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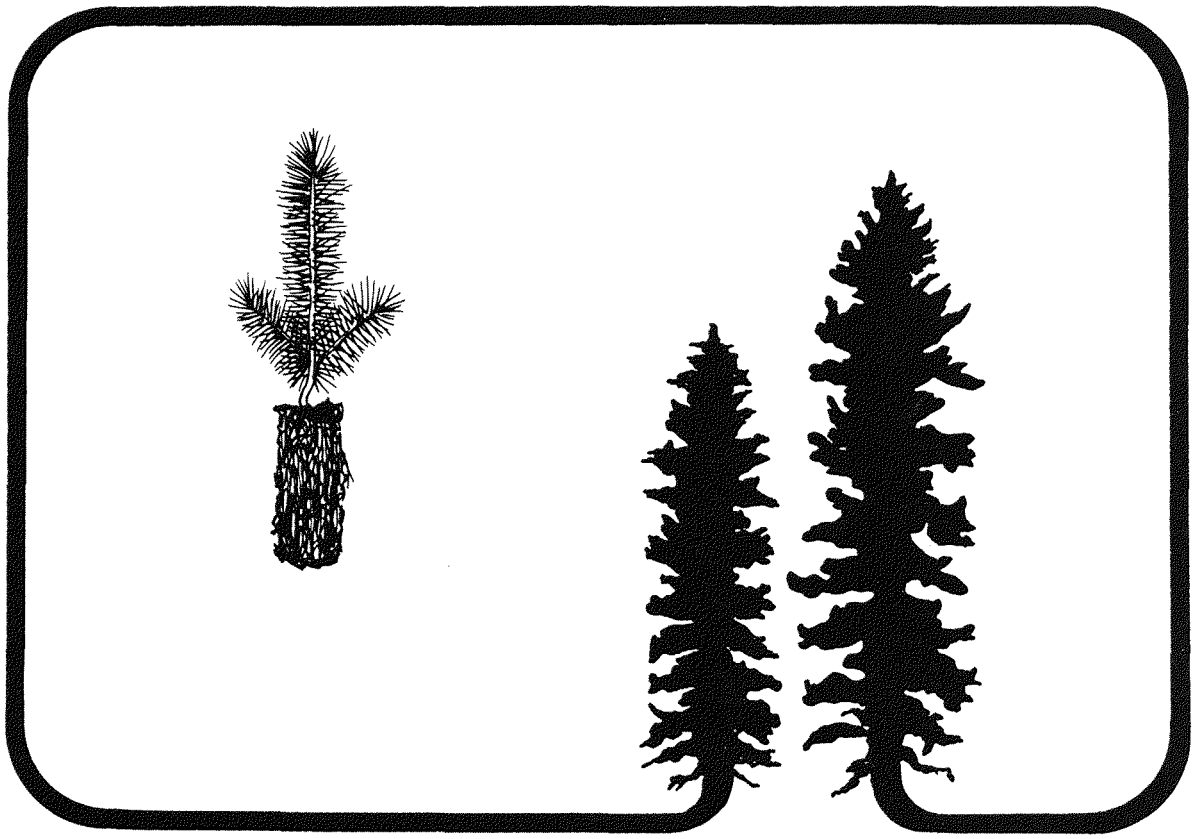

N.R. Walker

Northern Forest Research Centre • Edmonton, Alberta • Information Report NOR-X-207

FIELD PERFORMANCE OF SPENCER-LEMAIRE CONTAINER SEEDLINGS IN WEST-CENTRAL ALBERTA

BY

N.R. WALKER

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ABSTRACT

Since 1971 North Western Pulp and Power has been operationally rearing and planting Spencer-Lemaire container seedlings in the 40-cm^3 plug in west-central Alberta. Sample plots were established on sites planted to lodgepole pine (*Pinus contorta* Dougl. var. *latifolia* Engelm.) and white spruce (*Picea glauca* (Moench) Voss) to assess the field performance of these seedlings. Three years after outplanting, survival was generally acceptable, but growth was slow. A longer greenhouse rearing period is recommended.

RESUME

Depuis 1971, dans le centre-ouest de l'Alberta, la société North Western Pulp and Power produit et plante des semis en potets Spencer-Lemaire, cartouche de 40 cm^3. Au cours des opérations, on a établi des places-échantillons de Pin tordu latifolié (*Pinus contorta* Dougl. var. *latifolia* Engelm.) et d'Epinette blanche (*Picea glauca* (Moench) Voss) pour évaluer le rendement de ces semis. Trois ans après le plantage dehors, la survie s'avérait généralement acceptable mais la croissance demeurait lente. On recommande que la période de production en serre soit plus longue.

CONTENTS

INTRODUCTION

Experimentation with container planting on the North Western Pulp and Power Ltd. (NWPP) lease area at Hinton, Alberta began in 1962. In 1965 the Ontario split plastic tube was adopted and used on an operational scale. However, its small rooting volume and the hard plastic tube that restricted lateral root development limited both survival and growth of the planted seedling. Use of the split plastic tube was discontinued in favor of the Spencer-Lemaire fold-up plug tray in 1971. The volume of this container is 40 cm^3, and the seedling is planted in a plug form that permits free root egress. Present annual production is in excess of 1 million seedlings.

In 1972 NWPP requested the Canadian Forestry Service to monitor survival and growth of outplanted lodgepole pine (*Pinus contorta* Dougl. var. *latifolia* Engelm.) and white spruce (*Picea glauca* (Moench) Voss) seedlings reared in this container. This report gives the results of a small sample of these plantings carried out from 1972 to 1974.

STUDY AREA

The lease area, which consists of 7770 km^2 surrounding the pulp mill at Hinton, is part of the Lower Foothills (B.19a) and Upper Foothills (B.19c) section of the Boreal Forest Region (Rowe 1972). Species composition averages 53% lodgepole pine, 19% white spruce, 8% black spruce (*Picea mariana* (Mill.) B.S.P.), 5% subalpine fir (*Abies lasiocarpa* (Hook.) Nutt.), 9% aspen and poplar (*Populus* spp.) and 6% standing dead trees (MacArthur 1968). Most of the area lies between 918 and 1524 m elevation. The climate is continental, with long, cold winters and short, cool summers. The mean seasonal temperature from May to September ranges from 6°C in the western limits to 10°C in the east; the total seasonal number of days with mean temperatures greater than -2.2°C over this same period varies from 100 in the western portion to 145 in the east (Powell and MacIver 1976). At Entrance, 10 km west of Hinton, the frost-free period is 66 days, at Edson 74 days (Longley 1967). May to September precipitation varies from 380 to 430 mm. October to April snowfall contributes an additional 100-150 mm of moisture.

Since 1956, when cutting began, through 1970, 49 000 ha have been cleared (Anon. 1978). Reforestation practices are designed to favor lodgepole pine and white spruce, the two most common species. Scarification followed by natural seeding from cone-bearing slash or adjacent stands successfully regenerates 68% of the cutovers. A horizontal bar carrying three V blades mounted in front of a caterpillar tractor pulling anchor chains was commonly used in this study. Variations of this technique and equipment are presently employed to accommodate a variety of forest conditions. These scarified areas also provide a seedbed for artificial seeding or planting if a natural seed source is unavailable. Overmature white spruce-alpine fir cutovers have required blading to remove a deep duff layer. Prescribed burning is also used as a means of site preparation for seeding and planting.

