PRODUCTION, USE, AND FIELD PERFORMANCE OF CONTAINER SEEDLINGS IN THE PRAIRIE PROVINCES

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Abstract.--Data on the production, use, and field performance of container seedlings in the prairie provinces are presented. About 10% of the area harvested is planted to container stock, 70% of which is white spruce *(Picea glauca* [Moench] Voss). Refinements in container use await application of effective operational performance assessment procedures.

Résumé.--Un exposé est présenté sur la production, l'utilisation et le comportement sur le terrain de semis en récipients dans les provinces des Prairies. la superficie cultivée comporte environ 10% de semis en récipients, dont 70% sont des semis d'épinette blanche *(Picea glauca* [Moench] Voss). On attend l'application de méthodes efficaces d'évaluation des opérations avant de raffiner l'utilisation des récipients.

INTRODUCTION

The ultimate test of any regeneration method or material lies in the field performance of the new forest crop. In the case of container stock in the prairie provinces (Alberta, Saskatchewan and Manitoba), there are few available operational results from which to draw performance conclusions. However, there are some research results that can be interpreted and applied to illustrate container performance potential.

This report presents a region-wide view of the production, use, and field performance of container stock in terms of the three primary commercial tree species: white spruce *(Picea glauca* [Moench] Voss), lodgepole pine *(Pinus contorta* Dougl.), and jack pine *(Pinus banksiana Lamb.).*

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OVERVIEW OF REGIONAL REFORESTATION

From 1975 to 1979 the estimated total area harvested in the three prairie provinces was 281,000 ha (Table 1), of which 7% were seeded, 9% were planted to containers, 11% were planted to conventional stock, 32% were scarified for natural regeneration, and 41% were untreated.[2]

CONTAINER PRODUCTION AND USE 1975-1979

The container stock sizes that are produced vary according to species, container size, and greenhouse rearing times (Table 2). Seedling production doubled from 12.3 million in 1975 to 23.6 million in 1979. On the average, 46.4% of the stock produced during this period was grown in containers. In 1980, total planting stock production was 36.5 million seedlings, or three times 1975

[2]Data aggregated from provincial estimates.

Table 1. Reforestation activities in the prairie provinces 1975-1979a.

Year	Total seedling production (000,000)	Area planted[b]	Area seeded	Area scarified for natural regeneration	Area harvested[c]
		(000 ha)			
1975	12.3	8.2	1.9	20.4	55.5
1976	15.2	10.1	3.1	13.7	48.4
1977	14.7	9.8	5.0	13.6	54.2
1978	17.8	11.9	4.8	17.3	60.1
1979	23.6	15.8	5.5	23.9	63.2
Totals	83.6	55.8	20.3	88.9	281.4

[a]Data aggregated from provincial estimates.

[b]Based on 1500 stems·ha^{-1}. An average of 72% of the planted area in the period 1975-1979 was given some kind of site preparation.

[c]Total for areas planted, seeded, naturally regenerated, and left untreated does not add up to total harvest area. For example, area planted included both burn and backlog areas.

Table 2. Types of container stock commonly used in the prairie provinces.

Species	Container[a] type	Container[a] cross-sectional area (cm^2)	Container[a] volume (cm^3)	Greenhouse rearing time[a] (wk)
White spruce Lodgepole pine	Spencer-Lemaire (Ferdinand)	3.6	40	4 - 15
White spruce Jack pine	Paperpot (FH 308)	5.6	44	12 - 15
White spruce Jack pine	Paperpot (FH 315)	5.6	88	12 - 15
White spruce Jack pine	Paperpot (FH 408)	9.8	70	12 - 15

[a]Larger sizes and longer greenhouse rearing would increase establishment costs but should also improve growth performance in the field.

production. Container production for 1980 consisted of 62% white spruce, 25% lodgepole pine, 12% jack pine and 1% black spruce, and in 1981 comprised just over 50% of the total seedling production.

