EARLY MORTALITY OF CONTAINER PLANTING IN THE PEACE RIVER FOREST - ALBERTA

by
J. Soos

FOREST RESEARCH LABORATORY
CALGARY, ALBERTA
INFORMATION REPORT A-X-12

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INTRODUCTION

The principle of container planting as a reforestation technique is not new. Several materials and forms of containers have been used 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 over conventional planting:

1. Minimization of time to raise seedlings for outplanting.
2. Elimination of large planting crews.
3. Extension of planting season.
4. Higher survival rate.
5. Reduction of planting check.

Container planting will not completely eliminate the application of conventional planting. There are certain forest sites where this technique will not be as successful as conventional planting.

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[1] Canada Department of Forestry and Rural Development, Contribution No. A-X-12.

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As a result of co-operative work since 1962 between the Alberta Department of Lands and Forests, North Western Pulp and Power Limited, the Alberta Department of Agriculture and the Department of Forestry several experimental container plantations were established in the Hinton area. The early results of these plantings were promising (Ackerman 1965), therefore the Alberta Department of Lands and Forests continued the establishment of container planting trials in various forest districts in the province.

The present study was conducted by the Department of Forestry and Rural Development on four areas in the Peace River Forest during the 1966 field season in order to assess the mortality of container planting established in 1965 and 1966 by the Alberta Department of Lands and Forests.

DESCRIPTION OF THE GENERAL AREA

The general area is located approximately 37 miles north-west of Peace River in the (B. 19a,) Lower Foothills Section of the Boreal Forest Region (Rowe 1959).

The climate of this area is characterized by relatively cold winters and moderately warm summers. July is the warmest month while December is the coldest with mean temperatures of 60°F and - 14°F, respectively. The average yearly precipitation, which is well distributed, is approximately 17 inches. Seventy five percent of the precipitation

falls during the growing season and can be utilized by the vegetation. The frost-free period is approximately 90 days (Reeder and Odynsky 1965).

The soils were formed on lacustro-till deposits consisting of fine textured materials with the occurrence of some stones.

MATERIALS AND METHODS

Description of containers and nursery technique

Seedlings were grown in three types of containers:

1. Phenolformaldehyde - This material is used in commercial flower shops to keep cut flowers fresh. The size of the container is 3/4 3/4 x 3 1/4 inches.
2. New plastic container - The container is manufactured of polystyrene with dimensions of 6/8 x 2 3/8 x 1/64 inches. A slit is located on one side and on the bottom part of the container to provide an opportunity for roots to grow out of the container.
3. Acetate container - A paper cylinder with dimensions of 5/8 x 3 3/8 inches filled with acetate fiber similar to the material used in cigarette filters.

All seedlings were produced by the Department of Agriculture at the Provincial Tree Nursery Oliver. Two or three seeds of local provenance were placed in the soil mixture and were covered with sand. The germinants were six weeks old when removed from the greenhouse to

harden off for a period of four to six weeks prior to field planting.

Species

Two species white spruce (Picea glauca (Moench) Voss.) and lodgepole pine (Pinus contorta Dougl. var. latifolia Engelm.) were grown in three types of containers and planted on scarified and unscarified areas.

Survey procedure

Two areas planted in 1965 and 1966, were studied during the 1966 field season. Plantations established in 1965 were surveyed on August 14 and 15 while 1966 plantations were checked on August 28 and 29, 1966. Where the number of containers planted was relatively small, all were examined otherwise random sampling was conducted. Each container was described individually with particular emphasis on the identification of the soil medium at the surface level (top level of container) and at 2 3/8 inches depth (bottom level of container). Additional information was obtained on vegetative competition and smothering by aspen leaves. An attempt was made to preserve the original conditions of the seedlings to avoid confounding future surveys.

Four soil media were distinguished: 1. Mineral soil. 2. Humus. 3. Rotten wood. 4. Mixture (any combination of mineral soil, humus and rotten wood).

Five frost heaving classes were recognized: 1. Nil. 2. Containers heaved up to 1/4 of the total length. 3. Heaving to 1/2 of the length of container. 4. Heaving to 3/4 of the length of the container. 5. Containers completely heaved.

Four classes were established to describe the existing vegetative competition:

1. Nil. Seedlings having no interference from herbs, grasses and shrubs.
2. Light. Seedlings shaded from one side mainly by herbs, grasses or low growing shrubs. Leaders of seedlings completely free from competition.
3. Moderate. Herbs and light cover of grasses growing around seedlings, however; no serious interference noted in seedling development.
4. Heavy. Seedlings not readily visible and covered by heavy growth of grasses and shrubs.

Four classes were used to describe the degree of smothering:

1. Nil. No apparent interference by aspen leaves.
2. Light. Aspen leaves found on one side of seedlings.
3. Medium. Aspen leaves found around base and sides of seedlings, but terminal buds not covered.
4. Heavy. Seedlings completely covered with aspen leaves.

After an analysis of the data it was possible to relate the degree of mortality to various conditions.

No attempt was made to identify the cause of mortality (e.g. drought, insect or fungus attack).

Description of planting sites

All planting sites were located in Township 88, Ranges 1 and 2 and were previously scarified by the Department of Lands and Forests (Fig. 1). The entire area was burned twice, except in moist and wet pockets where conifers escaped the fires. A s a result of repeated burning young aspen stands invaded the area.

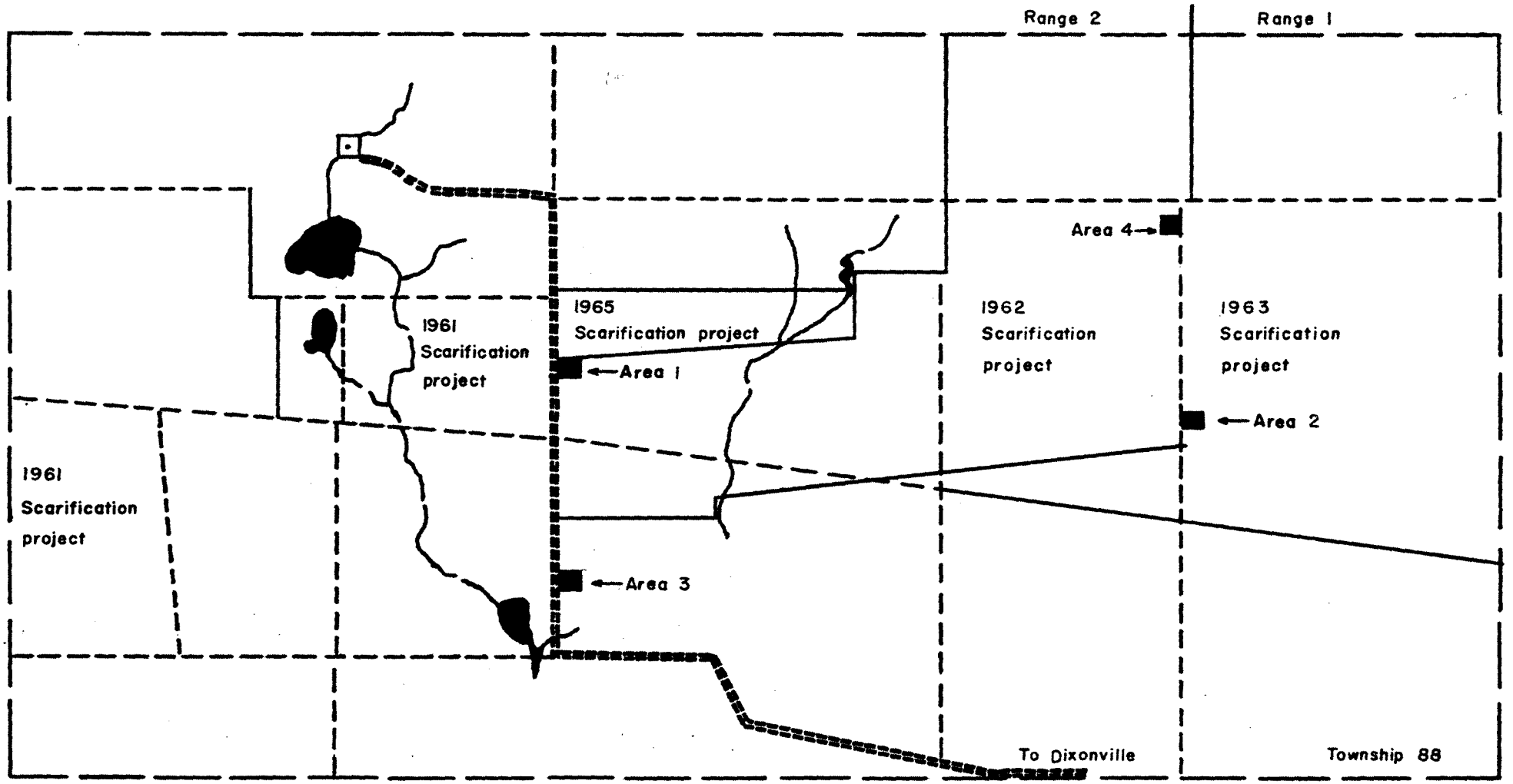
The topography of the area varies from gently rolling to rolling. The elevation of the study areas is between 2280-2550 feet. The most common soil type found was grey wooded solod developed on lacustro till material.

