CLEAR CUTTING ALTERNATE STRIPS AND SCARIFYING IN PURE WHITE SPRUCE STANDS TO INDUCE WHITE SPRUCE REGENERATION SASKATCHEWAN

by

V.S. Kolabinski

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CLEAR CUTTING ALTERNATE STRIPS AND SCARIFYING IN PURE WHITE SPRUCE STANDS TO INDUCE WHITE SPRUCE REGENERATION SASKATCHEWAN

Project MS-211

by

V.S. Kolabinski[1]

INTRODUCTION

In 1959 the Department of Forestry in co-operation with the Saskatchewan government began a study to determine whether clear cutting in alternate strips and mechanical seedbed preparation in pure white spruce stands would induce enough regeneration to form potentially merchantable stands.

Between 1959 and 1967 a total of six study areas has been established, but one (area 2) was burned and is no longer part of the study.

This report has been prepared to record the establishment of area 6, summarize the work completed on the project during the summer of 1966 and outlines the work proposed for 1967.

For further details concerning the scope of this project, methods of assessing results, scarification preliminary results, etc., the reader is referred to the project plan for MS-211, progress reports MS-211-1959, MS-211-1961, MS-211-1962, 63-MS-2, 64-MS-22 and internal report MS-6.

LOCATION AND ESTABLISHMENT, AREA 6

Area 6 was established in the fall of 1964 by the Saskatchewan Department of Natural Resources. It is approximately 33 acres in size and is located in Sec. 9, Twp. 66, Rge. 10, W 3 Mer., in the Prince Albert Region.

The area was divided into 2-chain-wide (east-west) strips; alternate strips were marked for cutting. Logging operations took place during the winter of 1964-65. All merchantable white spruce were removed from the strips that had been designated for cutting.

Seedbed treatment (on the cut-over strips) was carried out in September of 1965. A TD-20B crawler tractor equipped with a straight blade was used.

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[1]Forest Research Technician.

WORK DONE IN 1966

Plot Establishment Area 6

In July 1966 the Department of Forestry established on Area 6 a total of 315 randomly located milacre quadrats to assess regeneration. Two hundred and four quadrats were located on cut-over strips; 102 quadrats on scarified ground and 102 on non-scarified. In the uncut strips 111 quadrats were established.

Per cent stocking and number of stems per acre at the time of plot establishment are given in Tables 1 and 2 respectively. Distribution of seedbed types and occurrence of softwood regeneration on various seedbeds is given in Table 3.

In addition eight 1/5-acre plots were established in the uncut strips to supply stand data. All living trees over 0.5 inches d.b.h. were tallied by 1-inch diameter classes. Dead trees were blazed. The average stand table is shown in Table 4.

The location of all plots were recorded on maps for future reference.

Plantations

Between the spring of 1961 and 1964 small observation plantations were established on four of the study areas in this project by personnel of the Saskatchewan Forestry Branch. White spruce transplants (planted by the slit method at a 4 x 4 foot spacing) were set out on the following three conditons: (1) on cut-over scarified strips, (2) on cut-over not scarified strips and (3) in uncut strips. The objective is to determine whether or not uncut strips, cut-over scarified strips and cut-over unscarified strips can be regenerated satisfactorily by planting.

Area 1:

This area was established in 1959. It is about 53 acres in size and is located in the Hudson Bay Region of Saskatchewan in Twp. 41, Rge. 3, W.2. Mer. The area was logged during the winter of 1959-60 and scarified in August of 1960. Scarification was done with a TD-14 crawler tractor equipped with the Saskatchewan fire-line plow.

During the first week in June 1961 a total of 958 white spruce seedlings (2-2 stock from the Big River Nursery) were planted. Three hundred and twenty-one seedlings were set out on a cut-over scarified strip, 315 on a cut-over not scarified strip, and 322 on an uncut strip. For the period 1962 to 1966 the plantation plots on this area have been examined annually. At each re-measurement seedlings were classed as healthy, sickly, dead or browsed; the total height of survivors was measured to the nearest tenth of an inch.

Survival to August 1966 (Table 5) has been best on the cut-over scarified strip, poorest in the uncut strip and intermediate on the cut-over unscarified strip. The highest mortality (on all three conditions) occurred during the first growing season (1961-1962) and then became progressively less. On the cut-over scarified strip

20 per cent mortality was recorded in 1962; 18 per cent more occurred between 1962 and 1966. On the cut-over unscarified strip mortality was 39 per cent in 1962 with an additional 17 per cent occurring between then and 1966. On the uncut strip 50 per cent of the seedlings were dead in 1962 and 22 per cent more died between 1962 and 1966.

Condition of surviving seedlings (Table 6) to 1966 has generally been the better for seedlings on the cut-over scarified and unscarified strips than on the uncut strip. Between 1961 and 1962 the plantations were heavily browsed. More seedlings were browsed in the uncut strip than in the cut-over strips. This damage consisted of the removal of leaders and/or some of the laterals and probably contributed to the high percentage of sickly seedlings recorded in 1962. However browsing damage for the period 1962 to 1966 has been considerably less. In the summer of 1964 many terminals and laterals of seedlings in the cut-over strips were dead. Since none of the terminals of seedlings in the uncut strip were so affected it is believed that the damage was due to a late spring frost and that at the time the damage occurred seedlings on the uncut strip had not yet flushed.

Height growth of seedlings has been better consistently for seedlings on the cut-over strips than on the uncut strip. The average height (Table 7) of seedlings in 1966 was 22.9 inches on the cut-over scarified strip, 21.6 inches in the cut-over unscarified strip but only 9.5 inches on the uncut strip. Height increase for seedlings in both the cut-over scarified and cut-over unscarified strips has been the same, averaging 2.7 inches annually. In the uncut strip average annual increase for the same period has only been 0.9 inches.

