CANADA
Department of Northern Affairs and National Resources
FORESTRY BRANCH

SEEDING AND PLANTING OF SPRUCE ON CUT-OVER LANDS OF THE SUBALPINE REGION OF ALBERTA

BY

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Forest Research Division
Technical Note No. 2
1955

Published under authority of
The Minister of Northern Affairs and National Resources
Ottawa, 1955

CONTENTS

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PROJECT A-6

BY

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INTRODUCTION

One of the major forestry problems in Alberta is that of securing regeneration of white spruce (*Picea glauca* (Moench) Voss) on logged areas. Natural regeneration following logging is not usually sufficient to establish another stand and in many locations should be augmented either by planting, artificial seeding, or disturbing the forest floor to make it more receptive to natural seeding.

An experiment was initiated by de Grace (1) in the spring of 1947 to determine the best method or combination of methods for securing spruce regeneration on logged and non-burned lands in the Subalpine Region of Alberta. Logging in this context refers mainly to partial cutting which varies in intensity.

EXPERIMENTAL TECHNIQUES

Four methods of securing regeneration were tested: broadcast seeding; spot seeding; planting; natural regeneration.

Broadcast and spot seeding methods were similar, except that in the latter the seed was covered with soil. Planting was done with special attention to good contact between roots and soil.

The white spruce seed used was nine years old and the planting stock was 5–0. Both seed and stock were secured from the Kananaskis Forest Experiment Station. Half the seed used was stratified immediately prior to seeding by placing it in a moist medium for a period of six weeks at a temperature of approximately 40 degrees F.

Two methods of rodent protection were tested. In the first, wire cages were placed over the seed. These cages, constructed of 21-gauge, 4-mesh hardware cloth were approximately six inches square and three inches high. The second was a device consisting of two flat pieces of wood, about 0·75 inches wide and 1·5 inches in over-all length, which were hinged together at one end with a piece of drafting tape and pointed at the other (free) ends. In operation the device was used as a forceps and pushed into a mixture of seed and soil. With some of the mixture held between the pieces of wood, it was then inserted point first at an angle into the ground. (Figure 1 shows construction and use of this device.)

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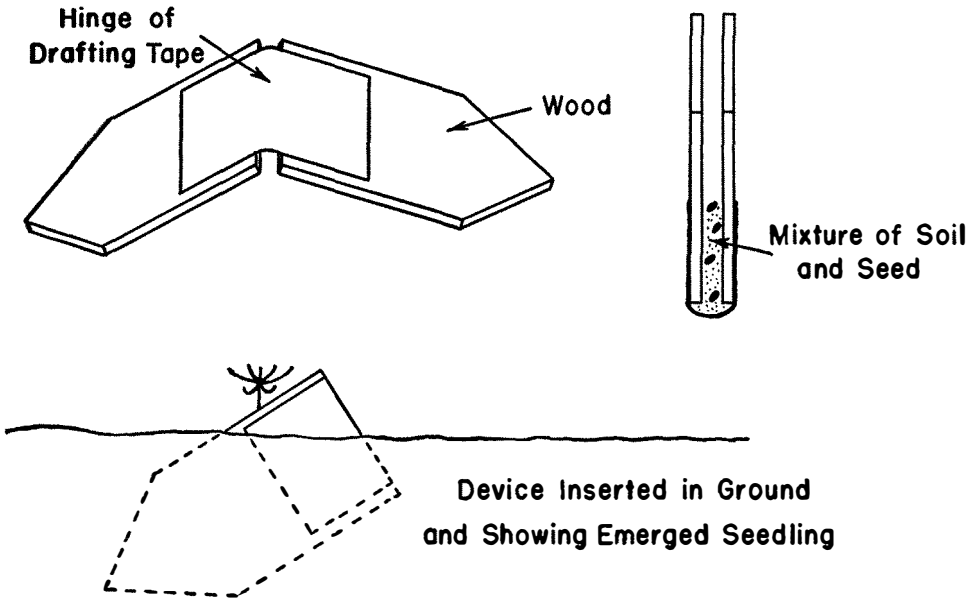

FIGURE 1.—Showing construction and use of seed protection device, (Full scale).

