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PRELIMINARY EVALUATION OF PILOT-SCALE CONTAINER PLANTING IN THE FOOTHILLS OF ALBERTA

by

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INTRODUCTION

The regeneration of forest land by container planting is of increasing interest in Alberta and elsewhere. In Alberta this interest has been encouraged by the results of a co-operative experiment initiated in 1962 by North Western Pulp and Power Ltd., the Alberta Department of Lands and Forests, the Alberta Department of Agriculture, and the Canada Department of Forestry (Ackerman et al 1965). Research and development work in Ontario (McLean 1959) and in British Columbia (Walters 1961) has also stimulated interest in this reforestation technique in Alberta.

The rapid development of culture and planting techniques by North Western Pulp and Power Ltd. made large scale trials of the system feasible by 1965. In that year the company commenced pilot-scale production and planting trials which were continued in 1966. The planting program consisted of approximately 200,000 seedlings in 1965 and 500,000 in 1966. The anticipated program for 1967 is close to one million seedlings. The Department of Forestry and Rural Development assumed responsibility for evaluation and assessment in 1966.

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The objective of the trials is to evaluate the present system of container planting developed by North Western Pulp and Power Ltd. for both white spruce (*Picea glauca* (Moench) Voss. *var. albertiana* (S. Brown) Sarg.) and lodgepole pine (*Pinus contorta* (Dougl.) *var. latifolia* Engelm.) on a variety of sites in the Foothills Section of Alberta. An attempt will be made to assess the influence of such factors as date of logging and scarification, slope, aspect, topographic position, local climate, soil fabric, depth of duff, soil texture, soil moisture and competing vegetation on the survival and growth of seedlings.

The results of this study will assist in defining those conditions requiring alternative regeneration methods and in the recognition of those aspects of container planting that require further research.

The advantages of using container stock are numerous. The cost of producing and planting this stock is presently about one-half that of conventional planting stock. Also logistics problems, characteristic of conventional planting operations, are greatly reduced as it is possible to use small crews of trained planters throughout the growing season. Another important feature of the method is that it is amenable to mechanization in the greenhouse and in the field.

METHODS

Culture of Stock and Planting.

Container planting is being done by North Western Pulp and Power Ltd. on a trial basis as part of the company reforestation program. The usual regeneration practice is to scarify after logging. If, six to eight years after scarification stocking is unsatisfactory, or if conditions are unsuitable for scarification, the area is planted. Container stock 8-weeks of age is currently being used.

Containers are split, plastic tubes $3\frac{1}{4}$ " in length and either $\frac{1}{2}$ " or $\frac{3}{4}$ " in diameter (Figs. 1 and 2). In the greenhouse these are packed in trays and kept in the trays until planted (Figs. 3 and 4). Soil mix in 1965 was three parts vermiculite, two parts acid peat moss, two parts local peat, and one and one-half parts sand.

Seed is of local origin and is not stratified. Seeded containers are exposed to incadescent light for three or four days of 16-hour photoperiod to encourage germination. The seed is then mulched with coarse grit and the trays are placed in tiers. Irrigation is by an overhead misting system as required. Fertilizer, Rx15, is applied by pressure spray once per week. Thiram fungicide is applied on the 13th and 20th days after seeding. The seedlings are grown for four weeks under long photoperiods in the greenhouse and then transferred to cold frames for four weeks. In the cold frames, seedlings are protected from frost and radiation injury by shading as required. Figures 5 to 7 show the greenhouse and cold frames developed and used by North Western Pulp and Power Ltd.

Planting is usually done by a three-man crew; two planters and a man to carry the planting stock (Figs. 8 and 9). Planters use a dibble, the shank of which is the diameter of the container and about one-half inch less than its length (Fig. 10). The dibble is punched into