Although height growth (on all three conditions) has been obscured by browsing in 1962 it is evident that seedling development is adversely affected by an overhead canopy.

Area 3:

This area, in the Prince Albert Region, is about 11 acres in size and is located in Twp. 53, Rge. 26, W.2. Mer. Logging took place during the winter of 1959-60. Scarification was done in August of 1960 with a TD-18 crawler tractor using a straight blade.

In June 1961 a total of 582 white spruce seedlings (2-2 stock from the Big River Nursery) were planted. Two hundred and one were set out on a cut-over scarified strip, 199 on a cut-over unscarified strip and 179 in an uncut strip. Measurements of seedling survival and growth (with exception of 1964) have been made annually.

Survival of seedlings to August 1966 is summarized in Table 8. The data shows that overall survival has been best on the cut-over scarified strip, next best in the uncut strip and poorest in the cut-over unscarified strip. Mortality during the first growing season (1961-62) was extremely high on the cut-over unscarified strip. On this condition 71 per cent of the seedlings died in 1962 as compared to 30 per cent on the cut-over scarified strip and 39 per cent on the uncut strip.

Reasons for the poor survival on the cut-over unscarified strip were not apparent, but it was observed that grass and ground vegetation in 1962 was extremely dense on this particular area. Competition from these plants may have been a major contributing factor to seedling mortality.

Mortality between 1962 and 1966 on the cut-over scarified and unscarified strips was 7 and 9 per cent while on the uncut strip it was 19 per cent.

Condition of survivors (Table 9) to 1966 on the cut-over scarified strip has been better than that of those on the cut-over unscarified and uncut strip. Extensive browsing damage occurred (as on Area 1) between 1961 and 1962. Here again more seedlings were browsed in the uncut strip than in the cut-over strips. Further damage from 1962 to 1966 was noted only in 1963 when 3 per cent of the seedlings in the cut-over scarified strip were recorded as browsed.

Height growth for the first six years after planting has been best for seedlings on the cut-over scarified strip, next best on the cut-over unscarified strip and poorest in the uncut strip (Table 10). On the cut-over scarified strip the average plantation height in 1966 was 30.5 inches, on the cut-over unscarified strip 24.0 inches but only 11.3 inches on the uncut strip. Average annual height increase has been 3.8 inches on the cut-over scarified strip as compared to 2.6 inches on the cut-over unscarified strip and 0.9 inches in the uncut strip.

Height growth of the seedlings (on all three conditions) has probably been obscured to some degree by the browsing damage in 1962, but the comparative figures (Table 10) do indicate that the presence of an overstorey has had an adverse effect on growth of seedlings.

Area 5:

This area was established in 1962. It is about 34 acres in size and is located in Twp. 42, Rge. 3, Sec. 10, W.2. Mer. in the Hudson Bay Region. Logging operations were carried out during the winter of 1962-63 and seedbed preparation was done in September of 1963 with a D-7 crawler tractor using a straight blade.

Small experimental plantations were set out on this area in the spring of 1964. A total of 363 white spruce seedlings (2-2 stock from the Big River Nursery) were planted. One hundred and thirty seedlings were set out on a cut-over scarified strip, 114 on cut-over not scarified strip and 119 in an uncut strip. Annual measurements of seedling survival and growth have been carried out on this area since 1964.

Seedling survival to August 1966 (Table 11) has been best on the cut-over scarified strip; on the uncut strip survival has been slightly better than on the cut-over unscarified strip. Mortality (on all three conditions) was highest during the first growing season. On the cut-over scarified strip 18 per cent mortality was recorded in 1965 but only 4 per cent more in 1966. On the cut-over unscarified strip it was 38 per cent with an additional 6 per cent in 1966. In the uncut strip, 34 per cent died in 1965 and only 1 per cent more in 1966. Much of the seedling mortality on the cut-over unscarified strip was attributed to profuse vegetation and shrub competition.

The condition of surviving seedlings (Table 12) in 1966 was better than it had been in the previous year. On the cut-over scarified strip 11 per cent was recorded in 1965 as sickly, on the cut-over unscarified strip 31 per cent and on the uncut strip 42 per cent. In 1966 over 90 per cent of the survivors (on all three conditions) were healthy.

To 1966, seedlings on the cut-over scarified strip have maintained the best growth (Table 13). Growth was next best on the cut-over unscarified strip and poorest in the uncut strip. The average plantation heights in 1966 on the cut-over scarified strip was 13.2 inches, on the cut-over unscarified 10.7 inches and only 8.7 inches in the uncut strip. For the period 1964 to 1966 the seedlings on the cut-over scarified strip have shown an annual increase of 2.5 inches, on the cut-over unscarified 1.7 inches and on the uncut strip 1.0 inches. The poorer growth of the latter was attributed to shading and competition by trees in the uncut stand.

Permanent Observation Transects

Permanent observation transect plots (each 2 feet wide) were established on Areas 1, 3 and 5. The purpose is to study the germination, survival and growth of white spruce seedlings on various seedbeds created by the scarification. These transects were located subjectively on the various moisture conditions representative of the areas.

At the time of establishment the transects were mapped to show the various seedbed types, and seedlings on the transect plots were plotted for future identification. Yearly remeasurements have been carried out; new germinants are recorded and mapped and mortality of previously recorded seedlings is noted.

Area 1:

Seedbeds were prepared on Area 1 during the summer of 1960 with a TD-14 crawler tractor using the Saskatchewan fire-line plow. A total of five permenent observation transects were established on the cut-over scarified strips in July of 1961. One transect was established on a moderately moist site (4 moisture regime), two on a moist site (5 moisture regime) and two on a very moist site (6 moisture regime).[2]

[2] Sites classified according to Hills 1952. The classification of sites for forestry. Ontario Dept. Lands and Forests Res. Div., Res. Rep. 24 41 pp.

