CANADA

DEPARTMENT OF FORESTRY

AND RURAL DEVELOPMENT

FIRST YEAR MORTALITY OF CONTAINER PLANTING IN THE CLEARWATER-ROCKY MOUNTAIN HOUSE FOREST-ALBERTA

by

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CONTENTS

ABSTRACT

A survey was conducted during the summer of 1966 to assess the first year mortality of four experimental plantations established by the Alberta Department of Lands and Forests in the Clearwater-Rocky Mountain House Forest.

Planting stock raised for 12 and 16 weeks in seven types of containers was used for experimental trials. Two species, white spruce and lodgepole pine were planted.

The average mortality of lodgepole pine seedlings raised in plastic containers was only 11 percent when planted on recently cut-over areas without scarification. However seedlings grown in other types of containers (phenoformaldehyde, waxed cardboard and asphalt) had an average mortality of 29 percent. The results indicated that cut-over areas were planted successfully even without scarification if the thickness of the duff layer did not much exceed the length of containers.

A high mortality rate of 43 percent resulted when an 80-year-old aspen stand was underplanted with spruce seedlings grown in plastic containers. Heavy losses were due mainly to smothering by aspen leaves. On the other hand good results were obtained when a young aspen stand was underplanted with spruce seedlings grown in plastic containers. An average of only 10 percent mortality occurred, caused mainly by smothering from aspen leaves.

INTRODUCTION

The principle of sustained yield forest management requires the rehabilitation of cut-over land either by natural or artificial means. Natural regeneration techniques are not always successful due to lack of seed or difficult environmental conditions. It is necessary to apply artificial reforestation techniques when natural reproduction fails. The most common method of artificial reforestation is conventional planting using nursery-grown seedlings. However, this method is a costly and time consuming operation. Container planting has several advantages over conventional planting in terms of labor and time to produce plantable stock.

Since 1962 the Alberta Department of Lands and Forests, North Western Pulp and Power Limited, the Alberta Department of Agriculture and the Department of Forestry have co-operated in the establishment of experimental container plantations and the application of various types of containers. Preliminary results were promising in the Hinton area (Ackerman et al 1965), therefore the Alberta Department of Lands and Forests established several experimental container plantations throughout the province.

BACKGROUND

Review of literature

The principle of applying various types of containers for re-

forestation purposes is not new. A German forester experimented with seedlings grown in containers as early as 1904 (Anonymous 1964). There were many forms and materials of containers involved in various experiments; earthen pots (Soulères 1958), baskets (Weerarantina 1958), paper cones (Dopper 1959), bituminized paper pots (Marrero 1950, Scaramuzza 1947), metal tubes (Anonymous 1947), plastic tubes (McLean 1959) and plastic bullets (Walters 1961).

All authors agree that container planting has the following advantages: 1. Minimization of time to raise seedlings for out-planting, 2. Elimination of large planting crews, 3. Extension of the planting season, 4. Higher survival rate, 5. Reduction of planting check.

In western Canada the development of a planting gun and the use of plastic bullets (Walters 1961) has created an interest in the establishment of experimental container plantations.

Description of containers

The following types of containers were used for trials:

Phenoformaldehyde - This material is commonly used by florists to keep cut flowers fresh. Approximate size of this container was 2.0 x 2.0 x 8.2 centimeters. A small hole of 1.0 - 1.3 centimeters was punched approximately 2.5 centimeters deep and a mixture of peat moss and top soil was placed into the hole.

Asphalt container - The material used is roofing tar paper with dimensions of 2.0 x 6.2 x 0.05 centimeters.

Waxed cardboard box container - The container is constructed of wax impregnated paper. The dimensions of this container were 2.0 x 6.2 x 0.08 centimeters.

Edmonton bullet - The material of the container is polystyrene with dimensions of 2.1 x 6.0 x 0.05 centimeters. The bullet is in two sections which are held together by an elastic band.

New plastic container - This container is also manufactured of polystyrene with dimensions of 1.9 x 6.0 x 0.05 centimeters. There is a slit on one side and the bottom part of the container to provide space for roots to penetrate.

One and four hole bullets - Both of these containers were developed by Walters 1961. The dimensions of one and four hole bullets are 2.1 x 6.0 x 0.16 and 2.1 6.0 x 0.12 centimeters, respectively. The material of containers is polystyrene with one and four holes respectively at the tips of each types.

Nursery techniques

All seedlings were produced by the Provincial Tree Nursery of the Department of Agriculture at Oliver, under greenhouse conditions. A mixture of two parts of black loam, one part of sand and one part of peat was placed in containers. The black loam was disinfected before mixing either

by using steam or an application of Dowfume MC-2 fumigant. Two or three seeds of local provenance were sown in the soil mixture and were capped with sand. The germinants were kept at approximately 70°F temperature and were watered with a misting system. Additional "complete foliage" fertilizers were applied twice weekly when seedlings were older than three weeks. Generally when germinants were 12 or 16 weeks old they were removed from the greenhouse to harden off for a period of two to three weeks before field planting.

Species

Two species, white spruce Picea glauca (Moench) Voss and lodgepole pine Pinus contorta Dougl. var latifolia Engelm., were grown in the greenhouse and planted under various environmental conditions for trial purposes.

DESCRIPTION OF THE GENERAL AREA

All planting areas of the Clearwater-Rocky Mountain House Forest are located in the Lower Foothills Section (B.19a,) which is a transition type of forest between the Boreal and Subalpine Regions (Rowe 1959).

The Rocky Mountain House area has a climate with moderately warm summers and relatively cold winters. The mean summer temperature is 50°F and January is the coldest month with a mean average of 10°F. The average annual precipitation is slightly under 20 inches. However, the distribution of precipitation is quite favorable since 60 percent of the total precipitation falls during the growing season from April to October. The average frost free period is only 50 days.

The most common parent material of soils on the experimental areas is glacial till. Alluvial, lacustrine and aeolian deposits also occur in the vicinity of the Rocky Mountain House area. Under forest conditions grey wooded soils have developed which are low in fertility especially lacking in sulphur (Peters & Bowser 1960).

METHODS AND MATERIALS

Survey procedure

During the 1966 field season all areas planted in the Clearwater-Rocky Mountain House Forest during 1965 were examined. If the number of containers planted was not too great, all were described individually, otherwise random sampling was done. Particular emphasis was given to the identification of external soil media at the surface (top of container) and at six centimeters depth (bottom level of container). Additional information on vegetative competition and smothering by aspen leaves was collected for each container. An attempt was made during the inspection to leave seedlings in the same condition as they were prior to the mortality check to avoid confounding future surveys (e.g. if aspen leaves covered seedlings during the investigation they were replaced).

When dead seedlings were found identification of mortality causes (e.g. climatic, insect and fungus damage) was not attempted. However, some environmental descriptions (soil medium, vegetative competition, and degree of smothering) were recorded for all seedlings living and dead.

Five soil media were recognized: 1. Mineral soil, 2. Rotten wood, 3. Duff, 4. Humus, 5. Mixture (including mineral soil, rotten wood, duff and humus).

Four classes were used to describe the existing vegetative competition (nil, light, medium, and heavy).

1. Nil vegetative competition was recorded when seedlings grew without interference from herbs, grasses and shrubs.

2. Light vegetative competition existed where seedlings were shaded from one side mainly by herbs, grasses or low growing shrubs. The leaders of seedlings were completely free from any competition.

3. Moderate vegetative competition was recorded when herbs and light cover of grasses have grown around the seedlings but did not interfere seriously with the development of seedlings.

4. Heavy competition existed when seedlings were not readily visible and were obscured by a heavy growth of grasses and shrubs.

Four classes were established for the description of smothering.

1. Nil. No interference of aspen leaves was apparent.

2. Light when aspen leaves were found on one side of the seedlings.

3. Medium when aspen leaves were found around the base and sides of seedlings, however the terminal buds were not covered.

4. Heavy smothering was recorded in cases when seedlings were completely covered (terminal buds included) with aspen leaves.

After an analysis of the data it was possible to determine the best

types of containers and the most favorable environmental conditions for container planting.

Description of planting sites

The general location of the four planting areas is shown in Figure 1.

