Forest Research Branch

EARLY DEVELOPMENT OF WHITE SPRUCE AS RELATED TO PLANTING METHOD AND PLANTING STOCK HEIGHT

by

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Résumé en français

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ABSTRACT

After nine growing seasons no practical difference in survival and growth of white spruce could be attributed to method of planting in a test of two planting methods that dispose the seedling roots in a horizontal plane close to the soil surface and a conventional one that places the roots vertically. Growth and variability in height were found to be related to height of planting stock. Planting stock less than 0.5 feet tall grew poorly on the planting site studied. Research into improved culling and grading procedures for size and quality of spruce planting stock is suggested.

RÉSUMÉ

En neuf années, on n'a pu déceler de différence notable dans la survivance et la croissance de l'épinette blanche, qui soit attribuable à la méthode de plantage; les essais portaient sur deux méthodes de repiquage; selon la première, les racines sont placées à l'horizontale à très faible profondeur; et selon la seconde, qui est la méthode classique, les racines sont placées à la verticale. L'allure de croissance et la hauteur des sujets variaient selon la taille des plants repiqués. Les plants de moins d'un demi-pied de hauteur ont mal poussé, tout au moins dans la pépinière à l'étude. D'après les constatations faites, il est souhaitable qu'on entreprenne des recherches pour améliorer les méthodes de tri et de classement des plants d'épinette, d'après leur taille et leur qualité.

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Early Development of White Spruce as Related to Planting Method and Planting Stock Height[1]

by

L. G. Brace[2]

INTRODUCTION

Low survival and poor growth of white spruce (*Picea glauca* (Moench) Voss) are sometimes associated with conventional planting methods. Some investigators have maintained that for optimum moisture and oxygen supply, spruce should be planted with roots in a horizontal plane a few inches below the soil surface. To test this hypothesis, Professor R. C. Hosie[3] initiated a study of planting methods in 1953 in which 18 co-operators participated.

One of the experiments was planted at the Petawawa Forest Experiment Station in 1954. After three growing seasons, none of the methods tested had shown any conclusive advantage in survival and initial growth in the Petawawa experiment (Stiell 1958 and 1960). This paper concludes the study after six additional years of growth.

Height growth was considered to be a suitable indicator of the effects of planting method, particularly as white spruce often exhibits the phenomenon of "check," or arrested growth. Height growth is easily measured on small trees and is of major significance in the successful establishment of spruce on sites where herb, grass, and shrub competition are severe.

PROCEDURE AND ANALYSIS

Previous Work

Stiell (1958a) described the Petawawa experiment fully. The description is briefly recapitulated here.

Planting Method

1. *Saddle Method*

   The saddle method of planting entails removing two wedges of soil with a straight-bladed spade to produce a low-angle, saddle-shaped planting surface about 8 inches wide by 10 inches long on which the tree roots are distributed when planting. The highest part of the saddle is about 1 inch and the lowest part 4 inches below the soil surface. The wedges are replaced over the roots.

2. *Half-Saddle*

   In the half-saddle method one shallow wedge of soil is removed so that a single sloping planting surface about 8 inches wide by 12 inches long is exposed. The tree is planted at the middle of the wedge with the root collar about 2 inches from the soil surface. The roots are spread over the planting surface, having a maximum depth of 4 inches, and are covered with the wedge of soil.

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3. *Wedge*

The wedge method used in the Petawawa experiment involves making a hole with one vertical face 7 inches to 8 inches wide and about 10 inches deep. The tree is planted with roots spread on the vertical face, thus placing them in a contrasting position compared with either the saddle or half-saddle methods.

Experimental Design

The plots were laid out in three blocks, each containing 10 rows of 25 trees planted by each method and randomly located within the block. Spacing was 3 by 3 feet. All the stock was 2-2, and had been culled by normal subjective nursery practice, which was mainly on the basis of morphology (Mullin 1959). Blocks A and B were planted in the spring of 1954 and Block C in the fall of 1954.