METHODS

All seedlings used in the present study were reared and planted by NWPP personnel. The rearing medium is a peat-horticultural vermiculite mixture in the ratio of 2:1, and the usual rearing period is 4 weeks in the greenhouse from the time of seeding, with a 4- to 10-week hardening off period in outdoor cold frames. Seedlings are produced in 14 weekly batches of about 130 000 per week starting in March. The first 3 or 4 seedings in March and April are kept in the greenhouse for 6-8 weeks; the last 2 seedings may be reared for 7-12 weeks before being transferred to the cold frames. Seedlings not planted during the same year in which they are reared due to unfavorable planting weather or lateness of the season are held over the winter and planted the following year (Table 1). Planting was usually done with a mattock, which enables the planter to clear or scalp the planting spot to mineral soil. On bladed, burned, or other areas that do not have a deep duff layer, a Pottiputki planting tool may be used if soil conditions permit.

Permanent sample plots of 100 seedlings each were located on prepared planting sites. Eleven such plots were established in 1972, 7 in 1973, and 15 in 1974. Locations are shown in Fig. 1; plot descriptions are given in Table 2. Each seedling was marked with a wire pin for future identification. Survival and height measurements were made 1, 3, and 5

TABLE 1. Planting times and site preparation

Year of planting - plot number	Species	Age at planting*	Planting date	Year of logging	Year of scarification	Hand scalping
1972 - 1	lP	unknown	unknown	1961	1962	yes
2	lP	unknown	unknown	1961	1962	yes
3	lP	14 wk	Sept. 15	1970	1971	no
4	wS	14 wk	Sept. 15	1970	1971	no
5	wS	14 wk	Sept. 15	1970	1971	no
6	lP	14-16 wk	Aug. 9	1970	1971	no
7	lP	14-16 wk	Aug. 9	1970	1971	no
8	lP	14-16 wk	Aug. 10	1968	1970 (bladed)	no
9	lP	14-16 wk	Aug. 10	1968	1970 (bladed)	no
10	lP	14 wk	Aug. 11	1968	1969 (prescribed burn)	no
11	lP	14 wk	Aug. 11	1968	1969 (prescribed burn)	no
1973 - 1	lP	1 yr	Aug. 10	1972	1972	yes
2	wS	1 yr	July 26	1971	1972	yes
3	lP	14-16 wk	Sept. 10	1966-67	1967	yes
3	wS	1 yr	Sept. 10	1966-67	1967	yes
4	lP,wS	1 yr	Aug. 21	1967	1969 (bladed Jan. 1970)	yes
5	lP	1 yr	July 23	1967-68	1968	yes
6	lP	14-16 wk	Sept. 10	1964-65	1965	yes
6	wS	1 yr	Sept. 10	1964-65	1965	yes
7	lP	14-16 wk	Sept. 20	1966-67	1967	yes
7	wS	1 yr	Sept. 20	1966-67	1967	yes
1974 - 1	lP	1 yr	June 6	1965-66	1966	yes
2	wS	2 yr	June 17	1966-67	1974 (bladed)	yes
3	wS	2 yr	June 17	1966-67	1967	yes
4	wS	2 yr	June 7	1973-74	1974 (bladed)	yes
5	lP	1 yr	July 22	1966-67	1967	yes
6	wS	1 yr	July 26	1973	1973 (bladed)	yes
7	wS	1 yr	July 30	1972	1972	yes
8	lP	1 yr	July 19	1966-67	1967	yes
9	wS	1 yr	July 30	1966-67	1967	yes
10	lP	1 yr	July 16	1972	1973	yes
11	lP	16-20 wk	Aug. 16	1971	1972 (burn)	yes
12	lP	16-20 wk	Aug. 14	1966-67	1967	yes
13	lP	1 yr	July 15	1973		yes
14	lP	1 yr	July 8	1965-66	1974 (rescarified)	yes
15	lP	1 yr	July 10	1966-67	1967	yes

* 4-12 weeks in greenhouse plus cold framing

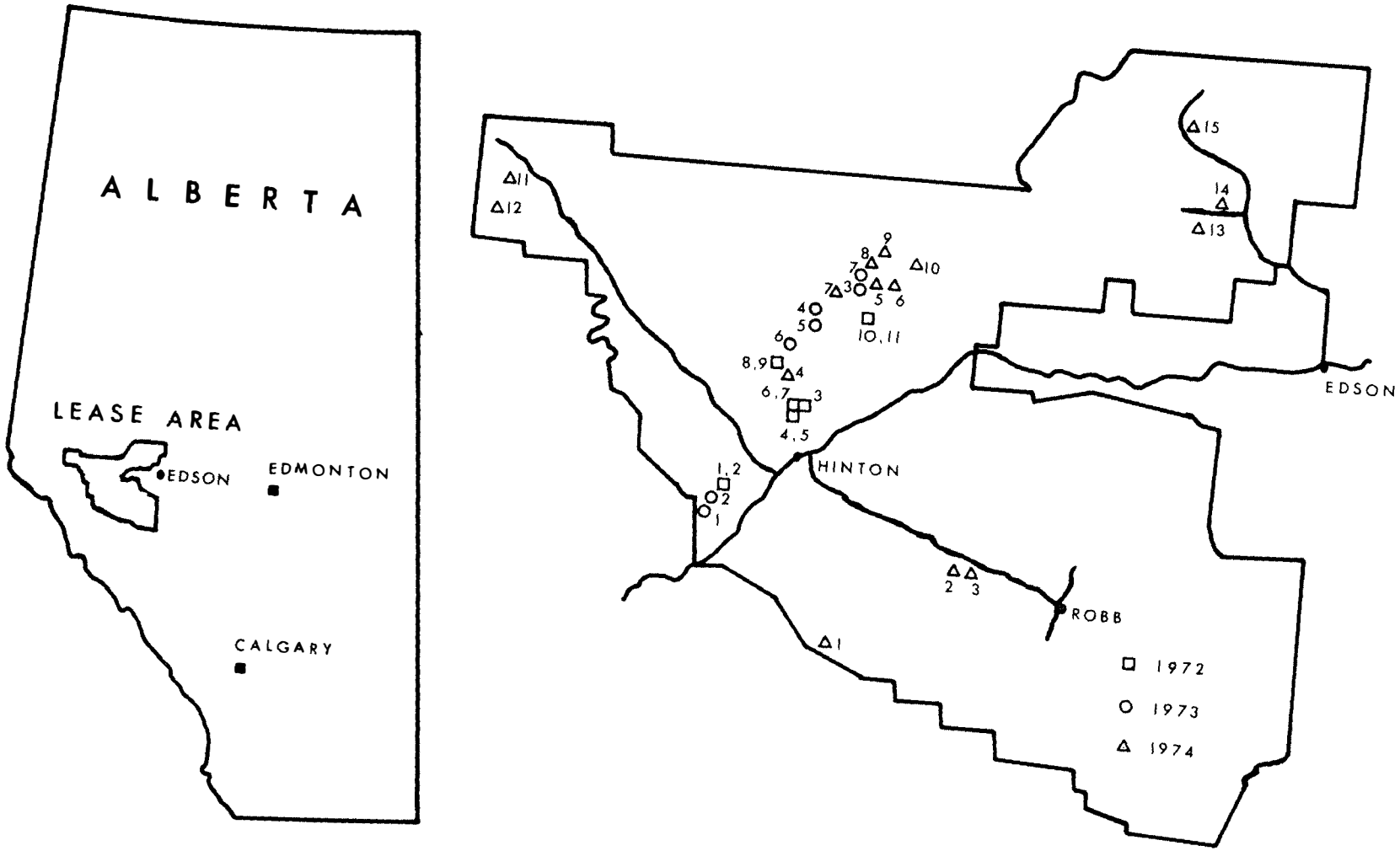

Fig. 1. Plot locations.

