GROWING CONIFEROUS SEEDLINGS IN SOILLESS CONTAINERS FOR FIELD PLANTING[1]

G. SCHNEIDER, DONALD P. WHITE, and *RANDALL HEILIGMANN* [2]
Department of Forestry
Michigan State University

Background

A large reforestation effort in North America during the past 40 years has been accomplished almost entirely with bare rooted coniferous stock grown in tree nurseries. Planting bare rooted seedlings is economical, relatively successful, especially for conifers, and can be mechanized. It will probably continue to be the standard method in some forest regions. However, there are a number of adverse soil and site situations, as well as important species differences, for which the use of bare rooted stock is not satisfactory. In such problem situations, planting container-grown trees offers certain advantages not obtainable with conventional nursery stock.

Container planting *per se is* not a new concept. It is used routinely in horticulture and has been widely accepted in the reforestation of many countries, particularly under adverse conditions where special care is needed. As commonly understood, the type of trees that are set out in containers are actually transplants; first produced in conventional nurseries; potted in containers; and then moved to a field in the more favorable container environment. This results in additional handling and production costs, as well as increasing the time necessary to obtain suitable planting stock.

The essential difference between the modern approach described in this paper and conventional container planting is that the coniferous seeds are germinated and the seedlings grown in containers. The period between seed germination and field planting can be as short as 6 weeks and possibly as long as 3 months. In both methods, the economy and production advantages are very promising.

Previous Work

Containerized conifer regeneration systems are an important part of forest management in various parts of the world. They have been described by Siren in Scandinavia (5) and researchers in Canada (2). The concept has gained considerable recognition by forest industry in Canada and the Pacific Northwest (1) . Containerized conifers in these areas are usually produced in small, split-plastic tubes containing a soilpeat mix. Although this rigid type of container has been used for several years in what might be termed full scale commercial production, there has been some dissatisfaction with the system. Of principal concern are the following: (1) The nonbiodegradability of the container; (2) its tendency to "frost heave;" (3) its relative small size *(5/8* in. by 3 in.) and inflexible walls, which hinder the development of a good seedling capable of surviving in a variety of planting sites; and (4) the high costs of filling and seeding the containers. Still unknown is the influence of root system constriction on future tree development including resistance to windthrow.

Recently a "soilless" plant growing-container was produced consisting of a molded block manufactured from an acrylonitrile bonded softwood pulp (3). This container is a product of the American Can Company and has the registered trade symbol of BR-8@. This planting media has received widespread acceptance in several horticultural applications. White *et al. (7)* have reported success in using modified BR-8 blocks for growing several hardwood species. Preliminary investigations have also indicated that the soilless containers can be successfully used to grow coniferous seedlings for reforestation purposes.

This method has also important implications for special uses, such as in the establishment of Christmas tree plantations. The intensive management usually practiced by the Christmas tree industry suggests several useful applications of such containers.

This paper reports the results of our investigations with "conifer seedlings" produced using special containers manufactured from the BR-8 wood pulp material. Various methods of block preparations for seeding, watering schedules, and nutrient regimes were tried. The following procedures gave us the best re-

1 J. Art. 5047. Mich. Agr. Exp. Sta. The work was supported in part by a grant in aid from the American Can Co., Neenah, Wis.

2 Respectively, associate professor, professor, and graduate research assistant.

suits in successfully growing conifer seedlings in soilless BR-8 blocks.

Procedure For Growing Conifer Seedlings In BR-8

Seed.-Whenever possible, the seed should be genetically uniform and stratified by whatever pretreatment is required for optimum germination. In our extensive trials with jack pine *(Pinus banksiana),* seed came from a native stand in Oscoda County, Mich. It was stored at 34° F. and cold soaked at that temperature for 24 hours before sowing. *BR-8* Blocks.-Experimental blocks have been made in several sizes and configurations for these trials. The basic conifer block size used is s/g in. by 5/a in. by 3 in., and it has a small (/4 in. deep) seed slit starting at one edge and extending halfway across the block. Its size is comparable to the split-plastic tubelings, which contain a soil-peat mix, mentioned earlier in this paper. A larger block of similar construction is 1 /8 in. by 1 /8 in. by 4 in. in dimension. Its performance is being evaluated in a program to determine the optimum container size necessary to produce superior plant growth. For forestry applications the fiber layers of the blocks are oriented vertically so that root penetration is unimpeded. Both block sizes have a bulk density of 0.1 gram/cc.

Preparing Blocks For Seeding.-The blocks are placed in a flat, rectangular tray to facilitate handling and watering. An ideal tray can be made from a plastic holder and depth of which is equal to the height of the blocks being used. The bottom of the tray is cut out and replaced with two layers of 16-mesh copper screen oriented at 45° to each other to minimize the effective mesh size of the screening. The copper screen also inhibits root growth below the block. The bottomless tray allows a more uniform distribution of water by subirrigation.

The total dry weight in grams of the blocks, and the weight of the tray and screens should be determined. These weights are used to adjust the moisture content of the containers to an optimum level. *Seeding the* Blocks.-Following weight determinations, the blocks are placed in the tray and seed is pressed into a slit in the top of each block. If the seed is embedded too deeply into the block, the seed coats may "hang up" in the fiber, resulting in seedling mortality. A good "rule of thumb" is to leave approximately one-fourth of the seed exposed.

