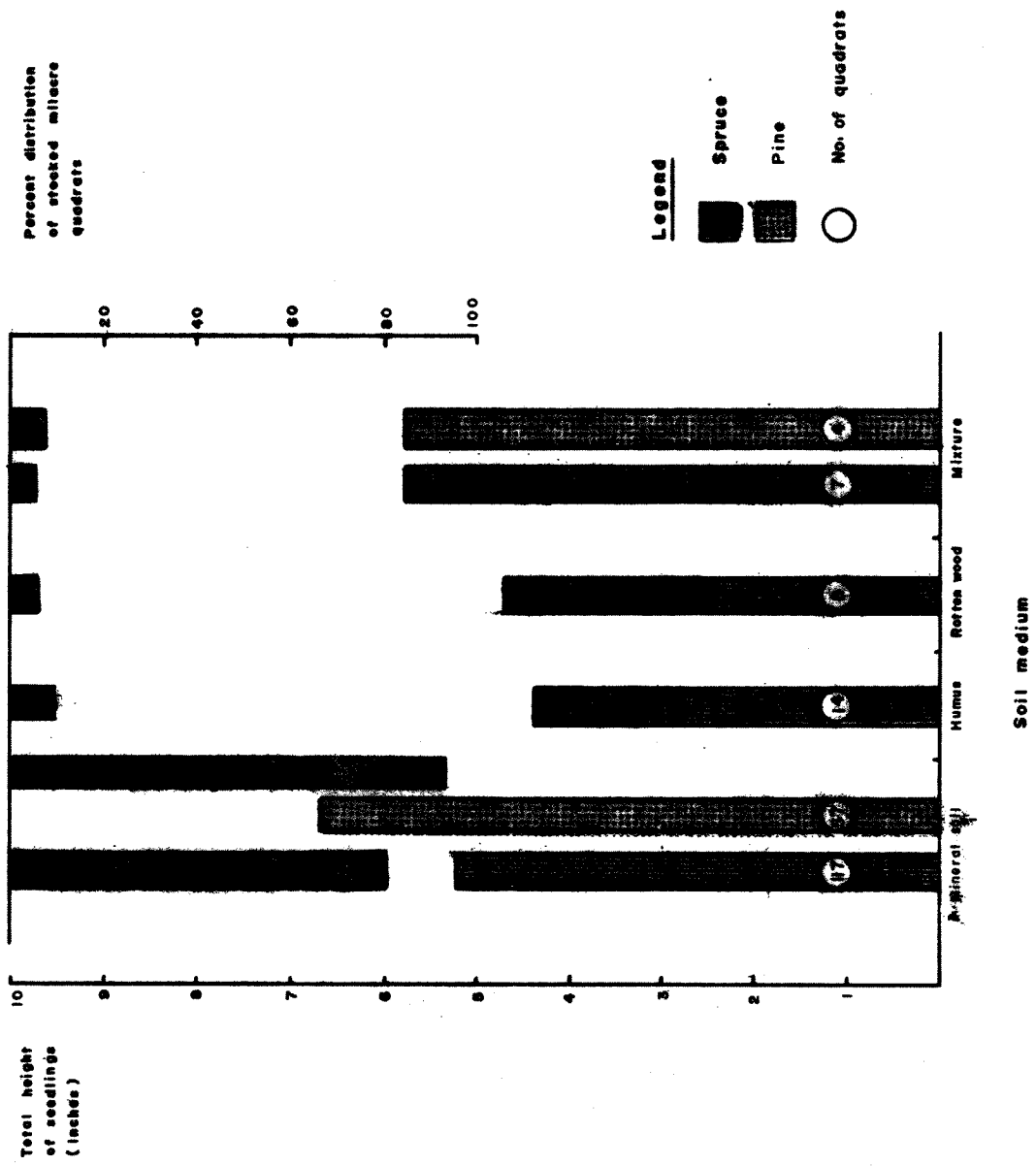


Fig. 10. Average height of tallest spruce and pine seedlings in various soil media.