Site

The area planted was part of a level field abandoned in 1942 after 50 years of cultivation or pasture. The soil consists of moist windblown fine sand over compacted silty sand, mottled at about 2 feet and containing small angular stones below 2½ feet.

When the area was planted there was a continuous sod base of grasses and sedges, and occasional patches of hair-cap moss (*Polytrichum* spp.). In the summer a luxuriant herbaceous cover up to 3 feet tall developed. Woody plants on the site included various shrubs and some white pine (*Pinus strobus* L.) regeneration.

During the first three years of the experiment, the density and composition of the ground cover changed little. In succeeding years the shrubs were cut back to reduce root competition and shading.

Three-year survival, height growth, and root development were analysed by Stiell (1958b) from measurements in the fall of 1956 and spring of 1957.

1962 Work

Field Procedure and Compilation

Height measurements were taken to the nearest tenth foot from mean ground level, by year, for all living trees in all blocks, after mid-July when height growth had ceased and terminal bud formation was apparent. Survival counts were made concurrently.

Certain trees were eliminated from this study because of unusual growing conditions or visible damage not associated with the treatments such as:

(a) mechanical breakage by snow or other agents;

(b) frost or animal damage to current or past leaders, as shown by deformation or loss of terminal growth or by double tops; and

(c) multiple stems.

Planting height as compiled and discussed throughout the paper is top length only and the relationship of height to other physical characteristics is assumed to have been considered in culling at the nursery. Size is sometimes used as a synonym for height.

Blocks A and B were considered simple replications of the same experiment and were treated together in the analysis. They had similar provenance, planting date, and initial culling procedure. Block C was considered separately as it had one less growing season, underwent an extra culling prior to planting, and was possibly of different provenance.

RESULTS AND DISCUSSION

Survival

Mortality related to planting method usually occurs mostly within a few years after planting. Average survival figures in Table 1 were tested by Chi-square in 1956 (Stiell 1958a). Blocks A and B showed no significant difference in average survival between methods and survival was high. 1962 survival was similar and satisfactory.

In Block C the saddle method was significantly poorer than the others, which were satisfactory. From 1956 to 1962, survival changed little. Mortality in the saddle method of Block C was attributed to extremely dry weather in the first (1955) growing season.

Compared within and between methods, survival was somewhat lower for small stock in Blocks A and B, especially for the wedge and saddle methods. In Block C, little relationship was apparent between survival and planting stock size in classes with a reasonable number of trees, except for the saddle method where mortality tended to be higher in larger stock, probably drought-caused as noted earlier.

Generally, survival was good and not related to planting method. Survival was somewhat poorer for small planting stock in Blocks A and B.

Height and Height Growth

The Effect of Planting Method

Table 2 and Figure 1 show that planting method had little influence on height growth of planting stock either within or between Blocks A and B. The trend in Block C was similar but even more uniform. An average yearly growth rate of

