JAPANESE PAPERPOTS FOR CONTAINERIZED PLANTING OF TREE SEEDLINGS. III. TRANSPORTATION OF SEEDED PAPERPOTS TO SATELLITE NURSERIES

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ABSTRACT

Loaded and seeded paperpot trays were transported 112 and 322 km to test the possibility of successfully shipping such trays from a central loading point to satellite nurseries. Seed disturbance, as reflected by the position of germinating seeds, was used to judge the effects of transportation.

The results showed that seed movement on the seedbed surface was strongly influenced by type and moisture content of the growing medium, distance travelled and seed size. Differences in surface (seedbed) texture resulted in far greater movement of seed on muck peat during transportation than on peat moss, although black spruce (*Picea mariana* [Mill.] B.S.P.) seed was found to be less susceptible to disturbance than the larger jack pine (*Pinus banksiana* Lamb.) seed; this is attributed to the greater ability of spruce seed to enter small interstices in the seedbed surface. Seed movement was much reduced, and the number of usable cavities increased, by wetting the growing medium (particularly peat moss) before shipping.

It is concluded that peat moss, properly compacted and wetted before shipping, provides a good seedbed for shipping of seeded paperpots over fairly long distances. The physical properties of muck peat render it an unsuitable seedbed material for use in the transportation of seeded trays.

RÉSUMÉ

On a transporté des plateaux de potets en papier remplis de terreau et ensemencés sur 112 et 322 km pour savoir s'il est possible d'expédier avec succès de tels plateaux à partir d'un point central vers des pépinières satellites. Pour juger le dérangement des graines en cours de transport, on a observé la position des graines germées.

Les résultats indiquèrent que le mouvement des graines sur le lit de germination était fortement influencé par le type de sol et sa teneur en humidité, la distance parcourue et la grosseur des graines. Les graines dans la tourbe évoluée bougèrent plus que dans la sphaigne, quoique les graines d'Épinette noire (*Picea mariana* [Mill.] B.S.P.) fussent moins vulnérables au déplacement que les graines plus grosses du Pin gris (*Pinus banksiana* Lamb.); ceci est attribué à la plus grande facilité des graines d'Épinette à pénétrer dans les petits interstices à la surface des lits de germination. Le mouvement des graines fut de beaucoup diminué et le nombre de cavités utilisables augmenta lorsqu'on humecta le milieu de croissance (particulièrement la sphaigne) préalablement à l'expédition.

L'auteur conclut que la sphaigne, adéquatement compactée et humectée avant d'être expédiée, procure un bon lit de germination pour expédier sur d'assez longues distances les pots en papier ensemencés. Les propriétés physiques de la tourbe évoluée la rendent ici impropre.

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INTRODUCTION

Despite early optimism, experience at Ontario nurseries indicates that production costs for containerized planting stock of acceptable size and quality are not likely to be any lower than those for conventional bare-root material. Apart from capital costs, "the filling and sowing of containers has proved to be a major operating expense and logistical headache" (Vyse and Ketcheson 1974). Containerized seedling production is frequently a labor-intensive operation in which filling and sowing must be done by hand, and the situation is aggravated by the fact that the need for a large labor force is usually restricted to one or more very short periods in each year.

Although mechanization of container filling and sowing is generally considered desirable as a means of reducing the demand for and cost of labor, the degree and sophistication of mechanization that can be justified are clearly related to the size of operation. Certainly the trend towards large, centralized container production centres favors increased mechanization. However, in Ontario the situation is such that there will also remain a number of smaller nurseries that continue to grow containerized seedlings.

With the growing acceptance of the Japanese paperpot in central and eastern Ontario, the question of loading equipment becomes an important item in the planning of seedling production facilities. The *Lännen* paperpot filling line (Scarratt 1973) has a minimum filling/sowing capacity of 40,000 - 50,000 cavities per hour with the most commonly used sizes of paperpots (308 and 408), and is well adapted to meet the needs of larger production centres. However, smaller nurseries would obviously find it difficult to justify expenditure ($25,000) on equipment that would be used for only a few days in each year. It is pertinent to ask, therefore, whether centralized loading facilities might not better serve the needs of these smaller nurseries. The feasibility of this proposition clearly depends to a large degree upon the success with which filled and seeded containers can be transported from the central loading point to satellite nurseries.