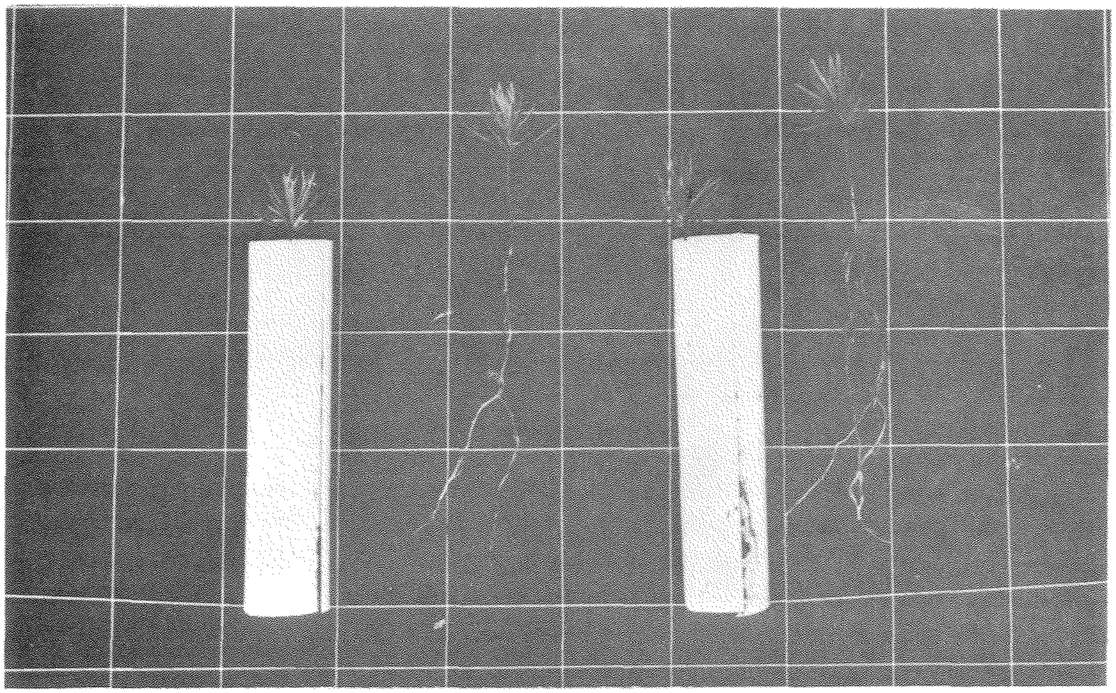

Figure 1. Plastic containers with spruce seedlings ready for planting.

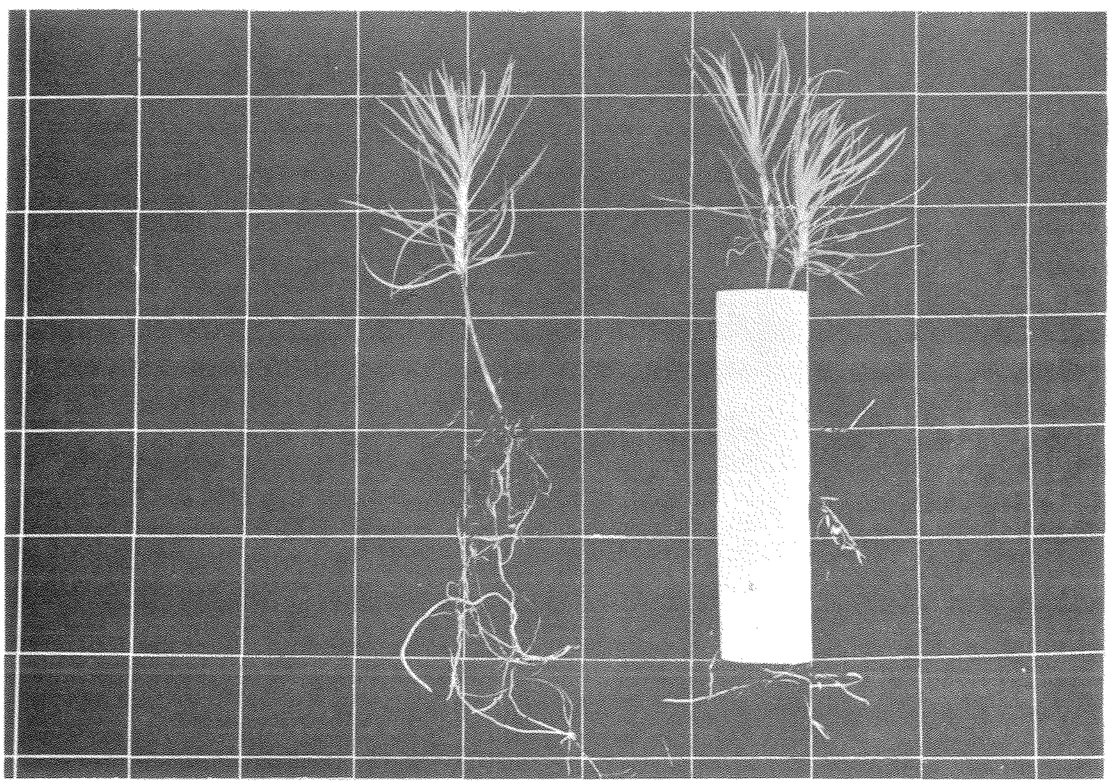

Figure 2. Plastic container with pine seedlings ready for planting. Photographs by R. F. Ackerman.