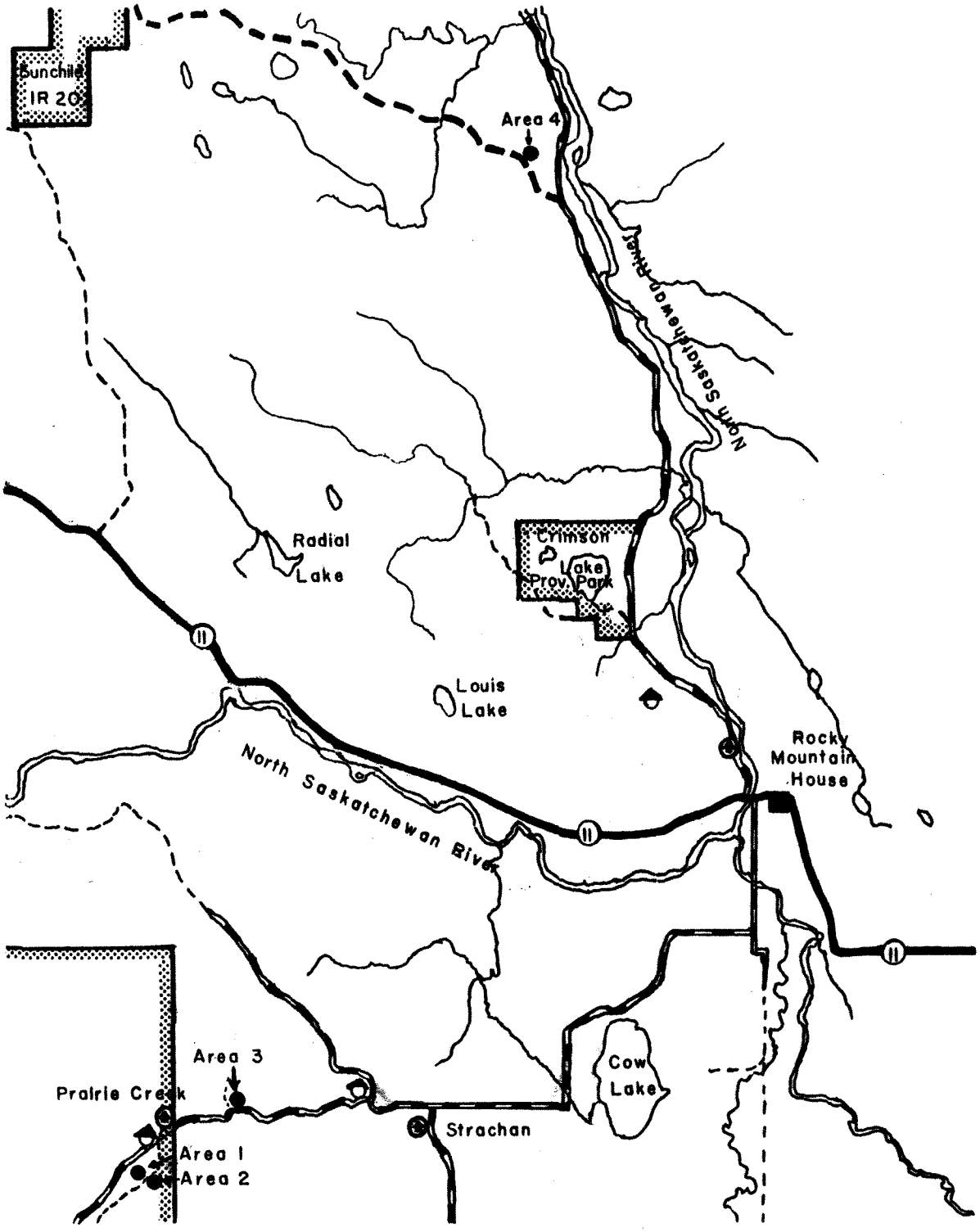
Area 1

Area 1 is located approximately 16 miles south-west of Rocky Mountain House. The elevation is 4200 feet and a bisequa gray wooded soil was formed on the glacial till parent material. The planting area slopes slightly to the north (0-5 percent). Generally competition from vegetation was light (Plate I Number 1).

The original stand was pure lodgepole pine 90 years of age. Five to six chain alternate strips were logged five years ago. Both Area 1 and Area 2 are located on the cut strips. No scarification was carried out on the planting site, however as a result of the logging operation the soil surface was disturbed exposing the mineral soil in small patches.

The area was planted with 16 and 12 week old lodgepole pine seedlings grown in seven types of containers on June 18th 1965 (Appendix 1). The average spacing was 1.5 x 1.5 feet. The location of each container was marked with a wooden lath for future identification.

Fig. 1 Location of planting areas.



Area 2

The stand history, elevation, soil, aspect, slope and date of planting is identical to Area 1 (Plate I Number 2). Sixteen and 12-week old lodgepole pine seedlings grown in two types of containers (four-hole bullet and new plastic container) were planted approximately four feet apart (Appendix 1). No scarification was done on the area, however mineral soil was exposed on certain locations during the logging process.

Area 3

Area 3 is located 2.5 miles west of the Strachan Ranger Station. The elevation of the study area is 3680 feet. Dark gray wooded soil was formed on glacial till parent material. The area is facing south-east with a slope of 10-15 percent. This area is different from Area 1 and Area 2 because of a luxuriant growth of herbs, grasses and shrubs (Plate I Number 3).

An 80 year-old, almost pure aspen stand was underplanted with spruce seedlings grown in three types of containers. No scarification or logging was carried out on this area prior to planting. An attempt was made by the planting crew to scrape away the litter and dead grass with the planting dibble. However this method did not prove to be successful. Therefore, all containers were planted in undisturbed soil media. Three types of containers (new plastic, Edmonton and one hole bullet) having 16 and 12 week old spruce seedlings were planted on June 21, 1965 (Appendix 2).

Area 4

The planting area is situated approximately 22 miles northwest of Rocky Mountain House. The elevation of this area is 3300 feet A weakly developed bisequa, gray-wooded, soil was formed on the glacial till parent material. The area was burned 23 years ago and as a result of this fire a young aspen stand invaded the land. Strips were bulldozed and the soil was scarified and seeded to spruce in 1962. A small portion of 1962 scarification was used for container planting.

Sixteen and 12 week old spruce seedlings raised in new plastic and one-hole bullet containers were planted on scarified and unscarified spots on June 17, 1965 (Appendix 2).

RESULTS

Area 1

The distribution of pine seedlings planted in undistrubed soil is shown in Figure 2. The most common soil media at the surface level were duff, rotten wood and a mixture without mineral soil. However the following media were found at six centimeters depth in decreasing order: Rotten wood, mixture, mineral soil and duff.

The mortality was highest for seedlings grown in phenoformaldehyde, waxed cardboard and asphalt containers. Seedlings raised in plastic containers (Edmonton bullet, new plastic container four hole bullet) had very low mortality compared to other types of containers (Table 1).

Table 1 Percent mortality of lodgepole pine seedlings on disturbed and undisturbed ground-Area 1.

Type of container	Undisturbed area			Disturbed Area			Percent mortality for the whole area
	Total no. of containers planted	No. of containers without live seedlings	Percent mortality	Total no. of containers planted	No. of containers without live seedlings	Percent mortality	
Phenoformaldehyde	35	16	46	7*	3	43	45
New plastic	41	3	7	9	0	0	6
Edmonton bullet	24	2	8	3	0	0	7
Asphalt	41	9	22	6	0	0	19
Waxed cardboard	23	6	26	3	0	0	23
One-hole bullet	OMITTED SMALL SAMPLE						
Four-hole bullet	122*	5	4	17	1	6	4

* One container was missing

Mortality of seedlings planted on disturbed areas was slightly less than on undisturbed areas especially in the case of asphalt and waxed cardboard box containers. An average of five percent lower mortality was found for all containers planted in disturbed soil.

Figure 3 shows clearly that duff is the most unfavorable growing medium for pine seedlings when raised in phenoformaldehyde, waxed cardboard, asphalt containers and Edmonton bullets.

Rotten wood was a good growing medium for seedlings in all types of containers except phenoformaldehyde.

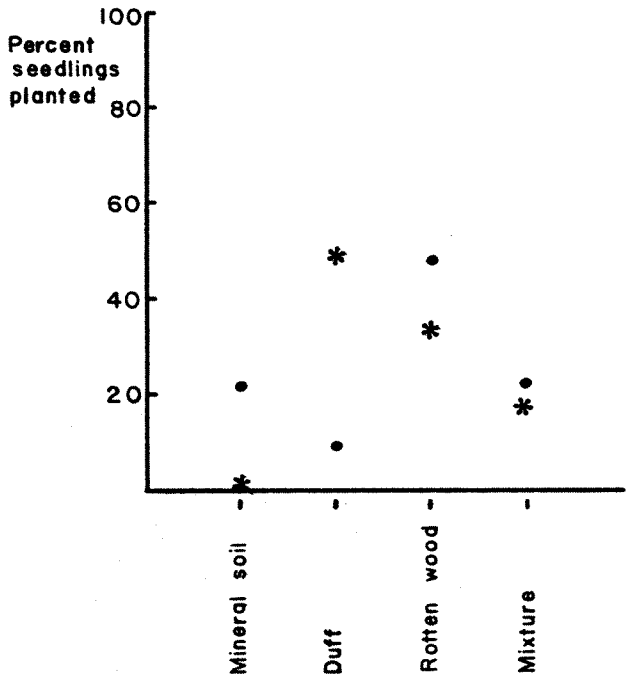
The mixture of mineral soil, duff, and rotten wood provided a good growing medium for seedlings in plastic and waxed cardboard containers.