Trends in regional container use during the period 1975-1979 can be inferred from production data shown in Figure 1. In general, the proportion of container stock produced was stable at 42-44% of total seedling production from 1976 to 1979; actual amounts began to increase considerably after 1977.

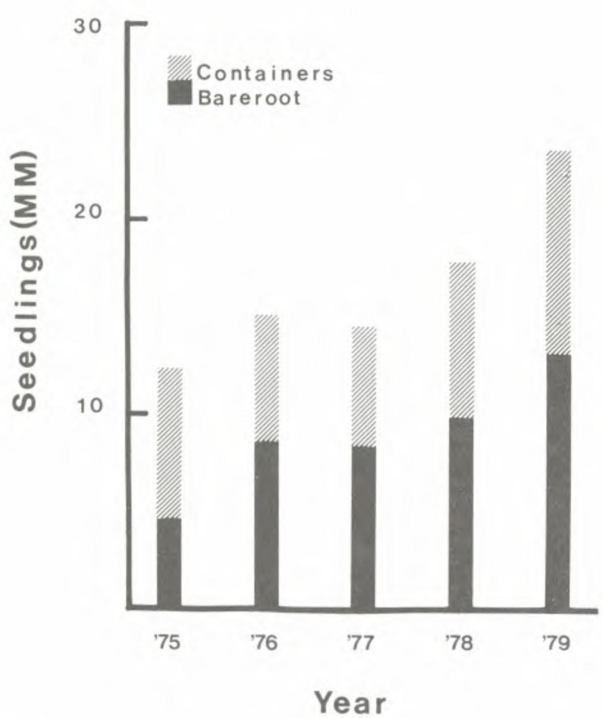


Figure 1. Trends in regional container use.

There appears to be a trend toward decreased container use for the pines and increased use for white spruce. The primary reasons for the relative decrease for pines are the suitability of lodgepole and jack pine for natural regeneration, usually following scarification, and the susceptibility of container-grown pine to root deformity and to winter storage damage in prairie nurseries and industrial storage sites.

On the other hand, the demand for container-grown spruce is likely to increase as forest management intensifies, and as refinements are made in silvicultural prescriptions to match stock size to site.

At present, container production tends to be limited to relatively small stock sizes (less than 1 g dry weight) with planting usually confined to sites with little vegetative competition; bare-root stock is usually preferred for more severe conditions of competition.

OPERATIONAL ADVANTAGES AND DISADVANTAGES OF CONTAINER STOCK

The characteristics and related advantages and disadvantages of container stock are summarized in Table 3. The information is based on the experience of the authors and comments from provincial and industrial foresters in the region.

Among the primary advantages of the use of container stock are flexibility in planning stock requirements and production timing. For example, container use eliminates the 2- to 3-year lead time for stock requirements and circumvents problems of lifting bare-root stock in the spring when ground may be frozen in bed centres and stock on bed edges begins to flush. Containers also provide good root protection in all phases of production, transportation, and planting. Greater planting productivity, improved planting quality, suitability for mechanization, and extended planting seasons are other reasons for container use.

Major disadvantages include conditioning and overwintering problems (especially with pine), root and top crowding if planting is delayed, extra space requirements for storage and shipping, and added distribution problems at the planting site. Problems with permanent root deformity and subsequent toppling with pines are minimized by planting grooved root plugs without the container and coordinating cavity size with rearing time to avoid severe root-bound situations. The high cost of producing large stock has led to a limited range of site choices because of the small seedling size currently being produced. The latter situation may change in the future if production costs for larger container stock can be justified in terms of other advantages gained in reforesting specific sites. For example, on sites where competition is too severe for slow-growing, small container stock, and where planting must be delayed until early summer because of site-related access problems, large container stock with its faster growth and good root protection may well be the key to success. Such refinements await development of regeneration prescriptions under more intensive management.

Table 3. Operational advantages and disadvantages of container stock for forest regeneration.