Figure 3. Tray with 200 pine tubelings.

Figure 4. Tray with 200 spruce tubelings.
Photographs by R. F. Ackerman.

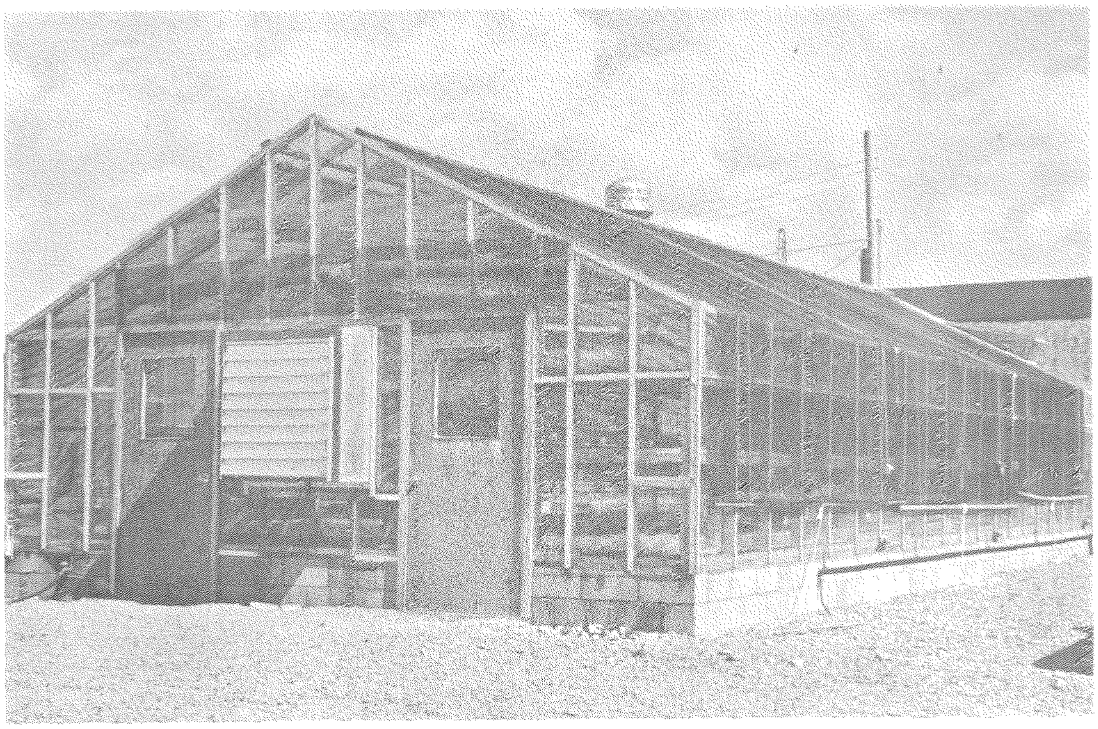

Figure 5. North Western Pulp and Power Ltd., greenhouse at Hinton, Alberta, showing heavy plastic covering (Mylar) with shade screens in use.