It is interesting to note that the lowest mortality occurred in mineral soil compared to other media for seedlings grown in phenoformaldehyde. The possible explanation of this fact is that phenoformaldelhyde itself and the external soil media (duff, rotten wood, and mixture of mineral soil, rotten wood and duff) lose moisture very quickly, and the roots die before they are able to reach a soil medium having more moisture.

The presence of vegetation on this area was beneficial to the survival of seedlings. The rate of mortality is definitely lower for those seedlings which were planted under or near existing vegetation (Figure 4).

Several vigorous seedlings growing in various types of containers were excavated, and it was found that roots grew out of containers (Plate II. Numbers 5-12).

Fig. 2 Percent distribution of lodgepole pine seedlings planted in undisturbed soil — Area I.

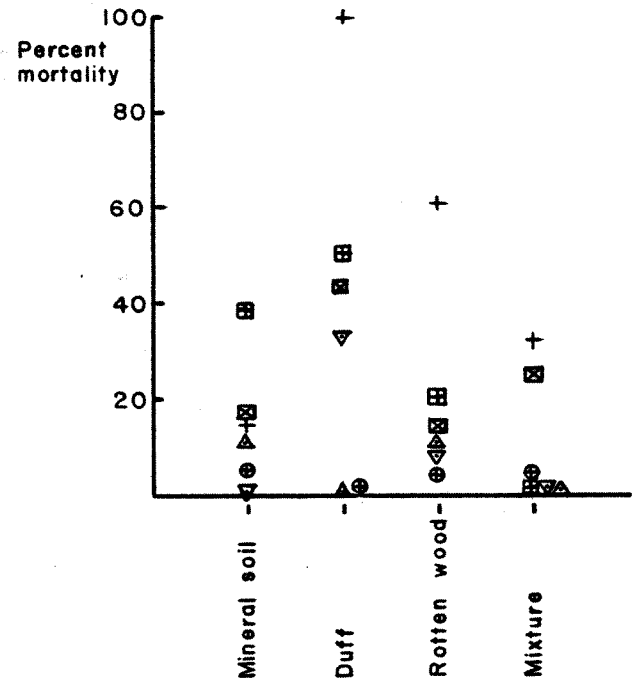


Legend

External soil medium at top of container *

External soil medium at bottom of container ●

Fig. 3 Percent mortality of lodgepole pine seedlings in undisturbed soil — Area I.



Legend

New plastic △

Edmonton bullet ▽

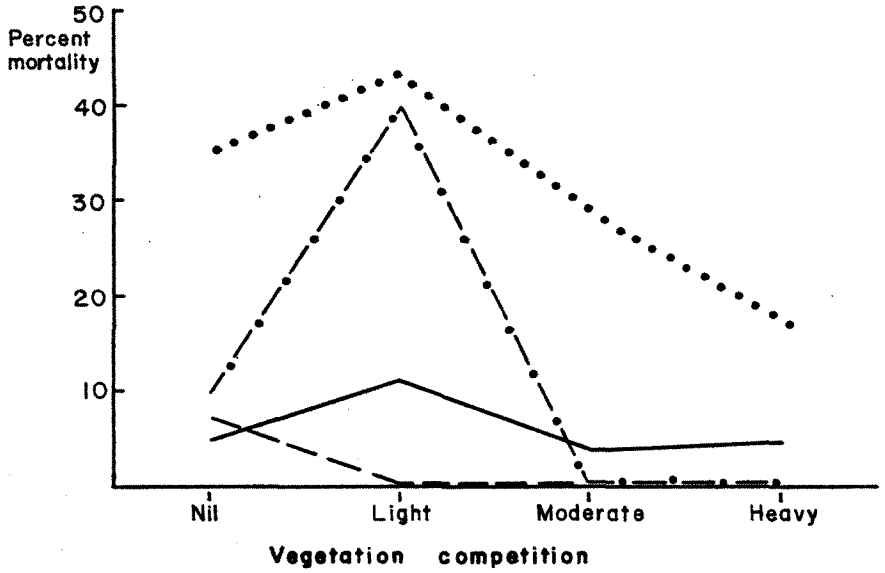
Four hole bullet ⊕

Phenoformaldehyde +

Asphalt ⊠

Waxed cardboard ⊞

Fig. 4 Percent mortality of lodgepole pine seedlings affected by vegetation — Area 1.



Legend

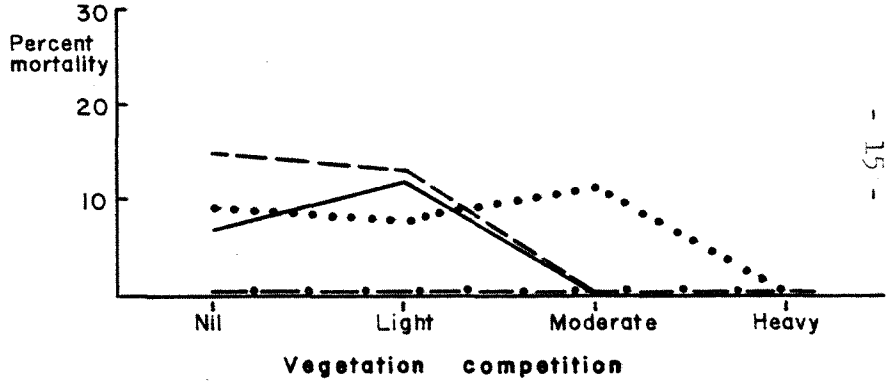
Plastic type containers on disturbed area

Plastic type containers on undisturbed area

Pheno, waxed cardboard and asphalt containers on disturbed area

Pheno, waxed cardboard and asphalt containers on undisturbed area

Fig. 7 Percent mortality of lodgepole pine seedlings affected by vegetation — Area 2.



Legend

New plastic containers on disturbed area

New plastic containers on undisturbed area

Four hole bullets on disturbed area

Four hole bullets on undisturbed area

Area 2

Seedlings were planted in a variety of soil media. Soil medium was identified for each container at surface level and six centimeters depth. Figure 5 shows that the most common surface material for planting was duff. However, examination of soil medium at six centimeters depth revealed that most containers reached the mineral soil at that depth. Rotten wood and mixtures followed the mineral soil in importance. A pure duff medium was not present.

The mortality of seedlings was low, however seedlings in new plastic container had slightly higher mortality than those in four-hole bullets. Seedlings planted in disturbed soil had less mortality than those in undisturbed soil (Table 2).

The lowest mortality was found in mineral soil and rotten wood. A higher rate of mortality occurred when mixtures were found at six centimeters depth (Figure 6).

The presence of vegetation reduced the mortality of seedlings. The occurrence of heavy vegetation provided protection to seedlings and completely eliminated mortality (Figure 7).

Area 3

Most containers were planted in two soil media, humus and mixture at the surface level. Mineral soil and rotten wood supported 10 and 12 percent of the seedlings respectively. However, when soil media were checked at six centimeters depth the most common soil medium

Fig. 5 Percent distribution of lodgepole pine seedlings planted in undisturbed soil — Area 2.

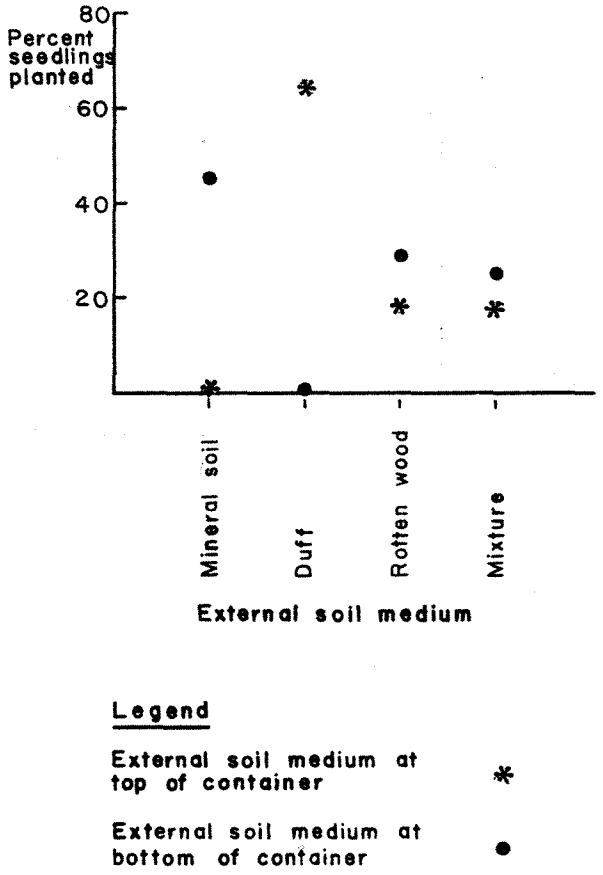


Fig. 6 Percent mortality of lodgepole pine seedlings in undisturbed soil — Area 2.