Two seeds are sown per container to insure that each block will contain at least one good seedling. Thinning to one seedling per block is done later. Once the seed is sown, watering is begun immediately. However, the seeded blocks could be held in cold storage for future use.

Watering.-A principal growth factor in growing seedlings in BR-8 blocks is moisture control. BR-8 will readily absorb about ten times its dry weight of water. However, the range from 400- to 600-percent water content on a dry weight basis is the operating moisture condition for best seedling growth. Before germination the blocks should be kept at or slightly above the upper moisture level.

So that the blocks can absorb water, trays of blocks are placed in a pan containing about 3/4 inch of water. Water absorption is considerably improved if the tray assembly is elevated about /4 inch above the bottom of the watering tray with a layer of mesh screen.

The blocks are allowed to soak up water equal to six times their dry weight. They are not watered again until moisture levels drop to four times (400-percent water content) their dry weight. Each time this minimum weight is reached, the blocks are rewatered until the weight of the water in the blocks is six times the weight of the blocks (600-percent water content). Moisture content can best be measured by placing trays from the watering pan on a towel to remove the excess and then onto a top loading balance (fig. 1). Depending upon growing conditions, small blocks may have to be watered 3 to 4 times a week, while the larger blocks should be watered twice a week.

Water Quality.-Water purity is important in the early stages of growth and can be critical. The BR-8 blocks, as made, are pathogen free. However, they will support algae growth if inoculum is present. To avoid alkalinity from hard water, mineral-free water should be used for the first 2 or 3 weeks.

Fertilization.-Fertilizer is first applied to the seedlings from 2 to 3 weeks after germination. Fertilizer is applied at watering time as a complete nutrient solution modified after Ingestad (4). The frequency of applying nutrient will vary with the species grown and the strength of the nutrient solution. In our studies, two application levels were used on each of the block sizes. Nutrient solution was substituted for water for I entire week (to a maximum of three

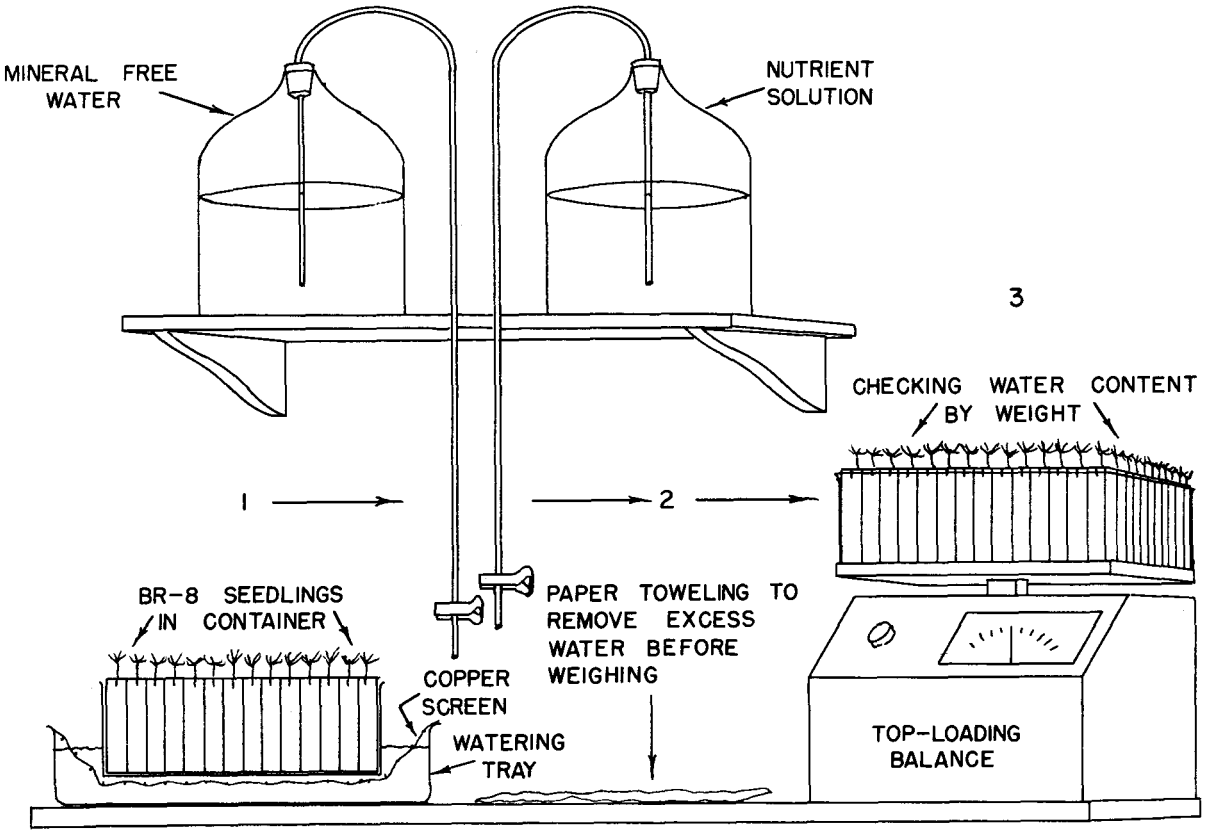

Figure 1.—Procedure for the addition of water and nutrient to growing seedlings in soilless containers.