This report, then, presents the results of an experiment in the transportation of filled and seeded paperpots, the effects of shipping being judged primarily in terms of seed movement as reflected by the position of germinating seeds.

METHOD

Sixty trays of FH 308 paperpots (532 pots per tray) were filled with growing medium on a *Lännen* filling line in Sault Ste. Marie. Half this number were sown with jack pine (*Pinus banksiana* Lamb.) and half with black spruce (*Picea mariana* [Mill.] B.S.P. seed.

For each species, a three-factor design was adopted, viz., two growing media (peat moss and peaty muck) x two moisture regimes (wetting of the growing medium before and after shipping) x three transportation treatments (contol, 112 km, 322 km). Each treatment combination was replicated five times.

Thirty of the trays were filled with a shredded and screened (6.3 mm mesh) commercial peat moss, the other thirty with screened peaty muck of local origin (the same type of material as was used in the Ontario tubed seedling program). Neither material was so dry that it might be blown from the trays; both were relatively damp, but with no free water when squeezed. Before loading, the tray bottoms were each lined with a single sheet of #1300 Kimwipe® wadding to prevent loss of growing medium through the perforations during handling, etc. Experience has shown that this paper decomposes completely within three weeks under normal growing conditions. The paperpots were completely filled with growing medium, and sufficient vibration was applied to obtain moderation compaction (i.e., to the extent that the material settled no more than 0.5 cm under normal handling and growing conditions).

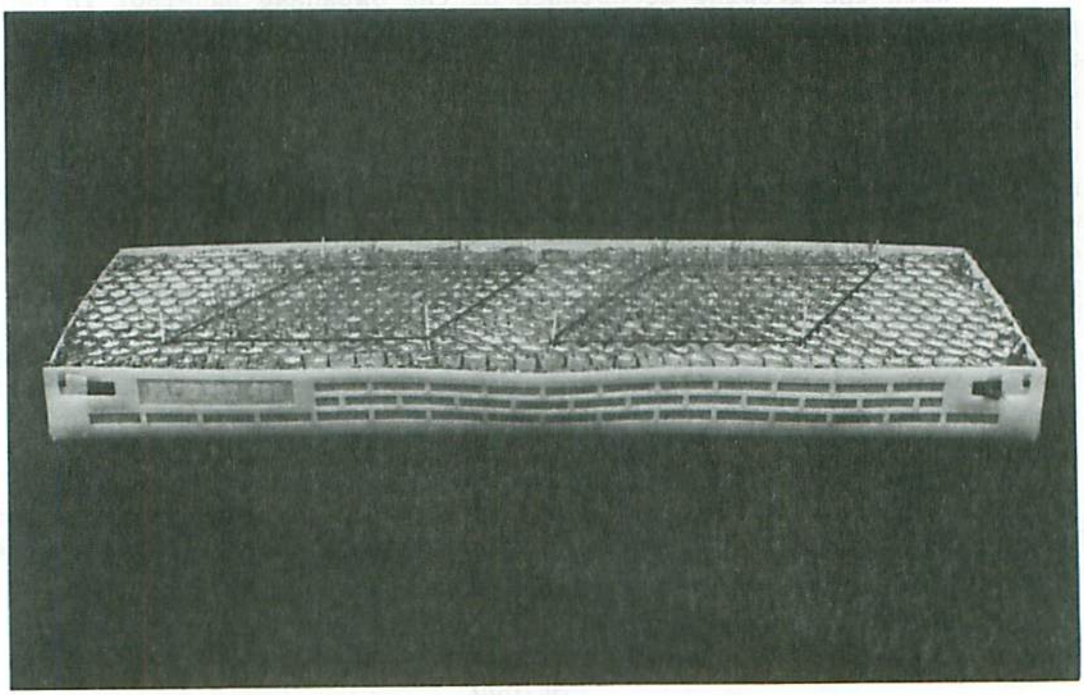

Figure 1. Paperpot tray showing arrangement and demarcation of 100-cavity seeded blocks. Photograph of control at time of germination assessment.

A block of 100 cavities (10 x 10) was located centrally in each half of each tray and demarcated by toothpicks and colored wool (Fig. 1); each block of cavities was treated as one replicate (i.e., two replicates per tray). Seeds were sown only in the 100-cavity blocks, one seed being placed carefully in the centre of each paperpot. After sowing the trays were misted lightly with water to minimize seed movement while the seed cover (#8 silica grit) was being applied. The filling line sander was used for the latter operation.

