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THE EFFECT OF AVAILABLE ROOTING VOLUME ON THE GROWTH OF LODGEPOLE PINE SEEDLINGS

by

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INTRODUCTION

After the work of McLean (1959) in Ontario and Walters in British Columbia (1961), container seedlings have been increasingly used for reforestation in Alberta. Starting with pilot plantings in 1962, about 3 million container seedlings are now planted annually by the Department of Lands and Forests, and Industry. The system as used in Alberta has been described by Johnson and Marsh (1967) and Carman (1967).

After some experimental trials of different types of container, a 3/4" x $3\frac{1}{4}$" rolled, high-impact polystyrene container with an 8- to 12-week-old seedling grown in peat, has been used exclusively for operational planting. Their initial survival was promising but after 1967, the monitoring of performance carried out by Dixon and Johnson (1969) and later Soos (1970) indicated that their survival was not maintained and growth was poor.

It was known that the container restricted root egress, but it was also thought that the small volume for rooting in the container might affect growth performance and possibly the balance of the

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agar to reduce variation in seedling size caused by parentage and different rate of germination. Only seeds with emergent radicles were sown into the containers, which were filled with horticultural peat sieved through a $\frac{1}{4}$" x $\frac{1}{4}$" mesh. The peat was treated with a wetting agent ('Soil Wet') and soaked before being loaded into containers. The seedlings were grown in a greenhouse under full light at 70°F day, and 50°F night temperatures, with photoperiod of 16 hours. Moisture was maintained at adequate levels throughout and nutrients were supplied by a weekly application of Ingestad's solution. Containers of the same size were placed together in plastic nursery trays. These trays were placed side by side on the south-facing bench of the greenhouse,and tray position and orientation were rotated weekly. At 108 days from sowing in containers, the seedlings were removed from the containers, thoroughly washed and destructively analyzed for dry weight of roots and shoots. Dry weights were determined to the nearest 10 mg.

RESULTS

Dry weights and shoot-to-root ratios are shown in Table 2.

There was a rapid increase (66%) in root weight with increase in container volume up to 2.3 cu. inches; after this point, root weight increased gradually with volume up to 18 cu. inches, the maximum tested. There was a highly significant correlation between dry weight of roots and rooting volume (r = .865) and between dry weight of roots and cross sectional area of container (r = .855).

Table 2. Mean dry weights of seedlings grown in different rooting volumes (in order of increasing volume of container)

Container type	No.of observations	Volume (cu.in.)	Seedling dry wt.(gm) Root	Shoot	Total	Shoot/root ratio
Black ½" diam.tube	26	0.64	0.03	0.06	0.09	2.0
Small curler	46	0.76	0.02	0.07	0.09	3.5
White 3/4" tube	46	1.48	0.04	0.09	0.13	2.25
1" Square pot	11	2.00	0.05	0.19	0.24	3.80
'Lab-pore' tube	23	2.35	0.05	0.20	0.25	4.00
Large curler	13	4.86	0.06	0.17	0.23	2.83
Small pot	42	6.32	0.06	0.13	0.19	2.17
Large pot	30	18.12	0.09	0.18	0.27	2.00

Shoot growth did not show the same trend of continuous increase with container volume; it achieved a maximum at 2.35 cu. inches volume followed by a steady decline to 6.32 cu. inches then an abrupt rise at 18.0 cu. inches. This behavior is not understood. There was not a significant correlation between rooting volume and shoot weight.

Total plant weight also achieved a maximum at 2.35 cu. inches rooting volume, the two factors being significantly correlated ($r = .6033$).

The increase in shoot-to-root ratios up to 2.35 cu. inches rooting volume reflect the more rapid growth of shoots in comparison with roots with increasing volume. The decrease in shoot-to-root ratio after 2.35 cu. inches volume is a function of maintained root growth and the unexplained reduction in shoot growth.

DISCUSSION

Stevenson (1967) quotes Baker and Woodruff (1962) who reported a soil volume effect on the growth of corn. Stevenson found that top growth of clover, wheat, and sunflowers increased steadily with increasing soil volume, but that only sunflower showed an increase in root growth correlated with increase in soil volume. He postulates that when roots are crowded beyond a certain density, each root interferes with the water supply of those around it and that growth is restricted. In a later paper, Stevenson (1970) found that soil volume had a greater effect than fertilizer on the growth of sunflowers and that fertilizers did not compensate for limited rooting volume.

Cornforth (1968) found uptake of nitrogen and phosphorous by horticultural plants to be affected by the rooting volume available.

The results for root growth obtained in this present investigation are in keeping with the findings of Stevenson described above. They indicate a steady increase in root weight with increasing rooting volume; maximum possible root weight is regarded as one of the most important aspects of container seedling establishment. The behavior of shoot growth does not agree with the experience of the authors referred to above; it is not explained by rooting volume and is not understood. The 3/4" white styrene container presently used in

Alberta has a strong inhibitory effect on root and shoot growth.

It seems that by increasing rooting volume to about 2.5 cu. inches, a plant of a given size with larger roots could be reared in a shorter time than in the present 3/4" container. The results suggest that such a plant might be unbalanced in terms of shoot-to-root ratio and further study of shoot growth and rooting volume is required to clarify this.

CONCLUSIONS

Rooting volume has been shown to have a sufficiently large effect on seedling growth to warrant a full investigation for lodgepole pine and white spruce up to 15 weeks old. This investigation would be valuable to the current research-programme on container seedlings.

The 3/4" x 3¼" container presently used in Alberta inhibits the growth of lodgepole pine in the first 15 weeks and this effect undoubtedly continues in the field before establishment. It is suggested that a container of at least 2.5 cu. inches should be used in the future until further information becomes available.

Rooting volumes of more than 0.76 cu. inches and up to 2.35 cu. inches, although producing larger plants, also induce an unbalance between shoots and roots because of more rapid shoot growth. This requires more thorough testing together with the suggested temporary decline in shoot growth between 2.35 cu. inches and 18.0 cu. inches.

Stevenson, D.S. 1970. Soil volume and fertilizer effects on growth and nutrient contents of sunflower plants. Can. J. Soil Sci.:50(3):353-360.

Walters, J. 1961. The planting gun and bullet. Forest. Chron. 57(2):94-95.