Plantations established in 1965

Area 1

Area 1 is situated on a small portion of a 1962 scarification project close to the Sulphur Lake Forestry Road. Two blocks were planted with 12-week old spruce and pine seedlings. Block A is located on the road right-of-way where both species in phenolformaldehyde and new plastic

Fig. 1 Location of planting sites



Scale: 2" = 1 mile

containers were planted in scarified soil. Block B is located under a 20-year old aspen stand where spruce and pine seedlings in new plastic containers were planted when they were 12-weeks old. Planting was carried out on August 5, 1965.

Area 2

Area 2 is located in a 1963 scarification project. Lodgepole pine and spruce seedlings were planted on scarified and unscarified land under a 20-year old aspen stand. Both species were raised in new plastic containers and planted at 12-weeks of age. The date of planting was also on August 5, 1965.

Area 3

Area 3 is 0.7 miles south of Area 1 in a 1965 scarification project. Lodgepole pine and spruce seedlings raised in three types of containers (acetate, phenolformaldehyde and new plastic) were planted in scarified and unscarified soil under a 20-year old aspen stand on June 13, 1966.

Area 4

Area 4 is situated 0.6 miles north of Area 2 in a 1962 scarification project. White spruce seedlings raised in three types of containers (acetate, phenolformaldehyde and new plastic) were planted in scarified and unscarified soil. The planting date was the same as that of Area 3.

RESULTS

Area 1 Block A

All spruce and pine seedlings were planted in mineral soil on the road right-of-way. Mortality of spruce and lodgepole pine seedlings in phenolformaldehyde containers was 90 and 68 percent respectively. Considerably less mortality was observed in new plastic containers for spruce and lodgepole pine seedlings with a rate of 16 and 21 percent respectively (Table 1).

Fig. 2 shows that heaving occurred to seedlings in both containers regardless of species. The highest percentage of complete heaving was observed for lodgepole pine seedlings in new plastic containers (24 percent) followed by spruce seedlings in phenolformaldehyde containers (14 percent), lodgepole pine in phenolformaldehyde (13 percent), and spruce in new plastic containers (8 percent).

The mortality rate of seedlings in plastic containers sharply increased when the degree of heaving was more than 1/4 of the length of the container. The mortality rate in phenolformaldehyde containers was very high regardless of degree of heaving (Fig. 3).

Area 1 Block B

All seedlings of both species were planted in mineral soil on the scarified area. The most common soil media were humus and mixture

Table 1. Mortality of seedlings on scarified open land

- Area 1 Block A.

Type of container	Spruce			Lodgepole pine		
	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
Phenolformaldehyde	29	26	90	38	26	68
New plastic container	38	6	16	38	8	21

Table 2. Mortality of seedlings in new plastic containers

under a young aspen stand - Area 1 Block B.

Species	Unscarified soil			Scarified soil			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	
White spruce	51	1	2	82	3	4	3
Lodgepole pine	36	10	28	97	33	34	32

Fig. 2 Percent of spruce and pine seedlings heaved on scarified open land — Area I Block A.

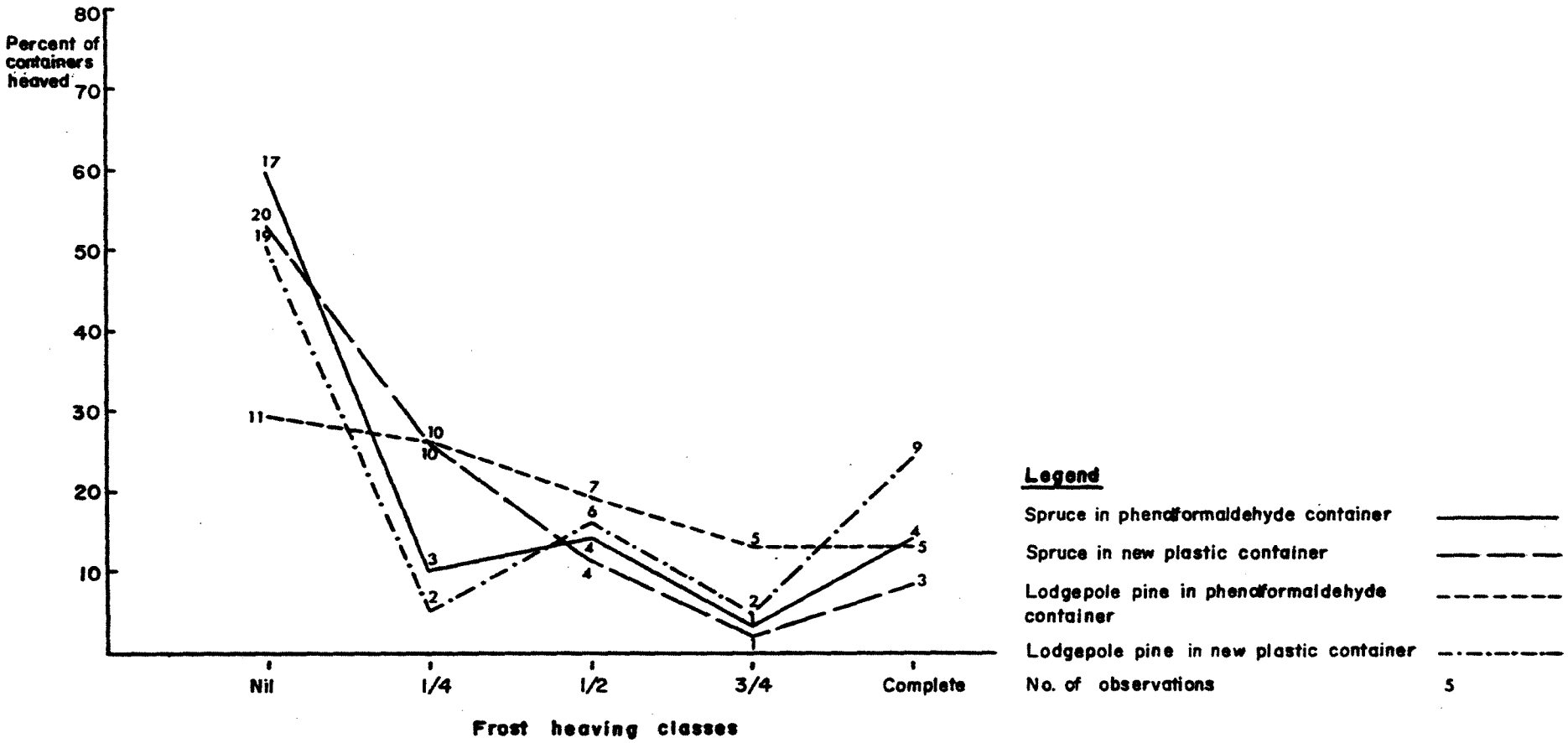
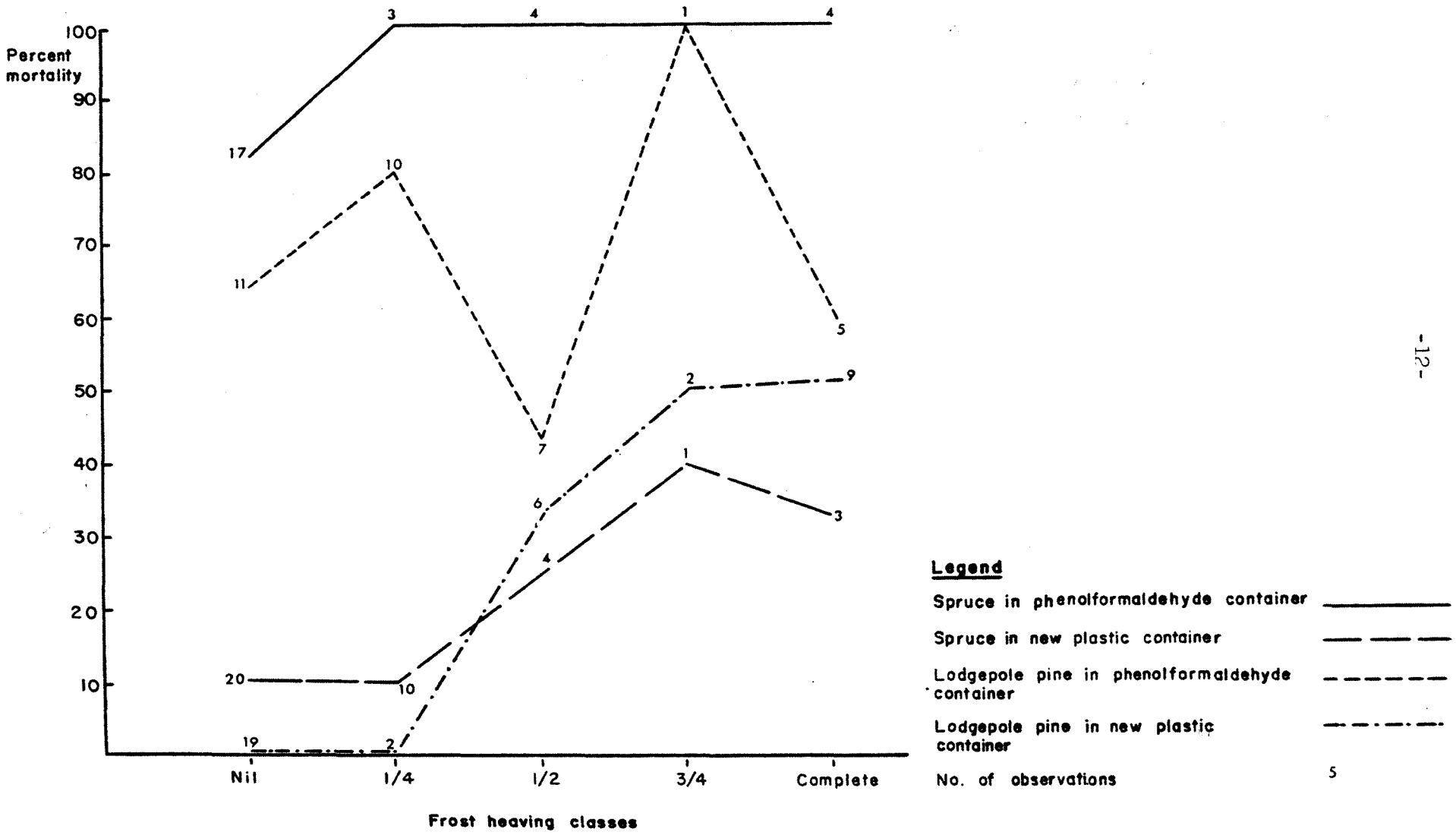


Fig. 3 Mortality of spruce and pine seedlings on scarified open land —— Area I Block A.