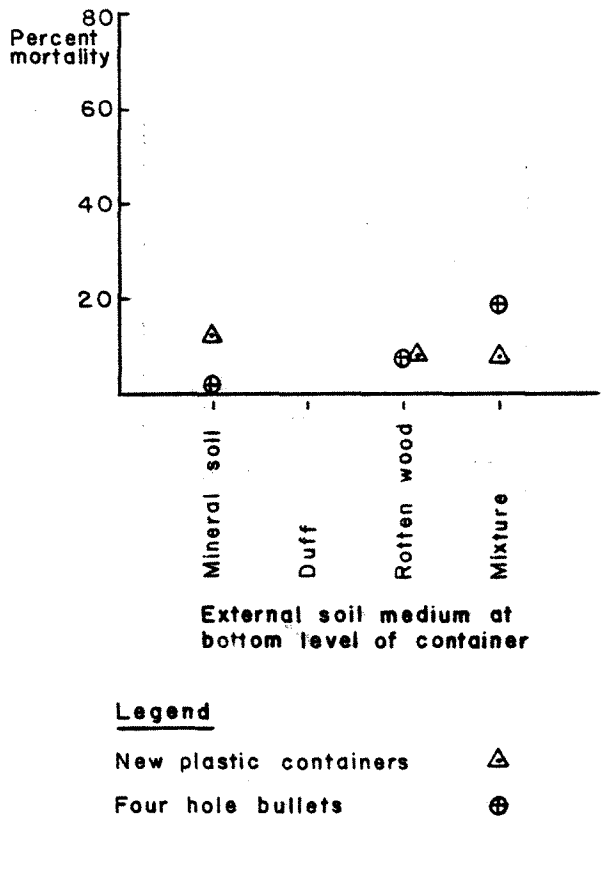


Table 2 Percent mortality of lodgepole pine seedlings

on disturbed and undisturbed ground-Area 2.

Type of container	Undisturbed area			Disturbed area			Percent mortality for the whole area
	Total no. of containers sampled	No. of containers without live seedlings	Percent mortality	Total no. of containers sampled	No. of containers without live seedlings	Percent mortality	
Four-hole bullet	92	8	9	26	0	0	7
New plastic container	279	35	13	41	3	7	12

was mineral soil, followed by mixture(Figure 8).

Mortality of seedlings was very high compared to other plantations. Seedlings raised in one-hole bullets had a mortality of 50 percent while in Edmonton bullets and new plastic containers the mortality was 40 and 39 percent respectively (Table 3).

Table 3. Percent mortality of white spruce seedlings planted under old aspen stand - Area 3.

Type of container	Total no. of containers planted	No. of containers without live seedlings	Percent Mortality
One-hole bullet	117	59	50
Edmonton bullet	52	21	40
New plastic container	215*	84	39

* 5 containers were missing

The average mortality of spruce seedlings for three types of containers was calculated and was found to be fairly uniform in various soil media. The lowest average mortality was encountered in mineral soil with 41 percent followed by rotten wood 42 percent, mixture 44 percent and humus 49 percent, respectively. Considerable variation in mortality existed between containers within a particular soil medium (Figure 9).

Fig. 8 Percent distribution of spruce seedlings planted — Area 3.

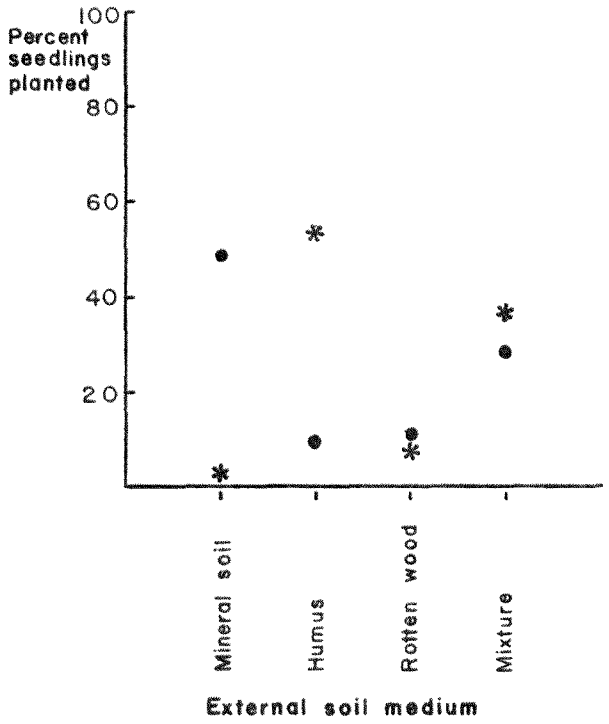
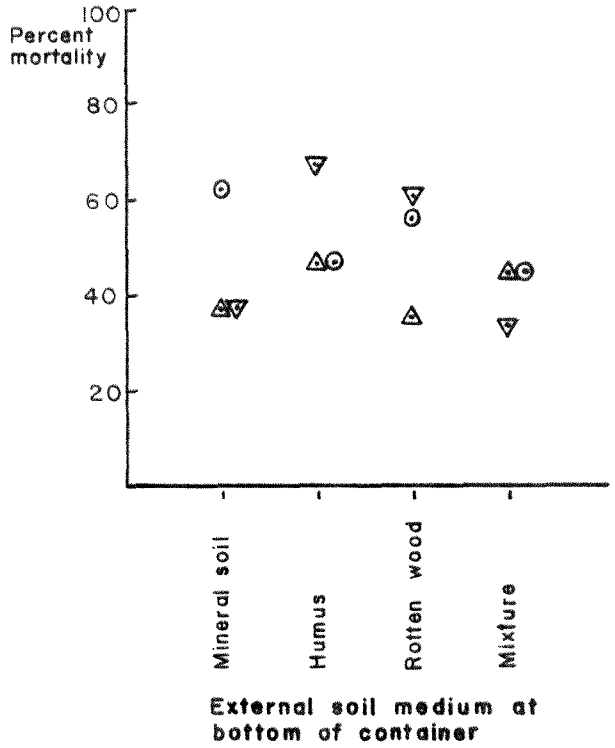


Fig. 9 Percent mortality of spruce seedlings — Area 3.



The effect of vegetative competition on the rate of survival was not apparent. Seedlings planted under heavy vegetation did not have a higher rate of mortality than those without any vegetative competition since the existing old aspen stand provided protection (Figure 10). The highest mortality was found under light vegetative competition in the case of one hole bullets and Edmonton bullets, however no explanation can be given for this trend.

Smothering by aspen leaves affected the mortality of seedlings grown in all types of containers. Highest mortality occurred when heavy smothering existed (Figure 11).

The high mortality was caused mainly by two factors: 1. Heavy smothering, 2. Extremely heavy shade. Those seedlings which were not killed by smothering of aspen leaves were retarded in terms of shoot and root growth.

Several containers of each type with live seedlings were excavated during the survival check and none was found where roots of seedlings were growing out from the containers.

Area 4

The majority of seedlings was planted in three soil media (identified at surface level) humus, rotten wood and mixture on unscarified areas. However, when soil medium was determined for each container at six centimeters depth the mineral soil was the most common medium. Less than 10 percent of the seedlings were planted in each of the other media except for the mixture (Figure 12).

Mortality of seedlings was low and Table 4 shows that survival

Fig. 10 Percent mortality of spruce seedlings affected by vegetation — Area 3.

