

FOREST RESEARCH BRANCH



ESTABLISHMENT REPORT
SOIL IMPROVEMENT FOR BETTER GROWTH
ON ABANDONED FARM LANDS
(Project Q-106)

by

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INTRODUCTION

Most of the studies made to improve growth of plantations on reforested unproductive abandoned farm lands are concerned with the use of fertilizers and very few attempts have been made to combine fertilization with soil scarification as a possible means of stimulating growth of various species in plantations.

This experiment will determine if adding essential nutrients to unscarified and scarified soil of farm land abandoned 10 years ago benefits establishment and development of red pine, Norway spruce and jack pine. These species were chosen because of the sandiness of the site. The use of potassium and magnesium fertilizers was suggested by previous experiments.

Observations on survival and on the general conditions of the plantations were made in the fall of 1964, after one growing season. Further observations^u will be made periodically but no appreciable growth response to treatments is anticipated before the end of the second growing season (fall 1965).

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LOCATION AND DESCRIPTION OF PLANTED AREA

The planted area is located about 3 miles west of Ste-Christine, Portneuf Co. and south of Ste-Anne river (Fig. 1).

The soils of the study area, typical of many abandoned farms in the Portneuf region, are deep old marine sand deposits of low fertility. The area was first planted to potatoes, and subsequently to tobacco. In 1953, the farm was abandoned and the site became overgrown with graminaceae (Fig. 2).

METHODS

Experimental design

A factorial design ($3 \times 2 \times 2$) combining three levels of potassium, two levels of magnesium and two soil treatments (scarified and unscarified), was laid out in complete randomized blocks with four replications (Fig. 3). Each block consisted of 12 plots. In each plot, nine trees were planted at 3 ft. spacing, giving a total of 432 seedlings. The same layout was repeated for all three species: red pine, Norway spruce and jack pine. A grand total of 1296 trees were planted on the study area.

In each plot, the corner trees will remain on the site and will make up the plantation. The other five trees will progressively be used for study of concentration of nutrients. Depending upon the development of root system, either the shoot-root dry weight ratio or the absorbing capacity of the roots will be determined when annual growth, expressed as percentage of growth over the size of tree at the beginning of the current growth, shows significant differences between treatments. For statistical purposes, the variables will be

studied on two randomly selected trees per plot.

Pre-planting

Before planting, the physical and chemical properties of the planting site were determined for evaluation of the capacity of the soil to transmit the effects of scarification and fertilizers treatments to growing stock and to permit a more objective interpretation of the results. Analyses were made of the upper 2-inch layer of soils, the root zone (6 to 8 in.) and at 10 to 12 inches. Top soil and root zone soil are of decisive importance in the initial growth of planted trees. Roots of 2-2 red pine and Norway spruce are usually placed at about 7 inches into soil. Roots of 2-2 jack pine, because of their larger size, are placed deeper into soil. Further, roots of seedlings can reach to and develop at about 10 to 12 inches soil depth within a few years.

Ten composite samples of each soil layer were collected by means of a calibrated sampling tube from the area to be planted with the three species. Each of the ten samples contained ten cores. Analysis of the physical and chemical properties of soil are given in Table 1, and soil characteristics are compared with minimum values necessary for satisfactory growth after S.A. Wilde, 1958 (Table 2).

Each block was subdivided into 12 equal plots planted as shown in Figure 3. Scarification was done with a Gravelly tractor with a tiller attachment.

Four corner posts marked with orange paint limit the 3 x 1 ch. area to be planted with each species. The whole area to be planted was 10 chains long by 1 chain wide.

Planting

The trees, grown in the Valcartier nursery, were planted May 21 with Saguenay planting tools. Black spruce and jack pine seeds were obtained from the Provincial nursery at Berthierville, and red pine seeds from Amos, Abitibi.

Fertilization

One day after planting, fertilizers were applied around each tree in an area of about 1 square foot. Potassium was applied as K_2SO_4 (50% K) at a rate of 100 and 200 lbs/acre of K, and magnesium as MgO at a rate of 100 lbs/acre of Mg.