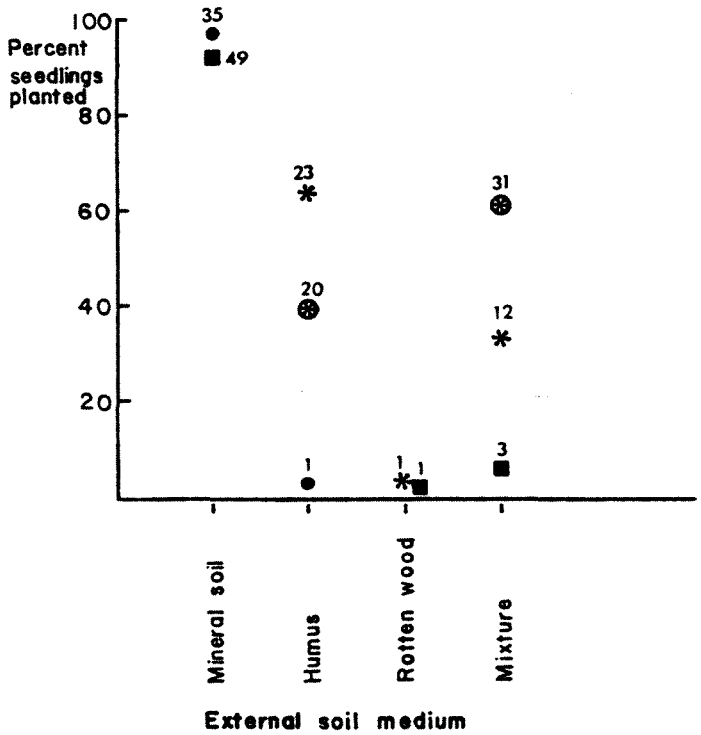
on the unscarified area, with a small percentage of rotten wood. Mineral soil was completely absent when soil media were checked at the top of the containers. However the examination of soil media at 2 3/8 inch depth (bottom of container) revealed that over 90 percent of the containers were in mineral soil and the other media represented less than ten percent individually (Fig. 4).

Mortality of spruce seedlings was only two percent on the scarified area and four percent on the unscarified area. Lodgepole pine seedlings had a mortality rate of 28 percent in unscarified soil and 34 percent in scarified soil (Table 2). Generally the mortality of both species was lower on unscarified than on scarified areas.

Spruce seedlings planted on unscarified areas had almost the same rates of mortality in mineral soil and humus. However, in the case of lodgepole pine seedlings mortality was 29 percent in mineral soil but only one percent in rotten wood and mixtures (Fig. 5).

Heaving of spruce and pine seedlings was definitely higher on the scarified than on the unscarified area. Eight percent of the lodgepole pine seedlings were completely heaved while no complete heaving occurred to spruce seedlings on the scarified area. Both species had only a slight heaving (1/4 of total length) with a frequency of eight and four percent for lodgepole pine and spruce seedlings, respectively on the unscarified areas (Fig. 6).

Fig. 4 Distribution of lodgepole pine and spruce seedlings planted on unscarified land under young aspen stand — Area 1 Block B.



Legend

External soil medium at top of container

Lodgepole pine ✱

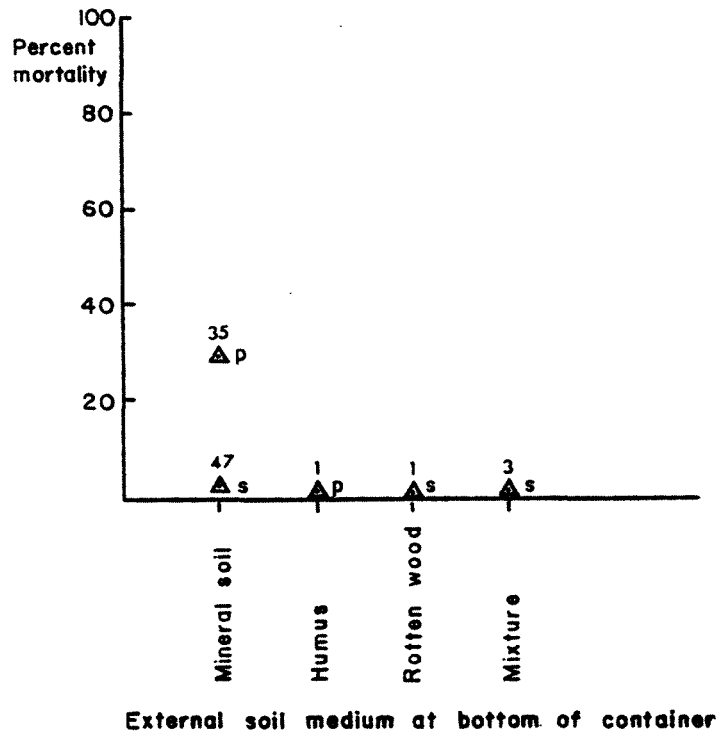
Spruce ⊛

External soil medium at bottom of container

Lodgepole pine ●

Spruce ■

Fig. 5 Mortality of lodgepole pine and spruce seedlings on unscarified land under young aspen stand — Area 1 Block B.



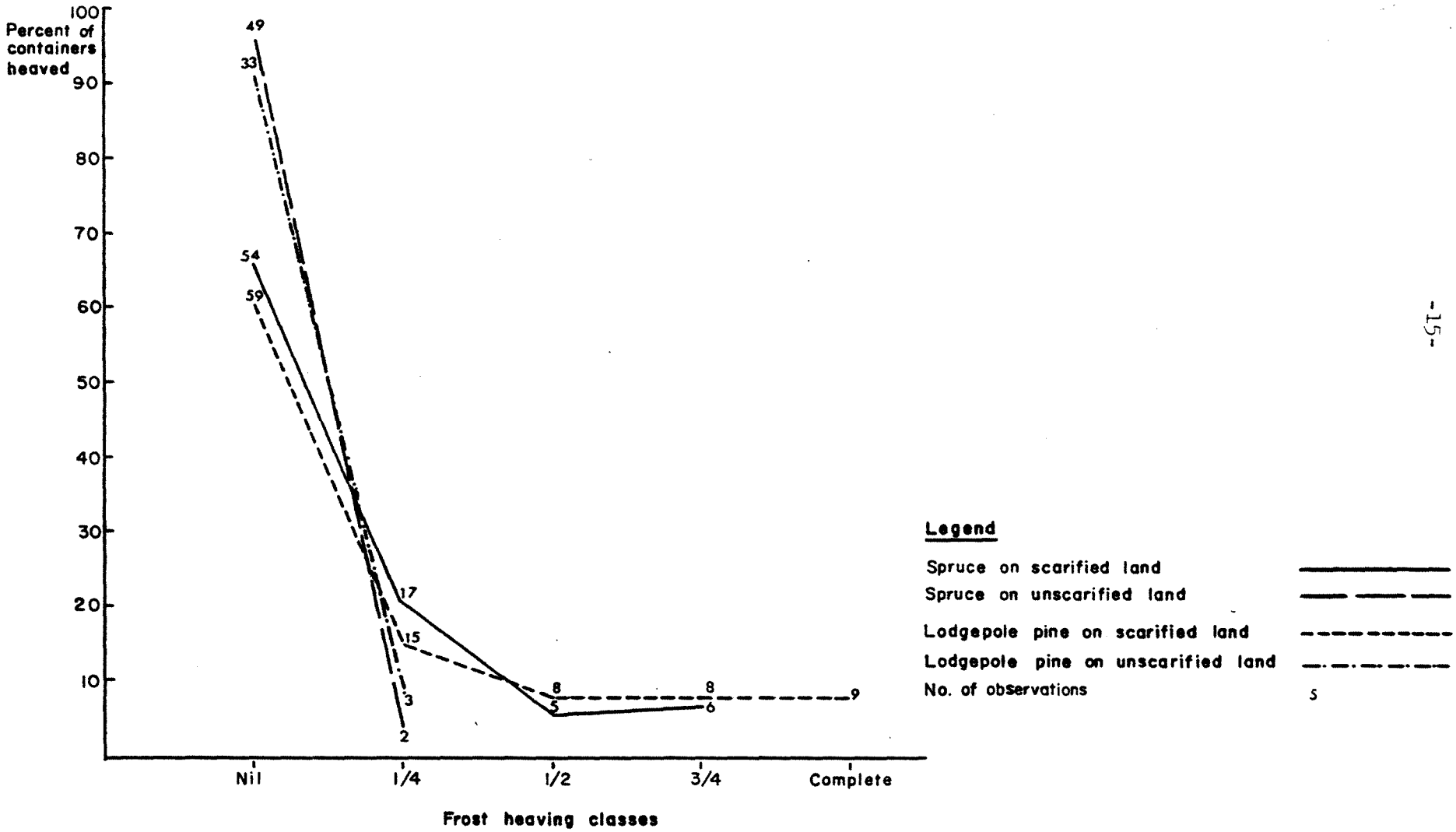
Legend

New plastic container — spruce ▲s

New plastic container — lodgepole pine ▲p

No. of observations 5

Fig. 6 Heaving of spruce and pine seedlings on scarified and unscarified land under young aspen stand —— Area I Block B.