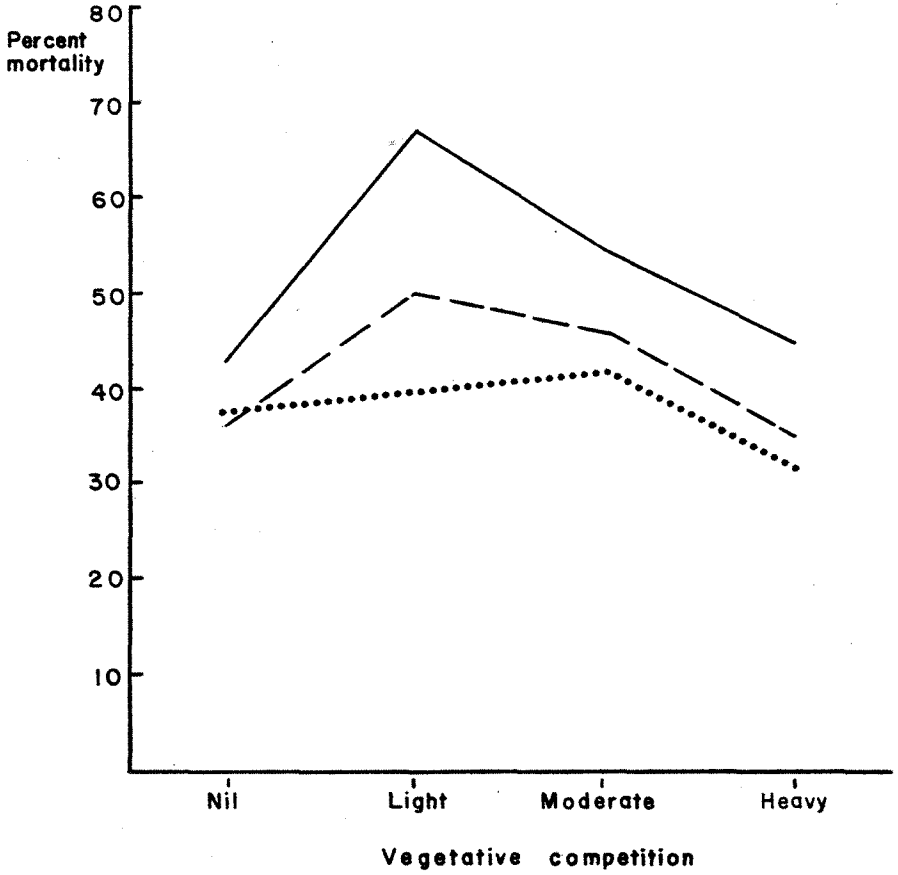
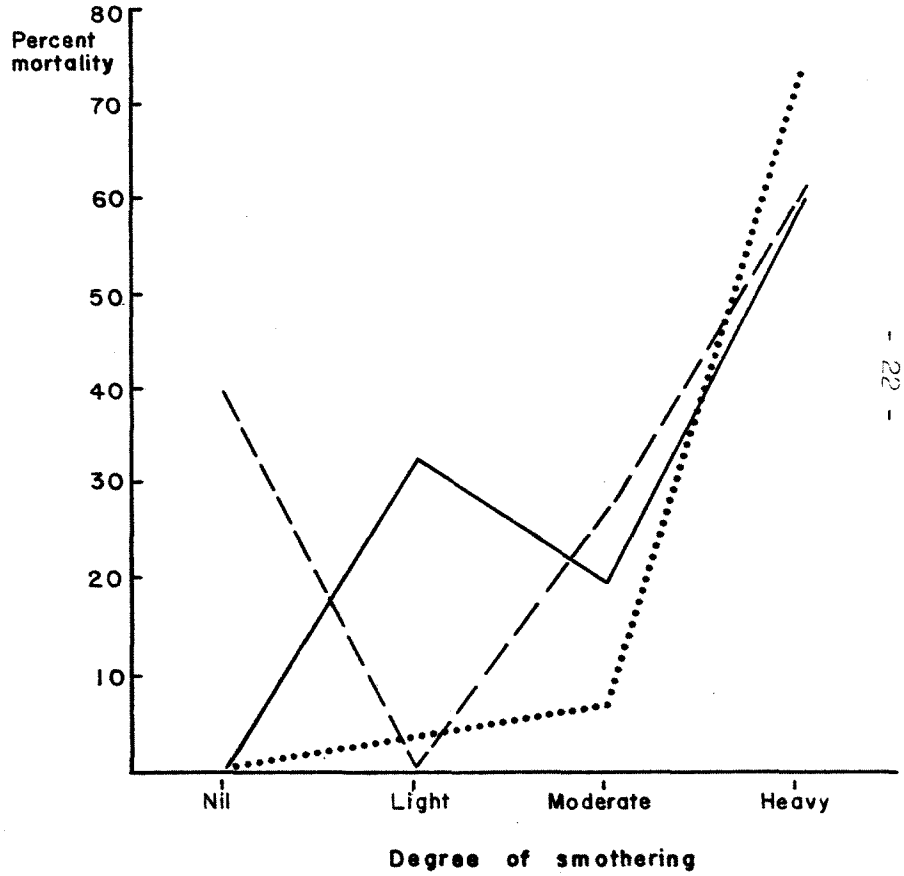


Fig. 11 Percent mortality of spruce seedlings affected by aspen leaves — Area 3.



Legend

One hole bullets ——————

Edmonton bullets — — — —

New plastic containers ....

Fig. 12 Percent distribution of spruce seedlings planted in unscarified soil — Area 4.

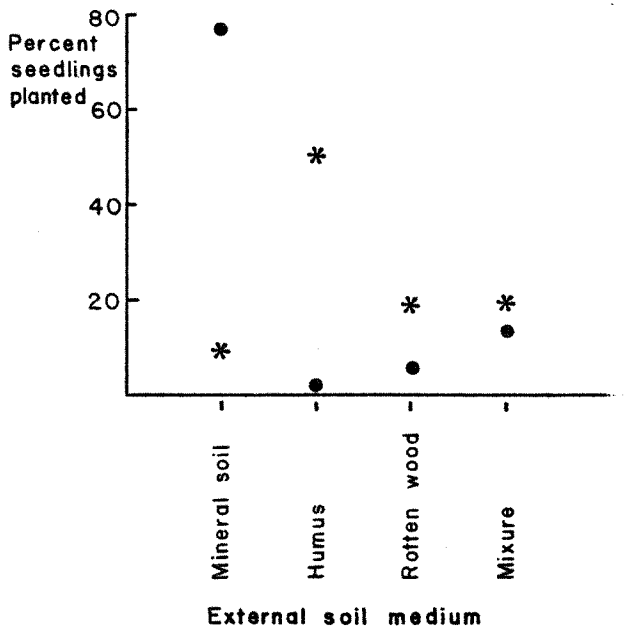


Fig. 13 Percent mortality of spruce seedlings in unscarified soil — Area 4.

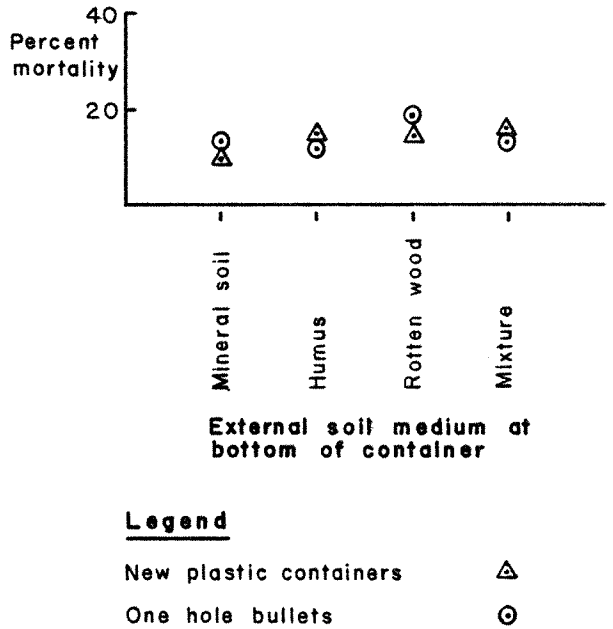


Table 4 Percent mortality of white spruce seedlings on scarified and unscarified area under young aspen stand-Area 4.

Row No.	Type of container	Unscarified soil			Scarified soil			Percent mortality for the whole row
		Total no. of containers planted	No. of containers without live seedlings	Percent mortality	Total no. of containers planted	No. of containers without live seedlings	Percent mortality	
1	New plastic	92	20	22	131	12	9	14
2	New plastic	45	4	9	176	19	11	10
3	New plastic	63	3	5	155	7	5	5
4	New plastic	25	5	20	168	19	11	12
5	One-hole bullet	30	4	13	101	15	15	15

Fig. 14 Percent mortality of spruce seedlings affected by vegetation — Area 4.

