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ABSTRACT

Survival and growth of three indigenous conifers, planted in the Clay Belt, Abitibi, northwest Quebec, during 1960 to 1962. Results of the study indicate black spruce (Picea mariana Mill.) and white spruce (Picea glauca Moench.) were the most promising species. Planted jack pine (Pinus banksiana Lamb.) was not only affected by higher mortality and lower growth rate than jack pine growing in nearby natural stands, but was also more susceptible to attack by the pitch nodule maker (Petrova albicapitana Busk.), when growing in pure artificial stands, causing heavy damage and deformation to trees.

RESUME

Cette étude présente des données sur la survie et la croissance de trois conifères indigènes plantés en 1960, 1961 et 1962 sur des terrains argileux de la région d'Abitibi, dans le nord-ouest québécois. Les résultats de cette expérience montrent que l'épinette noire (Picea mariana Mill.) et l'épinette blanche (Picea glauca Moench.) sont les espèces les plus prometteuses. La performance du pin gris (Pinus banksiana Lamb.) en plantation n'a pas seulement été compromise par un degré plus élevé de mortalité et un taux plus ralenti de croissance que celle du pin gris croissant dans les peuplements naturels du voisinage, mais également par une plus grande susceptibilité aux attaques du nodulier du pin gris (Petrova albicapitana Busk.) qui cause des dommages sévères et des déformations aux arbres.

INTRODUCTION

The vast territory of Abitibi and Temiscamingue in northwest Quebec, is situated within lat. 47 and 49 N, and long. 67 and 79 W, and known as the Clay Belt.

In 1960, J.D. MacArthur, a former research officer with the Canadian Forestry Service, chose some 100 acres of farmland at St. Marc de Figuery, Abitibi, Quebec, Forest Region B4 (Rowe, 1959), as a site for experimental tree planting to obtain information on species and planting methods for use in the Clay Belt. During 1960 to 1962, 12 acres of jack pine (Pinus banksiana, Lamb.), 6 acres of black spruce (Picea mariana, Mill.) and 8 acres of white spruce (Picea glauca, Moench.) were planted on 28 acres of the experimental site, and a small area with Norway spruce (Picea abies, L.) under a canopy of aspen (Populus tremuloides, Michx.). Four years after planting MacArthur (1964) published the results of his experiment. He stated jack pine was the most promising species, white spruce survived well but showed symptoms of checking or stagnation, and early mortality of black spruce was prohibitive.

Information on reforestation of abandoned farm land **with** clay soil is rare, therefore comparison is almost impossible. Differences in climate and species (Wilde and Voigt, 1967), or different types of land used for plantations (Stiell, 1958), are the main reasons.

This report gives an analysis of the survival and growth of the three indigenous species planted between 1960 and 1962 in the Clay Belt, and evaluates the success or failure. A comparison of jack pine and black spruce growth and vigor in relation to corresponding even-aged natural stands is made.

Soil and climate

All trees were planted on a heavy clay soil, developed on glacial till from the lacustrine deposits of land that was formerly Lake Ojibway (MacLean and Bedell, 1955). According to Dr. T.D. Phu, research scientist, Laurentian Forest Research Centre, Quebec, the average content of organic matter is 5%, 88% silt and clay, and carbon nitrogen ratio 26, PH value 4.9.

Climate in northwest Quebec is "humid continental with cold, snowy winters, moderately warm summers with fairly high rainfall" (Canada Land Inventory, 1966), mean annual temperature 33.6 F, and total annual precipitation 33 inches (Villeneuve, 1967).

Method

The three plantations chosen for the study, age from 7 to 9 years after planting, were spaced 5 x 5 ft and 6 x 6 ft. Twenty six sample plots (1/10 acre each) were established in the three plantations. In each plot the number of survivors, d.b.h., and total height of the trees were recorded. Measurement of the last five terminal shoots were taken of 10 trees that were close to the mean height of each plot.

The same measurements were taken of 20 jack pine and 20 black spruce average sample trees representing two 1/10 acre plots in natural stands of the same age, and growing on similar soil in nearby plantations. (Although this sampling was not statistically sufficient, because of the limited areas of comparable jack pine and black spruce in natural stands, it provides a comparison between natural stands and plantations of the two species.)

Damage by the pitch nodule maker (Petrova albicapitana, Busk.) was estimated by counting nodules on 600 jack pine in plantation, and 200 in natural stands.

Jack Pine

Survival

Twelve acres of jack pine were planted in 1960 and 1961 from planting stocks 2-2 and 1-1, provenance was from Dolbeau (lat. 48°50', long 72°10') and Manouan (lat. 47°38', long. 74°00') and from Chapleau (lat. 47°45', long. 83°30'). In both trials trees were planted 1210/acre. After 9 and 8 years, jack pine mortality was 79% in the 1960 plantation, and 43% in the 1961 plantation. Both mortality rates were too high.

Heavy mortality in the jack pine plantations was probably due to several factors, including climate and soil structure, but the difference in percentage of mortality between the 1960 and 1961 was due to the inferior quality of the 1960 planting stock. MacArthur (1964) noted that heavy mortality in the 1960 plantation resulted from poor stock condition, planting difficulties, and plants being too large. Actually, the 1-1 stock, planted in 1961, adapted better to unsatisfactory soil structure, such as high clay content, than the larger 2-2 stock. According to Cheyney (1932), jack pine drew the majority of its nutrients and moisture from the upper foot of soil, the same stratum from which most shrubs and herbs obtain nutrients. As the upper soil horizons are richer in heavy clay soils than the lower horizons, it is apparent the 1-1 planting stock, with its superficial root system, had a greater chance of survival than 2-2 planting stock, particularly as the 2-2 plants in 1960 were too large.