The choice of these fertilizers as forms of sulphate and oxide was dictated by the lack of forest ground vegetation and the sandy texture of the study area. Potassium sulphate and magnesia are not readily water-soluble materials and consequently are not easily leached to a depth which cannot be reached by the roots.

PLANTING CONDITIONS

At time of planting, May 21, the soil was moist and the temperature cool. A north wind at 4 miles per hour at 6:00 a.m. strengthened rapidly, the sky became cloudy, and scattered showers fell on the planting area. Maximum and minimum temperatures at Châte Panet, a few miles east of the planting site, were 56°F and 28°F on May 21. The minimum temperature was registered at night after the planting was done. Scattered showers fell on the planted area during the following five days.

The summer of 1964 was characterized by a great number of rainy days and cool temperatures (Table 3).

POST PLANTING OBSERVATIONS

Immediately after fertilization, the heights of all planted trees were measured. Results are given in Table 4.

In fall 1964, after one growing season, a close examination of the spring planting was made and survival by species and soil treatments is shown in Table 5. Living trees were generally in good condition. Less than one per cent of all trees had yellow tips. The most likely cause for the four per cent mortality was the frost which occurred immediately after planting.

FUTURE WORK

Leader length and survival will be recorded in fall 1965 (end of the second growing season). Leader lengths will be expressed as percentages of heights of trees in the spring 1965, and, if significant responses to treatments are found, concentrations of potassium and magnesium in current year needles, shoot and root dry weights and top-root ratios or absorbing capacities of roots will be studied on two trees selected at random from the five trees intended for this purpose (Fig. 3).

According to the project plan, the same experiment was to be repeated on farm land abandoned some 30 years ago and located few hundred feet south-east of the 1964 plantation (Fig. 3). However, because of the short period of time available for this project in the coming spring, planting will be restricted to the least exacting species, jack pine. Preliminary soil analyses indicated that this soil is much poorer in potassium but richer in magnesium than the one abandoned 10 years ago. Supplies of other nutrients are about the same with some variation between samples. Heterogeneity of the

soil is suspected also because of patches of different ground vegetation such as cladonia, polytrichum, vaccinium and occasional slow growing grey birch, white spruce and white pine trees. Therefore, a factorial design (4 x 2) combining four levels of potassium (0 - 100 - 200 - 300 lbs/acre of K as K_2SO_4 - 50% K) and two soil treatments (scarified and unscarified) will be used in this experiment. Blocks will be replicated four times and treatment within each block will be replicated twice (Fig. 4). Tree will be planted as shown in Figure 3. A total of 576 trees (144 per block) will be planted. The analysis of variance will have the following form:

<u>Source</u>	<u>Degree of freedom</u>
Block	3
Treatment	7
Treatment x Block	21
Expt'l Error	32
Sampling Error 1.....	64
TOTAL	127