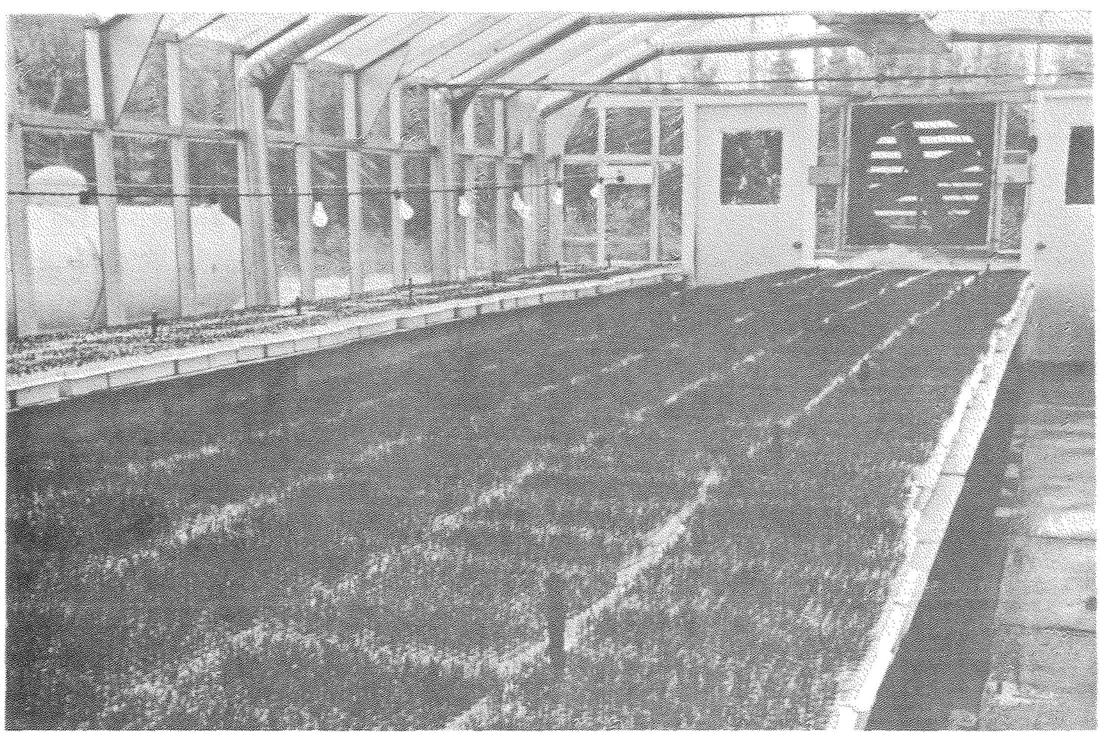

Figure 6. Interior of greenhouse before tiering procedures were initiated.

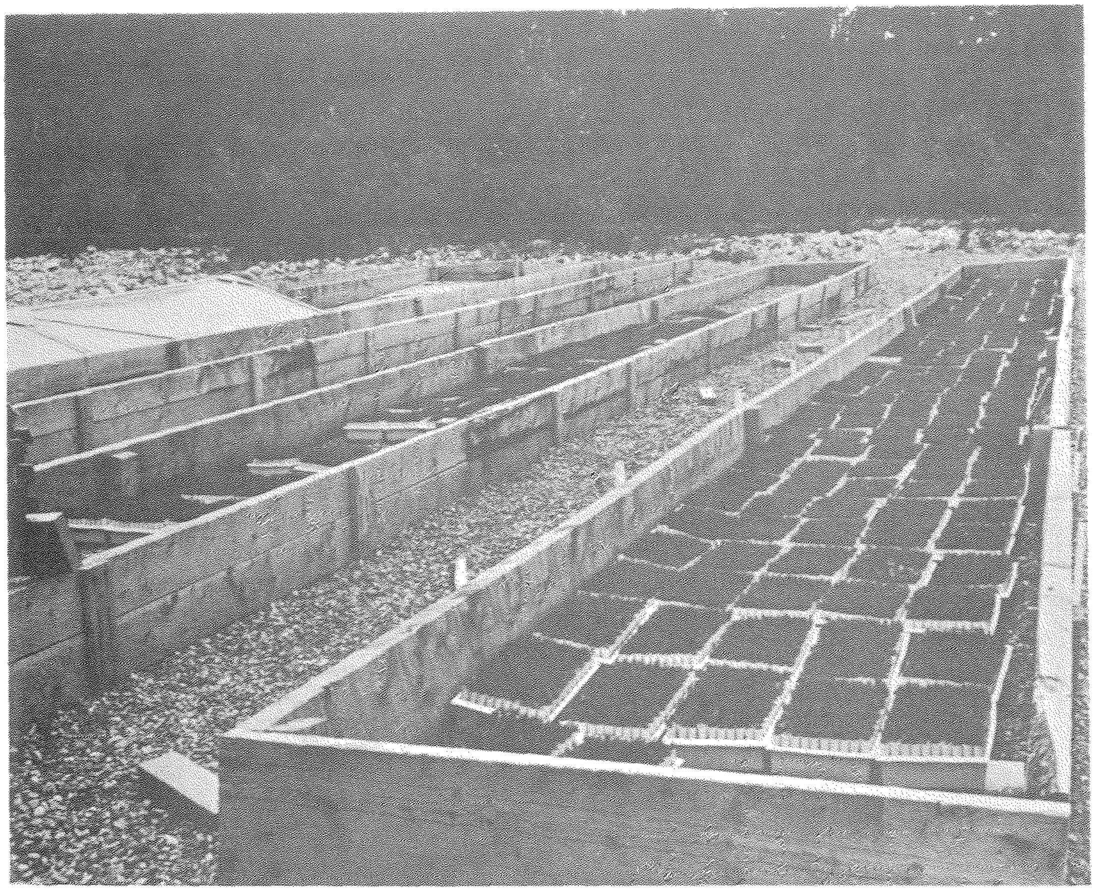

Figure 7. Container stock in cold frames.
Photograph by R. F. Ackerman.

Figure 8. Three-man planting crew.

Figure 9. Planter carrying lightweight rack of trays.

