WRIGHT

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COMPARISON OF MATTOCK- AND BAR-PLANTING METHODS WITH WHITE SPRUCE IN NORTH-CENTRAL BRITISH COLUMBIA

by

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ABSTRACT

Five planting methods, using mattock and planting-bar, were tested to determine superiority in production, survival, growth and establishment costs, in north-central British Columbia.

Observations were continued for four growing seasons.

The mattock is a better tool than the planting-bar. There was no evidence that screefing increased survival or growth. Non-screefed slit-hole mattock-planting resulted in the greatest production per man-day at significantly lower costs per established seedling.

The principal impedance to seedling survival was smothering and competition for light by vegetation. On dense vegetation sites, machine scarification may be necessary, as the amount of reduction achieved by hand screefing provided no significant improvement.

Operational scale trials are recommended before the method is employed on general reforestation programs, to confirm the economic superiority of non-screefed mattock-planting in central-interior spruce sites obtained under research techniques.

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COMPARISON OF MATTOCK- AND BAR-PLANTING METHODS WITH WHITE SPRUCE IN NORTH-CENTRAL BRITISH COLUMBIA*

INTRODUCTION

In the early 1960's operational planting of western white spruce was initiated in the interior of the Prince Rupert Forest District. Very erratic results, in terms of production, survival and establishment costs were experienced on these early trials.

Some of the variability was attributed to ecological conditions, planting crew efficiency and planting stock quality. There remained the possibility that planting methods could be improved.

The standard method required the use of planting mattocks, first to remove vegetation and litter around the planting spot, and then to make a vertical-sided slit or hole against which the seedling roots could be placed and the soil firmed-in.

A review of the literature (1-9) indicated conflicting survival and development results between scalping or screefing and no surface disturbance, including soil mounding to improve drainage and aeration. Therefore a more intensive investigation of hand-planting methods was proposed to determine production rates and survival of white spruce planted in the north-central interior of British Columbia. The project was limited to five methods, employing planting-bars and mattocks, considered to have some economic feasibility of achieving the desired results.

OBJECTIVES

The objective was to determine any significant superiority, in terms of production rates, survival, growth, establishment costs and site response, among five hand-planting methods, which are:-

(1) Planting-bar, with no surface scalping - B.N.

(2) Planting-bar, with surface scalping - B.S.

(3) Planting-mattock with no surface scalping - M.N.

(4) Planting-mattock with surface scalping - M.S.

(5) Planting-mattock with surface scalping and soil mounding - N.M.

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* E.P. 603 - A Comparison of Planting-bar and Mattock-Planting of White Spruce.

METHOD AND PROCEDURES

Four areas, representative of major spruce sites were selected in the interior of the Prince Rupert Forest District. On each site, two blocks were established at selected locations to sample minor site variations. In a block, rows of sufficient length to provide 50 planting spots of three- to four-foot intervals, were laid out eight to ten feet apart.