TABLE 2. Plot description

Plot number		Species	Depth to mineral soil (cm)	Moisture rating	Competing vegetation	Soil texture*
1972 -	1	lP	8-15	Dry	Heavy grass	Silt loam
	2	lP	8-15	Dry	Heavy grass	Silt loam
	3	lP	8-15	Moist-wet	Heavy grass	Organic over silt loam
	4	wS	15+	Moist-wet	Heavy grass	Organic over silt loam
	5	wS	15+	Moist-wet	Heavy grass and shrub	Organic over silt loam
	6	lP	8-15	Normal	Light grass	Silt loam
	7	lP	8-15	Normal	Medium grass and herb	Silt loam
	8	lP	3- 8	Normal	Light grass and herb	Silt loam
	9	lP	3- 8	Normal	Light grass and herb	Silt loam
	10	lP	8-15	Normal	Light herb	Loam
	11	lP	8-15	Normal	Light herb	Loam to clay loam
1973 -	1	lP	8-15	Dry	Heavy grass	Silt loam
	2	wS	8-15	Dry	Heavy grass	Silt loam
	3	lP,wS	8-15	Normal	Light grass	Loam
	4	lP,wS	8-15	Moist-wet	Light grass	Silt loam
	5	lP	8-15	Normal	Light grass	Loam
	6	lP,wS	8-15	Normal	Light grass	Loam
	7	lP,wS	3- 8	Normal	Light grass	Loam
1974 -	1	lP	3- 8	Normal	Light grass	Loam
	2	wS	3- 8	Normal	Light grass	Silt loam
	3	wS	3- 8	Normal	Medium grass	Silt loam
	4	wS	0-15+	Moist-wet	Light grass	Organic over silt loam
	5	lP	8-15	Normal	Medium grass	Silt loam
	6	wS	0- 3	Normal	Light grass	Silt loam
	7	wS	3-15	Moist-wet	Light grass	Silt loam
	8	lP	3-15	Normal-moist	Heavy grass	Loam
	9	wS	3- 8	Normal	Heavy grass	Silt loam
	10	lP	3- 8	Dry	Light grass	Clay loam
	11	lP	3- 8	Dry	Light grass	Loam
	12	lP	0- 8	Normal	Light grass	Clay loam
	13	lP	8-15	Normal	Heavy grass	Silt loam
	14	lP	3- 8	Normal	Heavy grass	Clay loam
	15	lP	8-15	Moist-wet	Heavy grass	Clay loam to clay

* Upper 15 cm of mineral soil

years after planting. Any damage to seedlings was noted, and cause of mortality, when apparent, was also recorded. Representative seedlings of particular age groups when planted were excavated from the plot surround during each remeasurement to obtain dry weights of roots and shoots.

RESULTS

Survival of the 1972 plantations 5 years after outplanting was 80% or better on 7 of 11 plots (Table 3). Site conditions and flooding were responsible for the poor survival on plots 1-4. Plots 1 and 2 are located on a dry site with heavy grass competition. Plots 3 and 4 are on a moist to wet site and have heavy grass competition, localized flooding also has occurred. Lodgepole pine seedlings on plots 6 and 7 showed good growth to the fifth year; these two plots have produced the best mean heights. Similar growth probably would have occurred on plots 10 and 11, but winter drying during 1976-77 resulted in extensive leader dieback; 63 and 42% of the seedlings on the respective plots were affected.

Heaving of 0.5 cm or more was extensive on a number of plots 1 year after planting. This could have contributed to the mortality rate, particularly on plots 1 and 2.

Survival on plots 1 and 2 of the 1973 plantations to the third year was only 17 and 50% respectively (Table 4). A dry site with heavy grass competition was responsible for most of the mortality. Good to excellent survival occurred on the remainder of the 1973 plots; survival was over 80% on all plots, except 65% for the white spruce on plot number 6. Eight percent of the white spruce plugs on plot 3 were heaved. Heaving on other plots ranged from 0 to 4%.

Third year survival of the 1974 plantings ranged from 62 to 93% (Table 5). On plots 3, 5, 7, and 8, 47% of the combined first-year mortality was attributed to the deep duff layer. Heaving during the first year was high on three plots: 11, 17, and 18% on plots 12, 7, and 2 respectively. Plots 13 and 14 produced the best growth for lodgepole pine over the 3 years of planting. Average heights at the end of the third growing season were 34.2 and 29.6 cm respectively.

There was a marked increase in the total dry weight of the lodgepole pine seedlings between the third and fifth growing season of the 1972 plantings (Table 6). The percentage increase, however, was not always greater than the percentage increase between the first and third year. Plots 10, 13, and 14 of the 1974 planting, which produced the best growth, have also produced the best seedling weights.

Survival and average heights of all plots for the three years of planting are stratified in Figs. 2-5 and 6-9, respectively, by age of seedling, month of planting, grass competition, and moisture rating. Although the number of plots is too few for valid statistical analyses, some trends are apparent. Increasing age of the seedling resulted in increased survival for spruce but not for pine. The month of planting appeared to have no particular effect on spruce survival; pine survival showed only a slight decline between July, August, and September. Increasing grass competition resulted in decreasing survival, and the driest sites also showed the poorest survival.

The varying greenhouse rearing period and the unknown differences of stock size when planted have confounded any growth trends. One-year-old lodgepole pine outperformed the other age categories, but the 14-week-old white spruce did as well as the 2-year-old stock. The earliest plantings, with the exception of the single lodgepole pine plot planted in June, resulted in better mean heights than the later plantings. Lodgepole pine with the heaviest grass competition had a better mean height than in the nil to medium categories; white spruce with light competition had a better mean height than the medium to heavy categories. Lodgepole pine performed best on the dry and normal sites, while white spruce had the best mean height on the moist to wet site.