APPENDICES

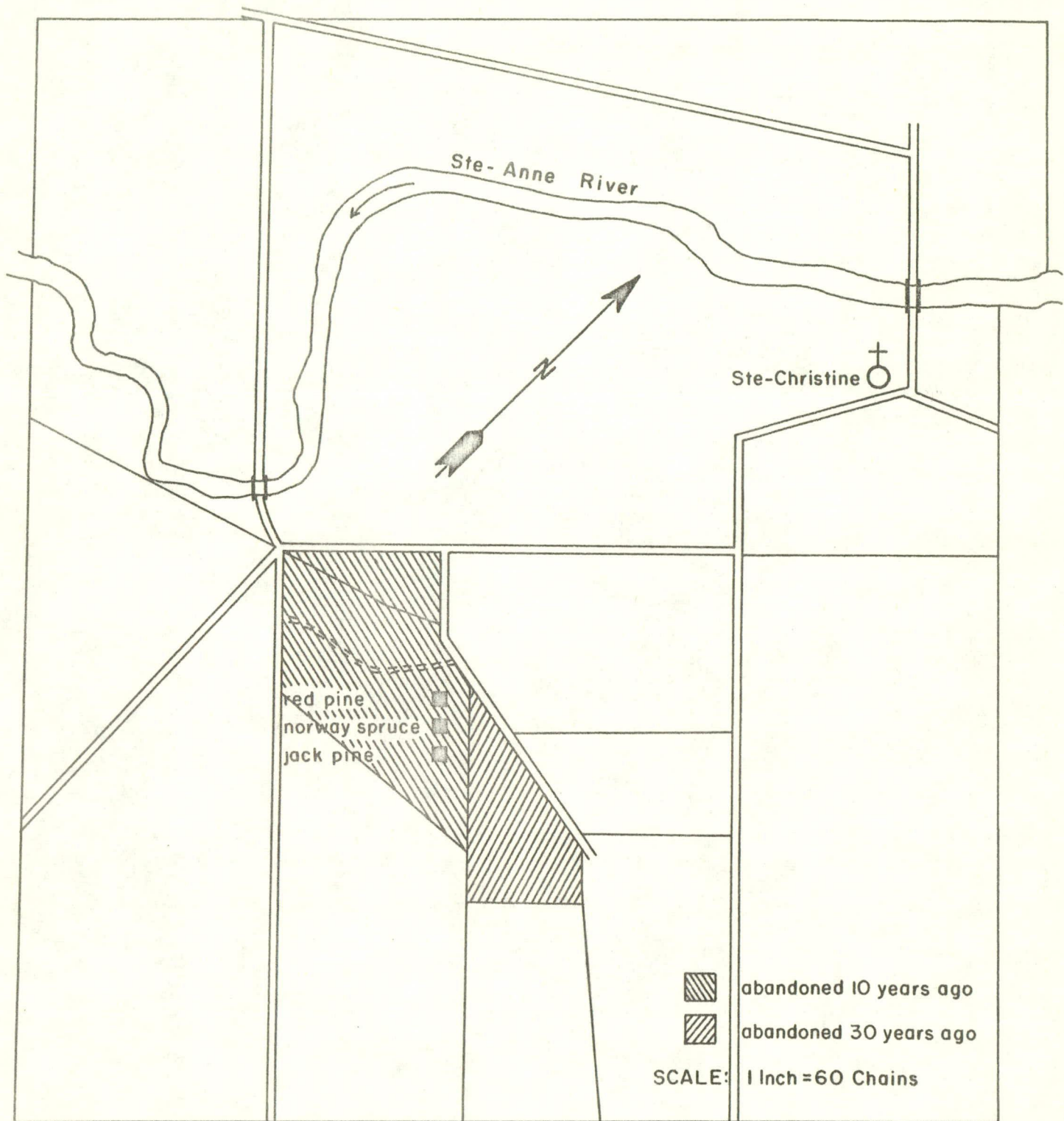


Figure.1. Index map



Figure 2. The planting site was formerly cultivated, but it was abandoned in 1953 and is now overgrown with graminaceae.

TREATMENT

C : no soil scarification
 S : soil scarification
 K₀ : zero application of potassium
 K₁ : potassium at 100 lbs/acre
 K₂ : potassium at 200 lbs/acre
 Mg₀ : zero application of magnesium
 Mg₁ : magnesium at 100 lbs/acre

1 : C-K ₀ -Mg ₀	7 : S-K ₀ -Mg ₀
2 : C-K ₀ -Mg ₁	8 : S-K ₀ -Mg ₁
3 : C-K ₁ -Mg ₀	9 : S-K ₁ -Mg ₀
4 : C-K ₁ -Mg ₁	10 : S-K ₁ -Mg ₁
5 : C-K ₂ -Mg ₀	11 : S-K ₂ -Mg ₀
6 : C-K ₂ -Mg ₁	12 : S-K ₂ -Mg ₁

DISPOSITION OF PLOTS IN EACH BLOCK FOR EACH SPECIES

BLOCK I	BLOCK II	BLOCK III	BLOCK IV
7	7	11	8
3	10	12	6
2	8	9	7
4	11	6	12
6	1	4	10
9	3	2	1
10	5	3	11
5	9	7	4
11	4	8	2
8	12	10	9
1	6	1	5
12	2	5	3

Each tree species will be planted on each plot as per this sketch

	Plot 7	Plot 7	Plot 11	Plot 8
	x . x 12'	x . x	x . x	x . x
6
	x . x	x . x	x . x	x . x
12	Plot 3	Plot 10	Plot 12	Plot 6
	x 1 x	x 1 x	x . x	x . x

	x . x	x . x	x . x	x . x

x = tree that will always remain on the planting site.