Table 4. Success of spruce seeding in young aspen stands.

Moisture regime	Area scarified (%)	Percentage of regeneration		Advance growth (%)	Total stocking (%)
		Scarified area	Unscarified area		
Normal	45	37	5	1	20
Wetter than normal	53	43	9	2	29
Drier than normal	46	45	-	1	22
TOTAL for area	47	39	5	1	22

Fig. 11. Average height of tallest spruce seedlings under various moisture conditions.

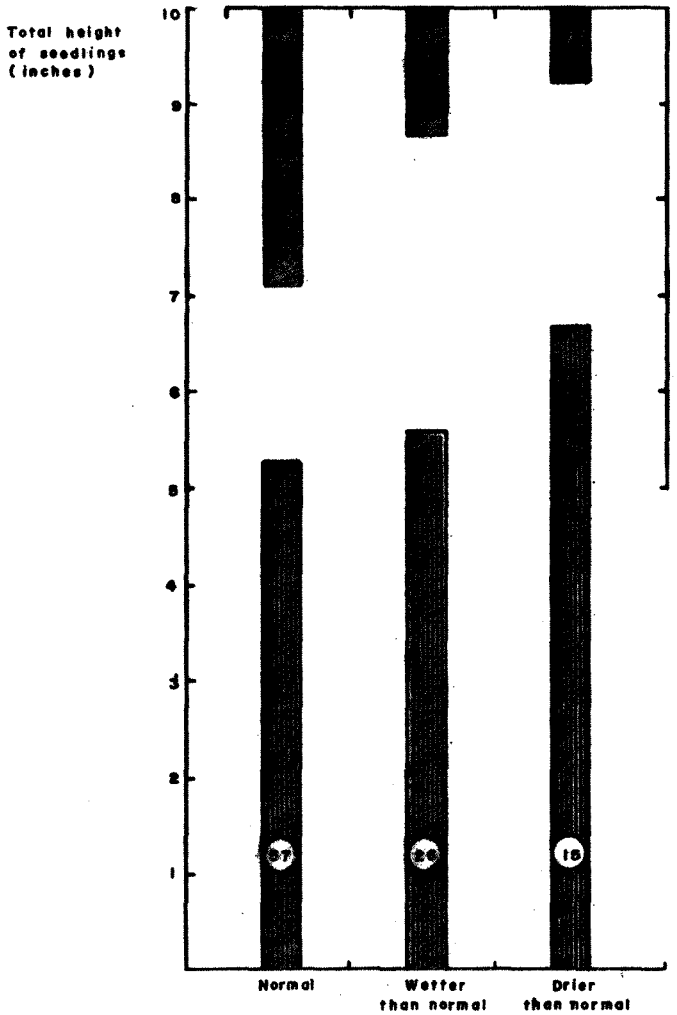
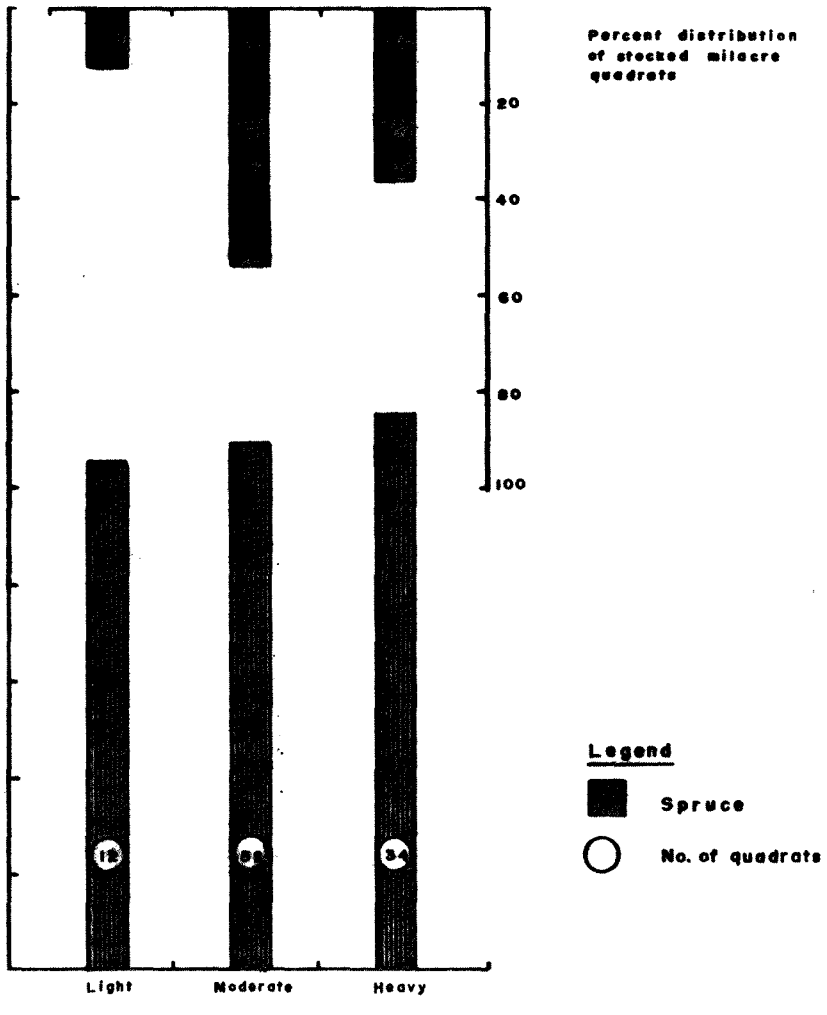