DISCUSSION

Overall third year survival was 80% or better for 68% of the plots, but the increase in average plantation height between the first and third year, whether pine or spruce, was only 2-3 cm on a number of plots. Therefore, an initial greenhouse rearing period of 10 weeks or more for all seedlings is strongly recommended, because it will produce larger

TABLE 3. Performance 1, 3 and 5 years after the 1972 planting

Plot number	Species	Age at planting	Number of seedlings	Percent survival 1 yr	3 yr	5 yr	Average height (cm) 1 yr	3 yr	5 yr	Percent heaved** 1 yr	3 yr	5 yr
1972- 1	lP	unknown	100	63	47	32	6.9	9.0	13.2(4.8)*	30	0	0
1972- 2	lP	unknown	100	65	39	34	7.3	10.1	15.2(6.0)	9	0	0
1972- 3	lP	14 wk	91	58	53	26	7.0	11.8	12.7(3.8)	6	5	0
1972- 4	wS	14 wk	100	72	61	57	8.2	14.8	23.7(7.5)	21	7	2
1972- 5	wS	14 wk	97	86	84	84	8.0	15.2	23.5(6.7)	6	0	0
1972- 6	lP	14-16 wk	99	93	90	88	8.0	21.3	49.2(17.2)	2	0	0
1972- 7	lP	14-16 wk	100	90	89	88	6.6	16.6	35.2(12.3)	4	1	1
1972- 8	lP	14-16 wk	101	99	94	93	8.0	13.4	28.5(9.6)	6	4	3
1972- 9	lP	14-16 wk	100	97	92	91	7.8	14.1	29.4(12.4)	7	3	3
1972-10	lP	14 wk	98	95	95	95	7.4	16.3	25.2(11.1)	2	0	0
1972-11	lP	14 wk	97	97	95	95	8.0	16.8	29.1(12.8)	2	1	1

* Standard deviation

** 0.5 cm or more at 1 yr
1.5 cm or more at 3 yr and 5 yr (based on 1 and 3 yr survival)

TABLE 4. Performance 1 and 3 years after the 1973 planting

Plot number	Species	Age at planting	Number of seedlings	Percent survival 1 yr	3 yr	Average height (cm) 1 yr	3 yr	Percent heaved** 1 yr	3 yr
1973- 1	lP	1 yr	93	73	17	6.4	7.6(4.2)*	0	0
1973- 2	wS	1 yr	99	84	50	7.5	13.2(5.8)	0	0
1973- 3	lP	14-16 wk	51	96	96	9.3	14.4(3.7)	0	2
- 3	wS	1 yr	51	100	92	9.4	11.8(3.4)	4	8
1973- 4	lP	1 yr	51	96	84	11.5	15.9(3.7)	0	0
- 4	wS	1 yr	52	94	86	10.0	12.8(3.3)	4	4
1973- 5	lP	1 yr	107	98	96	10.4	16.1(5.6)	2	2
1973- 6	lP	14-16 wk	53	94	89	9.2	14.0(4.2)	0	0
- 6	wS	1 yr	49	78	65	7.2	10.0(3.6)	0	2
1973- 7	lP	14-16 wk	51	100	92	9.5	15.6(5.0)	0	2
- 7	wS	1 yr	50	100	98	7.9	10.0(2.6)	0	0

* Standard deviation

** 0.5 cm or more at 1 yr
1.5 cm or more at 3 yr (based on 1 yr survival)

TABLE 5. Performance 1 and 3 years after the 1974 planting

Plot number	Species	Age at planting	Number of seedlings	Percent survival 1 yr	Percent survival 3 yr	Average height (cm) 1 yr	Average height (cm) 3 yr	Percent heaved** 1 yr	Percent heaved** 3 yr
1974- 1	lP	1 yr	102	83	62	7.0	8.2(3.4)*	3	0
1974- 2	wS	2 yr	101	86	81	8.2	13.4(5.6)	18	4
1974- 3	wS	2 yr	98	85	75	8.7	12.2(5.0)	2	0
1974- 4	wS	2 yr	100	99	92	10.5	19.2(7.2)	5	2
1974- 5	lP	1 yr	104	80	76	6.1	10.4(4.1)	0	0
1975- 6	wS	1 yr	101	92	90	8.2	20.1(6.5)	6	0
1974- 7	wS	1 yr	101	79	74	7.5	13.2(5.0)	17	3
1974- 8	lP	1 yr	99	87	82	8.2	13.2(6.0)	0	0
1974- 9	wS	1 yr	99	93	90	8.5	11.4(3.2)	2	0
1974-10	lP	1 yr	100	93	91	8.7	26.4(9.2)	1	0
1974-11	lP	16-20 wk	100	94	79	8.1	14.2(6.5)	2	2
1974-12	lP	16-20 wk	100	94	88	8.1	14.6(5.1)	11	5
1974-13	lP	1 yr	100	97	93	10.1	34.2(11.8)	0	1
1974-14	lP	1 yr	96	95	92	9.1	29.6(11.2)	0	0
1974-15	lP	1 yr	99	93	83	8.2	15.5(6.5)	0	0

* Standard deviation

** 0.5 cm or more at 1 yr

1.5 cm or more at 3 yr (based on 1 yr survival)

TABLE 6. Average ovendry weights of 1972-1974 planting

Plot number	Species	Age at planting	Average total seedling wt (g) 1 yr	3 yr	% increment	5 yr	% increment
1972 Planting							
1972- 4,5	wS	14 wk	0.597	3.126	424	6.255	100
1972- 6,7	lP	14-16 wk	1.080	7.263	572	37.048	410
1972- 8,9	lP	14-16 wk	0.928	4.933	432	32.116	551
1972-10,11	lP	14 wk	1.039	4.562	339	32.127	604
1973 Planting							
1973- 2	wS	1 yr	0.880	2.782	216		
1973- 3	lP	14-16 wk	0.674	1.030	53		
1973- 4	lP	1 yr	1.020	3.046	199		
- 4	wS	1 yr	0.580	2.164	273		
1973- 5	lP	1 yr	2.230	5.974	168		
1973- 7	lP	14-16 wk	1.097	2.210	101		
- 7	wS	1 yr	0.427	1.577	269		
1974 Planting							
1974- 1	lP	1 yr	0.708	1.404	98		
1974- 2,3	wS	2 yr	1.405	3.511	150		
1974- 4	wS	2 yr	2.380	9.036	280		
1974- 5,8	lP	1 yr	0.784	2.001	155		
1974- 6	wS	1 yr	0.807	6.932	759		
1974- 7,9	wS	1 yr	0.807	2.748	240		
1974-10	lP	1 yr	0.784	19.158	2344		
1974-11,12	lP	16-20 wk	0.904	4.818	433		
1974-13,14	lP	1 yr	1.425	13.970	880		
1974-15	lP	1 yr	1.425	1.530	7		