Stock characteristic	Advantage	Disadvantage
Produced in greenhouse environment on short production cycle	Short lead time. Flexibility in timing of production and in selection of stock and lot sizes. Minimal risk of crop loss during production.	Potential conditioning problems when removing crops from greenhouse in spring and fall. Survival and stock damage problems can develop during outside overwintering, especially for pine.
Bulky container units with upright orientation	Reduced risk of mold. Easy checking for major problems during storage and transit. Upright orientation and separation facilitates plant selection during planting.	Large storage and transportation space requirements. Increased distribution problems at planting sites. Some extra work is involved in pick-up and return of containers.
Seedlings rooted and retained in growing medium as individuals	Permits efficient use of valuable or genetically improved seed. Provides root protection in all phases of production through planting; this should result in improved survival and growth. No limitations on spring shipping time as no spring lifting is required.	Individual seedlings require intensive care. If planting is attempted too early, insufficient root development results in a weak plug that falls apart, while prolonged delays between production and planting can lead to top and root cavity crowding and reduced planting quality.
Uniform shape of container seedling root plug and small size grown under current production practices	Permits dibble planting, thereby improving planting productivity. Spacing and microsite selection are improved. Uniform, compact root mass is well suited to mechanization of planting.	Relatively low dry weight of seedlings from most current production practices limits the range of sites that can be planted. Incidence of permanent root deformity and subsequent toppling with pines.

PERFORMANCE ASSESSMENT

Operational assessment of container stock field performance in this region is in its infancy and a region-wide report is not possible. Assessments, where done, are confined mainly to survival.

Ball (1980) recommended a performance index, aimed at operational application, which combines plantation establishment costs with subsequent survival and height at 5 years.

Some regional performance results from research plantings are presented in the following section in terms of both survival and growth of container stock.

Survival

Five-year field results from research trials in Alberta show that plug-type container seedlings have better survival rates than conventional bare-root stock, particularly when planted during July and August (Walker and Johnson 1980).

If we disregard the snowshoe hare *(Lepus americanus)*, fires, severe flooding, and other disasters that can destroy all types of stock impartially, 5-year survival rates for all plug-type seedlings are high on prepared sites in Alberta and Saskatchewan. Survival data for all three species collected by the Canadian Forestry Service from several research plantations established between 1971 and 1974 based on 29,403 seedlings averaged 87% (range 75-97%) (Walker and Ball 1981).

Planting on poorly prepared or unprepared sites has been a major cause of low survival of past operational plantations in Alberta and Saskatchewan (Froning 1972). From 1975 to 1979, 40,300 ha or 72% of the area planted in this region (Table 1) was site prepared. No control of vegetative competition following planting is carried out in the region, primarily because of the lack of licensed herbicides for forestry use.

Growth

The ability of a seedling to grow cannot be inferred from its ability to survive (Zaerr and Lavender 1976). Site preparation on many sites improves growth of stock. Using a 5-year performance index, Ball (1980) calculated an average value of $1.16/m for white spruce styroblock-2 plugs on mixedwood sites in Saskatchewan in the mid-1970s. Performance was improved considerably by planting on prepared sites and by maximizing planting density to optimum levels for the species, site, and wood products concerned.

In the most comprehensive study of container seedling field performance in Alberta (and the region) Walker and Johnson (1980) found seedling size at outplanting to be the most important factor in subsequent seedling growth; larger white spruce seedlings with larger shoot:root ratios (up to 7.40) had significantly greater dry weight increases than smaller seedlings with smaller shoot: root ratios (ca. 2.00) (Fig. 2). Lodgepole pine and jack pine container seedlings showed a similar relationship.

It is not possible to aggregate growth data on container seedlings when outplanting weights vary. Data from Walker and Johnson (1980) show that relatively small additional increases in dry weights at outplanting are amplified considerably with time: mean outplanting dry weights of lodgepole pine seedlings grown in 40 cm^3 styroblock and RCA sausage containers were 0.632 and 0.417 g, respectively. (The size differences were attributed mainly to difficulty in watering the RCA sausages.) After 3 years in the field, styroblock seedlings averaged 17.2 g while sausages averaged 11.0 g. After 5 years, these weights were 110.8 and 60.3 g, respectively.