Maps were prepared of each transect showing the extent of the various seedbeds; seedlings originating in 1961 were staked with plastic sticks and their locations were plotted for future identification. For the period 1962 to 1966 the transect plots were examined annually. At each re-measurement mortality was recorded and new seedlings were staked and tallied.

Stocking by year to August 1966 and survival for the moderately moist, moist and very moist sites is summarized in Tables 14, 15 and 16. Based on total number of seedlings per acre; initial germination (all ages combined) for the period 1961 to 1966 was highest on the moist site (total 82,784 per acre), next highest on the very moist site (65,785 per acre) and lowest on the moderately moist site (13,866 per acre). Most germination (on all three sites) took place during the first and second growing season, then became progressively less. Per cent of the total germination for this period on the moderately moist site was 87 and 92 per cent for the other two sites. However considering the number of survivors remaining to 1966 the highest stocking was obtained on the very moist site (21,709 per acre) and next highest on the moist site (13,118 per acre). On the moderately moist site stocking was poorest (1,295 per acre).

Detailed stocking figures by seedbed types for the moderately moist site (Table 14) shows for the period 1961 to 1966 that seedbeds A, B, A/L and B/L[3] were the most favourable media for seedling germination and survival. Survival to the end of the 1966 growing season was 22 per cent on B, and averaged about 11 per cent on A, A/L and B/L seedbeds.

Seedling germination had occurred on all of the other remaining seedbeds but none had become established. Therefore it would appear that on the moderately moist site, seedbeds L, H, H/L, F/L, S/A, DW, and M are unsuitable for regenerating white spruce.

On the moist site (Table 15) germination had taken place on all of the seedbeds except S and M. Germinants were found on L, F, H, A, A/L, H/L, F/L, DW and D seedbeds.

The most favourable germinating media on this site was the H seedbed, next best were H/L and F/L. On the H seedbed total germination for the period 1961 to 1966 was 43,648 per acre, on H/L it was 14,141 per acre and F/L, 8,961 per acre. Less suitable seedbeds were L, F, A and A/L. On these seedbeds germination averaged between 3,000 and 4,000 per acre. Poorer seedbeds were DW and D. Total germination on DW was 1,506 per acre and on D only 327 per acre.

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[3]See explanation of symbols Appendex 1.

Survival to the end of 1966 has been the best on the H/L seedbed and was poorest on F and A seedbeds. On H/L survival was about 47 per cent as compared to 3 per cent on F and 0 on A. Survival on seedbeds L, DW and D averaged between 30 and 40 per cent, about 21 per cent on H/L, about 14 per cent on F/L and about 12 per cent on H.

Considering the stocking obtained it would appear that on the moist site the H seedbed is the best for regenerating white spruce followed by H/L and F/L seedbeds.

On the very moist site (Table 16) all seedbeds recorded except LD supported seedlings to 1966. Germination was the highest on H/L and next highest on A/L and F/L seedbeds. On H/L total germination had been 25,163 per acre on A/L 16,696 per acre and on F/L 12,561 per acre. Germination was poorer on seedbeds DW, GL and L; they averaged between 2000 and 4,000 per acre. The least number of germinants were found on LD and A/L. They averaged 1,206 and 697 per acre respectively.

Survival to the end of 1966 has ranged from a high of 75 per cent on A/L to zero on LD. On H/L survival was about 41 per cent and about 37 per cent on F/L. On seedbeds L, H, and GL survival was over 20 per cent but on DW only 8 per cent.

Considering the stocking obtained it would appear that on the very moist site H/L followed by F/L and H are the best seedbeds for regenerating white spruce. On the A/L seedbed total germination was very low but survival was very good so possibly this is also a good medium for regenerating white spruce.

Area 3:

Scarification was carried out on Area 3 in August of 1960 with a TD-18 crawler tractor using a straight blade. On this area two permanent observation transects (one on a fresh site — 3 moisture regime, the other on a moderately moist site — 4 moisture regime) were established in July of 1961. Establishment and re-measurement procedures were the same as on Area 1. Seedling germination and survival counts to 1966 have been carried out annually.

Data collected on the two transects to 1966 is quite similar in regards to stocking and survival by seedbed types. Therefore results have been combined and are summarized in Table 17.

On this area for the period 1961 to 1966 total germination (all ages combined) amounted to 68,130 per acre. Germination following seedbed treatment was highest during the first growing season amounting to 74 per cent of the total. In 1962 and 1964 germination was low probably because of poor seed years in 1961 and 1963 (See Table 22).

Stocking figures by seedbed types show that germination occurred on all seedbeds except H/L and S. It was most abundant on the mineral soil (B) seedbed (total 49,049 per acre). The next highest was on A, A/L and B/L, varying from 2,500 and 7,500 per acre. On L seedbeds 1,510 per acre had germinated and on F/L 1,068 per acre. Germinants were least abundant on H, LD, FM, D and DW. The average was less than 1,000 per acre on each of these seedbeds.

Overall survival to end of the 1966 growing season (all seedbeds combined) has been about 54 per cent and has resulted in a total stocking of 36,790 seedlings per acre. Survival has been the best on the H seedbed (100 per cent) and on the A seedbed (73 per cent). The next best was on B, A/L, B/L and M, averaging between 45 and 56 per cent. On seedbeds F/L and LD survival has been 33 per cent. Survival has been low on the L seedbed (12 per cent) while none of the seedlings survived on the FM and D seedbeds.

Stocking figures to 1966 indicated that on the fresh and moderately moist sites mineral soil seedbeds (B) followed by B/L, A and A/L are the best seedbeds for regenerating white spruce.