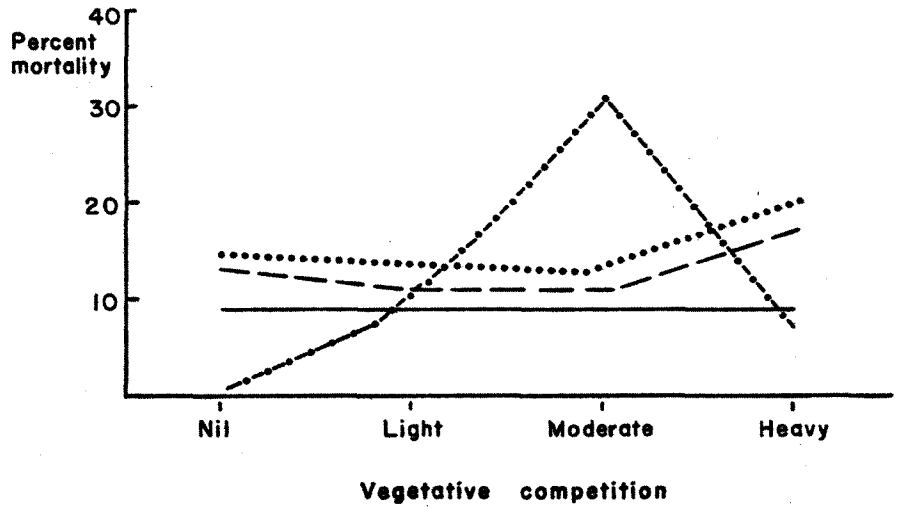
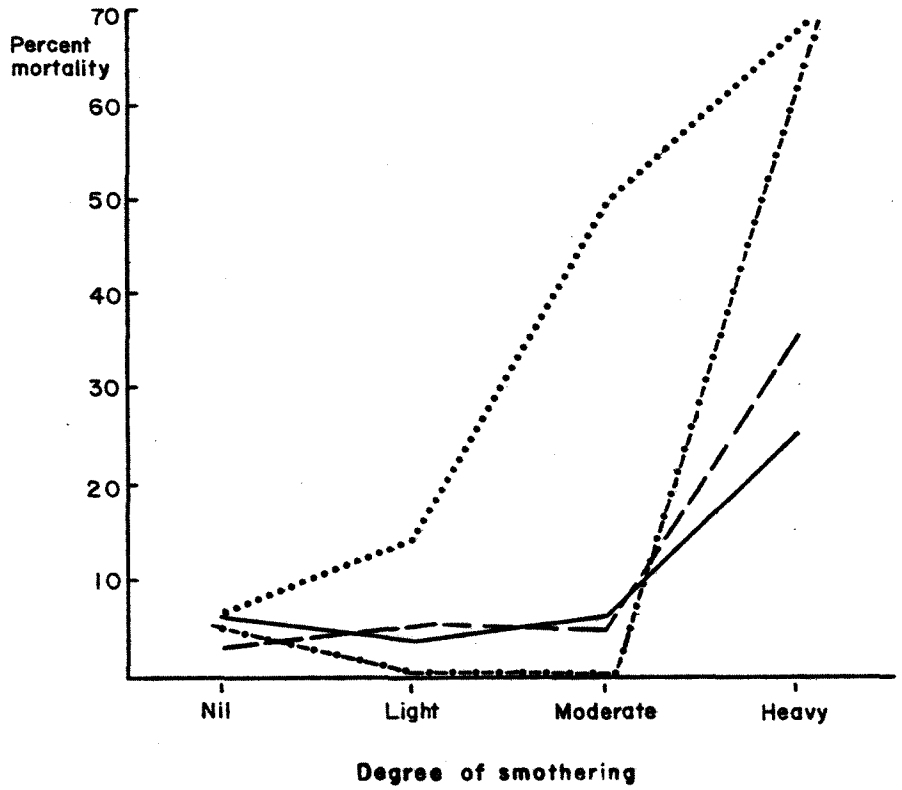


Fig. 15 Percent mortality of spruce seedlings affected by aspen leaves — Area 4.



Legend

Scarified area
New plastic container
One hole bullet
Unscarified area
New plastic container
One hole bullet

was generally better on scarified than on unscarified areas. An average of five percent better survival was obtained for seedlings planted on scarified than on unscarified areas, for all seedlings and both containers. Seedlings grown in new plastic containers had an average of 10 percent mortality compared to 15 percent for one-hole bullets.

Seedlings planted in mineral soil had the lowest mortality while in humus, mixture and rotten wood had increasingly higher mortality (Figure 13).

Degree of vegetative competition did not affect the mortality of seedlings in new plastic containers on scarified and unscarified areas. A similar trend existed for one hole bullets on scarified areas, however, maximum mortality is recorded under moderate competition on unscarified areas (Figure 14).

Higher mortality was associated again with an increasing degree of smothering for one hole bullets and new plastic containers (Figure 15).

SUMMARY AND CONCLUSIONS

Four experimental plantations were established by the Alberta Department of Lands and Forests in the Clearwater-Rocky Mountain House Forest to test the pracicability of container planting.

The first year results are promising on cut-over areas without scarification and under young aspen stands, with rates of mortality of 11 and 10 percent, respectively. A higher mortality rate (43 percent)

was observed when an 80-year-old aspen stand was underplanted with spruce. High losses were due chiefly to smothering by aspen leaves and heavy shade. The underplanting of old aspen stands should be discontinued until further research results are available on chemical treatment of aspen stands prior to planting.

These low mortality results are contrary to the results observed in the coastal region of British Columbia. An average of 83 percent mortality was obtained with Douglas-fir grown in plastic bullets, one year after planting, (Anonymous 1966).

The best types of containers in terms of growing seedlings in the greenhouse and field survival were the plastic containers. Phenoformaldehyde, waxed cardboard and asphalt containers showed definite inferiority in rate of survival compared to plastic containers. Considerable difficulty was experienced with waxed cardboard containers in the greenhouse where a thick layer of fungi grew on the paper which made maintenance and field planting difficult.

High survival results indicated that seedlings were able to establish themselves if the thickness of the duff layer was not in excess of the length of containers, because the roots were able to penetrate to mineral soil. Duff is not a favorable growing medium for seedlings. Rotten wood, especially when well decayed, was a good growing medium for spruce, and as well for lodgepole pine seedlings. Humus and mixtures were

generally fair growing media for both species.

Vegetative competition did not affect the mortality of seedlings directly under old or young aspen stands. On cut-over areas the presence of vegetation cover was definitely beneficial, providing protection for young seedlings.

Smothering by aspen leaves was a major factor causing heavy mortality under old aspen stand. However, good results were obtained with underplanting of young aspen stands and if no further significant mortality occurs the young aspen stands can be underplanted successfully.

Several seedlings were excavated on each area for root examination. The roots of seedlings on all areas except under the old aspen stand (Area 3) were grown out from the containers. The further root development of seedlings is not known for each type of container. No major problems are expected with Edmonton bullets and new plastic containers. However, one and four hole bullets should be eliminated from further trials since the root development of seedlings in both containers could be affected. There is no advantage in using them if they are planted with dibbles because they were originally designed for planting gun requiring heavy structure. Perhaps thin plastic tubes, open at both ends, should be used in future trials to avoid possible root deformation.

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PLATE I

1. Location of Area 1. Note the light vegetation cover five years after logging.
2. General view of Area 2.
3. General view of Area 3 where an 80-year old aspen stand was underplanted. Note luxuriant growth of vegetation.
4. General view of Area 4. Strips were bulldozed in a 23-year old aspen stand. Vegetative competition is medium to high on this portion of Area 4.