Walker and Ball (1981) showed that lodgepole pine and white spruce seedlings reared in 164-cm^3 containers for 14 weeks in the greenhouse were 106 and 84% taller, respectively, 5 years after outplanting, than seedlings reared for 4-12 weeks in 40 cm^3 containers (Fig. 3).

In a current study of lodgepole pine and white spruce reared "operationally" in 40- and 55-cm^3 Spencer-Lemaire "Rootrainers", both spruce and pine in the larger containers attained dry weights of 1000 mg--25% larger than the same species reared for the same period in smaller containers (Fig. 4). This indicates the potential for heavier stock production in the larger container when greenhouse rearing periods exceed 13 weeks. Spruce also showed generally increased height growth in the large container.

SUMMARY AND CONCLUSIONS

The main tree species produced in containers for the purpose of forest regeneration in the prairie provinces are white spruce, lodgepole pine, and jack pine. Over the period 1975 to 1979 about 20% of the regional cutovers were planted, 9% with container stock.

Operational container performance assessments are not well established in the prairie provinces; however, operational advantages and disadvantages of container stock over bare-root stock can be summarized from regional experience (Table 3).

Regional research on container seedling survival in Alberta indicates that plug-type container stock has better survival rates than bare-root stock, especially during July and August (Walker and Johnson 1980). Five-year survival figures for a total of over 29,000 container seedlings studied on a variety of sites in Alberta and Saskatchewan between 1971 and 1974 averaged 87% (Walker and Ball 1981). Inadequate site preparation and lack of competition control after planting are two major factors reducing container survival.

Research on container growth has shown that seedling growth is directly related to degree of site preparation and seedling weight at time of planting. There is a tendency for relatively small dry weight advantages at the time of outplanting to be amplified over time in terms of superior growth.

In the future, refined prescriptions that match stock type and size to site may help to justify higher production costs of larger container stock, especially when their other advantages for particular sites and operating conditions are taken into consideration.

Container use is well established in the prairie provinces but is still not refined to the point at which type and size of container are being most effectively matched to

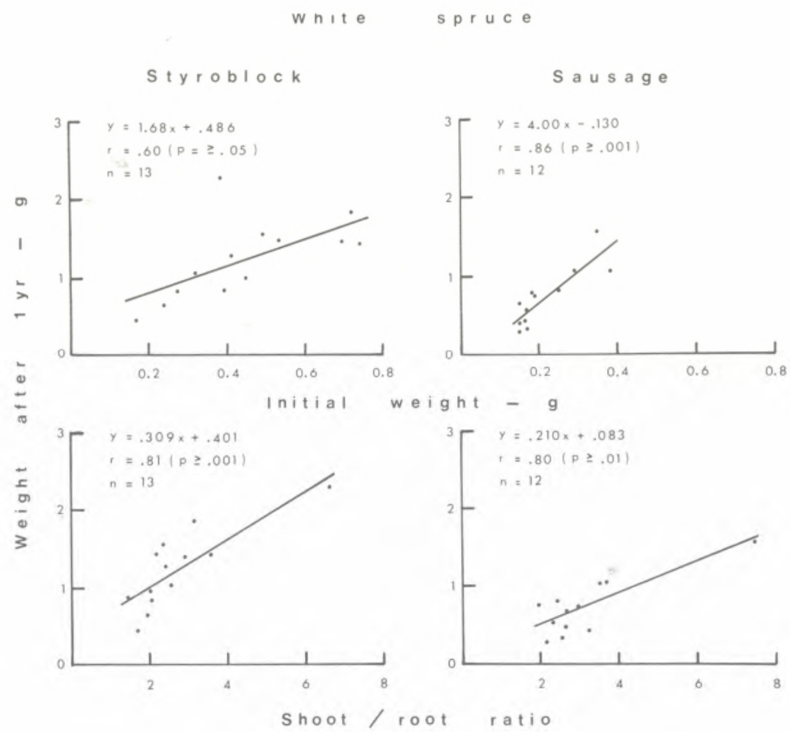


Figure 2. Relationships between seedling weight after 1 year and initial weight or shoot:root ratio (from Walker and Johnson 1980).