Mortality rates of lodgepole pine seedlings are higher than that of spruce but its relationship to the degree of heaving is uncertain because of the relatively small number of observations (Fig. 7).

Fig. 8 suggests a slightly decreasing trend of mortality for lodgepole pine seedlings with increasing vegetative competitions, while mortality of spruce seedlings was very low under all vegetative competition classes.

Smothering by aspen leaves affected the mortality of both lodgepole pine and spruce seedlings. Thirty-six percent of spruce seedlings planted on the scarified area died when heavy smothering occurred. Sixty six and 64 percent of lodgepole pine seedlings died on unscarified and scarified area, respectively, when heavy smothering was recorded (Fig.9). Only nil and light smothering was represented for spruce seedlings on unscarified area. No mortality occurred in the nil smothering class while 11 percent mortality was found in the light smothering class.

Area 2

Spruce and pine seedlings were planted in mineral soil on the scarified area, however both species had a variety of soil media on the unscarified area. The most common surface soil media were humus, mixture and rotten wood. However, the examination of soil media at the bottom of containers revealed that most containers reached the mineral soil. Humus

Fig. 7 Mortality of spruce and pine seedlings on scarified and unscarified land under young aspen stand — Area I Block B.

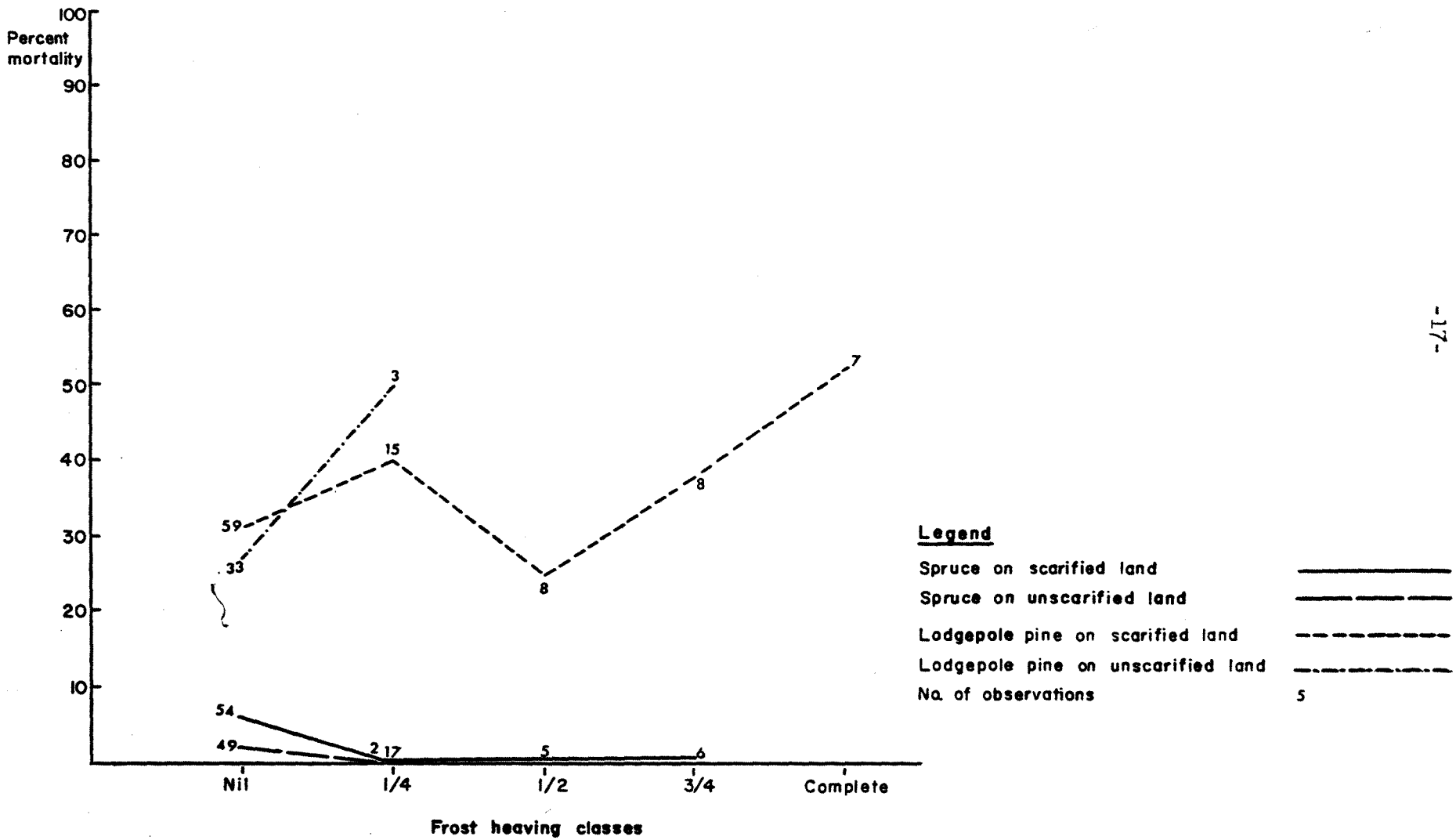


Fig. 8 Mortality of seedlings under young aspen stand affected by vegetation — Area I Block B.

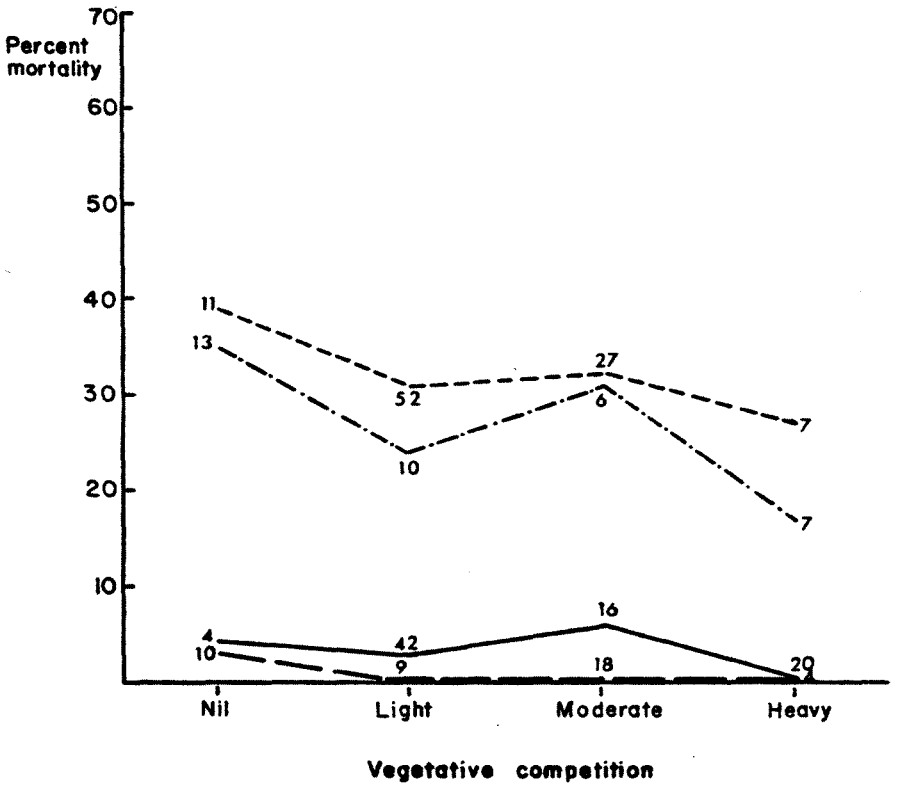
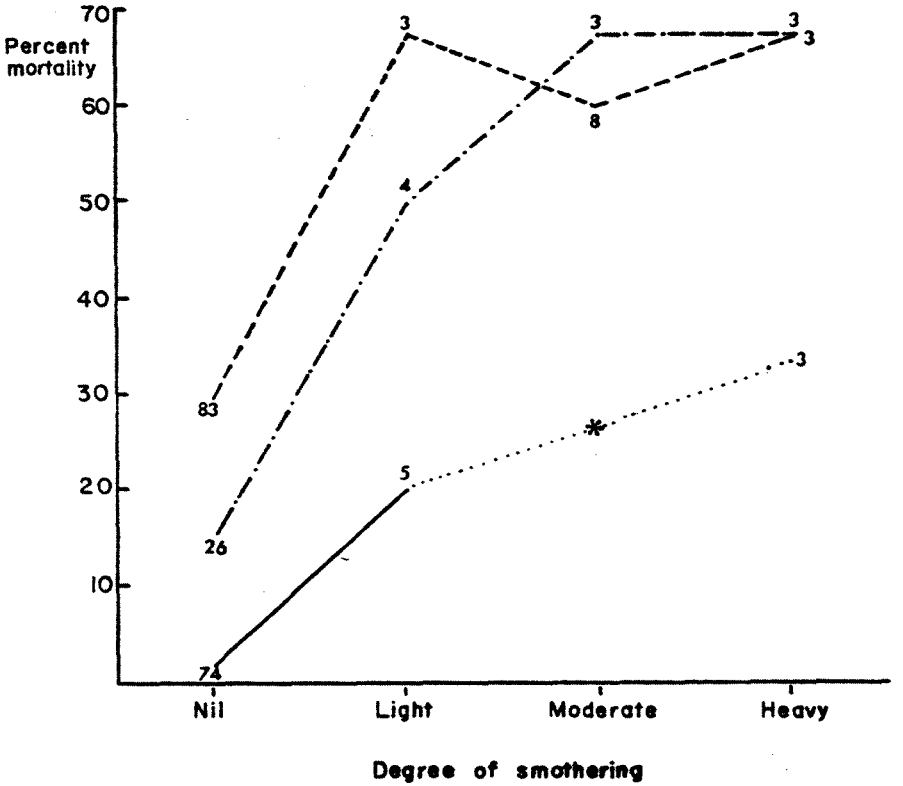