Figure 10. Planting dibble for container stock.

the ground to the depth of the stop and a container is placed into the hole. Average spacing is 9' x 9'. Typical planting conditions are illustrated in Figure 11. Figure 12 shows a container-planted seedling in situ.

A comprehensive description of culturing and planting container stock by North Western Pulp and Power Ltd. has been prepared by Carman (1967).

Description of the Area.

The trials are being conducted on the pulpwood lease of North Western Pulp and Power Ltd. in west-central Alberta. Most of the planting areas are at an elevation of 4000 to 5000 feet within the High Foothills Section of the Boreal Forest Region (Rowe 1959). The topography consists of a series of broad and deep valleys with rounded or flat topped plateaus rising to an elevation of 6000 feet.

Surface soils are generally light textured loams of glacial colluvial or alluvial origin. The soils on a relatively small portion of the lease are tills capped by aeolion silts and sands.

Competition from vegetation is not generally severe in this region. After logging the normal, well-drained sites develop a moderate grass-herb cover which is probably beneficial to seedling establishment on exposed slopes. Heavy grass competition is generally significant only on cool, moist sites with abundant surface moisture. Shrub competition is usually confined to cool, slope sites with telluric moisture.

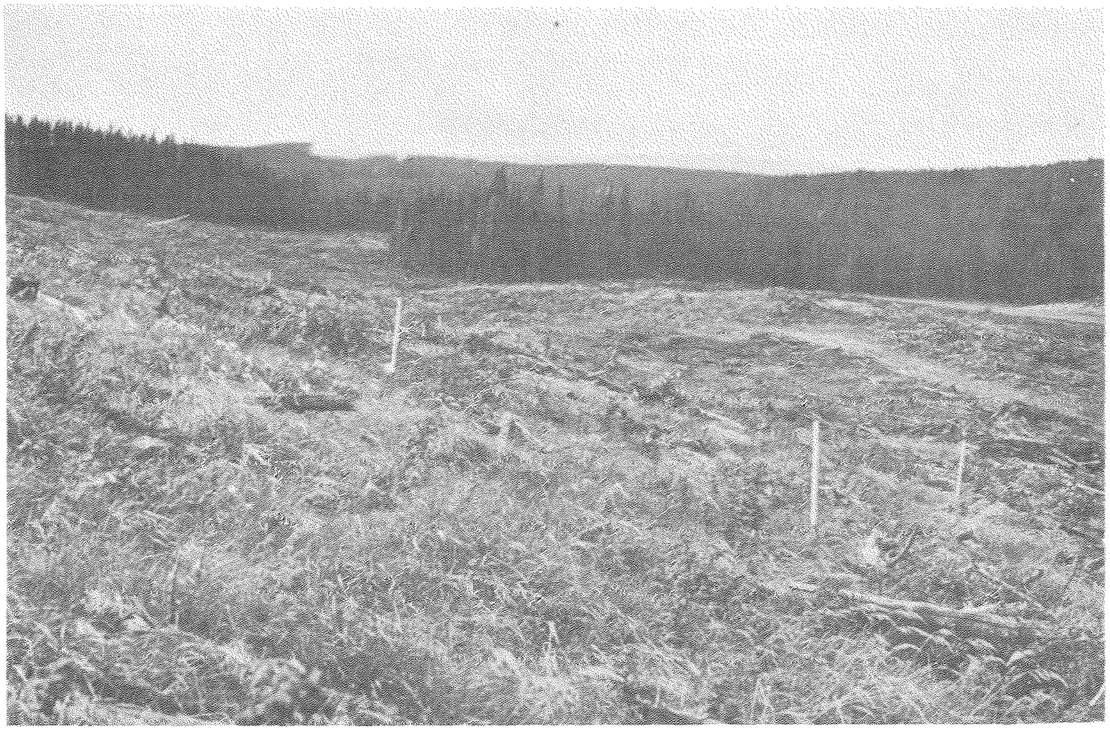

Figure 11. Typical planting conditions on North Western Pulp and Power Ltd., lease.

Figure 12. Typical container-planted spruce seedling.

The climate of the lease area is continental with summer high and winter low precipitation. Summer precipitation is generally well-distributed. Table I shows the mean temperature and precipitation during the growing season (May, June, July, August), from 1958 to 1966, inclusive.

TABLE 1: MEAN TEMPERATURE AND PRECIPITATION

1958 - 1966 (INC.)