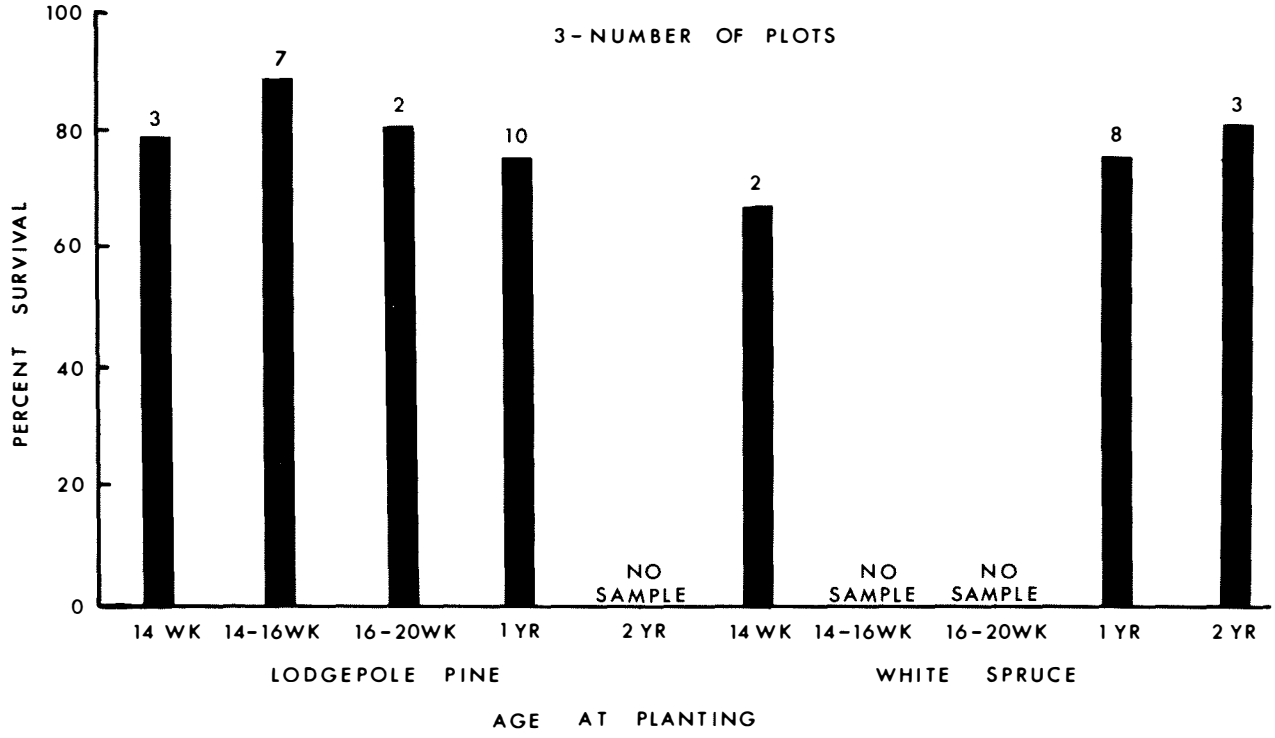

Fig. 2. Third-year survival by age of seedling.

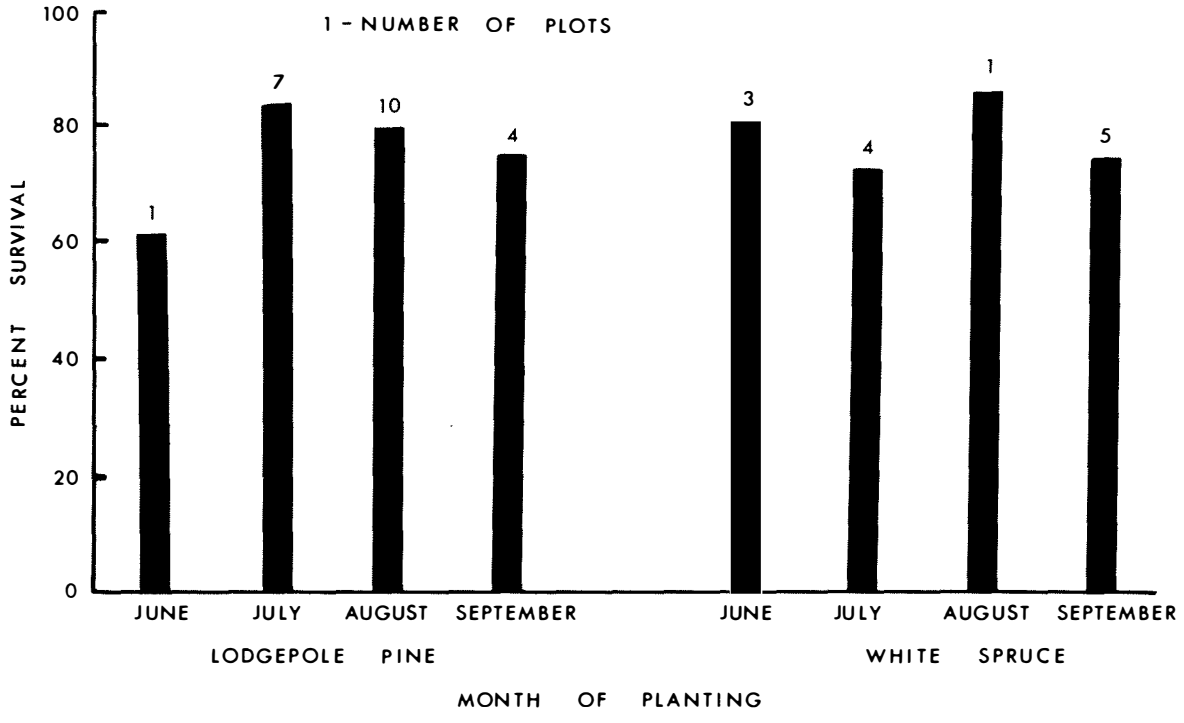

Fig. 3. Third-year survival by month of planting.

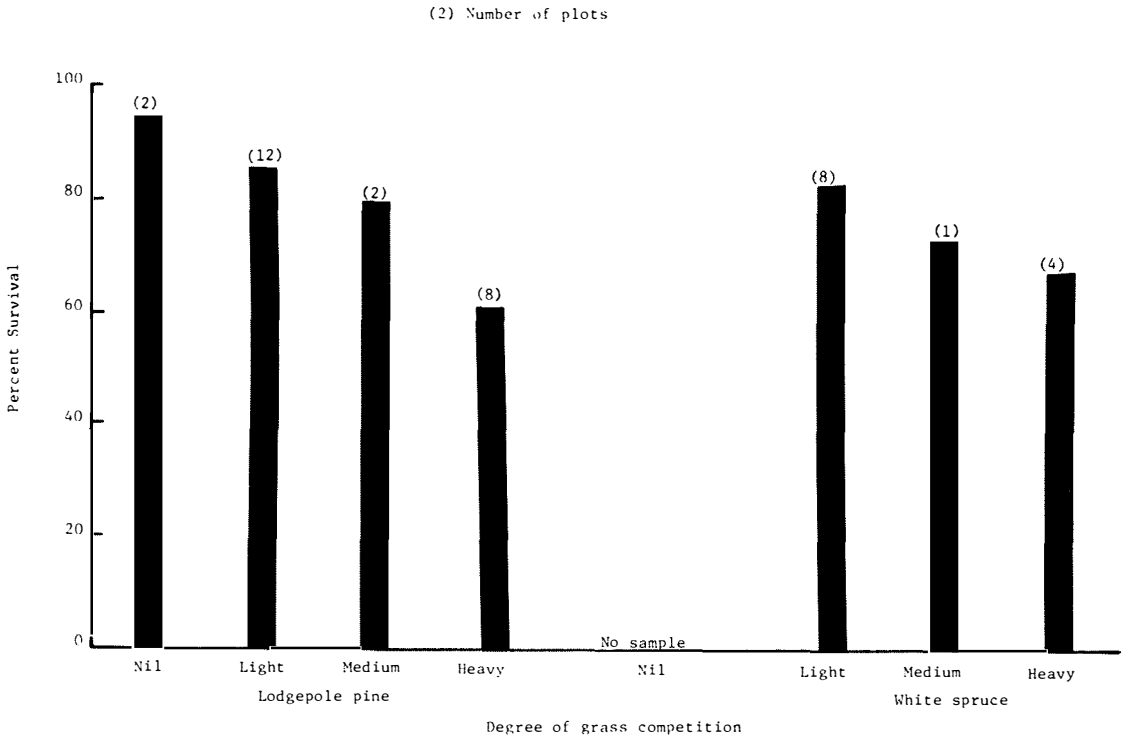

Fig. 4. Third-year survival by degree of grass competition.