Fig. 9 Mortality of seedlings under young aspen stand affected by aspen leaves — Area I Block B.



Legend

Lodgepole pine on scarified land

Lodgepole pine on unscarified land

Spruce on scarified land

Spruce on unscarified land

No seedlings found in moderate class *

No. of observations . 5

still retained 43 percent while rotten wood and mixture were represented by only three percent or less individually (Fig. 10).

Mortality of lodgepole pine seedlings was higher (51 percent) than spruce (18 percent) for the whole area. Both species had slightly higher mortality on the unscarified area than on the scarified area. The difference was only one and two percent for spruce and pine seedlings, respectively (Table 3).

The mortality of spruce seedlings on the unscarified area was similar in mineral soil, humus and rotten wood with percentages of 22, 17 and 20, respectively. However, much less mortality (one percent) was found in the mixture. The lowest mortality of lodgepole pine seedlings was 47 percent in mineral soil followed by 51 percent in rotten wood, 67 percent in mixture and 73 percent in humus (Fig. 11).

Fig. 12 demonstrates that both species were affected more by heaving on scarified areas than on unscarified areas. Percent heaving of containers did not seem to be affected by species. Four percent of spruce and five percent of pine seedlings were completely heaved on scarified areas.

Complete heaving of containers on scarified areas resulted in high mortality for both lodgepole pine and spruce seedlings with percentages of 100 and 80, respectively (Fig. 13).

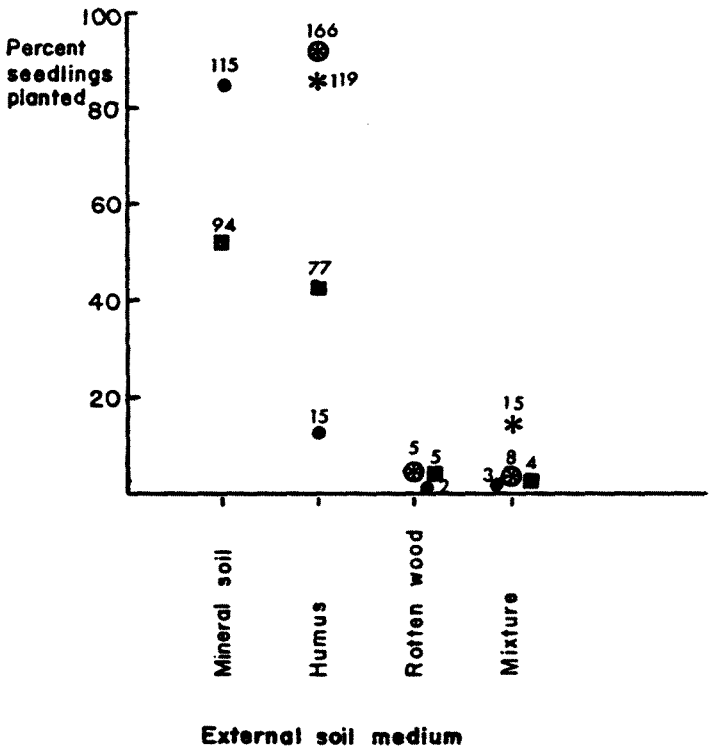
Table 3. Mortality of seedlings in new plastic containers under young aspen stand - Area 2.

Species	Unscarified soil			Scarified soil			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	
White spruce	180	34	19	114	20	18	18
Lodgepole pine	135	69	51	63	31	49	51

Table 4. Mortality of lodgepole pine seedlings planted under young aspen stand - Area 3.

Type of container	Unscarified soil			Scarified soil			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	
Acetate	104	37	36	94	56	60	47
New plastic	75	13	17	124	22	18	18
Phenolformaldehyde	69	61	88	28	26	93	90

Fig. 10 Distribution of lodgepole pine and spruce seedlings planted on unscarified land under young aspen stand — Area 2.



Legend

External soil medium at top of container

Lodgepole pine *

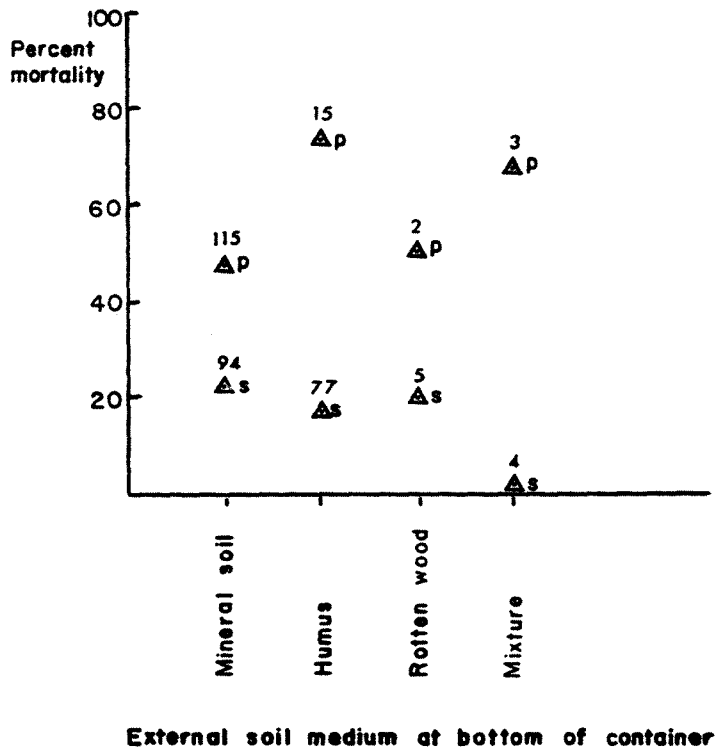
Spruce ●

External soil medium at bottom of container

Lodgepole pine •

Spruce ■

Fig. 11 Mortality of lodgepole pine and spruce seedlings on unscarified land under young aspen stand — Area 2.



Legend

New plastic container — spruce ▲s

New plastic container — lodgepole pine ▲p

No. of observations 5

Fig. 12 Heaving of spruce and pine seedlings on scarified and unscarified land —— Area 2.