HINTON, ALTA

Year	Mean Temp. F.				Precipitation-Inches				
	May	June	July	Aug.	May	June	July	Aug.	Total
1958	52	54	60	59	.52	4.09	2.24	1.73	8.58
1959	46	57	61	53	2.13	5.68	1.34	5.62	14.77
1960	44	52	63	56	4.54	6.95	1.13	4.85	17.47
1961	49	60	61	60	2.68	1.61	5.45	1.78	11.52
1962	45	54	57	56	2.22	2.62	3.48	1.83	10.15
1963	46	53	59	59	1.12	0.28	2.59	3.24	7.23
1964	46	55	58	54	2.18	2.91	2.16	2.87	10.12
1965	47	54	59	61	2.14	6.56	5.45	5.93	20.08
1966	48	51	57	55	4.00	1.51	4.26	6.82	16.59
Mean (9 yrs)	47	54	59	57	2.39	3.58	3.12	3.87	12.96

Sampling Methods and Analysis.

A variety of conditions on the lease area will be sampled during the three-year period 1965 - 1967. However, since only limited control is available over the conditions planted each year confounding between planting year and site is to be expected.

Ideally, plots containing 100 seedlings in 10 rows of 10 are established. In practice this was not always realized with the 1965 planting and plots varied in content from 25 to 200 seedlings. The specified number of 100 seedlings was obtained for all plots in 1966.

Sites are described and stratified as follows:

1. Soil fabric - on basis of North Western's Landform classification.
2. Depth to mineral soil - 4 classes 0-1", 1-3", 3-6", 6"+
3. Local climate-based on evaluation of slope, aspect and topographic position.
4. Surface texture (top 6" mineral soil)- sand, loamy sand, sandy-loam, silt, silt-loam, and clay.
5. Moisture regime - dry, normal, moist and wet (after Hills, 1952)
6. Competing vegetation - grass, herbs and shrubs in three density classes (light, medium and heavy)

Included in the site description of each plot are notes on logging history, slash condition and seed-bed treatment.

Rating of moisture regime, local climate and vegetative competition is necessarily subjective and has significance only to the range of conditions characteristic of the lease area.

A minimum of three plots each containing 100 seedlings are to be established on each major condition planted.

Each plot is examined one and three years after establishment to determine survival. Thus, the project encompasses a 6-year period. Obvious causes of mortality are noted - e.g., smothering, trampling, flooding, frost heaving, etc. Tallies are done after the beginning of August as it is often difficult to determine whether a seedling is living or dead early in the growing season.

Data will be analyzed on the basis of the various factors assessed and a routine analysis of variance will be conducted.

During 1965 and 1966 a total of 140 plots were established. Analysis of first yea r results is based on 77 plots. Table 2 shows the distribution of plots established in 1965 and 1966 on various sites.

TABLE 2. DISTRIBUTION OF 1965 AND 1966 PLOTS BY MOISTURE REGIME, LOCAL CLIMATE, DEPTH TO MINERAL SOIL AND VEGETATIVE COMPETITION.

1965 PLANTING

DEPTH TO MINERAL SOIL	VEGETATIVE COMPETITION	MOISTURE REGIME: DRY			NORMAL			MOIST & WET		
		LOCAL CLIMATE RATING								
		WARM	NORMAL	COOL	WARM	NORMAL	COOL	WARM	NORMAL	COOL
0-1"	LIGHT	2			2	3				
	MEDIUM	2			1	3				
	HEAVY	1								
1-3"	LIGHT	3			6	10	1		1	
	MEDIUM	5			8	17				
	HEAVY	1				1			1	
3-6"	LIGHT					1				
	MEDIUM				1				1	1
	HEAVY				1					
6"+	LIGHT								1	2
	MEDIUM									1
	HEAVY									

1966 PLANTING

DEPTH TO MINERAL SOIL	VEGETATIVE COMPETITION	DRY WARM	DRY NORMAL	DRY COOL	NORMAL WARM	NORMAL NORMAL	NORMAL COOL	MOIST & WET WARM	MOIST & WET NORMAL	MOIST & WET COOL
0-1"	LIGHT									
	MEDIUM									
	HEAVY									
1-3"	LIGHT	3			6	6				
	MEDIUM				3	6	6			
	HEAVY					3				
3-6"	LIGHT				6	3	3		3	
	MEDIUM	3						3		
	HEAVY									
6"+	LIGHT					3				3
	MEDIUM									3
	HEAVY									

FIRST - YEAR RESULTS.

Survival

First-year survival of the 1965 planting was encouraging. Average survival was 81 percent for spruce and 80 percent for pine. The distribution of plots in various percentage survival classes is shown in Table 3.

A preliminary analysis of the survival indicated no well-defined trends associated with site at the end of one year.