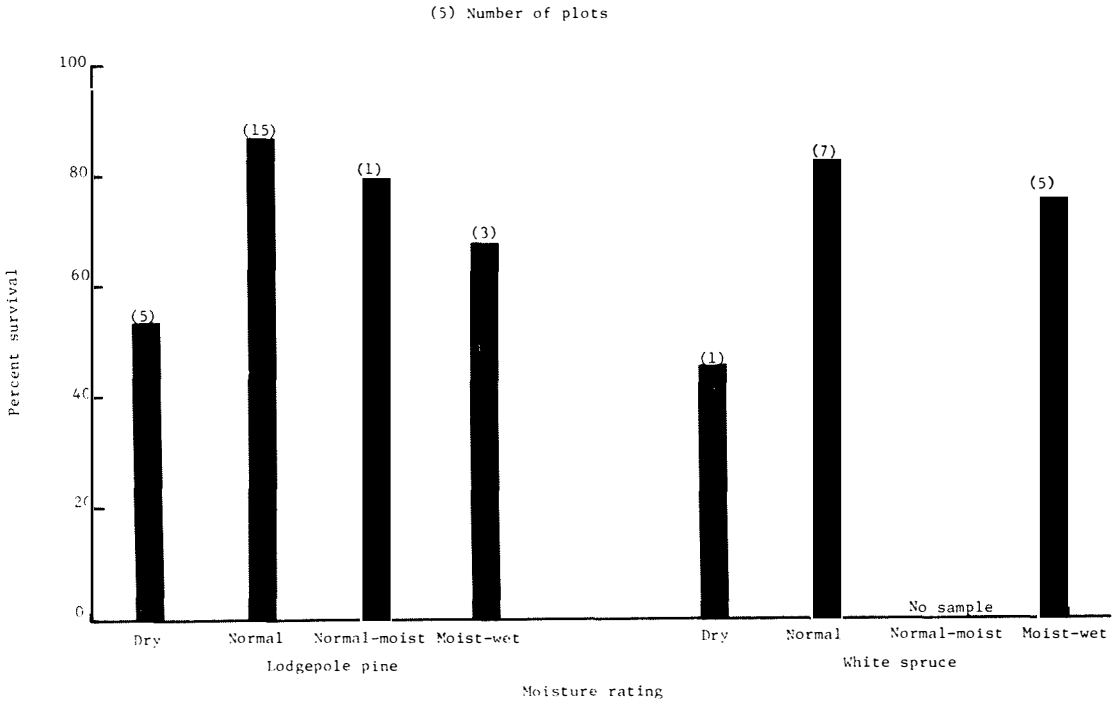

Fig. 5. Third-year survival by moisture rating.

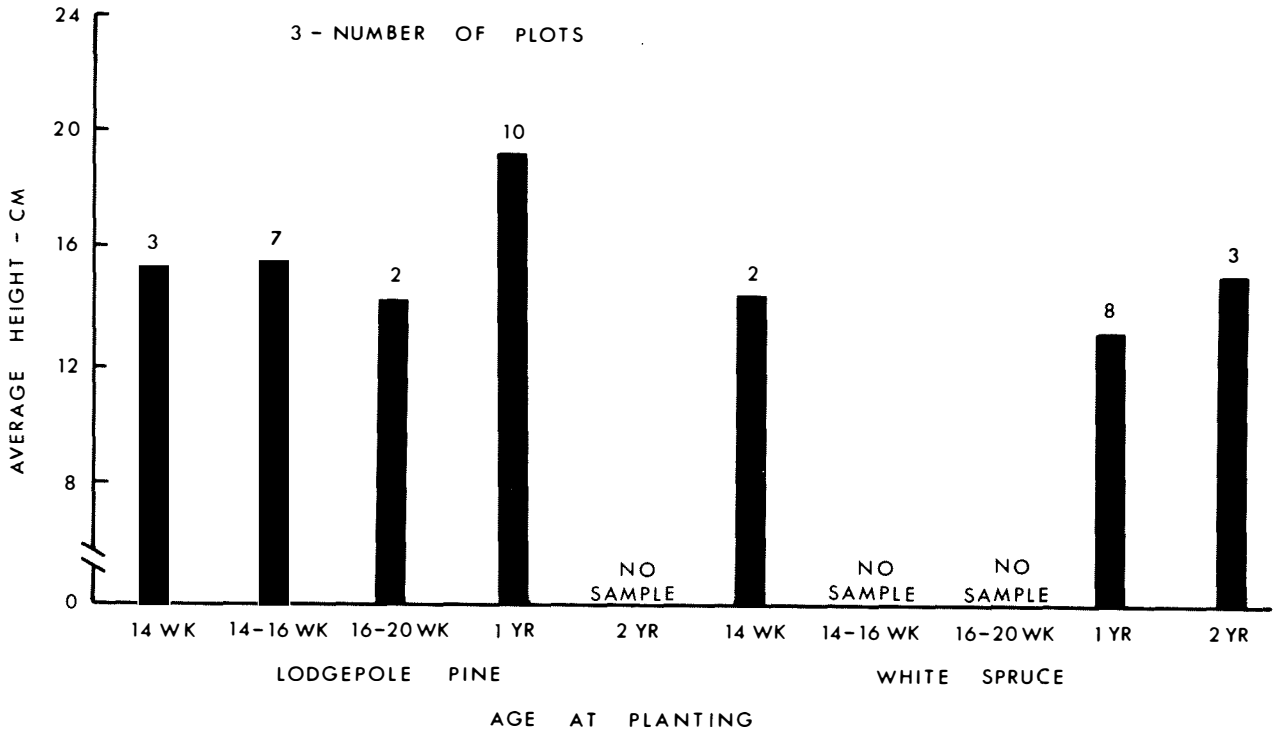

Fig. 6. Third-year height by age of seedling.