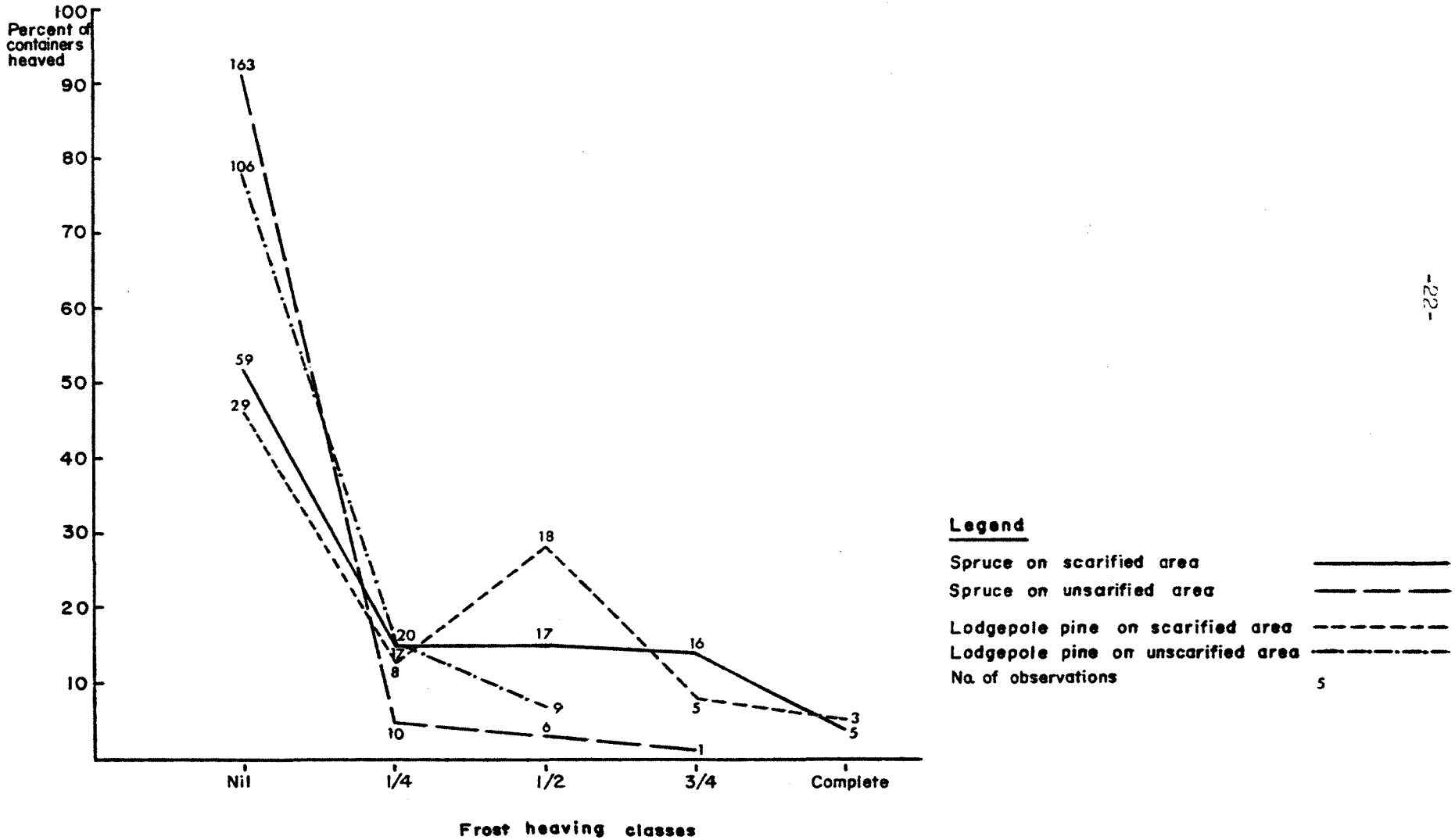
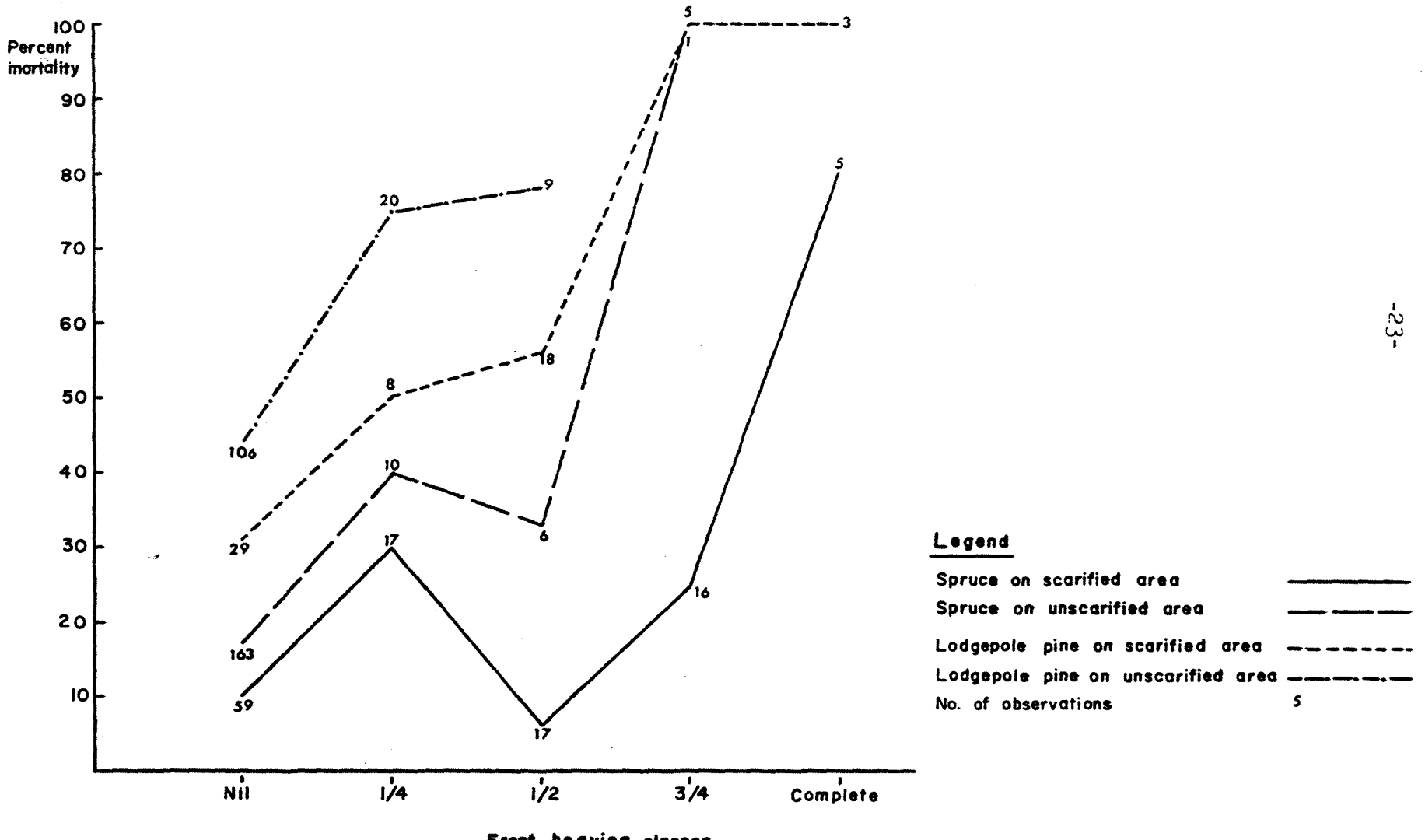


Fig. 13 Mortality of spruce and pine seedlings in various heaving classes —— Area 2.



The presence of vegetation was beneficial for spruce seedlings reducing the mortality on scarified and unscarified areas. However a similar trend for lodgepole pine seedlings was not defined (Fig. 14).

Smothering by aspen leaves increased the mortality of both species on scarified and unscarified areas. The increase in mortality with a higher degree of smothering was especially noticeable for spruce seedlings (Fig. 15).

Area 3.

All seedlings were planted in mineral soil on the scarified portion of the area. The majority of seedlings were found in humus, mixture and rotten wood which was identified at the top of the containers. However, when soil media were checked at the bottom of the containers mineral soil, mixture, humus and rotten wood were found in decreasing order (Fig. 16).

Contrary to the results for other areas, white spruce seedlings had a higher rate of mortality than lodgepole pine seedlings. The highest rate of mortality was found for spruce and lodgepole pine seedlings growing in phenolformaldehyde with 92 and 90 percent followed by acetate with 60 and 47 percent while 26 and 18 percent were observed in new plastic containers, respectively. The rate of mortality for both species and the three types of containers was lower on unscarified areas than on scarified areas. This trend was especially noted for phenolformaldehyde

Fig. 14 Mortality of seedlings under young aspen stand affected by vegetation — Area 2.