The following five types of ground treatment were also tested:

(1) No treatment other than placing seed in contact with litter and/or sod, or getting planting stock into mineral soil;

(2) Removing litter and/or sod from an area two feet in diameter;

(3) Removing litter and/or sod from an area four feet in diameter;

(4) Cultivation of an area four feet in diameter. Litter and/or sod cultivated into soil;

(5) Removing litter and/or sod, and then cultivating an area four feet in diameter.

EXPERIMENTAL DESIGN

Figure 2 is a diagrammatic presentation of the design of the experiment. Numerical and alphabetical designations can be determined from this Figure for each combination of method, seed treatment, protection, and ground treatment. In all, sixty combinations were tested.

The experiment was replicated eight times and these replications are located as shown in Figure 3. Each replication, or block, consisted of five sub-blocks and the sixty combinations were randomized in each sub-block. The sub-blocks were laid out in milacre units and one combination was applied on each milacre.

The eight blocks were established in the spring of 1947. Remeasurements were made in midsummer of that year on six of the blocks, and on all of the blocks in the autumn, in 1947, 1948, and 1949. The final tally was made in the autumn of 1951. In tallying, each milacre was recorded simply as a success or failure and no attempt was made to count the number of seedlings present.

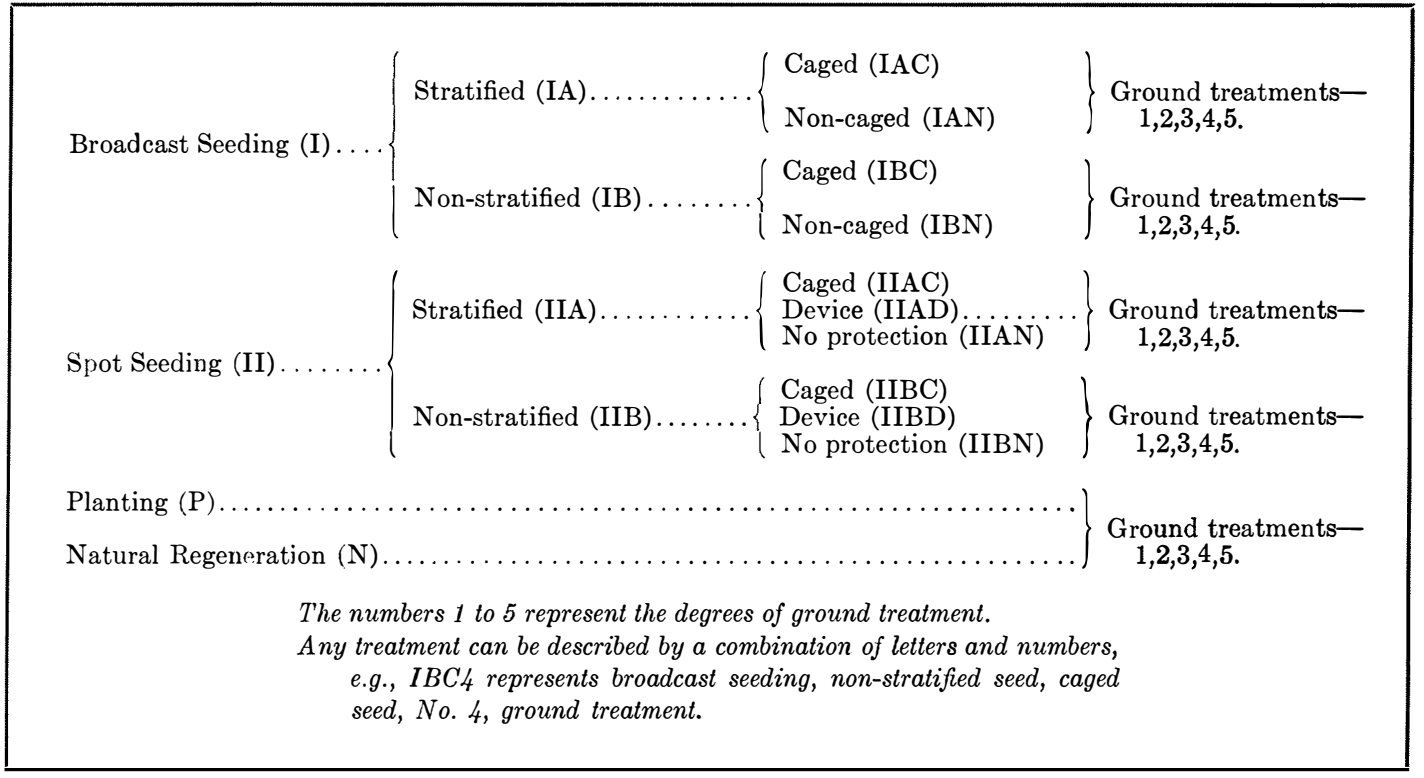

FIGURE 2.—Diagrammatic Presentation of Experiment on White Spruce Regeneration.

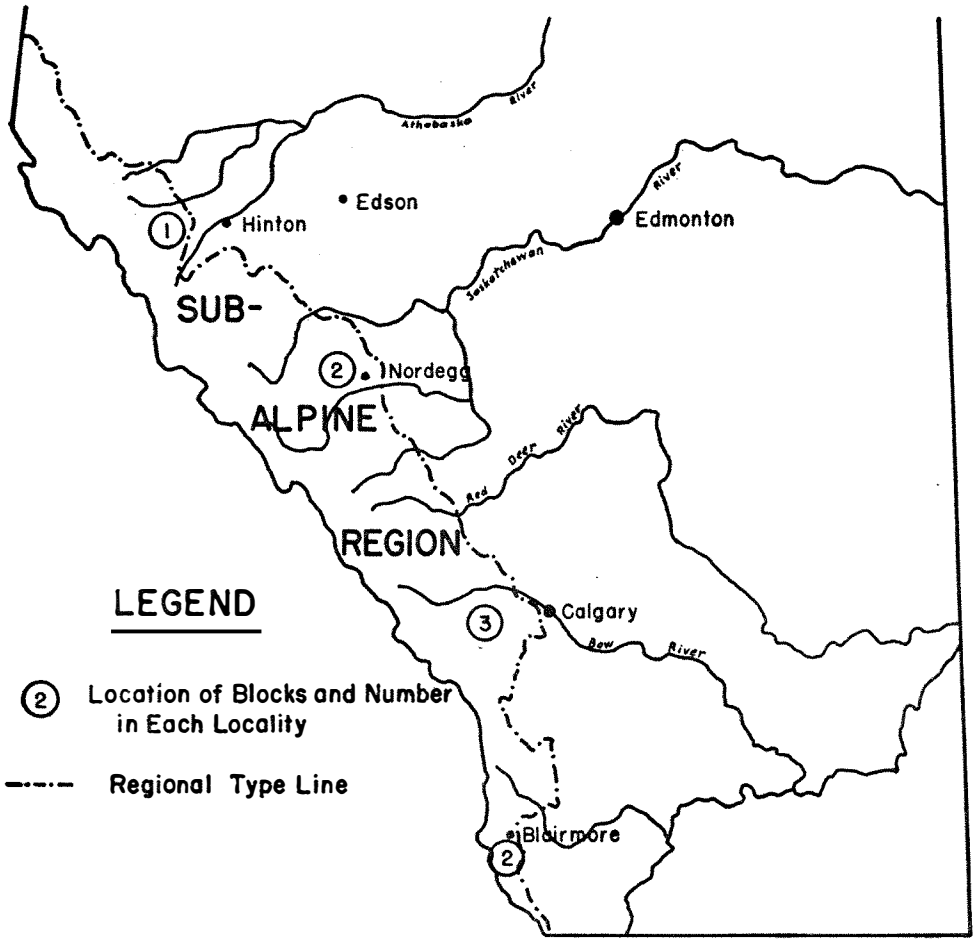

FIGURE 3.—Map of Alberta showing distribution of blocks in the Subalpine Region.