Trays to be shipped in a wetted state were watered to saturation over a 6 hr period and were then allowed to drain overnight. The following morning designated trays were loaded into random positions in wooden transportation racks on a 5-ton (4.5 tonne) truck; the trays were restrained from moving horizontally, but not vertically, while the racks were enclosed to restrict wind movement over the trays. Designated trays were then driven a total of either 112 or 332 km along the Trans-Canada highway east of Sault Ste. Marie at an average speed of 88 km per hr. All trays were weighed at the time of loading.

On completion of the transportation treatments, all trays, including controls, were moved directly to the greenhouse so that the seeds could be germinated. After germination at a temperature of 21-24°C, seedlings were allowed to develop to the primary needle stage (Fig. 1). At this time germination counts were made to determine the extent of seed movement, as reflected by total germination and seedling position in relation to original seed placement. The data were subjected to analysis of variance.

RESULTS AND DISCUSSION

Calculations from the data for the controls (a total of 2000 seeds per species) indicated that the average germinability of the black spruce seed was 94.6% and of the jack pine 90.8%. Within each 100-cavity black, therefore, the average number of cavities blank as a result of non-germination should have been 5.4 and 9.2, respectively. A higher frequency of blanks, associated with the occurrence of cavities with multiple seedlings and seedlings germinating outside the 100-cavity block, provided a useful measure of the degree of seed movement or seed loss occurring during handling and transportation.

Appendix tables A1 and A2 summarize germination data for the two species, and indicate the pattern of seedling distribution in relation to the original position of seed within the 100-cavity block.

The data for controls show that very little seed movement occurred during normal tray handling before shipping. Some movement of seed due to the impact of grit particles is usual when the seed cover is applied, but obviously surface texture and moisture status of the growing medium, seed and grit size all influence the extent of movement. Though not a standard treatment in operational practice, misting of the tray surfaces before sanding in this experiment undoubtedly restricted seed disturbance on both media. Nevertheless, on the basis of the small amount of seed movement observed, the peat moss appeared to provide a seedbed surface more restrictive to seed movement, even in the controls (Table 1).

Table 1. Seed movement in controls as expressed by number of cavities with multiple seedlings *plus* seedlings outside 100-cavity block (means of five replicates).

	Dry control	Wet control
Jack pine		
Peat moss	-	0.2
Muck	7.4	7.4
Black spruce		
Peat moss	0.2	0.6
Muck	3.4	3.4

The extent to which the growing medium might slump in the container during transportation was, in addition to the amount of seed disturbance, a matter of practical concern. The use of Kimwipe ®

wadding completely eliminated soil loss through the bottom of the trays as a cause of slumping. While there was some general settling within containers it was not considered serious for either growing medium. Trays filled with muck showed the least settling--mostly less than 0.5 cm--although it should be noted that vibratory loading had already produced an almost excessively compacted growing medium. There were no evident differences between wetted and dry trays.

Although the effects of transportation, as reflected by seed movement, were more pronounced in jack pine than in black spruce, the results show a similar pattern in both species. Basically, seed movement was greater on muck than on peat moss, and more serious where the growing medium was not wetted before shipping. As might be expected the amount of movement increased with distance travelled.

The smooth, close-packed muck surface presented a poor seedbed for seed retention. There was considerable grit movement across the tray surface during transportation, even with trays wetted before shipping, and this grit often accumulated in zones and ridges at the centre or ends of the trays. Under the worst treatment--a dry muck which had travelled the greater distance--there was a relatively severe loss of grit from the trays. By contrast the peat moss presented a more open-textured surface, which resulted in far less movement of both grit and seed.

The smaller size of black spruce seeds probably accounts for the lower incidence of seed movement in this species than in jack pine, since the former were better able to enter small interstices in the surface of both growing media. This is reflected in the fact that none of the treatments showed any significant reduction in total germination (i.e., no seeds were completely lost from the trays), and that most of the seeds germinated within the 100-cavity sowing block (Table A1). Although seed movement was greater over all on the muck surface, only with dry muck transported 322 km was there any significant reduction in the number of usable cavities within the sown block. (The low incidence of seedlings germinating outside the sown area indicates that movement distances were relatively short.)