Area 5:

The cut-over strips on Area 5 were scarified in October 1963 with a D-7 crawler tractor using a straight blade. A total of three permanent observation transect plots were established on this area during the latter part of July 1964. One transect was established on a fresh site (3 moisture regime), one on a moderately moist site (4 moisture regime) and one on a moist site (5 moisture regime). Establishment and annual remeasurements have been carried out in a manner similar to that on Areas 1 and 3.

Stocking from 1964 to 1966 for the fresh, moderately moist and moist sites is summarized in Tables 18, 19 and 20. The data based on total number of living seedlings per acre in 1966 (all ages combined) show that stocking was higher on the moderately moist site (averaging about 6,500 seedlings per acre) than on the fresh and moist sites (4,000-4,500 per acre). Seedling germination at the end of the first growing season was very low as compared to the second growing season. In 1964 no germinants were found on the fresh site; the moderately moist and moist sites supported only about 700 germinants per acre. In the following year these sites supported between 5,000 and 9,000 germinants per acre. No new germinants were present in 1966.

Low stocking in 1964 may be due partly to late scarification (October) after much of the seed had fallen. Also 1963 was a very poor seed year. For instance data for Area 1 shows an average of about 178,000 seeds per acre were disbursed on cut-over strips in 1963 as compared to 2,500,000 in 1964. No seedfall data were collected in 1965 so relationships between germination failure in 1966 and seedfall can not be made.

Stocking figures by seedbed types on the fresh site (Table 18) shows that the 1965 germination occurred on seedbeds F, H, B, B/L, M, D and DW. None was present on A and F/L seedbeds. The mineral soil (B) seedbed supported the most germinants averaging about 3,000 per acre. On the other seedbeds stocking ranged from approximately 200-500 per acre.

Survival to the end of the 1966 growing season has been 100 per cent on all of the stocked seedbeds except B/L and M. None of the germinants survived on the latter two seedbeds.

The higher stocking on B seedbeds would suggest that mineral soil is the best for regenerating white spruce on a fresh site.

On the moderately moist site (Table 19) germinants were found on H, B, B/L and M seedbeds; none were found on L, F, A, D, S/D, LD and DW. Total germination per acre on the stocked seedbeds ranged from approximately 3,700 on H to 1,500 on B/L.

Survival to the end of 1966 has been highest on seedbeds B, M, and H (between 60-90 per cent) and was lowest on B/L (25 per cent).

Considering the seedbeds encountered and those which supported seedlings to 1966, it is evident that B, M, H and B/L were the most favourable seedbeds on the moderately moist site for regeneration.

On the moist site (Table 20) germinants were found on H, A, B, H/L and D seedbeds; none were found on F, A/L, B/L, M, S/D and DW. Germination based on number of germinants per acre has been highest on the H seedbed (approximately 3,800 per acre); next highest on B (1,600 per acre) and lowest on A, H/L and D (between 180-500 per acre).

Survival to end of 1966 ranged between 67 and 100 per cent for seedlings on seedbeds H, A, H/L and D; on seedbed B survival was the lowest only 33 per cent.

Considering the higher stocking and good survival obtained on H it would appear that H seedbeds are the most favourable for regenerating white spruce on a moist site.

Seedtraps

Annual white spruce seedfall data is being collected on Area 1 by the Department of Forestry and on Area 3 by the Saskatchewan Forestry Branch to provide information on (1) distribution of seedfall on cut-over and uncut strips (2) amount of seed produced on the areas from year to year and (3) relationship of regeneration to abundance of seedfall.

Estimates of seedfall on Area 1 from 1961 to 1964 is summarized in Table 21. No data was available for 1965.

Estimates of seedfall on Area 3 from 1960 to 1966 are shown in Table 22.

WORK FOR 1967

Five-Year Remeasurements

The first five-year remeasurement of all sample plots on Area 4 will be carried out during the summer of 1967. This work will include: (1) a regeneration survey on the milacre transect plots, (2) measurement of the 1/5-acre permanent plots for stand information and (3) measurement of the plantation plots for seedling survival and growth.

Permanent Observation Transects

The permanent observation transects will be examined on Areas 1, 3 and 5. Survival counts will be made and new seedlings will be recorded.

Plantations

Plantation plots on Areas 1, 3 and 5 will be remeasured. Seedling survival, condition of survivors and growth will be recorded.

Seedtraps

Seed from the traps on Area 1 will be collected and counted.

Reports

Progress to fall of 1967 will be reported.

TABLE 1

PER CENT QUADRATS STOCKED TO WHITE SPRUCE, BALSAM FIR AND HARDWOODS, AREA 6, 1966

Condition	Number of quadrats	White spruce		Balsam fir		Hardwoods	
		Regeneration (per cent)	Advance Growth (per cent)	Regeneration (per cent)	Advance Growth (per cent)	Regeneration[1] (per cent)	Advance Growth (per cent)
Cut and scarified	102	34	8	26	11	79	1
Cut not scarified	102	8	21	36	80	6	13
Uncut	111	8	17	58	88	1	13
All	315	17	15	40	61	30	12

[1] These figures represent white birch regeneration; all other hardwoods regeneration were classed as advance growth.

TABLE 2

NUMBER OF WHITE SPRUCE, BALSAM FIR AND HARDWOOD STEMS

PER ACRE, AREA 6, 1966

Condition	Number list quadrats	White spruce		Balsam fir		Hardwoods	
		Regeneration	Advance Growth	Regeneration	Advance Growth	Regeneration	Advance Growth
		Number per acre		Number per acre		Number per acre	
Cut and scarified	26	962	115	769	423	37,269[1]	0
Cut not scarified	13	0	385	692	7,538	0	154
Uncut	21	667	190	1,857	10,238	0	190
All	60	650	200	1,133	5,400	16,150	100

[1] This total is made up entirely of white birch regeneration; all other hardwood regeneration were classed as advance growth.