1

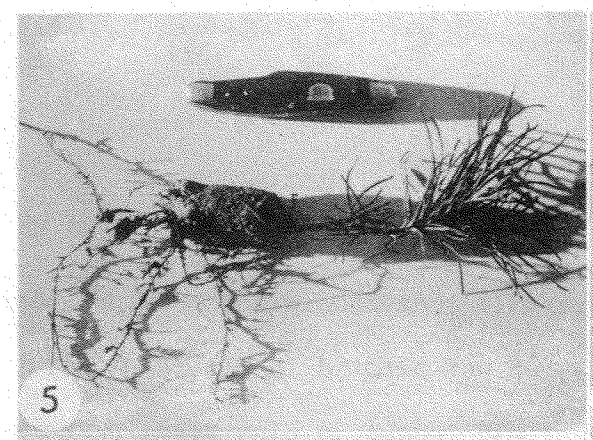

2


3


4

PLATE II

5. Root development of one-year old lodgepole pine seedling raised in phenoformaldehyde container and planted in mineral soil.
6. Root development of one-year old lodgepole pine seedling raised in waxed cardboard paper and planted in mineral soil.
7. Root development of one-year old lodgepole pine seedling raised in asphalt container and planted in rotten wood.
8. Root development of one-year old lodgepole pine seedling raised in asphalt container and planted in mineral soil.
9. Root development of one-year old lodgepole pine seedling raised in new plastic container and planted in rotten wood.
10. Root development of one-year old lodgepole pine seedling raised in Edmonton container and planted in mineral soil.
11. Root development of one-year old lodgepole pine seedling raised in four-hole bullet and planted in rotten wood.
12. Root development of one-year old lodgepole pine seedling raised in one-hole bullet and planted in rotten wood.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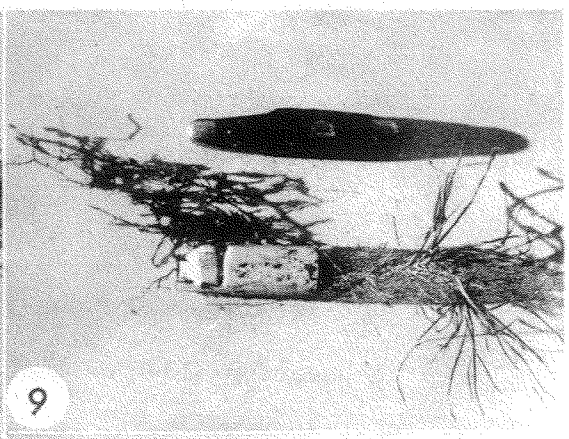
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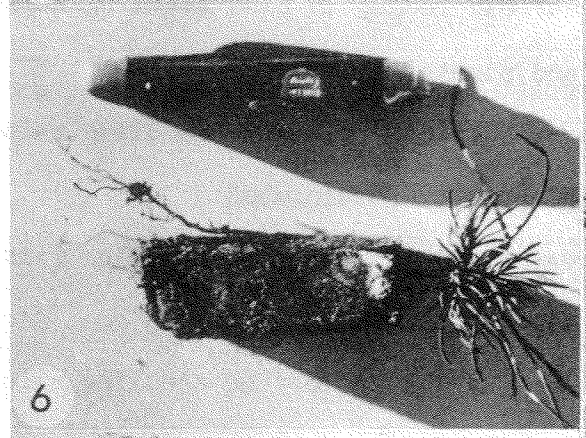
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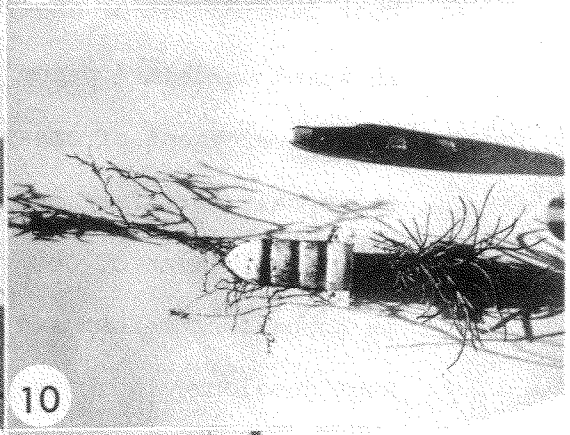
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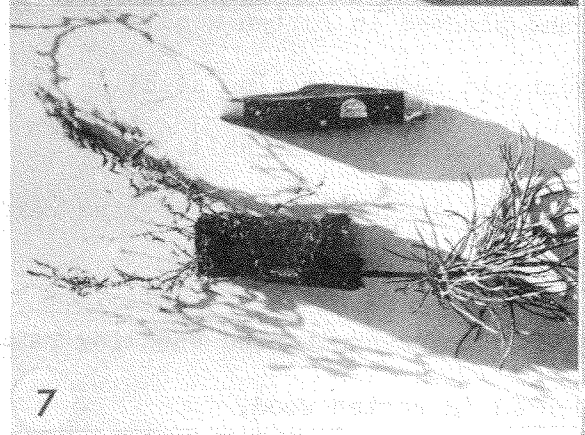
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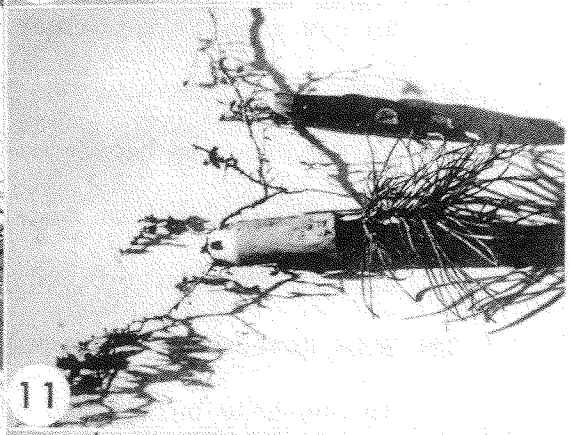
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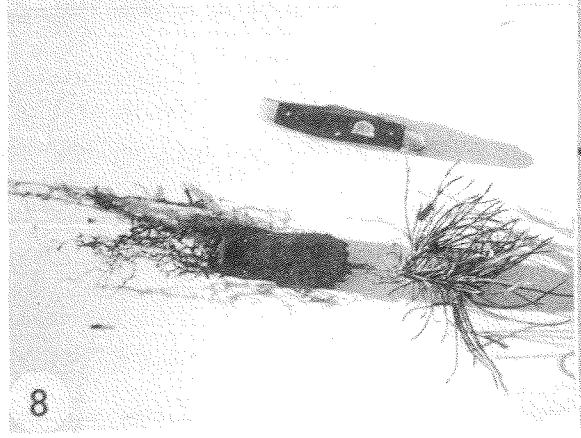
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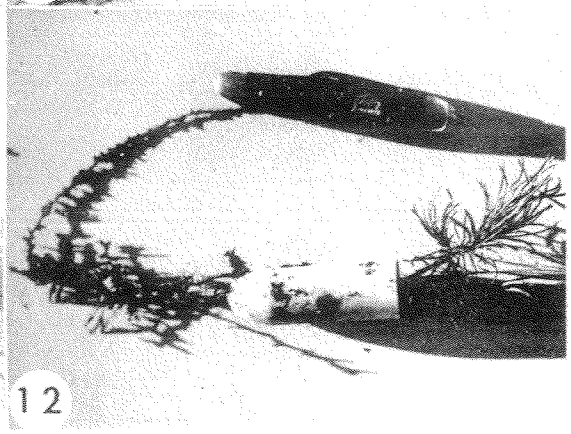
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APPENDIX 1

Location and planting data for Area 1 and Area 2

Distribution of lodgepole pine seedlings

grown in various containers and planted on Area 1.

Row No.	Type of Container	Age of seedlings (weeks)	Code of seed Source	No. of containers planted	Type of dibble used	Remarks
					inches	
1	Phenoformaldehyde	16	60-47	22	1x1x3	Punched
2	Phenoformaldehyde	16	60-47	21	1x1x3	"
3	New plastic container	12	62-3	25	3/4x3/4x3	"
4	New plastic container	12	62-3	25	3/4x3/4x3	"
5	Edmonton bullet	16	60-47	27	round	"
6	Asphalt container	16	60-47	24	1x1x3	"
7	Asphalt container	16	60-47	23	1x1x3	"
8	Waxed cardboard container	16	60-47	26	1x1x3	"
9	One hole bullet	16	60-47	5	round	"
10	Four hole bullet	16	60-47	25	round	"
11	Four hole bullet	16	60-47	25	1x1x3	"
12	Four hole bullet	16	60-47	25	3/4x3/4x3	"
13	Four hole bullet	16	60-47	25	3/4x3/4x3	twirled
14	Four hole bullet	16	60-47	26	1x1x3	"
15	Four hole bullet	16	60-47	14	1x1x3	"