With jack pine seed (Table A2) the effects of transportation were more serious, particularly on the muck, as expressed by the greater number of blank cavities and seedlings germinating outside the 100-cavity block. Seed movement on dry muck transported 322 km was so severe as to cause a substantial loss of seeds from the trays; this is reflected in the significant reduction in total germination on these trays. It is evident that the comparable treatment for peat moss also suffered some seed loss, but this loss was not as serious. Although wetting the trays before shipping by no means prevented seed movement on the muck (it did on the peat moss), the data nevertheless show a highly significant interaction between distance travelled and the moisture status of the growing medium. On both media, long-distance travel (i.e., 322 km) in a dry condition resulted in significant reduction in usable cavities within the sown block--a 41% reduction on muck and a 28% reduction on peat moss compared with controls. Where the growing media were wetted before shipping, reduction in the usable cavities amounted to only 3% for both materials.

While the data suggest that filled and seeded trays of paperpots can be transported relatively short distances (less than 150 km) over good highways with a reasonable expectation of success, in practice transportation distances to satellite nurseries would likely exceed 400 km and involve travelling over a variety of road conditions. Under these circumstances, the probability of adverse effects on seedling production is greatly increased unless seedbed conditions are favorable to seed retention. The risk of seed movement is greatest on growing media in a relatively dry condition, with the smooth and compacted surface of muck peat making this the least suitable material for use in the shipping of seeded containers. The more open texture of peat moss presents a surface more conducive to seed retention during rigorous handling and transportation, particularly for small seeded species such as spruce. Even so, the evidence points to unacceptable levels of seed movement, with a consequent reduction in usable cavities, where seeded trays are transported long distances or over bad roads without prior wetting. The desirable seedbed for successful transportation appears to be a well compacted peat moss wetted before shipping.

Although wetting of the growing medium before shipping certainly appears to aid the transportability of seeded trays, it may introduce further problems. With peat moss the addition of water may cause slumping of the growing medium in the container where road conditions are severe or where the peat has been inadequately compacted. Muck peats seem to be less liable to this problem, but the weight of wetted paperpot trays may become quite unacceptable, both in terms of handling in the nursery and, later, as trays of seedlings in the field. For the materials used in this experiment, average tray weights were as follows (n = 10):

Peat moss	(dry)	5.1 kg (4.8 - 5.3)
	(wet)	10.8 kg (10.1 - 12.7)
Muck	(dry)	16.7 kg (15.4 - 18.1)
	(wet)	41.8 kg (40.6 - 43.5)

In a separate test it was found that the addition of horticultural grade vermiculite to the muck (up to 50:50) did not materially reduce the weight of wetted trays.

CONCLUSIONS

It is clear that the decision to ship filled and seeded paperpot trays from a central loading point to satellite nurseries should not be taken lightly. It must be balanced against the centralized production and shipping of trays of ready-grown seedlings. However, where circumstances dictate the need for satellite nurseries, the results indicate that, with certain provisos, there is no reason why filled and seeded paperpot trays cannot be transported successfully over relatively long distances. Apart from the obvious need to restrain the trays from excessive movement during shipping and for adjusting driving speeds to road conditions, the most important factors to consider are the type and moisture status of the growing medium, transportation distance and seed size.

Apart from other, biological, objections to its use as a growing medium, the physical properties of muck peat render it an unsuitable seedbed material for use in the transportation of seeded trays. The potential for seed movement and seed loss is high, and peat moss is the preferred seedbed material.

Peat moss, properly compacted, provides a good seedbed for successful shipping and, in a dry condition, is suitable for shorthaul transportation over good highways for small-seeded species (e.g., spruce). For longer distances, poorer road conditions or large-seeded species (e.g., pine), wetting of the peat moss before shipping would seem to be essential. As a general recommendation, wetting of the peat moss would avoid the risk of seed disturbance due to careless handling during the off-loading of trays, irrespective of distance travelled.

Where circumstances are such that the shipping of seeded trays is deemed undesirable (e.g., if road conditions are severe), some of the benefits of centralized loading may still be had through the shipping of filled, but not seeded, paperpot trays to satellite nurseries. In this case the satellite nursery must be provided with suitable seeding and sanding equipment. For most operations of this nature the relatively inexpensive *Sator 7* seeding unit (Scarratt 1973) would appear to be adequate to meet seasonal sowing requirements.