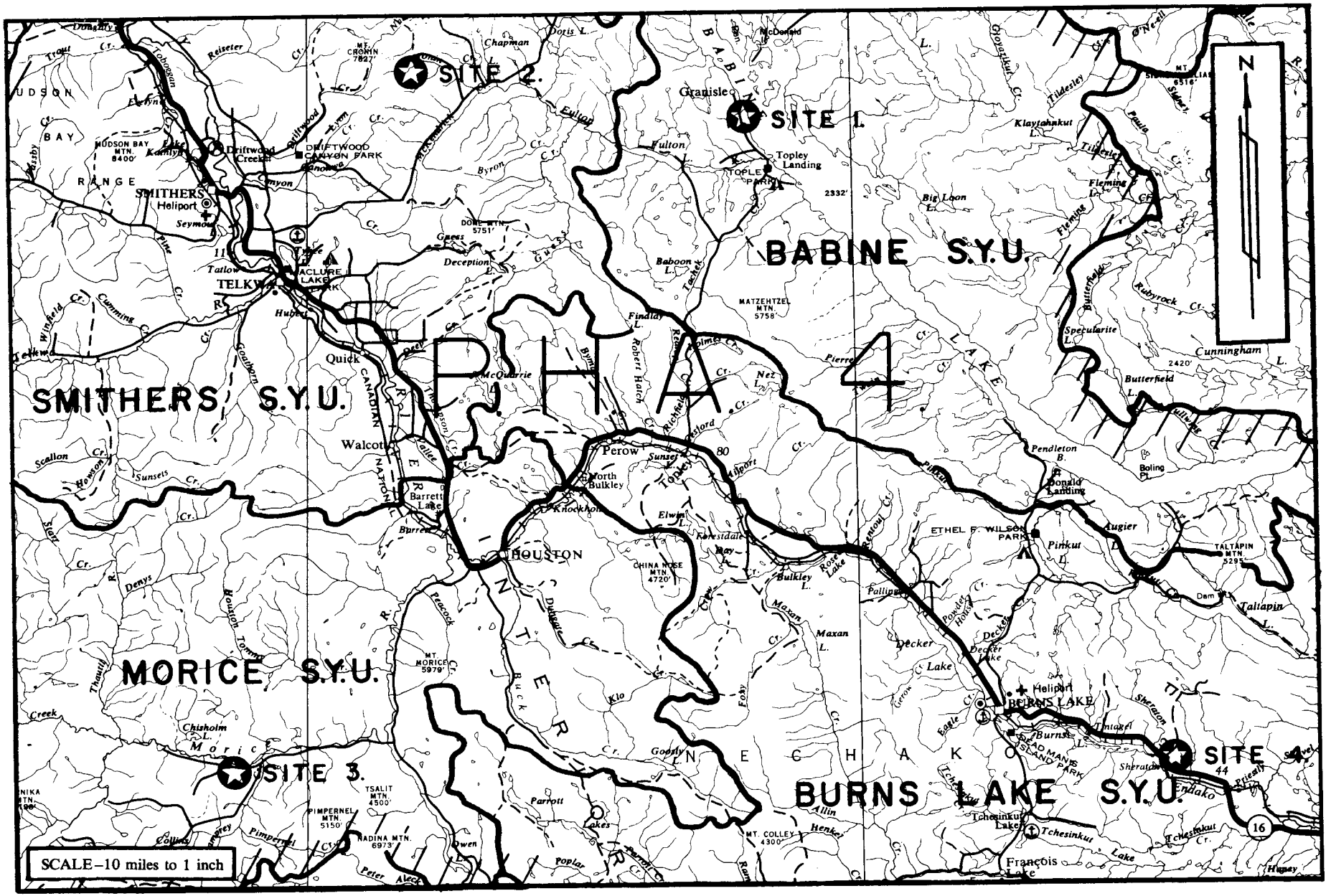
On four planting dates, October 1963, and May 1964, October 1964 and May 1965, one row of 50 spots was planted by each of the planting methods on one block on each major site following a randomized design.

Western white spruce 2+0 stock from one seedlot grown at the Telkwa nursery (93M1/B3/357/2.2) was used for all plantings.

The time in minutes to plant each row was recorded. Measurements and observations were made on survival, total height, height growth, seedling condition, and pertinent ecological influences in May and October 1964 and 1965, and in October of 1966 and 1967. Three blocks were subsequently destroyed by power-line construction and mining activity, during the winter of 1967-68.

On all four dates, the seedlings planted were in vigorous, healthy condition. October planting stocks were completely dormant, while the May planting stocks were top-dormant but with active root-hair development. The stock was consistent in size as indicated by the following summarized data.

Planting Date	Length (cms) Tops	Roots	Root Collar Dia. (mm)	Weight (gms) Tops	Roots	Top/Root Ratio Length	Weight
Oct. '63	14.5	17.3	2.8	1.5	.86	0.86:1	1.8:1
May '64	14.2	19.8	2.7	1.2	.52	0.72:1	2.3:1
Oct. '64	16.8	22.0	2.4	1.0	.44	0.76:1	2.4:1
May '65	16.3	24.6	3.0	1.2	.48	0.66:1	2.4:1
Average	15.4	20.9	2.7	1.2	.58	0.74:1	2.2:1



Regional Map and Plot Locations

The weather was cool during all four planting periods. Soil moisture conditions were generally more favourable during fall planting than during spring planting, when wet soil, surface run-off and free water pockets frequently occurred.

Vegetation cover was a serious hindrance on two sites. The adverse influences of vegetation were also significantly greater during fall planting. The following synopsis indicates the nature and differences on the four test sites.