A comparison of climatic data (Table 1) from the Hinton townsite shows that precipitation during the 1965 growing season was exceptionally high, whereas temperatures were normal. This may have contributed to the high survival of the 1965 container planting on all sites.

TABLE 3: PERCENTAGE DISTRIBUTION OF PLOTS IN VARIOUS PERCENTAGE SURVIVAL CLASSES

1965 PLANTING

Species	Percentage Survival Class				
	0-20	21-40	41-60	61-80	81-100
White Spruce	0	1.8	7.4	20.4	70.4
Lodgepole Pine	0	8.7	4.3	17.4	69.6

Mortality and Injury.

An assessment of mortality and injury factors, by species and camp, is given in table 4. The data were stratified by camp because these geographic units generally represent somewhat different site conditions and because mortality and damage factors are often of regional significance.

Undetermined factors were responsible for roughly one third to one half the total mortality of both spruce and pine. Agents causing injury were more easily determined.

Of the known factors trampling by horses accounted for the highest mortality of white spruce seedlings (9 per cent) and was located mainly in the vicinities of Camps 1 and 6. Lodgepole pine plantings in the Camp 4 area also suffered significant mortality by horse trampling. Trampling injuries were greater in spruce than in pine plantations and were prevalent in the Camp 1 area where injuries were 11 per cent. Horses on the lease area are either skid horses or strays from nearby ranches. There is some evidence that trampling during the winter is concentrated on bare, south slopes. However, summer trampling is probably more common as skid horses are allowed to graze on logged-over areas and probably tend to concentrate on flat, moist areas supporting good stands of grass.

On wet sites in the Camp 3 and 5 areas smothering resulted in the loss of 6 to 7 per cent of white spruce seedlings. Moss, matted grass, and in one isolated case leaves from a dense growth of alder, were

TABLE 4: PERCENTAGE MORTALITY AND INJURY TO WHITE SPRUCE AND LODGEPOLE PINE SEEDLINGS BY AGENT AND CAMP- 1965 PLANTING IN 1966.

CAMP	WHITE SPRUCE																			
	AGENT OF MORTALITY OR INJURY																			
	TRAMPLING			SMOTHERING			FROST HEAVING			POOR PLANTING			FROST DAMAGE			UNKNOWN			ALL	
	D[1]	I[2]	D+I	D	I	D+I	D	I	D+I	D	I	D+I	D	I	D+I	D	I	D+I	D	I
1	9	11	20	-	2	2	-	1	1	2	16	18	-	2	2	4	-	4	15	32
3	2	3	5	7	9	16	-	1	1	4	10	14	-	20	20	7	-	7	20	42
4	2	3	5	2	-	2	-	-	-	1	4	5	-	40	40	7	-	7	12	48
5	-	5	5	6	4	10	-	1	1	2	19	21	-	6	6	6	-	6	14	35
6	9	4	13	2	3	5	-	-	-	1	3	4	1	53	54	18	-	18	31	61
MEAN	5	5	10	3	4	7	-	1	1	2	10	12	-	24	24	8	-	8	18	44
LODGEPOLE PINE																				
4	7	2	9	3	2	5	-	-	-	4	7	11	-	5	5	14	-	14	28	16
5	3	2	5	2	4	6	-	2	2	2	5	7	-	1	1	3	-	3	10	14
MEAN	5	2	7	2	3	5	-	1	1	3	6	9	-	3	3	8	-	8	19	16

1 - DEAD

2 - INJURED

responsible. Smothering was not a significant factor on sites planted to lodgepole pine in 1965. Notable damage was caused by smothering in the Camp 3 area.

Frost heaving caused no mortality in the 1965 planting as heavy soil conditons conducive to heaving were not planted. Direct frost damage was very high on white spruce in the Camp 3, 4 and 6 areas with 51 per cent damage being recorded in the latter area. This was caused by a late frost after the seedlings had flushed in 1966. Lodgepole pine seedlings were not affected appreciably. Frost mortality is very difficult to identify and if present is included under "unknown" factors in Table 4.

Mortality as a result of poor planting was generally light. The highest mortality recorded from this source was 4 per cent in the Camp 3 and 4 areas. This was caused mainly by positioning of containers in poor microsites, deep planting, shallow planting and stem damage resulting from the seedling being pressed against the rim of the container. Planting injuries to stems and roots of seedlings occurred directly as a result of physical damage or indirectly as a result of planting on unfavorable microsites such as stumps, logs and dense mats of slash. Examples of direct injury included stem lesions resulting from seedlings being pressed against container rims and root damage from containers being constricted and torn while being forced into dibble holes in rocky ground.