Grass competition in the plantations also contributed to an increase in mortality (it diminishes the supply of water during the dry season). Heaving is another phenomenon, causing mortality during freezing and thawing in late fall and spring, particularly during the first year of plantation in clay soils.

Considering all these factors, I believe the problem of survival of planted jack pine trees in the Clay Belt, particularly under the harsh soil and climatic conditions of the Abitibi region, has not been resolved; although some results show the advantage of 1-1 planting stock. Further studies to re-examine planting techniques, particularly specifications for planting stock, are recommended.

Growth

In addition to high mortality, the growth of jack pine was also unsatisfactory. This was evident when planted jack pine was compared with nearby natural stands of approximately the same age, on similar sites. After 13 years the growth of jack pine natural stands was 25% greater. Also, the average elongation of shoots for the last 5 years of growth was 9.5 inches for plantation trees, and 13 inches for trees in natural stands ($t=4.99$ for 78 degrees of freedom at the probability level 0.001%) (Table 1).

A marked contrast between natural stands and plantations was that the pitch nodule maker severely attacked plantation trees up to an average of eight attacks a tree. Consequently, planted jack pine often had crooked and forked stems. The insect was rare in natural stands. No doubt the pitch nodule maker attacks also effected growth. Why the pest outbreak occurred was not determined, although it could be that natural jack pine stands, mixed with poplar and birch, have greater resilience to the pest than pure stands.

Black Spruce

Survival

Black spruce, 2-2 stock, provenance Long Lake, Ontario, was planted in 1960 on 4 of the 28 acres within the experimental site. Although the weather and

soil conditions were not good during the planting period (MacArthur, 1964), mortality in spring 1969 was only 12%. Another 2 acre trial stand of black spruce, 2-2 stock, provenance Kapuskasing, Ontario, was planted in 1962 in the same area. Nine years later mortality was 39%, due apparently to site conditions and grass competition, despite superior stock to that used in 1960. Because of heavy mortality, jack pine, planted in 1960, was replanted with black spruce in 1962. But, where jack pine failed black spruce was very successful (i.e., 6% mortality, provenance from Kapuskasing).

Growth

After 11 and 13 years of growth from seed, black spruce attained average height 3.4 and 5.1 ft respectively. Contrary to jack pine, planted black spruce grew much better than in natural stands (Table 1). During 13 years growth from seed planted black spruce averaged 1.7 ft taller than natural stands of the same age and growing on similar sites.

From observations made by MacArthur (1964) it is apparent that black spruce, in relation to other species (particularly jack pine), is unable to successfully compete in sites such as the Clay Belt. MacArthur's observations and predictions were based on the mortality and health of the transplants, kept in check at the time of his observations by a prolonged period of slow top growth. After 1969 the health of the black spruce plantation changed; yellow needles (MacArthur, 1964) disappeared, and the trees were a healthy green.

Despite problems, black spruce performance in the Clay Belt plantations showed very good survival and satisfactory growth.

White Spruce

Survival and growth

White spruce planted in 1961, covered 8 of the 28 acre study plot; mortality was 33% in 1969. After 8 years in plantation, or 13 years from seed, white spruce averaged 4.1 ft high. That white spruce grows well in the ecological conditions of the Clay Belt is proved by its growth vigor in plantation (Table 1), and is comparable to black spruce planted in 1962.

According to MacArthur (1964) white spruce survived better than black spruce after one growing season. But my observations after 8 years growth in plantation showed there was no significant difference in growth between the two spruces; and the survival of black spruce, particularly stock planted in 1960, was greater than white spruce (Table 1). Although the early growth of white spruce was the same as black spruce affected by yellowing needles, caused by checking (MacArthur, 1964), my last study confirmed the good health and vigor of white spruce. Also, if no damage by insect or disease occurs in the future, the growth and yield of white and black spruce would be satisfactory for the soil and climatic conditions of the Clay Belt.

CONCLUSIONS

1. Black and white spruce, as shown by survival and growth, are the most promising species for planting on clay soils in the Clay Belt. They may suffer immediately after planting (2 or 3 years) but after this critical period growth becomes normal and vigorous.

2. Jack pine performance, contrary to MacArthur's (1964) predictions, falls short of expectations. The appearance, health, and unacceptable level of mortality after 8 or 9 years in plantation, is not conducive to growing jack pine in clay soils; particularly when compared with natural stands. Further studies

on provenances, planting techniques and specifications for planting stock are advisable.

3. It is important the stock not only survive in selected planting sites, but also produce high yields of timber to justify planting costs. More research in this field is necessary in the Clay Belt. Research should include soil and site conditions, provenance, nursery technique, planting methods, composition of plantations, spacing, growth, yield, and cost of planting.

TABLE 1

Survival and early growth of jack pine, and black and white spruce in plantations and nearby natural stands

	Jack pine			Black spruce			White spruce
	Plantation		Natural stand	Plantation		Natural stand	Plantation
	1	2	3	1	2	3	1
No. of Plots (1/10 acre)	7	5	1	5	5	1	4
Trees measured	260	140	20	645	907	20	239
Age from seed	13	10	13	13	11	13	13
Planting yr.	1960	1961	-	1960	1962	-	1961
Trees planted/ acre	1,210	1,210	-	1,210	1,740	-	1,210
Survival %	21	57	-	88	61	-	67
Average height (ft)	10.3	7.3	13.8	5.1	3.4	3.4	4.1
Average d.b.h. (inch)	1.4	1.1	1.9	-	-	-	-
Average annual lenght, last five terminal shoots (inch)	9.5	-	13.0	6.9	5.4	4.4	6.2

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