TABLE 3

DISTRIBUTION OF SEEDBED TYPES AND OCCURRENCE OF

SOFTWOOD REGENERATION ON AREA 6 IN 1966

Seedbed Types	Per cent Occurrence Seedbeds and Softwood Regeneration								
	Cut-over scarified basis: 102 quads			Cut-over unscarified basis: 102 quads			Uncut basis: 111 quads		
	Seedbeds	wS	bF	Seedbeds	wS	bF	Seedbeds	wS	bF
Litter	0			49	12	11	29	11	2
Grass	0			1	0	0	0		
Feather moss	0			14	0	38	41	0	45
F-horizon	2	0	4	0			0		
Humus	<1	3	0	0			0		
Mineral soil	63	94	73	0			0		
Litter disturbed	11	0	8	0			0		
Debris	22	0	8	<1	0	0	0		
Overturned root	0			0			<1	0	0
Slash	0			14	0	0	9	0	0
Decayed wood	2	3	7	22	88	51	21	89	53
All	100	100	100	100	100	100	100	100	100

TABLE 4

STAND TABLE, AREA 6, UNCUT STRIPS, 1966

(basis - 8, 1/5-acre P.S.P.'s)

D.B.H. (inches)	White Spruce		Balsam Fir		Hardwoods	
	Number of trees per acre	Basal area per acre (Sq. ft.)	Number of trees per acre	Basal area per acre (Sq. ft.)	Number of trees per acre	Basal area per acre (Sq. ft.)
1	1.2	.006	160.6	.803	6.2	.031
2			73.1	1.608	0.6	.013
3			43.1	2.112	4.4	.216
4	0.6	.052	29.4	2.558		
5	0.6	.082	30.6	4.162		
6	1.2	.235	30.0	5.880		
7	1.2	.320	26.9	7.182		
8	1.2	.419	25.0	8.725		
9	1.2	.530	15.6	6.895		
10	3.8	2.071	15.6	8.502	1.2	.654
11	1.2	.792	10.0	6.600	1.9	1.254
12	6.2	4.867	3.8	2.983		
13	3.8	3.504	1.9	1.752	0.6	.553
14	6.2	6.628	0.6	.641		
15	3.8	4.663	1.2	1.472		
16	6.2	8.655			0.6	.838
17	2.5	3.940				
18	5.0	8.835			1.2	2.120
19	2.5	4.922			0.6	1.181
20					0.6	1.309
21						
22	1.2	3.168				
23						
24	1.2	3.770				
25	0.6	2.045				
26						
27	0.6	2.386				
All	52.0	61.890	467.4	61.875	17.9	8.169

TABLE 5

PER CENT SURVIVAL WHITE SPRUCE PLANTATIONS ON AREA 1,

JULY 1962 TO AUGUST 1966

Planting site	Number planted June 1961	Per cent survival				
		July 1962	August 1963	July 1964	August 1965	August 1966
Cut-over scarified	321	80	73	68	63	62
Cut-over unscarified	315	61	55	49	46	44
Uncut	322	50	37	33	29	28

TABLE 6

CONDITION OF PLANTED WHITE SPRUCE SURVIVORS

ON AREA 1, FROM 1962 TO 1966

Planting Site	Number Survivors	Condition (per cent)			
		Healthy	Sickly	Browsed	Terminal Frost Damage
1962					
Scarified	256	82	18	61	-
Unscarified	191	80	20	81	-
Uncut	160	60	40	98	-
1963					
Scarified	233	95	5	<1	-
Unscarified	172	91	9	1	-
Uncut	120	83	17	2	-
1964					
Scarified	218	89	11	1	20
Unscarified	153	94	6	1	14
Uncut	105	90	10	7	0
1965					
Scarified	203	92	8	1	<1
Unscarified	144	90	10	2	0
Uncut	93	92	8	5	0
1966					
Scarified	200	87	13	0	-
Unscarified	137	92	8	1	-
Uncut	90	91	9	0	-

Original number planted spring 1961 in cut-over scarified = 321
Original number planted spring 1961 in cut-over unscarified = 315
Original number planted spring 1961 in uncut = 322

TABLE 7

AVERAGE HEIGHTS WHITE SPRUCE PLANTATIONS ON AREA 1,

1961 TO 1966

Planting Site	Average Height (inches)						Average Height Increase (inches)				
	1961	July 1962	August 1963	July 1964	August 1965	August 1966	1961-62	1962-63	1963-64	1964-65	1965-66
Cut-over Scarified	6.4	8.4	12.7	15.8	18.8	22.9	2.0	4.3	3.1	3.0	4.1
Cut-over Unscarified	5.3	7.1	10.4	13.4	16.9	21.6	1.8	3.3	3.0	3.5	4.7
Uncut	4.3	5.0	6.1	7.1	8.1	9.5	0.7	1.1	1.0	1.0	1.4

TABLE 8

PER CENT SURVIVAL WHITE SPRUCE PLANTATIONS ON AREA 3,

JULY 1962 TO AUGUST 1966

Planting Site	Number planted June	Per cent Survival				
		July 1962	July 1963	- 1964	July 1965	August 1966
Cut-over Scarified	201	70	66	No Data	63	63
Cut-over Unscarified	199	29	25	No Data	21	20
Uncut	179	61	48	No Data	44	42