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Site Factor	Site 1	Site 2	Site 3	Site 4
Location	Red Bluff Babine Lake	Cronin Mine Road 30 Miles N.E. of Smithers	Morice P.W.C. Mile 29	Co-op Lake 17 Miles E. of Burns Lake
Elevation	3300'	2400'	2500'	2800'
Aspect	North - East	East	North - West	South
Slope	5-15%	5-10%	15-20%	2-5%
Soil	sand-silt-clay rolling till complex Gleyed Humic Podsol	silty-clay upland till complex Gleyed Humic Podsol	silty-clay upland till complex Orthic Humic Podsol	gravel sandy loam rolling till complex Orthic Gray Luvisol
Drainage	Retarded	Retarded	Moderate	High
Moisture	Moist-fresh	Moist-fresh	Fresh	Fresh-dry
History	Logged 1959 Scarified 1960	Logged 1958 Scarified 1960	Logged 1959 Burned 1962	Wild fire 1922 and 1952
Stand Type	S - B- Pl	S - B	S - B	Pl - S
Slash	Light	Moderate	Heavy	Nil
Duff-Humus	Moderate (2"-4")	Moderate	Thick (4"-6+")	Nil
Vegetation				
Trees	Moderate (50-100 sta)	Light (< 50 s.t.a.)	Nil	Nil
Shrubs	Moderate	Moderate	Moderate	Light
Herbs	Moderate	Heavy	Heavy	Light
Site Type*	A - D	A - D + O	A - D	C
Site Index	95	95	100	75

* After Illingworth and Arlidge, Research Note 35, 1960.

RESULTS

Survival

After one growing season, seedling survival did not differ significantly for any of the five methods tested. The average survival was 90 per cent. However there was a small seasonal difference favoring spring planted stock. On sites 2 and 3, survival of 1963 fall planted stock was significantly poorer due to wet soil and dense vegetation which severely affected survival and vigor.

In the second year, the effect of planting season on survival was still apparent, with losses higher for fall planting.

Subsequent losses due principally to site adversity had increasingly significant influence on seedling survival levels but there were practically no significant differences between planting methods when the project was terminated. Serious frost heaving was associated with the fall N.M. planting but not with any other treatment.

Per cent Survival - October 1967 - Treatment x Season

Season	Method					Period of observation (yrs.)
	M.N.	B.N.	M.S.	B.S.	M.M.	
Fall '63	67	63	64	49	54	4
Spring '64	67	65	69	69	92	4
Fall '64	78	78	83	75	67	3
Spring '65	74	85	89	94	85	3
Average	72	73	76	72	74	

Survival levels stabilized on all replicates by the fall of 1967. Residual seedlings were healthy and vigorously established. On site 1, vegetation light-competition caused most losses, while on sites 2 and 3,

a combination of overwinter vegetation smother, light-competition and surface flooding was responsible. Losses on site 4 were due principally to frost damage.

Survival of the Fall '64 and Spring '65 plantings were markedly higher than the Fall '63 and Spring '64 plantings on sites 2 and 3, and to a lesser degree on site 1, due to more favorable climate conditions and soil moisture levels in the first growing season. On site 4, due to severe frost losses in the first growing season on the Fall '64 - Spring '65 plantings, survival of the Fall '63 - Spring '64 plantings were better. Survival was not significantly reduced by climatic conditions on any replicates after the first year.

Per cent Survival - October 1967 - Site-Season

Season	Site 1	Site 2	Site 3	Site 4	Period of observation (yrs.)
Fall '63	76	15	50	94	4
Spring '64	79	44	72	94	4
Fall '64	83	59	87	74	3
Spring '65	90	85	84	81	3

Seedling Development

Total height and height growth assessments were based on analysis of measurements of the dominant trees on each row.

At project termination, the method of planting had slight influence on seedling development. Growth and height for M.M. when spring planted was above average; frost heaving and root damage retarded development of fall M.M. planting. Growth was otherwise consistently uniform for all methods within each site-season replication.

Growth and Height in Cms. by Methods

Periodic Growth		Method					Average
		MN	MS	BN	BS	MM	
3 Year Growth	F'64 - S'65 Planting	10.9	11.4	10.7	10.4	10.4	10.7
3 Year Growth	F'63 - S'64 Planting	14.0	14.2	14.7	12.4	15.5	14.2
4 Year Growth	F'63 - S'64 Planting	22.1	20.8	22.1	18.8	23.7	21.6
Total Height to Oct. 1967	F'63 - S'64 Planting	38.4	35.6	37.3	33.8	39.6	36.8
	F'64 - S'65 Planting	28.2	27.4	27.4	27.8	27.4	27.8

Productivity potentials of sites 1, 2 and 3 are similar and superior to that of the drier site 4. Climatic conditions in 1964, 1966 and 1967 were cool to mild, with relatively high summer precipitation, while 1965 was warm and dry. Summer dormancy occurred earlier on the dry site and in the dry year, than on the moister sites or in the wetter years.

