THE OPTIMIZATION OF PLANTATION ESTABLISHMENT BY POT PLANTING

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Abstract.--The optimization of plantation establishment depends on the mechanical efficiency of the planting technique and on the subsequent growth of the trees. The technique should accommodate the biological characteristics of the species throughout its life as a unit of the plantation. Pot planting offers the greatest promise of achieving these mechanical and biological objectives.

Résumé.--L'optimisation de l'établissement d'une plantation dépend de l'efficacité mécanique de la méthode utilisée ainsi que de la croissance subséquente des arbres. La méthode de plantation doit convenir aux caractéristiques biologiques de l'essence pendant toute sa vie au sein de la plantation. Les plants en pots semblent offrir les meilleures chances d'atteindre ces objectifs biomécaniques.

INTRODUCTION

There is an increasing awareness that the Canadian forest industry may be unable to maintain its present economic importance unless plantations are established on a scale and at a rate unprecedented in the history of any nation. This awareness of the magnitude and urgency of reforestation projects facing Canada and other countries has provided impetus to the mechanization of tree planting. Much of the interest in mechanization is associated with the increasing cost and decreasing supply of manual planters. Although this is an important reason for mechanization, additional reasons can be offered which are of greater significance to plantation establishment in the context of the inevitable mechanization of all the main silvicultural treatments. As we replant our forests we should do so in ways which anticipate and prepare for this inevitability. The mechanization of tree planting is a first and vital element in the sequence of mechanized silvicultural practices necessary for modern plantation establishment. I believe that mechanization of tree planting can be greatly facilitated by exploiting the mechanical and biological properties of rigid plant pots.

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SOCIO-ECONOMIC REASONS FOR MECHANIZING PLANTATION ESTABLISHMENT

The increasing cost and decreasing supply of manual planters are well recognized factors which have stimulated interest in mechanized planting. The shortness of the planting season compounds the problem of labor supply. Another factor which will influence the design of tree-planting machines relates to the comfort of the operators. Air conditioning, sound-proofing, and musical entertainment will soon be a part of the silviculture industry in the same way that they are a part of other industries. Eventually, comfort becomes an important reason for machine development.

SILVICULTURAL ENGINEERING REASON

A less obvious reason for machine development, but one, I believe, of greater importance, is the need to establish plantations in a systematic configuration. Seedlings should be planted precisely in rows and at uniform spacing to facilitate mechanized weeding, cleaning, thinning, and harvesting operations. In my opinion, systematic plantation configuration is a crucial prelude to the efficient mechanization of all silvicultural practices subsequent to planting. The optimization of mechanized weeding, cleaning, thinning, and harvesting practices is contingent on the system of plantation establishment. A reforestation program already suffering from labor shortages would be further constrained if, to the manual work of planting, the manual work of plantation layout were added. Indeed, the latter is usually more laborious than the former.

The fact that tree-planting machines plant in a systematic configuration is an incidental, but nevertheless important, benefit of mechanization. As silvicultural practices are mechanized they, too, will traverse the terrain in straight lines. Only trees in rows will be cultivated efficiently; trees of valuable species may well be weeds if growing between, rather than in, rows. Systematic plantation configuration can significantly increase the efficiency with which subsequent silvicultural practices can be mechanized.

Hence, in addition to the use of tree-planting machines to reduce the cost of reforestation (something that has not yet been accomplished) and their ability to accelerate the rate of planting, machines have an important role in what can and should be called "silvicultural engineering".

The systematic establishment of plantations is vital to Canada's reforestation objectives and it alone is reason enough to mechanize tree planting. For both socio-economic and engineering reasons, the development of tree-planting machines deserves far greater emphasis in Canada than it receives at present.

BIOLOGICAL REASONS

Bare-root seedlings are the most commonly used type of nursery stock. Many foresters believe that bare-root seedlings have advantages over balled and pot seedlings. Many foresters also believe that the silviculture industry will always be dependent on the planting of bare-root seedlings with mattock and shovel. Yet there are serious and chronic problems associated with the planting of bare-root seedlings and with the use of those tools. Lifting, sorting, packaging, transporting, storing, and planting all contribute to physiological deterioration. Moreover, the factors involved in physiological deterioration of seedlings remain largely unknown. For example, an examination of plantations established in the Kamloops Forest District from 1960 to 1975 revealed that survival averaged only 51% two years after planting (Anon. 1977). The report stated: "The reasons for the poor average survival were unknown but planting quality and quality of planting stock were suspected as having contributed to a major portion of the mortality".

A year earlier a study of lodgepole pine plantations in British Columbia revealed significant mortality shortly after out-planting and poor growth over a period of several years (Anon. 1976). In addition it was reported that a major problem was mechanical instability, possibly leading to toppling and the formation of basal sweep. This problem, related to morphological development of root systems, is of increasing concern.