TABLE 9

CONDITION OF PLANTED WHITE SPRUCE SURVIVORS

ON AREA 3, FROM 1962 TO 1966

Planting Site	Number Survivors	Condition (per cent)		
		Healthy	Sickly	Browsed
1962				
Scarified	139	96	4	56
Unscarified	57	89	11	53
Uncut	109	77	23	92
1963				
Scarified	132	98	2	3
Unscarified	50	90	10	0
Uncut	86	91	9	0
1964				
Scarified	No Data	No Data	No Data	No Data
Unscarified	No Data	No Data	No Data	No Data
Uncut	No Data	No Data	No Data	No Data
1965				
Scarified	127	98	2	-
Unscarified	41	90	10	-
Uncut	79	84	16	-
1966				
Scarified	126	94	6	-
Unscarified	39	90	10	-
Uncut	75	92	8	-

Original number planted spring 1961 in cut-over scarified = 201
Original number planted spring 1961 in cut-over unscarified = 199
Original number planted spring 1961 in uncut = 179

TABLE 10

AVERAGE HEIGHTS WHITE SPRUCE PLANTATIONS ON AREA 3,

1961 TO 1966

Planting Site	Average Height (inches)						Height Increase (inches)				
	1961	July 1962	July 1963	- 1964	July 1965	August 1966	1961-62	1962-63	1963-64	1963-65	1965-66
Cut-over Scarified	7.6	10.0	12.3	No Data	22.5	30.5	2.4	2.3	No Data	10.2	8.0
Cut-over Unscarified	8.4	10.1	12.0	No Data	18.4	24.0	1.7	1.9	No Data	6.4	5.6
Uncut	5.9	6.9	8.4	No Data	9.8	11.3	1.0	1.5	No Data	1.4	1.5

TABLE 11

PER CENT SURVIVAL WHITE SPRUCE

PLANTATIONS ON AREA 5, JULY 1964

TO AUGUST 1966

Planting Site	Number Planted 1964	Per cent survival	
		August 1965	August 1966
Cut-over Scarified	130	82	78
Cut-over Unscarified	135	62	56
Uncut	119	66	65

TABLE 12

CONDITION OF PLANTED WHITE SPRUCE SURVIVORS

ON AREA 5, FROM 1965 TO 1966

Planting Site	Number Survivors	Condition (per cent)	
		Healthy	Sickly
1965			
Scarified	107	89	11
Unscarified	84	69	31
Uncut	79	58	42
1966			
Scarified	102	97	3
Unscarified	76	93	7
Uncut	77	99	1

Original number planted spring 1964 in cut-over scarified = 130
Original number planted spring 1964 in cut-over unscarified = 135
Original number planted spring 1964 in uncut = 119

TABLE 13

AVERAGE HEIGHTS WHITE SPRUCE PLANTATIONS ON AREA 5,

1964 TO 1966

Planting Site	Average Height (inches)			Height increase (inches)	
	Height After Planting 1964	August 1965	August 1966	1964-65	1965-66
Cut-over Scarified	5.7	9.0	13.2	3.3	4.2
Cut-over Unscarified	5.6	7.6	10.7	2.0	3.1
Uncut	5.6	6.4	8.7	0.8	2.3

TABLE 14

NUMBER WHITE SPRUCE SEEDLINGS PER ACRE AND PER CENT SURVIVAL TO AUGUST 1966

BY YEAR OF ORIGIN AND SEEDBED TYPE, MODERATELY MOIST SITE, MS-211 AREA 1

Seedbed Types[1]	L	H	A	B	A/L	B/L	H/L	F/L	S/A	DW	M	All Seedbeds
Area of seedbed (sq. ft./acre)	10,628.6	522.7	4,181.8	2,570.0	10,628.6	3,005.7	1,045.4	6,882.5	1,263.3	2,308.7	522.7	43,560.0
1961 Germinants[2]	0	218	1,731	1,079	648	0	853	0	217	0	0	4,746
Per cent survival	-	0	25	20	0	-	0	-	0	-	-	14
1962 Germinants	648	218	2,601	432	1,297	1,307		434	0	436	0	7,373
Per cent survival	0	0	0	50	16	16	-	0	-	0	-	9
1963 Germinants	0	0	435	432	0	0	0	0	0	217	227	1,311
Per cent survival	-	-	0	0	-	-	-	-	-	0	0	0
1964 Germinants	0	0	0	0	0	0	0	0	0	0	0	0
Per cent survival	-	-	-	-	-	-	-	-	-	-	-	-
1965 Germinants	0	0	0	0	0	436	0	0	0	0	0	436
Per cent survival	-	-	-	-	-	0	-	-	-	-	-	0
1966 Germinants	0	0	0	0	0	0	0	0	0	0	0	0
Total Germination	648	436	4,767	1,943	1,945	1,743	853	434	217	653	227	13,866
Total Survivors	0	0	435	432	212	216	0	0	0	0	0	1,295
Per cent survival	0	0	9	22	11	12	0	0	0	0	0	9

[1] See explanation of symbols Appendix 1.

[2] Actual number germinants expressed as number per acre.

TABLE 15

NUMBER WHITE SPRUCE SEEDLINGS PER ACRE AND PER CENT SURVIVAL TO AUGUST 1966

BY YEAR OF ORIGIN AND SEEDED TYPE, MOIST SITE, MS-211 AREA 1

Seedbed Types[1]	L	F	H	A	A/L	H/L	F/L	S	DW	M	D	All Seedbeds
Area of Seedbed (sq. ft./acre)	8,668.4	1,350.4	13,155.1	740.5	1,873.1	6,098.4	7,100.3	1,176.1	2,700.7	566.3	130.7	43,560.0
1961 Germinants[2]	693	2,328	16,760	1,851	925	5,793	2,911	0	116	0	218	31,595
Per cent survival	34	5	14	0	37	18	12	-	100	-	50	15
1962 Germinants	1,968	1,342	23,863	1,504	2,197	6,726	5,467	0	1,042	0	109	44,218
Per cent survival	35	0	10	0	37	19	15	-	22	-	0	14
1963 Germinants	234	0	2,565	116	230	695	469	0	0	0	0	4,075
Per cent survival	0	0	0	0	50	17	0	-	-	-	-	5
1964 Germinants	0	0	0	0	0	0	0	0	0	0	0	0
Per cent survival	-	-	-	-	-	-	-	-	-	-	-	-
1965 Germinants	234	0	460	0	579	927	114	0	348	0	0	2,662
Per cent survival	100	-	52	-	100	62	100	-	67	-	-	74
1966 Germinants	0	0	0	0	0	0	0	0	0	0	0	0
Total Germination	3,129	3,670	43,648	3,471	3,931	14,141	8,961	0	1,506	0	327	82,784
Total Survivors	1,161	116	5,012	0	1,850	3,012	1,278	-	580	-	109	13,009
Per cent survival	37	3	12	0	47	21	14	-	38	-	33	16