On the Fall '64 - Spring '65 replications, periodic height growth and total height were similar for all five methods, in both seasons. Only site variation was evident, with significantly slower development on site 4.

In contrast, height growth on the Fall '63 - Spring '64 replications reflected complex site-seedling vigor interactions. Vigor of residuals was lower as mortality increased, and survivors were slower to establish and develop, which produced a differential effect masking real site differences.

Responding to favorable climatic conditions, seedlings planted Fall '63 - Spring '64 developed more than the Fall '64 - Spring '65 plantings on site 4, while the low vigor residuals on sites 2 and 3 were not able to respond to site potential, until the third year.

Over the four year period, site re-asserted its paramount influence on the Fall '63 - Spring '64 replications, and at termination, growth response to site was nearly similar to the Fall '64 - Spring '65 replications. Growth on site 4 progressed at a lower level than on sites 1 and 3, while residuals on site 2 were recovering from severe vegetation competition. These relationships are clearly evident on the accompanying graph.

Growth and Height in Cms. by Site and Season

Periodic Growth		Method				Season	
		Site 1	Site 2	Site 3	Site 4	Spring	Fall
3 Year Growth F'64 - S'65 Planting		11.9	11.2	13.7	6.1	10.4	10.9
3 Year Growth F'63 - S'64 Planting		18.5	9.4	14.2	14.2	12.7	13.5
4 Year Growth F'63 - S'64 Planting		27.4	15.0	25.1	18.3	22.9	20.6
Total Height	F'63 - S'64 Planting	43.7	29.5	39.2	35.3	38.9	35.1
Oct. 1967	F'64 - S'65 Planting	29.0	28.0	28.7	25.0	27.1	28.2

Production and Established Seedling Costs

Planting time increased for all tested methods as ground conditions (slash, vegetation and soil) increased in severity with up to 30 per cent more time required on the adverse sites than was needed on the open site.

Planting time differed significantly between all five planting methods, with mattock-planting faster than bar-planting, and no-screef methods 50 per cent faster than screefed spot methods. Mounded soil planting was by far the slowest method, the order being MN.**<B.N.*<M.S.**<B.S.**<M.M. These differences were consistent for all replications.