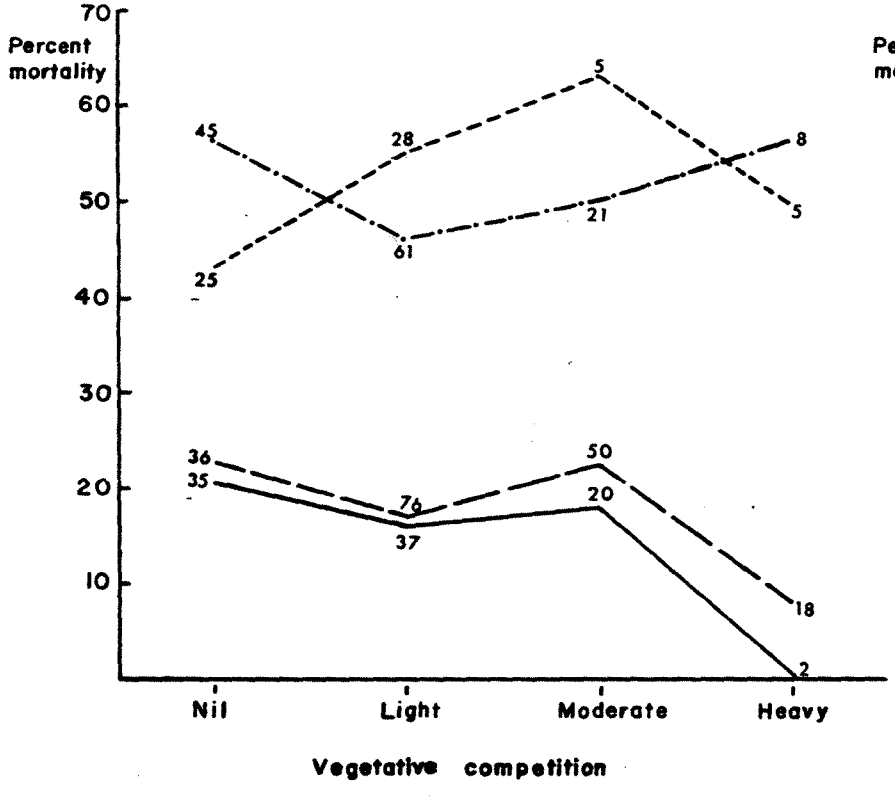
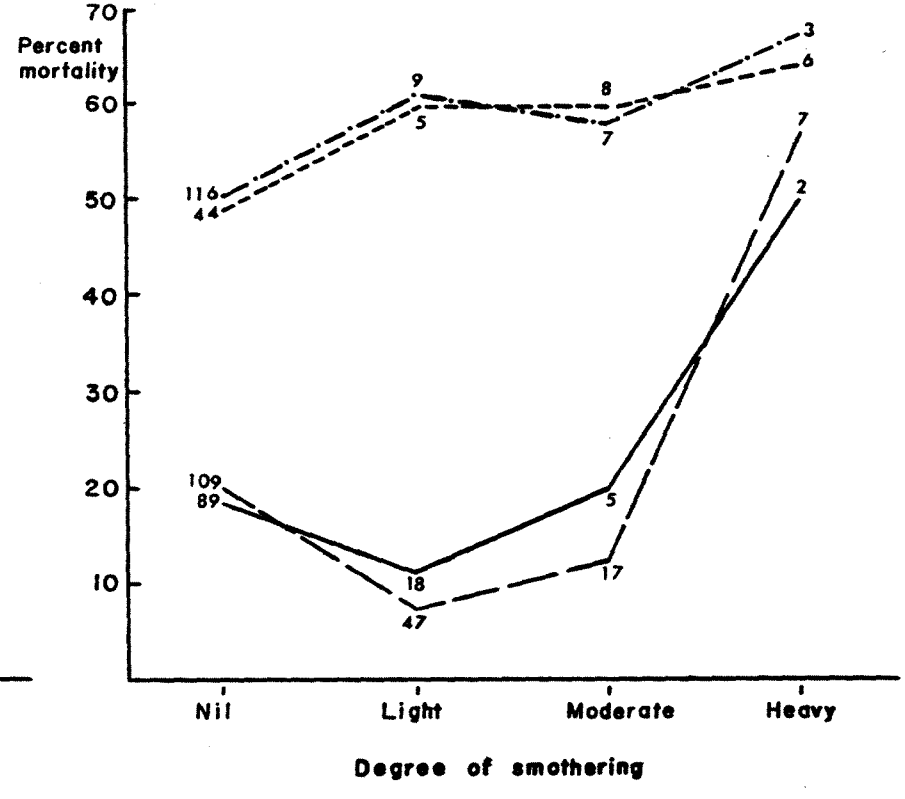


Fig. 15 Mortality of seedlings under young aspen stand affected by aspen leaves — Area 2.



Legend

Lodgepole pine on scarified area — — — — — — —

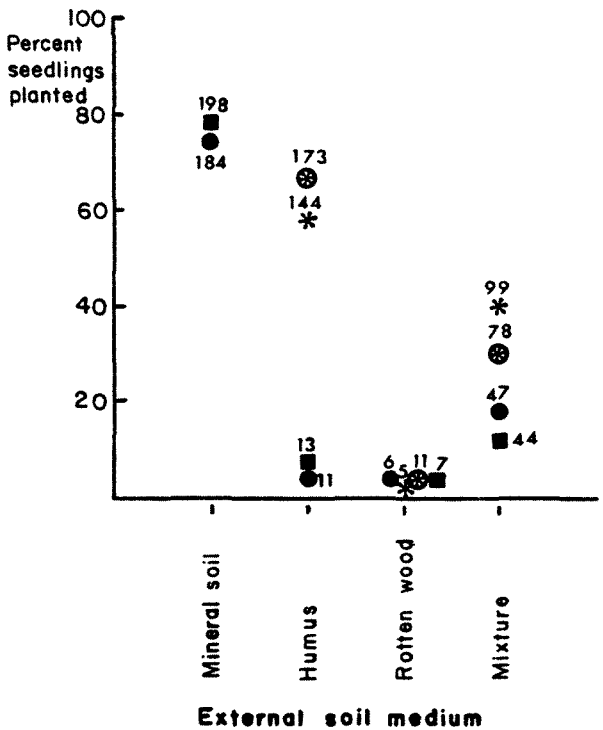
Lodgepole pine on unscarified area —·—·—·—

Spruce on scarified area ————————

Spruce on unscarified area — — — — —

No. of observations 5

Fig. 16 Distribution of lodgepole pine and spruce seedlings planted on unscarified land under young aspen stand — Area 3.



Legend

External soil medium at top of container

Lodgepole pine *

Spruce ⊛

External soil medium at bottom of container

Lodgepole pine ●

Spruce ■

No. of observations 5

and acetate containers (Tables 4 and 5).

The rate of mortality in acetate and phenolformaldehyde containers was lowest in mineral soil on unscarified area for both species (Figures 17 and 18). In new plastic containers the lowest mortality was observed in rotten wood for spruce seedlings while humus and rotten wood resulted in the lowest mortality for lodgepole pine seedlings.

Area 4

Spruce seedlings were planted in mineral soil on scarified areas while humus, mixture and rotten wood were the most common media at the top of the containers on the unscarified area. However, when soil media were checked at the bottom of the containers mineral soil, humus, mixture and rotten wood were found in decreasing order (Fig. 19).

Ninety-six percent mortality was observed in phenolformaldehyde, 64 percent in acetate and only eight percent in new plastic containers. The mortality rate in phenolformaldehyde and new plastic containers was slightly higher on unscarified than on scarified areas. The difference was greater for acetate containers where 70 percent mortality was found on unscarified area opposed to 45 percent on scarified area (Table 6).

The mortality of spruce seedlings in acetate containers was lower in humus than in other media on the unscarified area. The soil media did not affect appreciably the rate of mortality in phenolformaldehyde and new plastic containers (Fig. 20).

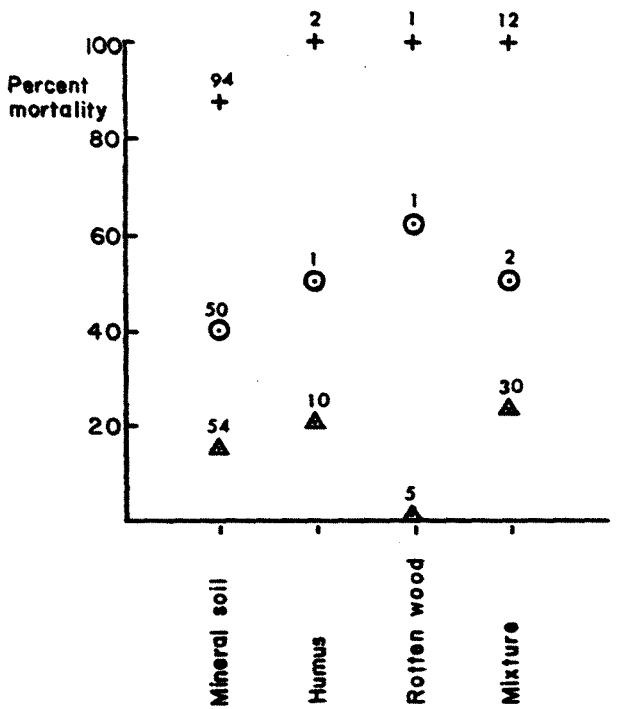
Table 5. Mortality of white spruce seedlings planted under young aspen stand - Area 3.

Type of container	Unscarified soil			Scarified soil			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	
Acetate	54	22	41	45	37	82	60
New plastic	99	17	17	100	35	35	26
Phenolformaldehyde	109	97	89	82	78	95	92

Table 6. Mortality of spruce seedlings under young aspen stand - Area 4.

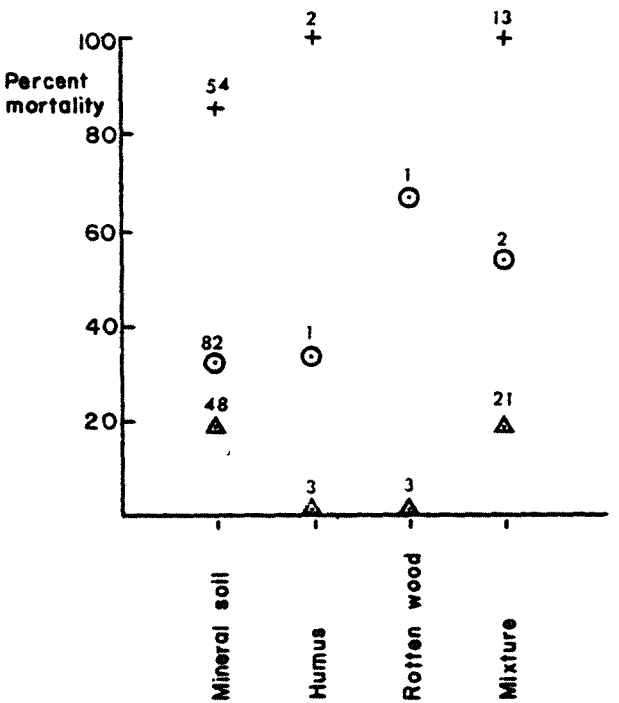
Type of container	Unscarified soil			Scarified soil			Percent mortality for the whole area
	Total no. of containers sampled	No. of containers without live seedlings	Percent mortality	Total no. of containers sampled	No. of containers without live seedlings	Percent mortality	
Acetate	73	51	70	20	9	45	64
New plastic	136	11	8	63	4	6	8
Phenolformaldehyde	114	110	96	36	34	94	96

Fig. 17 Mortality of white spruce seedlings on unscarified land — Area 3.