[1] See explanation of symbols Appendix 1.

[2] Actual number germinants expressed as number per acre.

TABLE 16

NUMBER WHITE SPRUCE SEEDLINGS PER ACRE AND PER CENT SURVIVAL TO AUGUST 1966
BY YEAR OF ORIGIN AND SEEDBED TYPE, VERY MOIST SITE, MS-211 AREA 1

Seedbed Types[1]	L	H	A/L	H/L	F/L	LD	DW	GL	All Seedbeds
Area of Seedbed (sq.ft./acre)	9,060.5	7,231.0	261.4	8,668.4	8,145.7	1,481.0	1,263.0	7,448.8	43,560.0
1961 Germinants	1,205	7,231	523	11,546	1,890	517	0	857	23,769
Per cent Survival	14	29	66	25	27	0	-	0	28
1962 Germinants	2,917	7,231	0	12,066	10,329	689	1,558	1,892	36,682
Per cent survival	35	19	-	51	40	0	0	36	33
1963 Germinants	0	1,721	0	693	342	0	519	514	3,789
Per cent survival	-	10	-	50	0	-	33	0	18
1964 Germinants	0	0	0	0	0	0	0	0	0
Per cent survival	-	-	-	-	-	-	-	-	-
1965 Germinants	0	513	174	858	0	0	0	0	1,545
Per cent survival	-	100	100	100	-	-	-	-	100
1966 Germinants	0	0	0	0	0	0	0	0	0
Total Germination	4,122	16,696	697	25,163	12,561	1,206	2,077	3,263	65,785
Total survivors	1,205	4,143	522	10,341	4,643	0	173	685	21,709
Per cent survival	29	25	75	41	37	0	8	21	33

[1] See explanation of symbol Appendix 1.
[2] Actual number germinants expressed as number per acre.

TABLE 17

NUMBER WHITE SPRUCE SEEDLINGS PER ACRE AND PER CENT SURVIVAL TO AUGUST 1966

BY YEAR OF ORIGIN AND SEEDBED TYPE, MS-211, AREA 3

Seedbed Type[1]	L	H	A	B	A/L	B/L	H/L	F/L	LD	S	FM	D	M	DW	All Seedbeds
Area of seedbed (sq. ft./ acre)	5,140.1	1,306.8	609.9	18,600.1	1,393.9	5,183.6	43.6	2,526.5	827.6	1,916.7	1,393.9	1,611.7	1,611.7	1,393.9	43,560.0
1961 Germinants[2]	87	178	3,789	38,893	2,030	4,707	0	356	91	0	0	0	89	0	50,220
Per cent Survival	0	100	71	57	61	47	-	0	0	0	0	0	100	0	57
1962 Germinants	0	0	0	1,507	0	88	0	0	0	0	0	0	0	0	1,595
Per cent Survival	-	-	-	47	-	100	-	-	-	-	-	-	-	-	49
1963 Germinants	534	0	93	4,278	353	1,508	0	624	0	0	0	89	264	0	7,743
Per cent Survival	0	-	100	40	25	23	-	43	-	-	-	0	34	-	33
1964 Germinants	0	0	0	353	0	0	0	0	0	0	0	0	0	0	353
Per cent Survival	-	-	-	74	-	-	-	-	-	-	-	-	-	-	74
1965 Germinants	889	266	277	3,832	176	1,178	0	88	182	0	351	89	529	176	8,033
Per cent Survival	20	100	100	63	50	62	-	100	50	-	0	0	50	0	53
1966 Germinants	0	0	0	186	0	0	0	0	0	0	0	0	0	0	186
Total Germination	1,510	444	4,159	49,049	2,559	7,481	0	1,068	273	0	351	178	882	176	68,130
Total Survivors	180	444	3,050	27,398	1,411	3,383	-	356	91	-	0	0	442	0	36,790
Per cent Survival	12	100	73	56	55	45	-	33	33	-	0	0	50	0	54

[1] See explanation of symbols Appendix 1.

[2] Actual number germinants expressed as number per acre.

TABLE 18

NUMBER WHITE SPRUCE SEEDLINGS PER ACRE AND PER CENT SURVIVAL TO AUGUST 1966

BY YEAR OF ORIGIN AND SEEDBED TYPE, FRESH SITE, MS-211 AREA 5

Seedbed Type[1]	F	H	A	B	F/L	B/L	M	D	DW	All Seedbeds
Area of Seedbed (sq. ft./acre)	1,045.5	2,178.0	304.9	19,819.8	1,524.6	1,960.2	2,570.0	12,937.3	1,219.7	43,560
1964 Germinants[2]	0	0	0	0	0	0	0	0	0	0
Per cent survival	-	-	-	-	-	-	-	-	-	-
1965 Germinants	180	544	0	3,270	0	182	180	181	359	4,896
Per cent survival	100	100	-	100	-	0	0	100	100	93
1966 Germinants	0	0	0	0	0	0	0	0	0	0
Total Germination	180	544	0	3,270	0	182	180	181	359	4,896
Total survivors	180	544	-	3,270	-	0	0	181	359	4,534
Per cent survival	100	100	-	100	-	0	0	100	100	93

[1] See explanation of symbols Appendix 1.