LITERATURE CITED

Scarratt, J.B. 1973. Japanese paperpots for containerized planting of tree seedlings. I. Tools and equipment. Can. For. Serv., Sault Ste. Marie, Ont. Inf. Rep. 0-X-188. 27 p.

Vyse, A.H. and D.E. Ketcheson. 1974. The cost of raising and planting containerized trees in Canada. p. 402-411 *in* Proceedings of the North American containerized forest tree seedling symposium, Denver, Colo. Great Plains Agric. Counc. Publ. 68.

APPENDIX

Table A1. Germination of black spruce seed after transportation test (means of five replicates).

Growing medium	Moisture status	Distance travelled (km)	Total germination	Germination within 100-cavity block: Single** seedlings	Multiple** seedlings	Blank cavities	Usable cavities	Seedlings outside 100-cavity block
			(1)*	(2)*	(3)	(4)*	(2 + 3)*	
Peat moss	wet	control	93.8^{a}	92.8^{a}	0.4	6.8^{a}	93.2^{a}	0.2
"	"	112	92.2^{a}	91.8^{a}	0.2	8.0^{a}	92.0^{a}	-
"	"	322	92.8^{a}	90.6^{a}	0.8	8.6^{a}	91.4^{a}	0.6
"	dry	control	92.8^{a}	92.4^{a}	0.2	7.4^{a}	92.6^{a}	-
"	"	112	94.0^{a}	82.6^{ab}	4.8	12.6^{a}	87.4^{ab}	1.6
"	"	322	92.6^{a}	89.4^{a}	1.2	9.4^{a}	90.6^{a}	0.8
Muck	wet	control	96.0^{a}	89.3^{a}	3.2	7.5^{a}	92.5^{a}	0.2
"	"	112	92.3^{a}	72.3^{ab}	9.5	18.2^{a}	81.8^{ab}	0.8
"	"	322	97.0^{a}	88.8^{ab}	3.7	7.5^{a}	92.5^{a}	0.7
"	dry	control	96.0^{a}	89.3^{a}	3.2	7.5^{a}	92.5^{a}	0.2
"	"	112	96.0^{a}	87.8^{ab}	3.7	8.5^{a}	91.5^{a}	0.7
"	"	322	91.5^{a}	67.8^{b}	9.8	22.4^{b}	77.6^{b}	2.7

* Entries with different superscript letters differ significantly at the 5% level.

** Number of cavities with single or multiple seedlings within 100-cavity block.

Table A2. Germination of jack pine seed after transportation test (means of five replicates).

Growing medium	Moisture status	Distance travelled (km)	Total germination	Germination within 100-cavity block				Seedlings outside 100-cavity block
				Single** seedlings	Multiple** seedlings	Blank cavities	Usable cavities	
			(1)*	(2)*	(3)	(4)*	(2 + 3)*	
Peat moss	wet	control	89.6^{a}	89.2^{a}	0.2	10.6^{a}	89.4^{a}	-
"	"	112	91.4^{a}	90.2^{a}	0.6	9.2^{a}	90.8^{a}	-
"	"	322	89.2^{a}	85.6^{a}	1.0	13.4^{a}	86.6^{a}	1.6
"	dry	control	89.8^{a}	89.8^{a}	-	10.2^{a}	89.8^{a}	-
"	"	112	90.2^{a}	70.4^{ab}	7.4	22.2^{ab}	77.8^{ab}	4.0
"	"	322	83.8^{ab}	47.8^{bc}	13.6	38.5^{bc}	61.4^{bc}	7.4
Muck	wet	control	92.0^{a}	78.3^{ab}	6.2	15.5^{ab}	84.5^{a}	1.2
"	"	112	88.0^{a}	70.8^{ab}	7.0	22 2^{ab}	77.8^{ab}	2.5
"	"	322	86.0^{a}	77.3^{ab}	4.0	18.7^{ab}	81.3^{ab}	0.5
"	dry	control	92.0^{a}	78.3^{ab}	6.2	15.5^{ab}	84.5^{a}	1.2
"	"	112	88.5^{a}	71.0^{ab}	8.3	20.3^{ab}	79.3^{ab}	0.5
"	"	322	72.0^{b}	34.3^{c}	9.5	56.2^{c}	43.8^{c}	18.5

* Entries with different superscript letters differ significantly at the 5% level.

** Number of cavities with single or multiple seedlings within 100-cavity block.