Fig. 12. Average height of tallest spruce seedlings under various vegetative competition.



The distribution of stocked quadrats shows that sites with normal moisture regime were more common than wet or dry sites (Fig. 11). The tallest spruce seedlings were found on drier than normal sites. Most of the seedlings were growing under moderate vegetative competition (Fig. 12). The degree of vegetative competition did not influence the total height of seedlings. Mineral soil was the most common soil medium although about 1/3 of seedlings were found on humus and rotten wood (Fig. 13). The tallest seedlings grew on mineral soil and the smallest in rotten wood.

CONCLUSIONS AND RECOMMENDATIONS

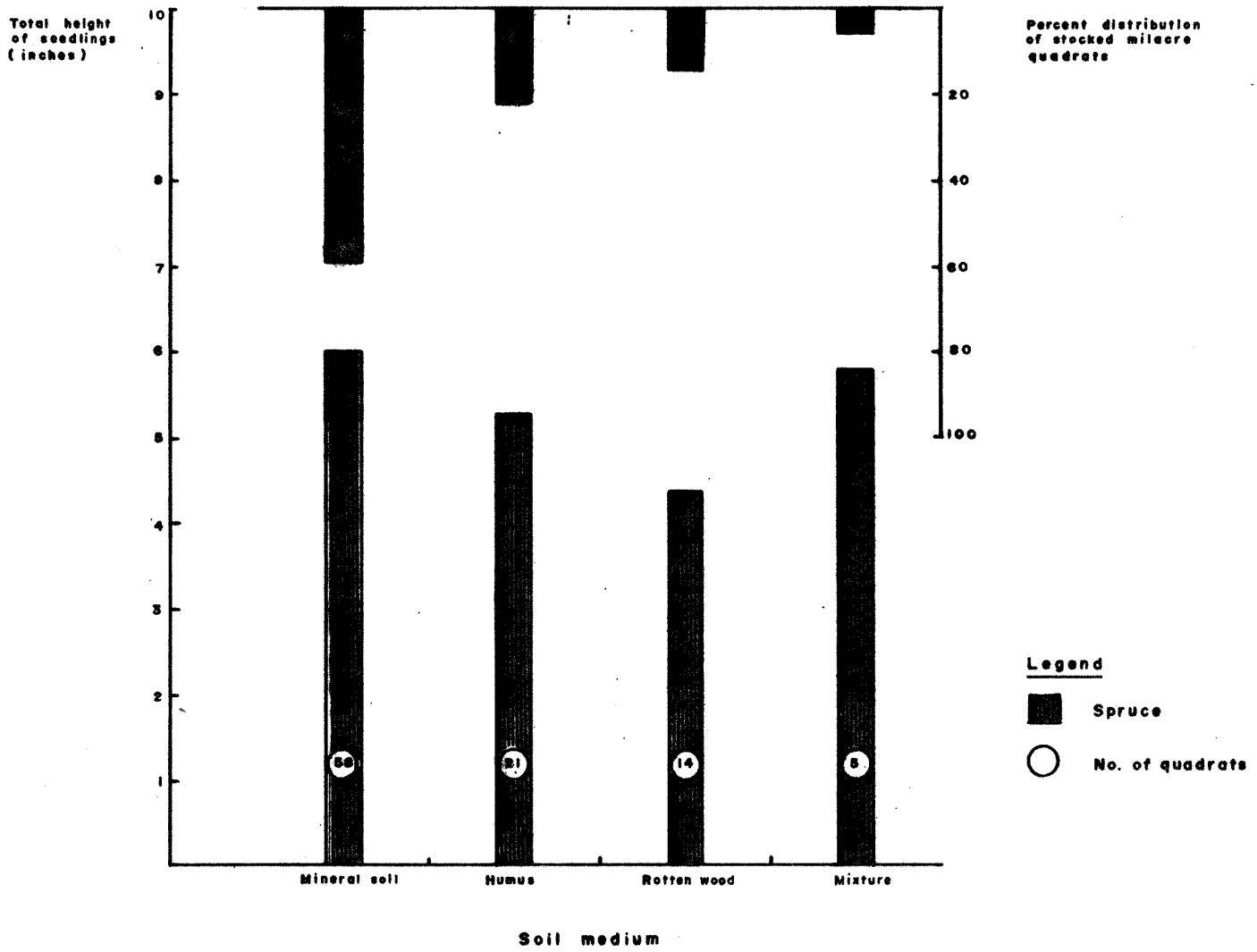
Results show that owing mainly to low intensity of scarification, poor stocking was obtained under partially logged mixedwood stands. The timing of scarification was correct because enough natural seed was available to regenerate the scarified areas.

Scarification and seeding in young aspen stands was only successful in the fall of 1961, when the coverage of scarification was approximately 90 per cent. The reason for the high intensity of scarification was that the blade of the caterpillar was kept in the ground continuously.

Winter scarification under severe frost conditions was not satisfactory for three reasons: 1) Low intensity of scarification, 2) Relatively high costs, 3) Low stocking.

The following recommendations are based on the results of this study and a selected literature review:

Fig. 13. Average height of tallest spruce seedlings in various soil media.



1. Young, vigorous aspen stands should not be converted to softwoods because of the high probability that they will be utilized at maturity.
2. Approximately 60 per cent of the total area should be scarified to achieve 40 per cent stocking.
3. Under partially cut stands, large patches should be scarified to delay the invasion of grasses and shrubs.
4. When heavy vegetation is present, deep scarification should be practised.
5. Wet areas should not be scarified, because they are not suitable for seeding owing to the flooding effect on germinants.
6. When inferior young aspen stands are converted to softwoods, the whole strip should be scarified to compensate for the residual strip.
7. Seeding should be carried out in the late fall or winter, or early spring. Only high spots should be seeded if microtopographic conditions are not uniform.
8. Seeding and planting of lodgepole pine under dense aspen stands should be discontinued, because lodgepole pine is a shade-intolerant species. White spruce is more suited to this purpose.
9. All seeded areas should be checked after the second growing season; in case of failure, re-seeding should be done to protect the scarification investment.
10. If topographic and economic conditions allow, the conversion of inferior aspen stands by machine planting should be considered.

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