[2] Actual number germinants expressed as number per acre.

TABLE 19

NUMBER WHITE SPRUCE SEEDLINGS PER ACRE AND PER CENT SURVIVAL TO AUGUST 1966

BY YEAR OF ORIGIN AND SEEDBED TYPE, MODERATELY MOIST SITE, MS-211 AREA 5

Seedbed Type[1]	L	F	H	A	B	B/L	M	D	S/D	LD	DW	All Seedbeds
Area of Seedbed (sq.ft./acre)	261.4	522.7	5,488.5	3,615.5	14,505.5	2,090.9	8,015.0	4,268.9	261.4	4,007.5	522.7	43,560.0
1964 Germinants[2]	0	0	181	0	189	366	0	0	0	0	0	736
Per cent survival	-	-	0	-	0	50	-	-	-	-	-	25
1965 Germinants	0	0	3,485	0	1,654	1,100	2,933	0	0	0	0	9,172
Per cent survival	-	-	63	-	100	17	75	-	-	-	-	68
1966 Germinants	0	0	0	0	0	0	0	0	0	0	0	0
Total Germination	0	0	3,666	0	1,843	1,466	2,933	0	0	0	0	9,908
Total survival	-	-	2,201	-	1,654	368	2,196	-	-	-	-	6,419
Per cent survival	-	-	60	-	90	25	75	-	-	-	-	65

[1] See explanation of symbols Appendix 1.

[2] Actual number germinants expressed as number per acre.

TABLE 20

NUMBER WHITE SPRUCE SEEDLINGS PER ACRE AND PER CENT SURVIVAL TO AUGUST 1966

BY YEAR OF ORIGIN AND SEEDBED TYPE, MOIST SITE, MS-211 AREA 5

Seedbed Type[1]	F	H	A	B	H/L	A/L	B/L	M	D	S/D	DW	All Seedbeds
Area of Seedbed (sq. ft./acre)	174.3	13,155.1	7,840.8	10,105.9	3,223.4	1,481.0	217.8	261.4	5,793.5	217.8	1,089.0	43,560.0
1964 Germinants[2]	0	724	0	0	0	0	0	0	0	0	0	724
Per cent survival	-	100	-	-	-	-	-	-	-	-	-	100
1965 Germinants	0	3,091	541	1,637	180	0	0	0	185	0	0	5,634
Per cent survival	-	77	67	33	100	-	-	-	100	-	-	64
1966 Germinants	0	0	0	0	0	0	0	0	0	0	0	0
Total Germination	0	3,815	541	1,637	180	0	0	0	185	0	0	6,358
Total Survivors	-	3,092	361	546	180	-	-	-	185	-	-	4,364
Per cent survival	-	81	67	33	100	-	-	-	100	-	-	69

[1] See explanation of symbols Appendix 1.
[2] Actual number germinants expressed as number per acre.

TABLE 21

WHITE SPRUCE SEEDFALL

AREA 1

Location	Number seed per acre[1]				
	1961	1962	1963	1964	1965
Uncut strip					
South 1/3	3,008,000[2](17)	1,200,000(8)	278,461(13)	3,049,090(11)	(No data)
Middle 1/3	3,000,000(5)	1,035,000(8)	340,000(9)	2,816,000(5)	(No data)
North 1/3	3,104,000(5)	1,416,667(6)	343,636(11)	3,640,000(5)	(No data)
Average	3,024,000(27)	1,119,091(22)	316,970(33)	3,134,286(21)	(No data)
Cut-over strip					
South 1/3	2,600,000(21)	1,018,333(12)	264,444(9)	2,542,222(9)	(No data)
Middle 1/3	1,998,000(8)	850,909(8)	150,667(15)	2,521,250(16)	(No data)
North 1/3	2,346,000(19)	953,333(9)	121,053(19)	2,408,750(16)	(No data)
Average	2,394,000(48)	919,070(43)	177,674(43)	2,481,951(41)	(No data)

[1]Viability of 1961 seed in December 1962 determined by cutting test on 800 seed was 35%.
Germination test of 1962 seed in January 1964 on 500 seeds indicated 12% viability.
Germination test of 1963 seed in January 1965 on 500 seeds indicated 7% viability.
Cutting test of 1964 seed in December 1965 indicated 63% sound.

[2]Figures in brackets indicate number of traps on which estimates were based.

TABLE 22

WHITE SPRUCE SEEDFALL

AREA 3

Location	Number Seed per acre						
	1960	1961	1962	1963	1964	1965	1966
Uncut Strip	3,005,640	89,120	2,308,680	21,780	5,600,000	840,000	33,600
Cut-over Strip	1,161,247	43,560	1,248,353	2,904	3,120,000	144,000	2,400

APPENDIX I

Explanation of symbols in Tables.

L, F and H - organic horizons) L horizon undisturbed, the remainder exposed
A and B - mineral horizon) by the bulldozer blade or by the Saskatchewan fire-line plow.

B/L - material from B horizon deposited on undisturbed litter.
A/L - material from A horizon deposited on undisturbed litter.
H/L - material from H horizon deposited on undisturbed litter.
F/L - material from F horizon deposited on undisturbed litter.

S/A - light slack deposited on A horizon.

LD- litter disturbed by action of tractor treads.

M - mixture of organic and mineral materials.

D - debris including litter, organic matter, mineral soil pushed up into piles by the bulldozer.

S/D - slack deposited on debris.

S - slash.

FM - feather moss.

DW - decayed wood.

GL - undisturbed grass litter.