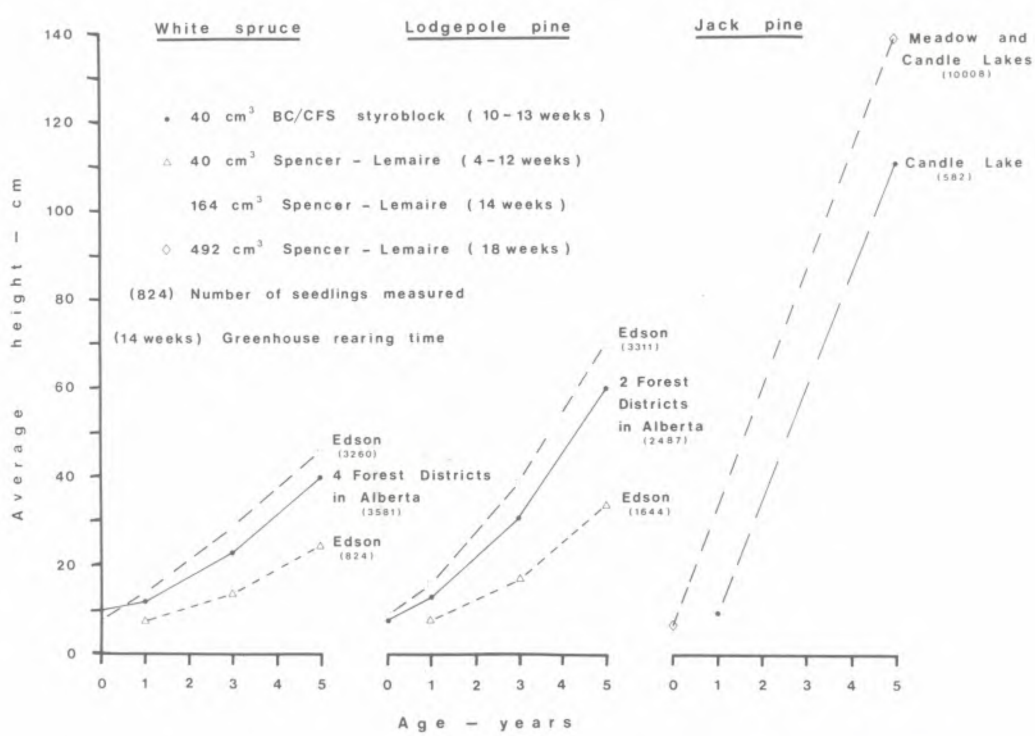
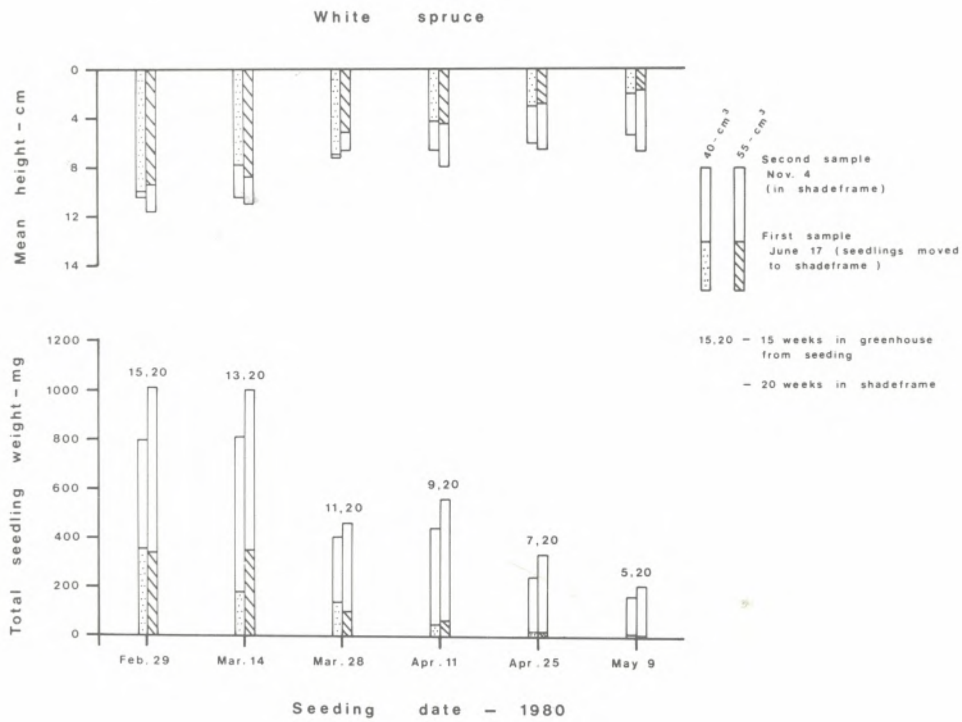