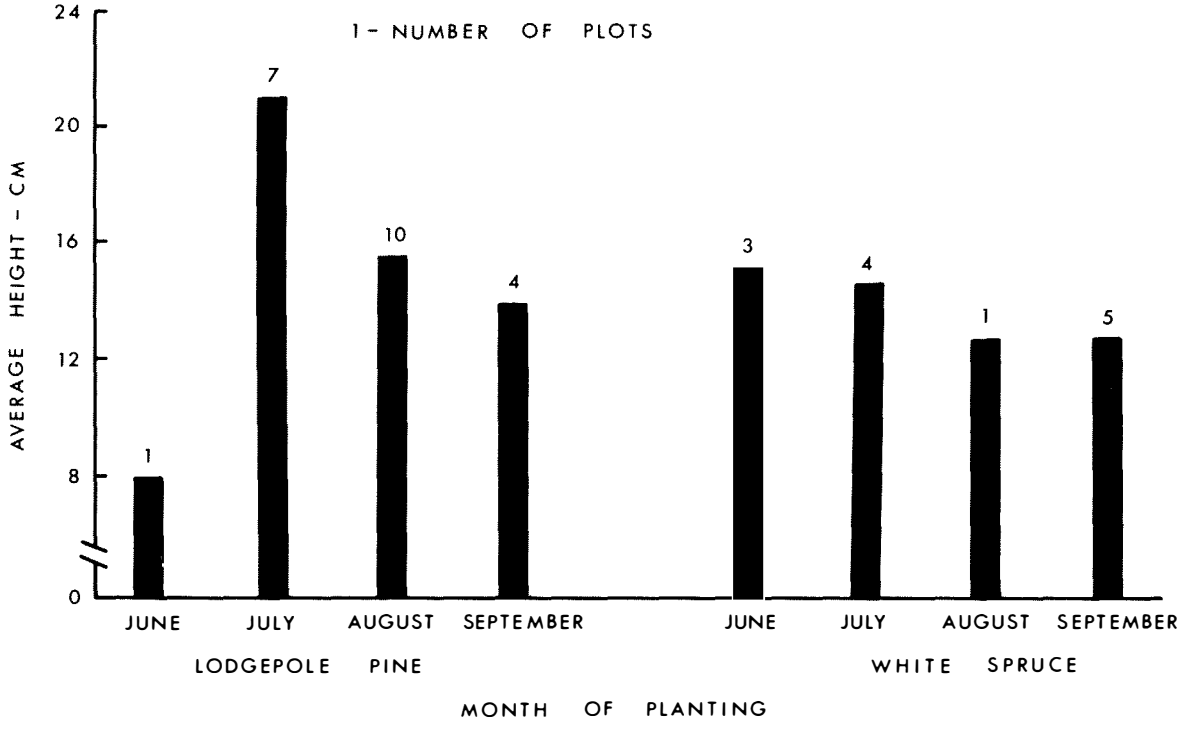

Fig. 7. Third-year height by month of planting.

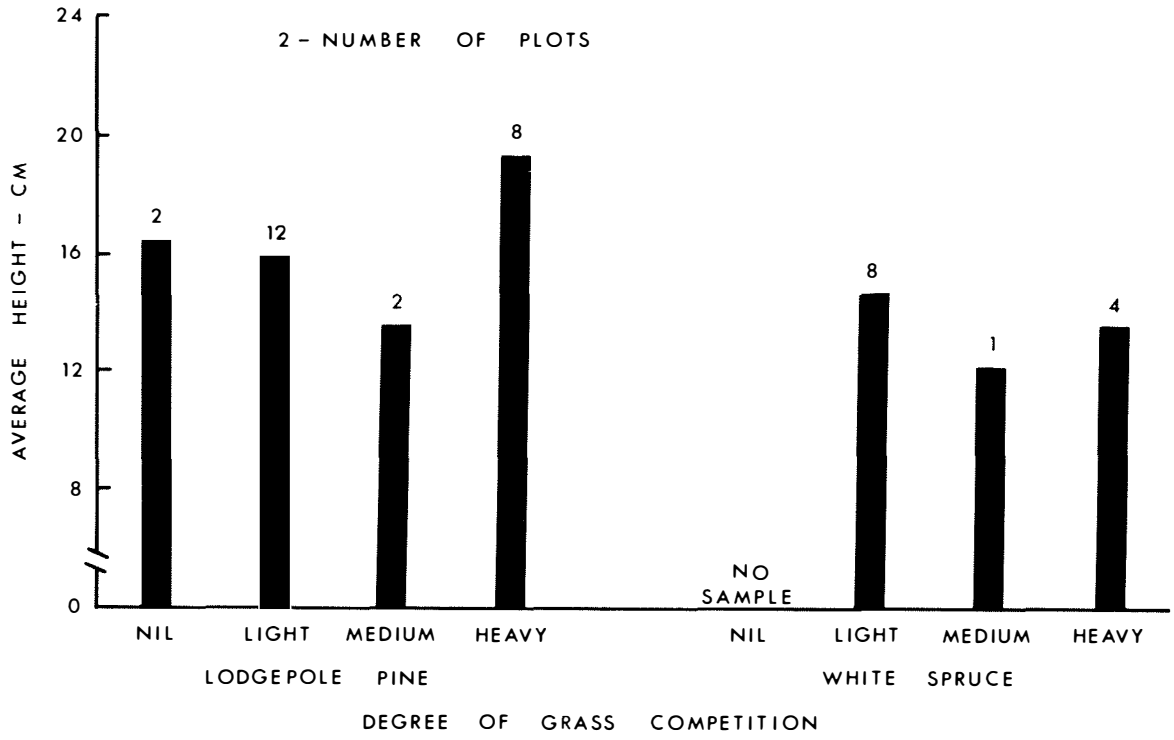

Fig. 8. Third-year height by degree of grass competition.

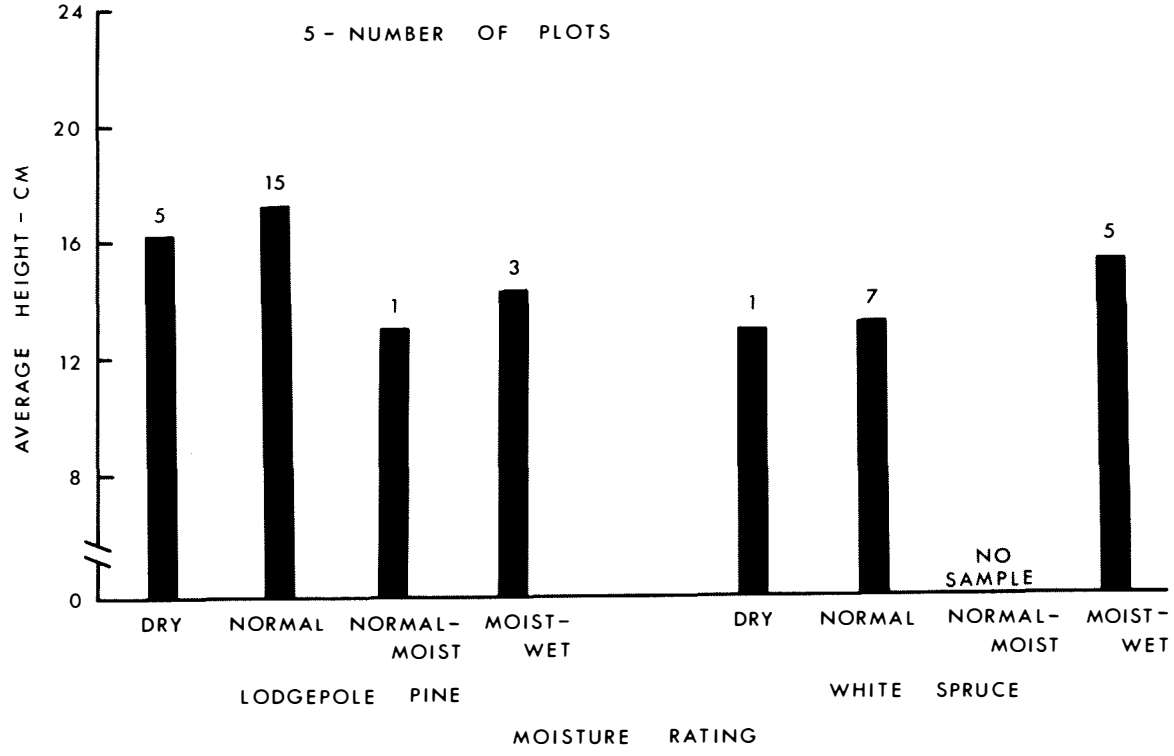

Fig. 9. Third-year height by moisture rating.

and sturdier planting stock with better field performance (Walker and Johnson 1974, Johnson and Walker 1976).