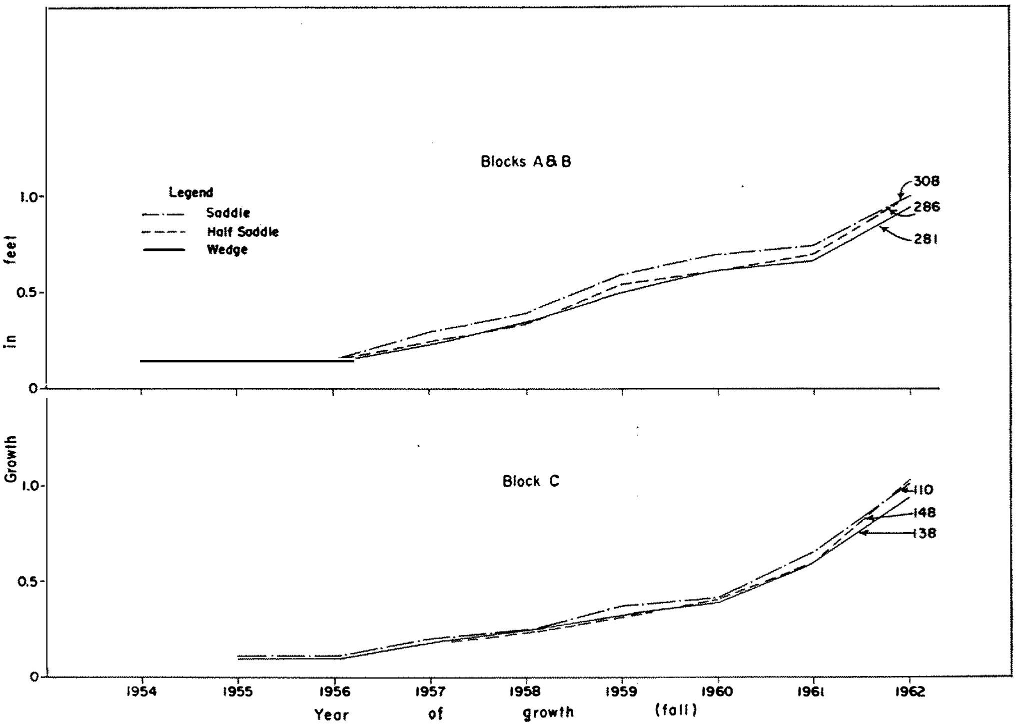

FIGURE 1. Mean height growth by year by method Blocks A, B and C

TABLE 1. NUMBER OF TREES PLANTED, AND SURVIVAL BY METHOD, BY HEIGHT CLASS AND BY AVERAGE OF ALL HEIGHT CLASSES.

Wedge						
Number planted						
Planting height	0.3−	0.4	0.5	0.6	0.7	0.8+
Block A	56	65	61	36	14	18
Block B	80	68	52	29	9	1
Block C	6	42	49	114	30	9
Percent survival 1962						
Block A	71.4	95.4	93.4	94.4	100.0	100.0
Block B	75.0	80.9	94.2	89.7	88.9	100.0
Block C	100.0	88.1	89.8	87.7	86.7	100.0
Average survival percent						
			1956†	1962		
Block A			92.9	89.6		
Block B			92.1	83.3		
Block C			94.0	88.9		

Half-Saddle						
Number planted						
Planting height	0.3−	0.4	0.5	0.6	0.7	0.8+
Block A	64	72	59	28	13	3
Block B	54	82	51	31	13	8
Block C	2	32	49	120	24	5
Percent survival 1962						
Block A	92.2	91.7	88.1	100.0	100.0	100.0
Block B	90.7	81.7	96.1	87.1	100.0	100.0
Block C	100.0	87.5	79.6	90.0	91.7	100.0
Average survival percent						
			1956	1962		
Block A			95.8	92.5		
Block B			96.2	89.1		
Block C			90.0	87.1		

Saddle						
Number planted						
Planting height	0.3−	0.4	0.5	0.6	0.7	0.8+
Block A	46	55	54	48	22	15
Block B	41	71	59	40	18	11
Block C	6	40	48	117	31	6
Percent survival 1962						
Block A	84.8	90.9	90.7	97.9	100.0	100.0
Block B	78.0	83.4	88.1	92.5	100.0	90.9
Block C	100.0	82.5	60.4	72.7	48.4	66.7
Average survival percent						
			1956	1962		
Block A			93.3	92.5		
Block B			89.6	86.7		
Block C			72.2	69.3		

†2 year survival for Block C and 3 year survival for Blocks A and B from Stiell 1958a.