External soil medium at bottom of container

Fig. 18 Mortality of lodgepole pine seedlings on unscarified land — Area 3.



External soil medium at bottom of container

Legend

Phenolformaldehyde	+
Acetate container	⊙
New plastic container	▲
No. of observations	5

Fig. 19 Distribution of spruce seedlings planted on unscarified land under young aspen stand — Area 4

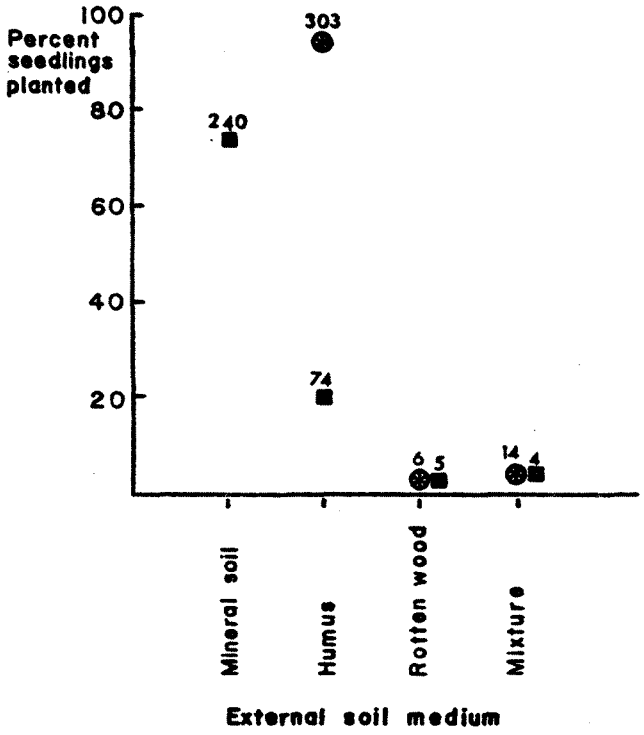
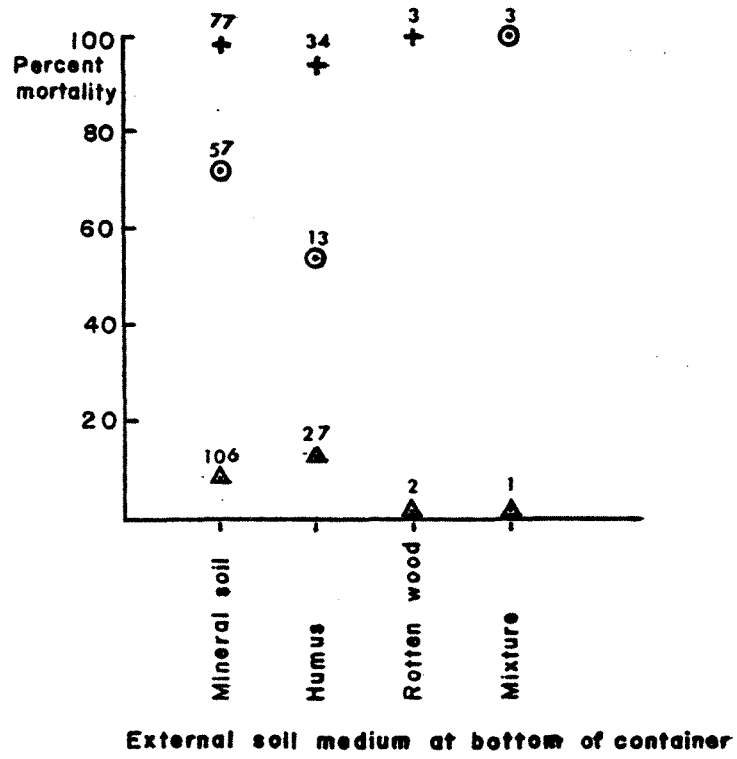


Fig. 20 Mortality of spruce seedlings on unscarified land — Area 4.



Legend

External soil medium at top of container ●

External soil medium at bottom of container ■

No. of observations 5

Legend

Phenolformaldehyde +

Acetate container ⊙

New plastic container ▲

CONCLUSIONS AND RECOMMENDATIONS

Mortality rates were highest in phenolformaldehyde and acetate containers and lowest in new plastic containers for both species. These results support the findings on the mortality of container planting in the Rocky Mountain House area, (Soos 1967).

Generally a higher rate of mortality occurred in phenolformaldehyde and acetate containers for spruce than pine seedlings. Spruce seedlings had lower mortality in new plastic containers than pine seedlings, except on Area 3.

Slightly better survival was obtained for both species and all types of containers on unscarified areas as compared to scarified areas. Remarkable differences were found on Area 3 where mortality of spruce seedlings in acetate containers was 41 percent on unscarified areas and 82 percent on scarified areas. Lodgepole pine seedlings followed the same trend with 36 percent and 60 percent mortality in acetate containers for unscarified and scarified areas, respectively.

Opposite results were observed with acetate containers on Area 4 where spruce seedlings had 70 percent mortality on unscarified area compared to 45 percent on scarified area. The possible reason for higher mortality on the unscarified area is that the thickness of litter and humus exceeded three times the length of the container. The moisture

holding capacity of these media was not as good as mineral soil.

Smothering by aspen leaves increased the mortality of spruce and pine seedlings.

The presence of vegetation was generally beneficial for both species from the standpoint of mortality.

A maximum of 28 percent of lodgepole pine seedlings was completely heaved on the road right-of-way. Less heaving was observed under the protection of young aspen stands. Both species had a higher percentage of complete heaving on scarified areas than on unscarified areas under aspen stands. Eight percent of lodgepole pine seedlings were completely heaved while no spruce seedlings were found completely heaved on the scarified portion of Area 1 Block B. Only seven percent of spruce seedlings were heaved up to 3/4 of the total length of container on the same area. Five percent of lodgepole pine seedlings and four percent of spruce seedlings were completely heaved on the scarified portion of Area 2. These results suggest that heaving could be a problem on cut-over areas where large spots are scarified and planted with containers.

As a result of this study the following recommendations are presented:

1. Further trials of phenolformaldehyde and acetate containers in their present form should be discontinued due to a high rate of early mortality for both lodgepole pine and spruce.

2. Small-scale trial container plantations should be established in cut-over areas using plastic tubelings (open at both ends) to study the survival of seedlings on more exposed areas.

3. Large scale operational container planting should be restricted in this region until further results from pilot scale trials are available on cut-over areas.

4. The low mortality of spruce seedlings on Area 1, Block B, indicates that container planting using plastic containers can be successful under the protection of young aspen stands.

REFERENCES

ANONYMOUS. 1947. Tube planting in Hong Kong. Rep. For. Off. Hong Kong (3). Cited from For. Abst., Vol. 11 No. 2 (1008).

ACKERMAN, R. F. et. al. 1965. Preliminary results of a field test of bullet planting in Alberta. Canada Department of Forestry, For. Res. Br., Publication No. 1098.

DOPPER, A. 1959. Paper cones for forest planting. Allg. Forstztg., 70 (5/6) (61-2) G. Cited from For. Abst., Vol. 20 (4502).

MARRERO, J. 1950. Results of reforestation in the insular forests of Puerto Rico. Carib. For., 11(4) (151-95). Cited from For. Abst., Vol. 13 (176).

MCLEAN, M. M. 1959. Experimental planting of tubed seedlings. Ont. Dept. of Lands and Forests, Tech. Series, Res. Dept., No. 39, 13 pp.

REEDER, S. W. and W. M. ODYNSKY. 1965. Reconnaissance soil survey of the Cherry Point and Hines Creek Area. Alberta Soil Survey. Rep., No. 23.

ROWE, J. S. 1959. Forest regions of Canada, Can. Dept. Northern Affairs and Nat. Res., For. Br., Bull. 123.

SCARAMUZZA, L. C. 1947. The eucalyptus and the reforestation at the sugar mills. Proceedings of the 21st Annual Meeting of the Associación de Tècnicos Azucareros de Cuba, Havana 1957, (115-23). Cited from For. Abst., Vol. 13 (197).

SOOS, J. 1967. First year mortality of container planting in the Clearwater-Rocky Mountain House Forest-Alberta. Canada Department of Forestry and Rural Development, Forestry Branch, Inf. Rep. A-X-7.

SOULERES, G. 1958. Raising forest planting stock in compressed earth pots. Rev. For. Franc., Vol. 10 (12) (807-16). Cited from For. Abst., Vol. 20 (3113).

WALTERS, J. 1961. The planting gun and bullet. A new tree planting technique. For. Chron., Vol. 37:2 (94-95).

WEERARANTINA, W. G. 1958. Studies on artificial propagation of the more important timber trees of Ceylon. Ceylon For., (n.s) 3 (3/4), (293-314). Cited from For. Abst., Vol. 20 (3116).