METHOD OF ANALYSIS

For the purpose of analysis, the four methods of securing regeneration were treated as separate experiments. Under broadcast seeding an analysis of variance was performed making the following comparisons:

(1) Stratified compared to non-stratified seed;

(2) Caged compared to non-protected seed;

(3) Between the five methods of ground treatment.

A similar analysis was done for spot seeding except that device protection was included with caged and non-protected seed.

The only comparison under planting was between the five methods of ground treatment. Natural regeneration was such a distinct failure that no attempt at analysis was made.

RESULTS

The tabular results presented here are those obtained at the end of the first, third, and fifth year. Only the fifth year or final results have been analysed statistically.

Tables 1 and 2 show the percentage of treatments successful for broadcast and spot seeding respectively, using stratified and non-stratified seed.

TABLE 1.—BROADCAST SEEDING

Years since seeding	Percentage of success	
	Stratified seed	Non-stratified seed
1	39·5	36·7
3	27·5	25·0
5	26·0	23·7

TABLE 2.—SPOT SEEDING

Years since seeding	Percentage of success	
	Stratified seed	Non-stratified seed
1	37·2	34·7
3	23·7	22·2
5	21·7	20·2

For both broadcast and spot seeding there is no statistical significance* at the end of five years between the results for stratified and non-stratified seed.

On the six blocks which were tallied in the midsummer of 1947 (2 months after seeding), stratified seed showed a percentage of success 15·5 per cent higher than non-stratified. Between midsummer and autumn, however, on the same six blocks, the greater delayed germination of the non-stratified seed reduced this difference to 3·2 per cent.

Table 3 shows the percentage of treatments successful under broadcast seeding for caged and non-protected seed. Table 4 is for spot seeding and includes device-protected seed along with caged and non-protected seed.

TABLE 3.—BROADCAST SEEDING

Years since seeding	Percentage of success	
	Caged seed	Non-protected seed
1	59·7	16·5
3	36·5	16·0
5	34·2	15·5

* Throughout the analysis Snedecor's "F" test was used to test for significance and Fisher's "t" test to determine the order of efficiency of the individual treatments. "Highly significant" and "significant" refer to significance at the 1 per cent and 5 per cent levels respectively.

TABLE 4.—SPOT SEEDING

Years since seeding	Percentage of success		
	Caged seed	Device-protected seed	Non-protected seed
1	65·5	22·5	19·7
3	37·0	14·0	17·7
5	34·7	12·7	15·2

Under both broadcast and spot seeding there is a highly significant difference at the end of five years, between caged and non-protected seed. Also, in spot seeding there is a highly significant difference between caged and device-protected seed. Device protection has given very disappointing results and appears to have an adverse effect on final success.

An examination of the data in Tables 3 and 4 reveals that under both broadcast and spot seeding the mortality between the first and third year remeasurements has been much greater on the caged than on the non-protected spots. It is estimated, on the basis of the diameter of the wire composing the cages, that the light intensity under the cages was reduced by approximately 25 per cent. This reduced light intensity must also have reduced evaporation and thus there was a quite different ecoclimate under the cages. When these were removed at the end of the first year the seedlings were suddenly subjected to the same conditions as those on the non-protected spots. Some of the seedlings which had germinated and survived under the cages were unable to withstand the sudden change in ecoclimate and heavy mortality occurred. It appears very probable therefore that cages not only provide rodent protection but, while still in place, have a beneficial effect on germination and early survival. Some or all of this beneficial effect is lost when the cages are removed.

Tables 5 and 6 show the percentages of success for broadcast and spot seeding respectively using the five ground treatments tested.