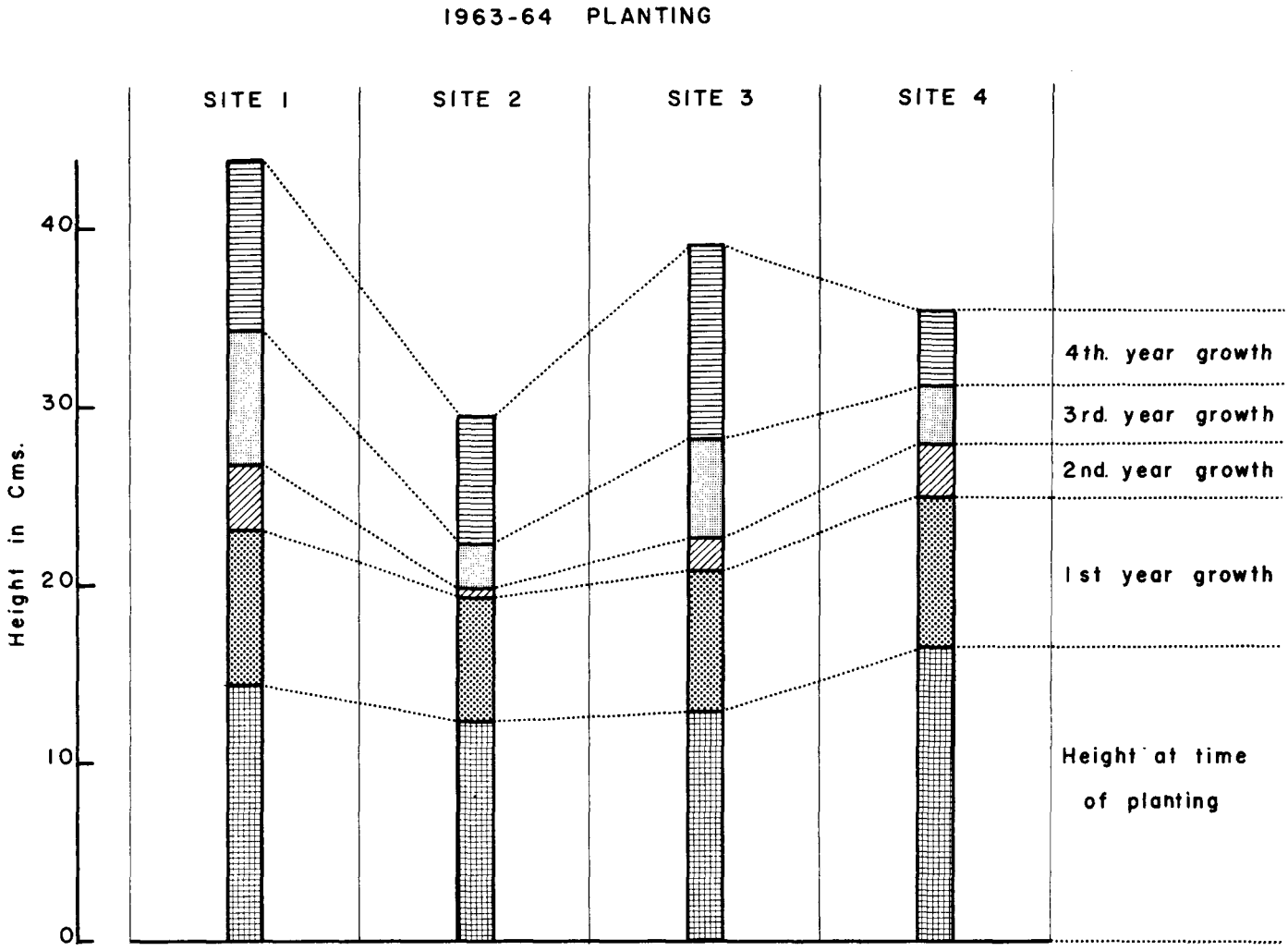
In general, spring planting was faster than fall planting. As site adversity increased, the seasonal difference was accentuated. Differences were slight on site 4, but exceeded 25 per cent on the severe site 2, with intermediate differences recorded on sites 1 and 3.

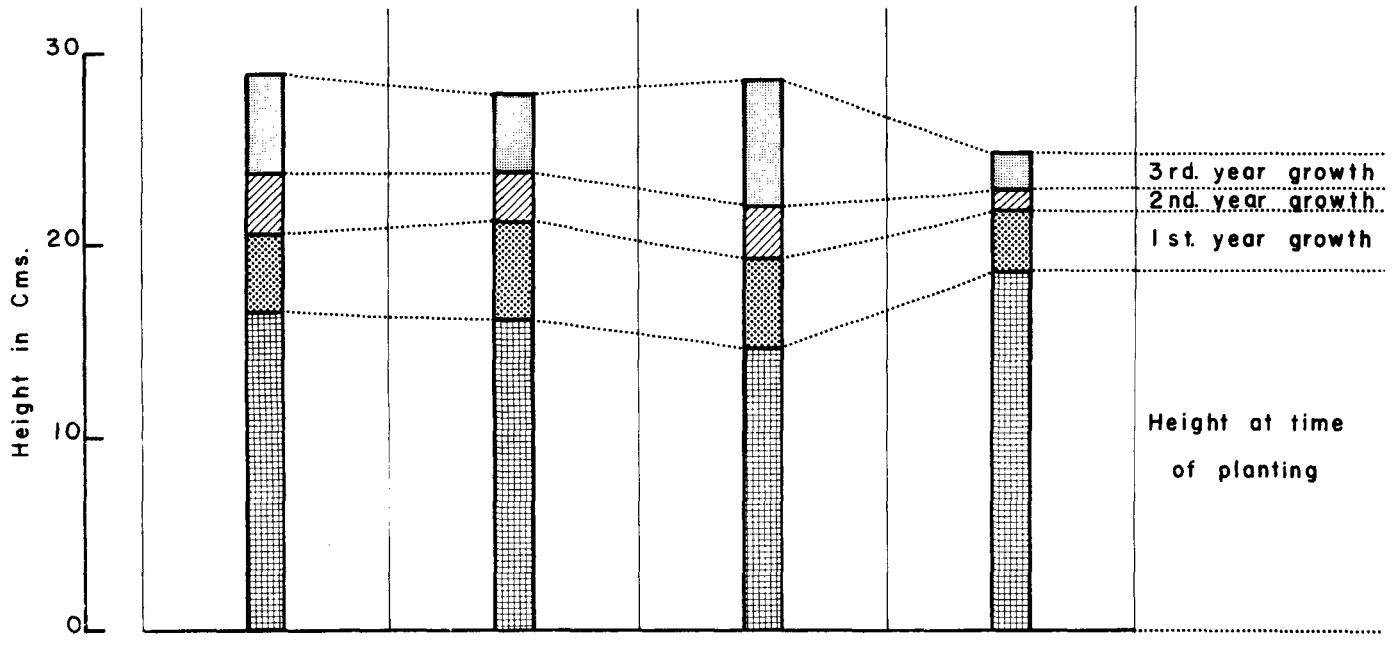
Planting times are summarized as follows:

Time in Minutes to Plant 50 Seedlings

Planted	M.N.	M.S.	B.N.	B.S.	M.M.
Fall 1963	29	55	41	71	86
Spring 1964	28	44	40	63	75
Fall 1964	31	46	42	62	70
Spring 1965	27	40	36	56	67

HEIGHT GROWTH BY SITE AND SEASON IN Cms.





The observations reported for planting time are equally applicable to daily production rates.

Production/Man-day (7 hour's planting time)

Method					Treatment*		Tool*	
M.N.	B.N.	M.S.	B.S.	M.M.	N.	S.	M.	B.
748	537	467	340	288	642	404	608	438

Site				Season		Year	
1	2	3	4	Spring	Fall	63-64	64-65
481	433	452	534	500	451	461	489

* excludes M.M. treatment for 2 x 2 comparison

Planting costs per seedling were determined on the basis of $27.00 per 7 hour effective man-day for planting and overhead, plus one per cent for seedling cost.

Costs per established seedling are lowest for non-screefed mattock-planting, intermediate for screefed spot mattock-planting and non-screef bar-planting, while mounded soil mattock-planting and screefed-spot bar-planting have much higher costs than the other three methods. As a result of the very poor survival on two sites in the fall of 1963, and lower production levels, established seedling costs for fall planting were higher.

Costs in Cents, per Established Seedling (to October 1967)

Planted	Planting Method M.N.	M.S.	B.N.	B.S.	M.M.
Fall 1963	5.6	9.1	10.1	23.7	17.7
Spring 1964	5.9	7.8	9.5	11.0	11.0
Fall 1964	6.6	8.4	8.9	12.8	15.9
Spring 1965	6.1	7.0	6.8	8.7	11.8
Average	6.1	8.1	8.8	14.1	14.1

Lower establishment costs for spring planting were incurred with all methods, on all sites. On the densely vegetated site 2, establishment costs for both seasons were much greater than on the other areas.

CONCLUSIONS AND RECOMMENDATIONS

The mattock is a better tool than the planting-bar for the range of spruce sites tested, providing lower cost seedling establishment with no sacrifice of seedling survival or development.

There was no evidence that screefing improved survival or growth. Plant competition for moisture is rarely a significant factor within the spruce sites of north-central British Columbia. On sites with light ground cover plant competition was not an important factor. On moister sites with dense ground cover, competition for light and physical smothering are significant factors and hand-screefing is ineffective for even the first growing season, as re-invasion is rapid. On sites where lush herbaceous growth develops after logging, machine scarification prior to planting is considered necessary to clear off and reduce vegetation effectively.

On well drained sites with light ground cover both spring and fall planting are fast and produce low-cost plantations.

Spring planting only is recommended for areas with medium dense vegetation. Frost heaving is lighter in the spring, and establishment is more rapid. Even spring planting will not be truly effective on wet, dense ground cover sites without machine preparation.

Mounded soil planting should only be considered for sites with special drainage problems and then limited to the spring season. It is costly, and severe frost heaving can occur on fall planting by this method.

Since non-screef mattock planting provides higher production at lower cost than the standard screefed spot slit-hole mattock planting, with no sacrifice in survival or development, it would seem to be the more economical and efficient method to use for planting within the range of spruce sites tested.

As all the planting in this study was done with close control of planting technique and work quality, the results may be unattainable with operational planting programs; hence pilot scale trials with normal supervision, are recommended to provide a broader-based comparison for confirmation of project results. Similarly, the impact of machination scarification on both these methods in high vegetation density spruce sites should also be tested. There is little doubt that the non-screef method would be effective on the lighter vegetation sites in north-central British Columbia.

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