Figure 3. The effects of container size and rearing time on seedling height 1-5 years after planting (from Walker and Ball 1981).



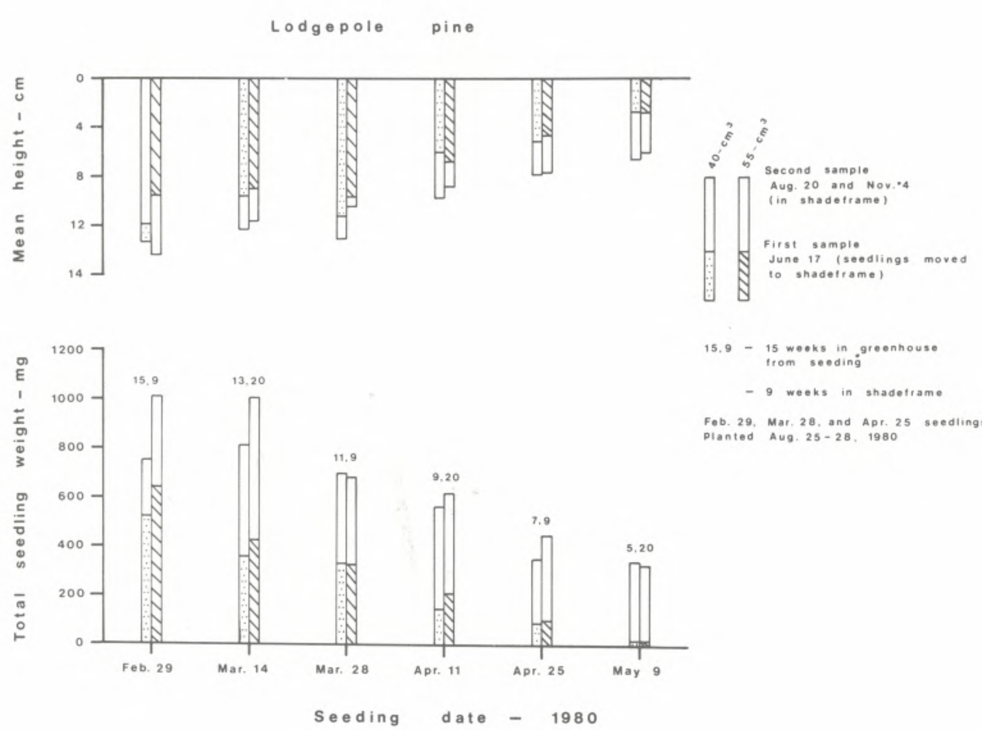


Figure 4. The effect of greenhouse rearing time on total weight and mean height for two sizes of white spruce (top) and lodgepole pine (bottom) container seedlings.

site. There is a need for operational field performance assessment to provide feedback necessary for refining the operational application of various container types.

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