TABLE 2. HEIGHT BY PLANTING METHOD AND BLOCK (FEET)

	Block A			Block B			Block C			Blocks A & B		
	Wedge	Half-Saddle	Saddle	Wedge	Half-Saddle	Saddle	Wedge	Half-Saddle	Saddle	Wedge	Half-Saddle	Saddle
No. of trees	154	146	165	127	140	143	138	148	110	281	286	308
Mean planting height	0.49	0.45	0.53	0.46	0.46	0.50	0.57	0.58	0.55	0.48	0.46	0.52
Mean total height (1962) and SeM	4.56 ±0.10	4.49 ±0.12	4.81 ±0.10	3.89 ±0.12	4.19 ±0.11	4.54 ±0.11	3.41 ±0.08	3.54 ±0.07	3.65 ±0.10	4.26 ±0.08	4.34 ±0.08	4.69 ±0.07
Standard deviation	±1.25	±1.41	±1.28	±1.32	±1.30	±1.27	±0.94	±0.82	±1.02	±1.32	±1.36	±1.28
Coefficient of variation	27.4	31.4	26.6	33.6	30.9	28.0	27.6	23.2	27.9	31.0	31.4	27.3
Range of 1962 heights	2.0–8.8	2.1–8.5	2.1–8.2	1.7–8.9	1.7–7.8	2.0–7.7	1.6–5.8	2.0–5.9	1.6–5.8	1.7–8.9	1.7–8.5	2.0–8.2

The only significant differences found between 1962 heights by "t" tests were:

1. between the wedge and saddle methods within Block B (P.05).
2. between the wedge methods of Blocks A and B (P.02).

one foot had been reached or approached by 1962 regardless of planting method, apparently without a maximum rate yet being reached. Von Althen (1962) found that the rate of height growth in Petawawa spruce plantations increased for 17 years before a temporary plateau became evident.

The Effect of Planting Stock Height

Figure 2 illustrates the yearly trend in growth of planting stock in Blocks A and B. Small planting stock had a slower rate of increase in height growth than taller stock. By 1962 all stock 0.5 feet and taller in planting height had an annual rate of growth of one foot or more and according to "t" tests was, in most cases, significantly taller than stock less than 0.5 feet tall when planted (see Table 3). In all cases 1962 heights were progressively greater with increasing planting height. Thus all differences tested in Table 3 were positive.

Table 4a shows the distribution of stock by planting height and 1962 height class for Blocks A and B. Tall planting stock occurred more frequently than short stock in larger 1962 height classes. Some of the variability of height growth within planting height classes may be due to morphological and physiological variation and site differences but these cannot be evaluated here.

Figure 3 and Tables 3 and 4b show the relative uniformity of growth of Block C stock, which underwent a heavy second culling in the field before planting, compared with Blocks A and B. It is also possible that since the seedlings of Block C have been outplanted for a shorter time—one season—and since the condition of the planting stock in this block was poorer (Stiell 1958a), these seedlings have had less opportunity to express the influence of initial height on subsequent growth.