It is suspected that the majority of those plugs rated as frost heaved were actually planted with a portion of the plug exposed. In any event, heaving could be minimized by setting the plug top approximately 1 cm below the ground surface and then pressing a small amount of soil over the top to level it with the surrounding surface.

Numerous plugs were encountered that contained more than one seedling, usually two. The resulting competition is detrimental; one healthy seedling per plug would result in better overall performance.

In using a mattock the planter tends to excavate a hole on a slant rather than perpendicularly. The entire plug is then closer to the ground surface and more susceptible to drought than it would be if it were planted straight downward. Some mortality was recorded where the plug had been planted obliquely and entirely within the duff layer, yet contact could have been made with mineral soil had the plug been set straight downward. This method of planting also encourages the development of roots oriented to one side of the seedling (Figs. 10-11). With some concern now being expressed about root deformity caused by containers (Bergman and Haggstrom 1976, Carlson and Nairn 1977) this method of planting could in future cause some problems.

It is not suggested that a mattock is a poor planting tool. It is possibly the easiest means a planter has to clear away the debris or duff layer to create a favorable habitat. More time and care should, however, be spent in hand scalping to ensure that the mineral soil is reached, and planting at extreme angles should be avoided. Mortality attributed to competition occurred chiefly due to inadequate scalping. In most instances hand scalping was only the width of the mattock blade, which is the barest minimum required to plant the seedling. This allowed competing vegetation to quickly overtop the seedling.

In 1976 NWPP began using the Bräcke scarifier as a means of site preparation prior to planting. This scarifier clears a scalped spot somewhat less than 30 x 30 cm at a controlled depth and spacing. The scalped spots appear to be optimum for planting and should provide the necessary control of the competing vegetation for 1-2 years following planting. Use of this scarifier has freed the planter from the difficult and time-consuming job of hand scalping and also permits increased use of dibbles and the Pottiputki for faster and easier planting.

REFERENCES

Anon. 1978. Brief to the Environment Council of Alberta on the environmental effects of forestry operations in Alberta. North Western Pulp & Power Ltd., Hinton, Alberta.

Bergman, T. and B. Haggstrom. 1976. Some important facts concerning planting with rooted forest plants (Trans. by R.A. Hellenius). For. Chron. 52:266-273.

Carlson, L.W. and L.D. Nairn. 1977. Root deformities in some container-grown jack pine in southeastern Manitoba. For. Chron. 53:147-149.

Johnson, H.J. and N.R. Walker. 1976. Five-year field performance of pine and spruce styroplugs in Alberta. For. Chron. 52:197-198.

Longley, R.W. 1967. The frost-free period in Alberta. Can. J. Plant Sci. 47:239-249.

MacArthur, J.D. 1968. North Western: Pioneer and pace-setter in forest management. Pulp and Pap. Mag. Can. 69(16):36-43.

Powell, J.M. and D.C. MacIver. 1976. Summer climate of the Hinton-Edson area, west-central Alberta, 1961-1970. Environ. Can., Can. For. Serv., North. For. Res. Cent. Inf. Rep. NOR-X-149. 43 p.

Rowe, J.S. 1972. Forest regions of Canada. Environ. Can., Can. For. Serv., Publ. No. 1300. 172 pp.

Walker, N.R. and H.J. Johnson. 1974. Field performance of pine and spruce reared in the BC/CFS styroblock—Alberta. Environ. Can., Can. For. Serv., North. For. Res. Cent. Inf. Rep. NOR-X-84. 12 p.

Fig. 10. Lodgepole pine (left) and white spruce (right) 3 yr after outplanting. There are two seedlings in the white spruce plug.

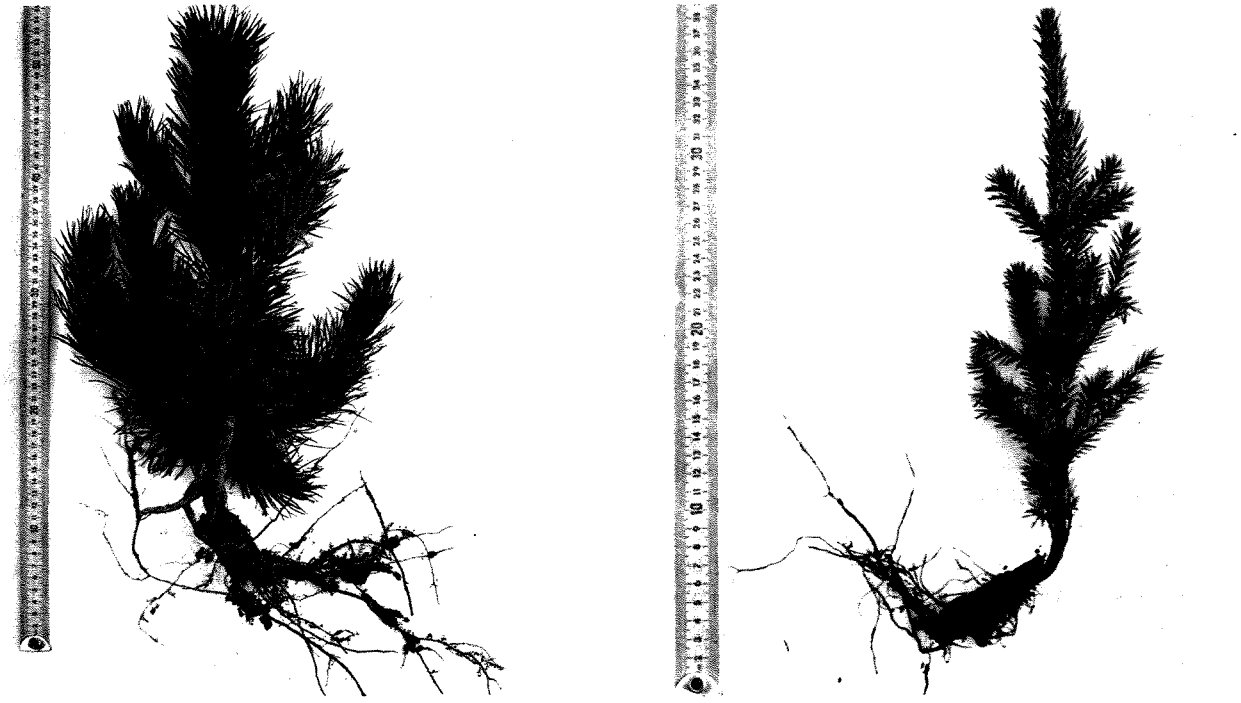

Fig. 11. Lodgepole pine (left) and white spruce (right) seedlings 5 yr after outplanting.