Effect of More Than One Seedling Per Container

In 1965, container stock was produced with variable numbers of seedlings per container. Numbers varied between 1 and 7 for white spruce and 1 and 4 for lodgepole pine.

The number of seedlings per container may be an important factor in ultimate survival and more than one seeling per container may increase the chance of realizing at least one healthy established seedling. Conversely, too many seedlings could result in over-crowding in the future.

The optimum number of seedlings per container cannot be determined on the basis of first-year results. However, Figure 13 indicates relationships between stocking and number of seedlings per container for both lodgepole pine and white spruce. These trends are not considered very significant at present but may assume greater importance a few years after planting.

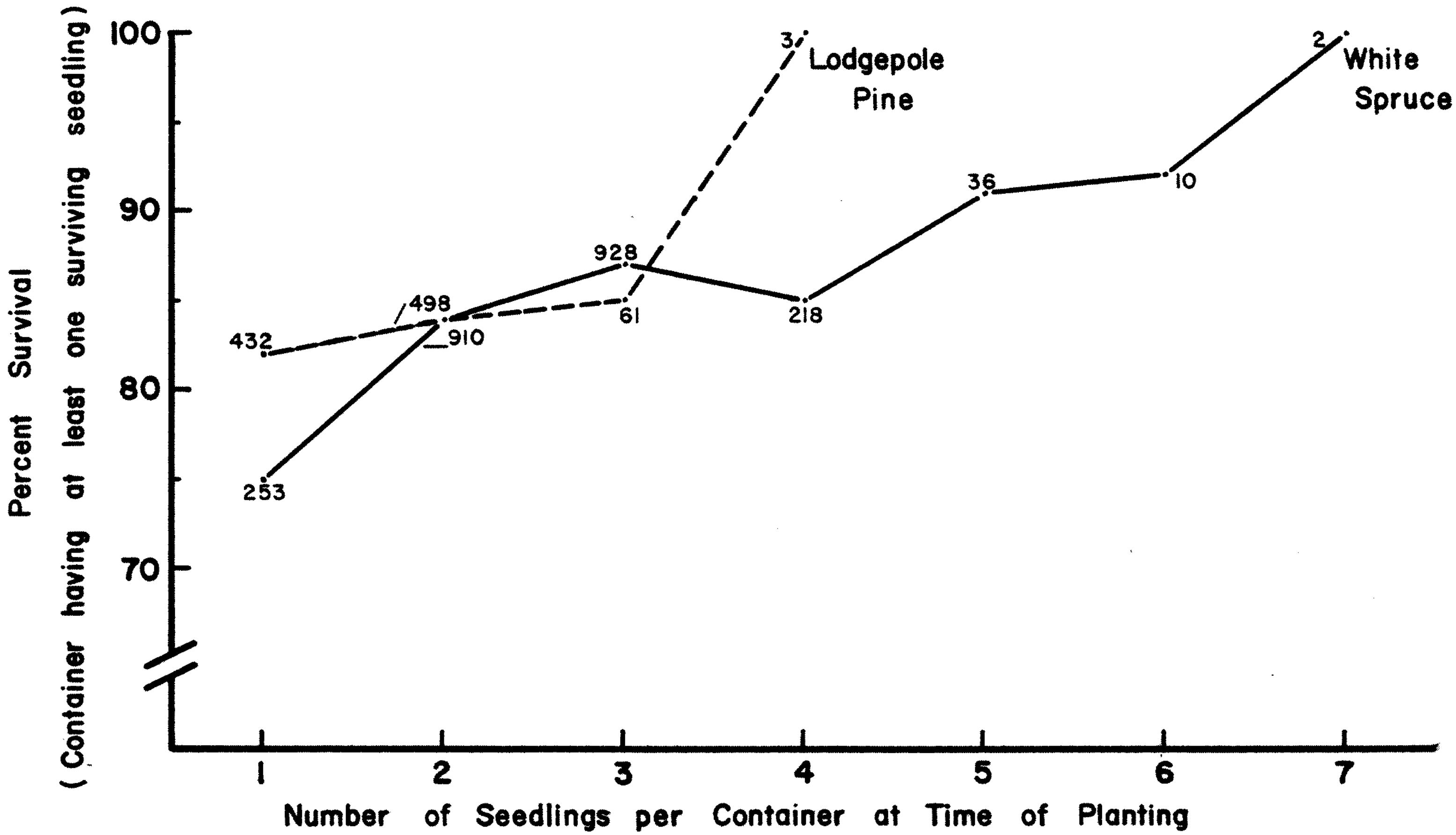

FIGURE 13. Relationship of Initial Number of Seedlings per Container to Survival After One Year.

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