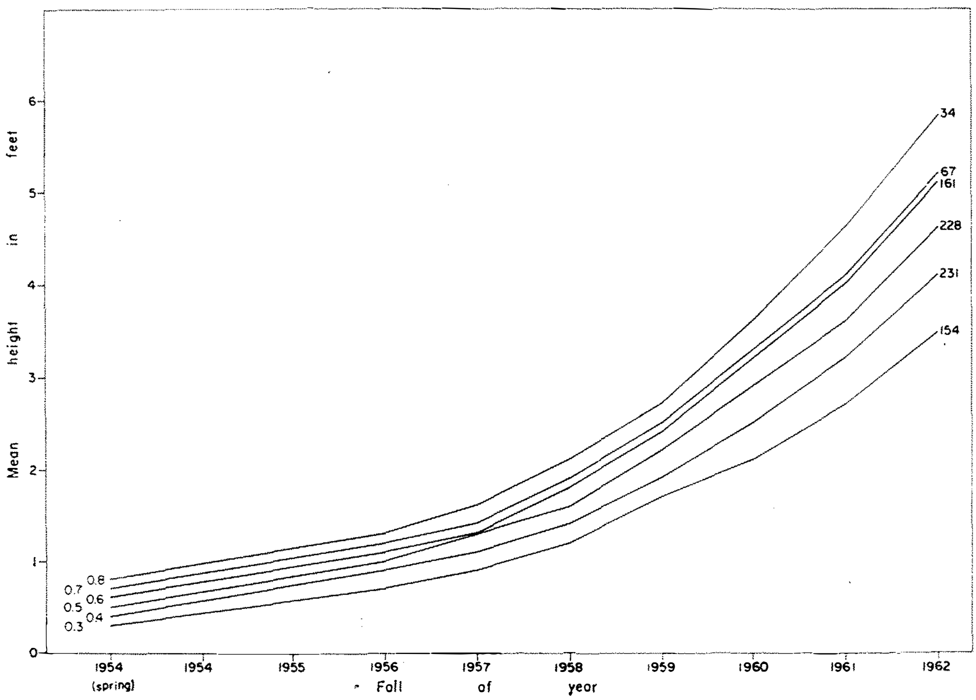

FIGURE 2. Mean yearly height by planting height class for white spruce planted as 2—2 stock in spring 1954
Blocks A and B

TABLE 3. RESULTS OF "T" TESTS OF MEAN 1962 HEIGHTS BY PLANTING HEIGHT CLASS

	Wedge					Blocks A and B Half-Saddle					Saddle				
Planting height (ft.)	.4	.5	.6	.7	.8	.4	.5	.6	.7	.8	.4	.5	.6	.7	.9
.3	NS[1]	***[2]	***	***	***	**	***	***	***	***	***	***	***	***	***
.4	—	***	***	***	***	—	NS	***	***	***	—	NS	**	**	***
.5	—	—	NS	NS	NS	—	—	NS	NS	NS	—	—	NS	NS	*
.6	—	—	—	NS	NS	—	—	—	NS	NS	—	—	—	NS	NS
.7	—	—	—	—	NS	—	—	—	—	NS	—	—	—	—	NS
	Wedge					Block C Half-Saddle					Saddle				
Planting height (ft.)		.5	.6	.7	.8		.5	.6	.7	.8		.5	.6	.7	
.4	—	NS	NS	NS	NS	—	NS	*	***	***	—	NS	*	NS	
.5	—	—	NS	NS	NS	—	—	NS	*	NS	—	—	NS	NS	
.6	—	—	—	NS	NS	—	—	—	NS	NS	—	—	—	NS	
.7	—	—	—	—	NS	—	—	—	—	NS	—	—	—	—	

[1]NS —not significantly different
[2]* —significant difference at P.05
** — " " P.02
*** — " " P.01