TABLE 5.—BROADCAST SEEDING

Years since seeding	Percentage of success for each of five ground treatments				
	1	2	3	4	5
1	19·4	44·4	38·1	39·4	49·4
3	7·5	28·1	30·0	25·6	40·0
5	6·9	26·2	28·1	24·4	38·7

TABLE 6.—SPOT SEEDING

Years since seeding	Percentage of success for each of five ground treatments				
	1	2	3	4	5
1	21·7	34·6	34·2	40·0	49·2
3	7·1	25·8	22·9	23·3	35·4
5	6·2	21·7	21·2	21·7	33·8

Under both broadcast and spot seeding, treatment 5 (removing litter and/or sod, and cultivating an area four feet in diameter) is the most effective, and at the end of five years there is a significant, or highly significant, difference between this treatment and the others. Under both methods of seeding there is also a highly significant difference between treatments 2, 3, and 4 as compared to treatment 1. The results show that the best success was obtained when the ground preparation was at a maximum. In comparing treatments 5 and 3, which are similar except that in 5 the ground was cultivated after the litter and/or sod was removed, the results show that cultivation has a beneficial effect.

When the third year examination was made, the physical effects of the treatments on the vegetation and litter were easily discernable, but at the end of five years the effects had almost disappeared.

Table 7 shows the results obtained by natural regeneration for the five ground treatments tested. Natural regeneration has been a distinct failure and no attempt at analysis was made. With one exception, all blocks had an adequate potential seed source.

TABLE 7.—NATURAL REGENERATION

Years since treatment	Percentage of success for each of five ground treatments				
	1	2	3	4	5
1	0·0	0·0	0·0	0·0	0·0
3	2·5	0·0	2·5	7·5	5·0
5	0·0	0·0	2·5	5·0	2·5

Table 8 shows the results obtained by planting for the five ground treatments tested.

TABLE 8.—PLANTING

Years since planting	Percentage of success for each of five ground treatments				
	1	2	3	4	5
1	75·0	75·0	97·5	95·0	90·0
3	57·5	60·0	85·0	70·0	72·5
5	55·0	60·0	80·0	70·0	67·5

For planting there is no significant difference, at the end of five years, between the five ground treatments tested.

Table 9 is a summary of the fifth year results contained in Tables 1 to 8. The data have been presented in this way to facilitate making comparisons between the success of the various regeneration methods.

TABLE 9.—SUMMARY OF RESULTS SHOWING PERCENTAGE OF SUCCESS FIVE YEARS AFTER TREATMENT

Method of regeneration	Ground treatments					Average of Treatments
	1	2	3	4	5	
Natural regeneration	0	0	2	5	2	2
Planting	55	60	80	70	68	67
Broadcast seeding						
Stratified						26
Non-stratified						24
Caged						34
Non-protected						15
Average	7	26	28	24	39	25
Spot seeding						
Stratified						22
Non-stratified						20
Caged						35
Device protected						13
Non-protected						15
Average	6	22	21	22	34	21

SUMMARY

An experiment was started in the spring of 1947 to determine suitable means for securing white spruce regeneration on logged and non-burned lands (cut-over lands) in the Subalpine Region of Alberta. In all, sixty combinations of treatments were tested on eight blocks distributed in four localities. Each block contained five sub-blocks within which the treatments were randomized and applied to milacre units. The following conclusions were drawn from the experiment following a final examination made in the autumn of 1951:

(1) Planting was the most successful method of regeneration, with 55 to 80 per cent survival five years after planting. For broadcast and spot seeding the average degrees of success for all conditions were 25 and 21 per cent respectively. Natural seeding was a failure, averaging only 2 per cent success.

(2) Ground treatment had no effect upon the success of planting, but for regeneration by seeding, produced superior results. Removal of litter and/or sod combined with cultivation of an area four feet in diameter was the most effective treatment. Natural regeneration was unsatisfactory on all ground treatments.

(3) Seed stratification resulted in earlier germination but had no significant effect upon final survival.

(4) Protection of seed from rodents was essential. Wire mesh cages were effective and there were indications that they also improved the eco-climate on the caged spot. A small wooden seed-protecting device was unsatisfactory.

(5) Seeding success varied greatly with site (between blocks). Heavy ground vegetation, especially grass, had an adverse effect.

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OTTAWA, 1955