. = tree that will progressively be used for study of concentration of nutrients, roots and also for replacement in case of mortality

Figure 3. Experimental layout

TREATMENT

C : no soil scarification
 S : soil scarification
 K_0 : zero application of potassium
 K_1 : 100 lbs/acre of potassium
 K_2 : 200 lbs/acre of potassium
 K_3 : 300 lbs/acre of potassium

1 : C-K	5 : S- K_0
2 : C- K_1	6 : S- K_1
3 : C- K_2	7 : S- K_2
4 : C- K_3	8 : S- K_3

DISPOSITION OF PLOTS IN EACH BLOCK

Block I				Block II			
7	5	1	2	2	8	4	5
3	6	4	8	7	3	6	1
5	1	8	2	6	3	7	8
3	6	7	4	4	2	5	1

Block III-				Block IV			
4	3	8	7	3	1	5	4
6	5	2	1	6	8	2	7
8	4	3	6	2	7	5	8
1	2	7	5	4	1	3	6

Figure 4. Experimental layout for farm land abandoned 30 years ago (from Tippet's Random Sampling Numbers).

Table 1. Physical and chemical soil profile characteristics of the Ste-Christine plantation.

Depth (ins.)	Number of pooled samples	Mechanical analysis		pH	Nutrient content			
		Sand %	Silt & Clay		N %	K	Mg (lb. per acre)	P
0 - 2	10	87	13	5.59	.21	100	80	30
6 - 8	10	89	11	5.79	.15	30	50	20
10 - 12	10	94	6	5.70	.09	30	40	20

Table 2. Minimum content of nutrients in the surface 6-in. layer of soil, texture and pH of soil for satisfactory growth of tree species in plantations (After Wilde, S.A. 1958, Forest Soils pages 417 and 419).

	red pine	norway spruce	jack pine
Total Nitrogen (%)		.10	.02
Available K (lbs/acre)	somewhat more exacting than jack pine	125	30
Exchangeable Mg (lbs/acre)		300	120
Available P (lbs/acre)		50	trace
Silt & Clay (%)	10	40	5
Range of pH reaction	5.0 - 6.5	4.7 - 6.5	5.5 - 7.0

Table 3. Summer precipitation, number of rainy days, and mean minimum and maximum monthly temperature near the plantation

Month	Precipitation (inches)	Number of rainy days	Mean minim. temp. (°F)	Mean maxim. temp. (°F)
May *	1.25	6	39.7	63.5
June	4.17	13	45.6	73.2
July	6.12	18	55.2	76.4
August	5.81	19	47.8	69.5

* Data compiled from May 21st, date of planting.

Table 4. Average height of seedlings at time of planting on May 21/1964 at Ste-Catherine. (in 1/100 ft).

Plot No.	red pine	Norway spruce	jack pine
1	.42	.52	.73
2	.33	.62	.73
3	.29	.67	.69
4	.32	.65	.78
5	.33	.59	.69
6	.31	.67	.75
7	.26	.56	.65
8	.30	.55	.63
9	.26	.64	.68
10	.26	.51	.71
11	.32	.70	.64
12	.30	.59	.68

N.B. Plots are distributed at random in each block (see Fig. 3).

Each average comprises 36 seedlings.

Table 5. Per cent of survival by species on scarified and unscarified soils after the first growing season.

Species	per cent of survival		Total
	scarified	unscarified	
Red pine	96	92	94
Norway spruce	97	94	95
Jack pine	99	97	98