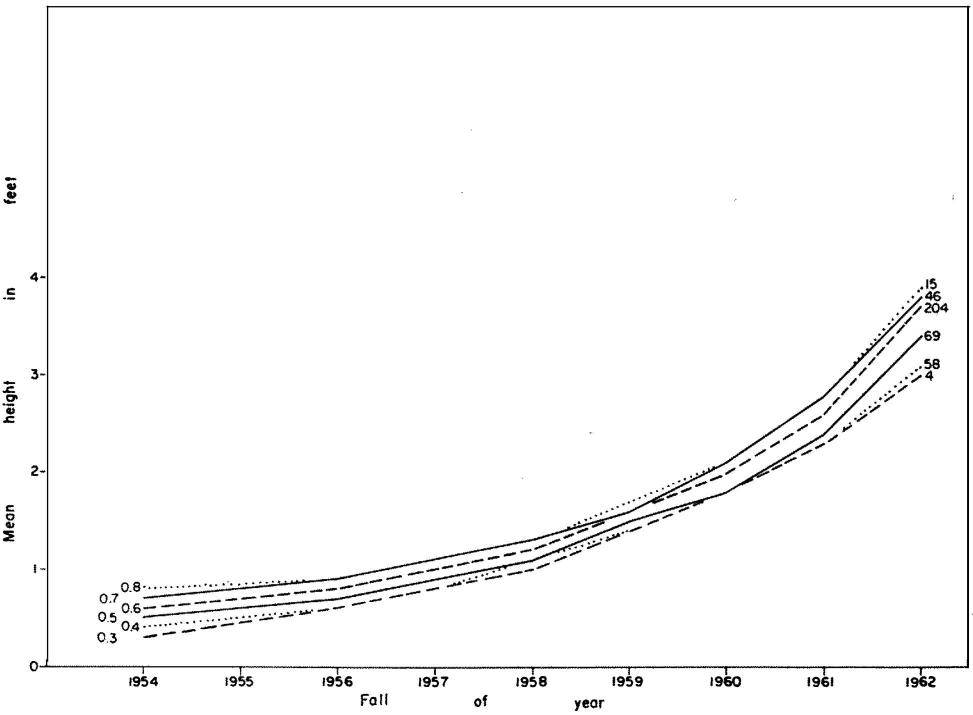

FIGURE 3. Mean yearly height by planting height class for white spruce planted as 2—2 stock in fall 1954
Block C

TABLE 4a. RELATIONSHIP OF PLANTING HEIGHT AND 1962 HEIGHT BLOCKS A AND B

Planting Height	No. of trees	No. of trees by 1962 height class							
		2.0(−)	2.1-3.0	3.1-4.0	4.1-5.0	5.1-6.0	6.1-7.0	7.1-8.0	8.1-9.0
0.3−	154	4	52	63	23	11	1	—	—
0.4	231	3	45	73	61	38	9	2	—
0.5	228	1	22	61	63	47	24	8	2
0.6	161	—	6	26	49	50	22	7	1
0.7	67	—	1	13	19	15	13	6	—
0.8+	34	—	—	1	11	7	9	4	2

TABLE 4b. RELATIONSHIP OF PLANTING HEIGHT AND 1962 HEIGHT BLOCK C

Planting height	No. of trees	Number of trees by 1962 height class					
		2.0(−)	2.1-3.0	3.1-4.0	4.1-5.0	5.1-6.0	6.1-7.0
0.3−	4	1	1	1	1	—	—
0.4	58	5	25	19	9	—	—
0.5	69	4	21	30	12	2	—
0.6	204	6	49	86	44	17	2
0.7	46	—	7	23	13	3	—
0.8+	15	—	3	6	6	—	—

CONCLUSIONS AND RECOMMENDATIONS

The establishment phase of the experiment was considered complete by 1962. The result showed no practical advantage for saddle and half-saddle methods over the conventional wedge method on the site concerned. Since the saddle method required twice as long to execute as the half-saddle and three times as long as the wedge and chances of root damage were greater with the saddle method (Stiell 1958a), the order of desirability for planting method on the sites concerned would be wedge, half-saddle and saddle.

Mortality was related to small planting size in Blocks A and B. Slower rates of growth and consequently lower mean total heights are indicated for short relative to tall stock in all blocks. It would be advisable to improve grading by height class at the nursery and to match the height of planting stock to the site, particularly in view of the height growth advantages noted.

Variability of growth within planting height classes indicates that height alone is not an adequate criterion for grading planting stock. Table 4a shows that if stock less than 0.5 feet currently surviving on Blocks A and B had been culled before planting, 43 percent would have been rejected—yet many of these smaller trees are growing well to-day. Other factors such as height-diameter ratio, root collar diameter, foliage color and density, oven dry weight and top-root ratio should be given more consideration in culling and grading. Physiological differences not apparent in seedling morphology would still cause growth differences in the planting stock. Rigorous morphological grading would presumably reduce this to an acceptable level.

Top length or height is apparently an important criterion for judging the growth potential of planting stock, but more basic research on seedling quality is required to further improve planting stock selection.

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