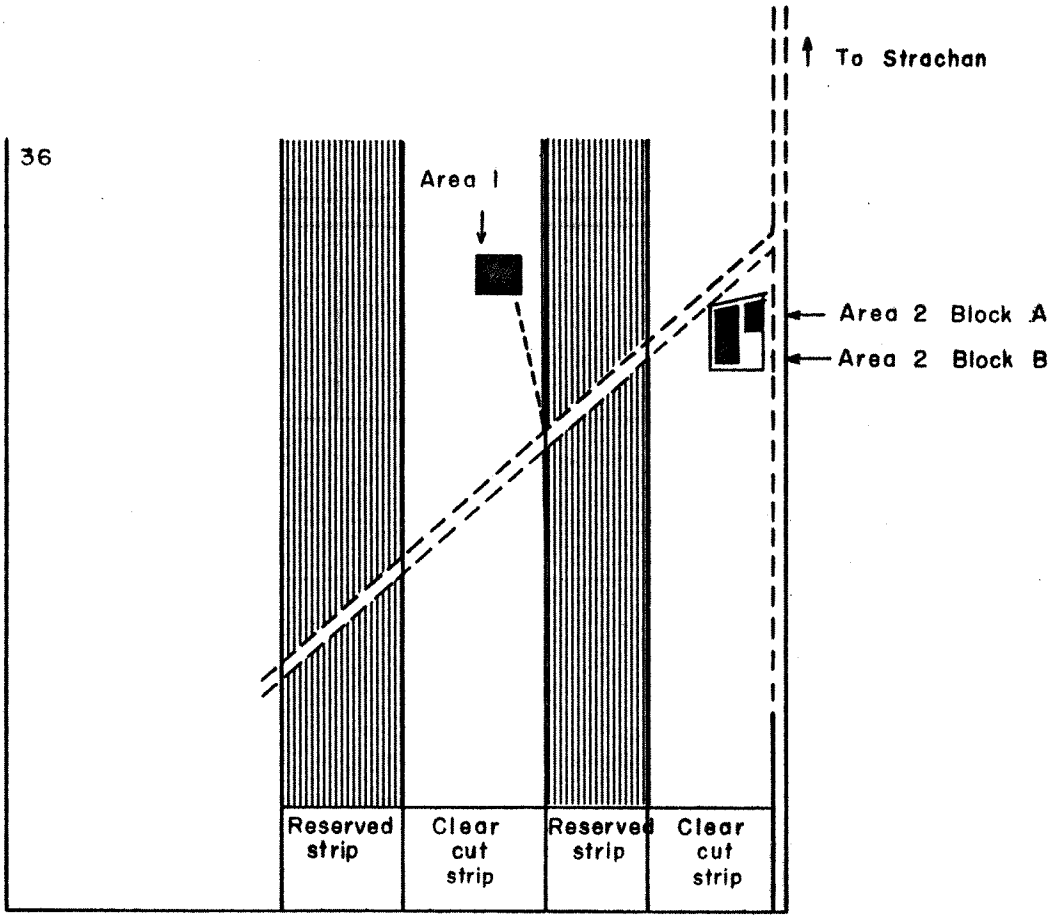
Distribution of lodgepole seedlings

planted on Area 2.

Type of container	Age of seedlings (weeks)	Code of seed source	No. of containers planted	Type of dibble used
Four-hole bullet	16	60-47	118	3/4x3/4x3
New plastic container	12	62-3	1031	1x1x3

Location of Area 1 and Area 2.

Sec. 36 Twp. 37 Rge. 10 W. 5 Mer.



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APPENDIX 2

Location and planting data for Area 3 and Area 4

Distribution of white spruce seedlings

grown in various containers planted under old aspen stand - Area 3.

Row No.	Type of container	Age of seedlings (weeks)	Code of seed source	No. of containers planted	Type of dibble used
1, 2	One-hole bullet	16	61-118	117	1x1x3
3	Edmonton bullet	16	61-118	52	1x1x3
4, 5, 6, 7,	New plastic container	12	61-151	220	1x1x3

Distribution of white spruce seedlings

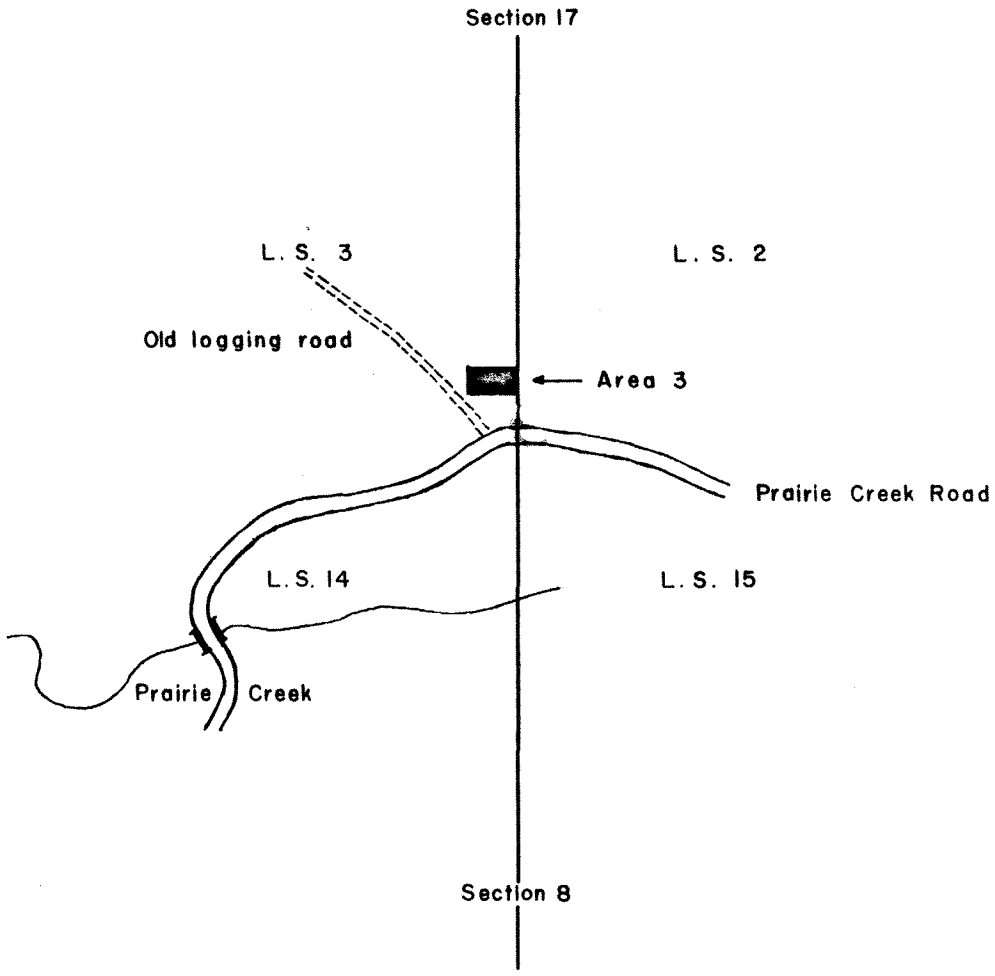
planted under young aspen stand - Area 4.

Row No.	Type of container	Age of seedlings (weeks)	Code of seed source	No. of containers planted	Type of dibble used	Remarks
1	New plastic	12	61-151	225	1x1x3	223*
2	New plastic	12	61-151	226	1x1x3	221*
3	New plastic	12	61-151	223	round	218*
4	New plastic	12	61-151	199	3/4x3/4x3	193*
5	One-hole bullet	16	61-118	138	round	131*

* No. of containers found during survival check.

Location of Area 3

Twp. 37 Rge. 10 W. 5 Mer.



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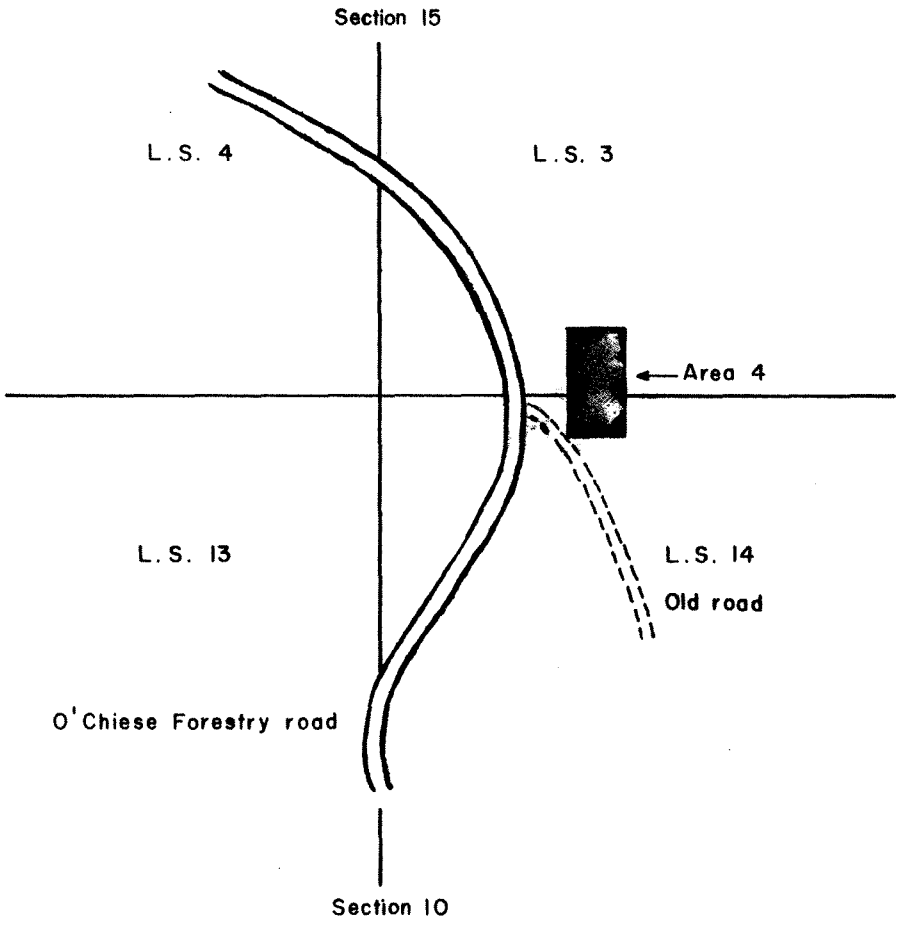
Location of Area 4

Twp. 42 Rge. 8 W. 5 Mer.



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