A planting trial in the Nelson Forest District in 1973 using three methods of manual planting showed that by 1976 "no method produced satisfactory rooting on lodgepole pine". Similar results were obtained in the Cariboo Forest District. Another study in the same report (Anon. 1977) concluded: "The great majority of mattock-planted trees exhibited hockey-stick or bunched roots. It appears that proper positioning of roots of bare-root lodgepole pine seedlings in the planting hole is very difficult if not impossible when the mattock is used as a planting tool".

One of the most important studies of plantation performance made anywhere in the world surely must be that of Mullin (1974) who found that planting can exert a considerable long-term effect on growth. His study of red pine (*Pinus resinosa* Ait.) showed that two crews produced a 14% difference in volume growth 20 years after planting. As in many other studies no significant differences in growth were apparent 5 years after planting. Hence, the large volume difference occurred in only 15 years and there seems reason to expect an even greater difference in the future.

Balled seedlings, such as those produced by the Kopparfors multipot, styroblock, and "Rootrainer" systems, avoid most of the physiological problems of bare-root plants. However, there is concern that the pot binding of the roots, *inherent in these systems,* may retard growth and reduce stability. Evidence of these problems was presented by several speakers at the Symposium on the Root Form of Planted Trees in Victoria (Van Eerden and Kinghorn 1978). Moreover, while root deformation of seedlings in poor physiological condition, such as that common to bare-root plants, may disappear as new roots are formed, root deformation of plants in good physiological condition, such as that of some balled plants, may persist. The long-term consequences for the stability of the new plantations are uncertain.

Setting out seedlings in pot-shaped receptacles has long been recognized as a successful means of achieving high survival rates. Seedlings can be transferred to the planting site with a minimum of physiological deterioration. For this reason, it is a method much used in semi-arid countries. However, the pot-binding of roots, common to modern balled seedlings, is, of course, also common to pot plants. Seedlings in soft-walled pots must have pot-bound roots, as must balled plants, to be transportable as a unit. Rigid pots, on the other hand, are fundamentally different in that the seedlings in them do not affect the efficiency of transportation and metering techniques. It is true that seedlings can be grown in rigid pots until pot-bound but it is true also that rigid pots can carry seedlings in any stage of development *before* pot-binding occurs. *It is only through the use of rigid pots that seedlings can be planted with root systems undisturbed by nursery or planting practices, while developing in accordance with their* natural *silvical habits.* The literature describes enough growth and stability problems associated with planting to make foresters uncertain of the future of their plantations. They have good reason to be uncertain, but no reason to accept uncertainty. Nursery stock should not suffer physiological or morphological disturbance in the nursery or during planting. The principle of the rigid plant pot offers the best promise of achieving this objective. Moreover, rigid pots of suitable composition and design offer important post-planting benefits to seedlings. I disagree with those who have stated that containers are of no benefit to seedlings after out-planting (Arnott 1973 and 1974, Van Eerden 1972). The work of Day and Skoupy (1971) and Day and Cary (1974) shows that containers can have a beneficial influence because their root masses lose moisture slowly and remain moist for. longer periods than do those of balled plants. Seedlings planted in biodegradable rigid plant pots now under development also benefit from the supply of nutrients released by the process of degradation.

To these biological advantages can be added mechanical advantages which are unique to plants grown and planted in rigid pots. The use of rigid pots maximizes efficient mechanical handling and planting and optimizes the establishment of the plantations so important to Canada's economic future.

LITERATURE CITED

Anon.
1976. Forest research review. B.C. Min. For., Victoria, B.C. 71 p.

Anon.
1977. Forest research review. B.C. Min. For., Victoria, B.C. 78 p.

Arnott, J.T.
1974. Performance in British Columbia. p. 283-290 *in* R.W. Tinus, W.I. Stein, and W.E. Balmer, *Ed.* Proceedings of the North American Containerized Forest Tree Seedling Symposium. Great Plains Agric. Counc. Publ. No. 68.

Day, R.J. and Cary, J.R.
1974. Differences in post-planting soil-moisture relations of container-grown tube and plug stock affect the field survival and growth of black spruce. p. 388-392 *in* R.W. Tinus, W.I. Stein, and W.E. Balmer, *Ed.* Proceedings of the North American Containerized Forest Tree Seedling Symposium. Great Plains Agric. Counc. Publ. No. 68.

Day, R.J. and Skoupy, J.
1971. Moisture storage capacity and post planting patterns of moisture movement from seedling containers. Can. J. For. Res. 1:151-158.

Mullin, R.E.
1974. Some planting effects still significant after 20 years. For. Chron. 50:191-193.

Van Eerden, E.
1972. Influences affecting container seedling performances near Prince George. p. 92 in Waldron, R.M., *Ed.* Proceedings of a Workshop on Container Planting in Canada. Dep. Environ., Can. For. Serv., Ottawa, Ont. Inf. Rep. DPC-X-2.

Van Eerden, E. and Kinghorn, J.M., *Ed.*
1978. Proceedings of the Root Form of Planted Trees Symposium. B.C. Min. For./ Can. For. Serv. Joint Rep. No. 8. 357 p.