waterings in any 1 week) and applied either every week or every second week. Algae growth may develop on the blocks but does not appear to interfere with seedling development. The pH of the blocks is approximately 6.5 and should be maintained at this level or slightly lower. The development of an alkaline reaction in the growing medium can result in some new needles showing a yellow tipping. This yellowing can be corrected by adding acidified water (brought to pH 3.0 with H_2SO_4) until the condition is remedied.

Production Schedules.-The time required to grow seedlings suitable for outplanting will vary with the species grown, growing environment, nutrients applied, and block size. Jack pine stock for outplanting has been grown in environmental chambers at Michigan State in 6 to 9 weeks from the time of seeding (fig. 2). The chamber environment consisted of a 14-hour photoperiod with 80° F. and a 70° F. night temperature. Light intensity at the "ground line" should be in excess of 1500 foot candles, although we have successfully produced jack pine seedlings at an intensity as low as 800 foot candles.

Results

Seedling Performance.-Jack pine seedlings grown in BR-8 blocks for 8 weeks according to the procedures outlined were "outplanted" in deep boxes filled with potting soil. The general fertility level of the soil used is characterized by the following analytical data:

Nitrogen	*Phosphorus*	*Potassium*	*Calcium*	*pH*	*Percent O.M.*
P.P.M.	*P.P.M.*	*P.p.m.*	*P.P.M.*		
78.6	*7.5*	*97*	*797*	*5.5*	*7.03*

This soil is low in both phosphorus and potassium, a condition often found on jack pine planting sites.

Seedling height, stem diameter, and ovendry weight of shoots were measured for each of the two nutrient

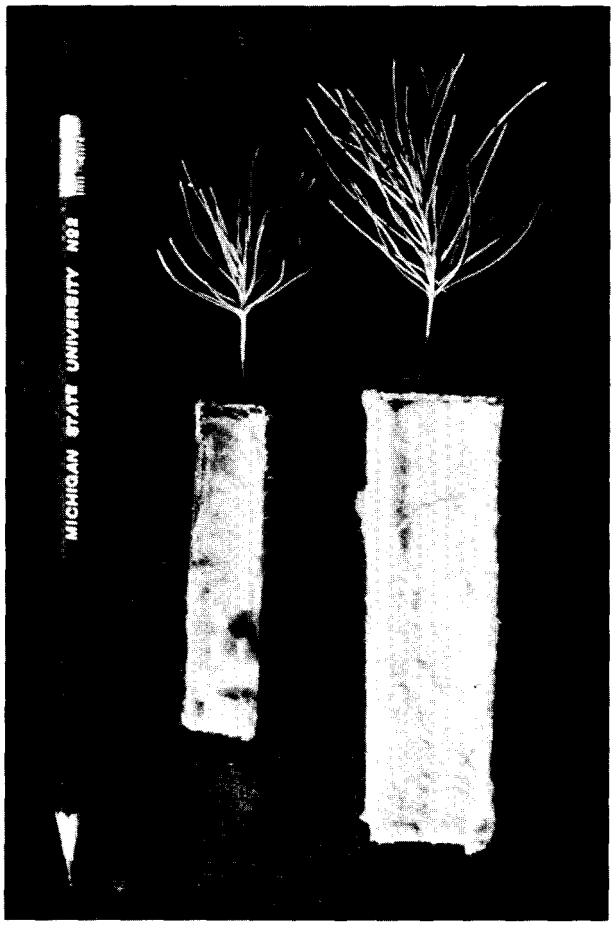

Figure 2.—8-week old jack pine seedlings raised in small and large woodpulp containers. The containerized pine seedlings are ready for planting.

application levels and block sizes 4 months after germination (table 1).

In all seedlings, the greater tree growth was made in the larger blocks. The best treatment was the combination of large block and nutrient application in alternate weeks (Treatment B). Large blocks with nutrients applied with each watering also resulted in excellent growth (Treatment A) but were not significantly better than fertilization every other week, except for terminal height growth (5-percent level).

No treatment difference was found in seedling growth in the small blocks regardless of frequency of nutrient application (Treatment C and D). The larger blocks produced significantly superior seedlings than those in the small container in all growth parameters except terminal growth. Only in height growth was Treatment B (large block and alternate-week nutrient application) significantly superior to all other treatments.

Figure 3 illustrates the growth and development of 4-month old jack pine seedlings grown in both small and large wood pulp containers. This response to block size is impressive. Good growth occurred in the smaller blocks and was comparable to that observed in comparison trials with 20-week-old tubelings grown in split-plastic containers. The greater shoot and root growth in the larger blocks results from the larger block favoring a greater volume of root growth. Roots penetrate the vertically oriented wood fibers and develop easily into the surrounding soil once the containers are planted.

TABLE 1.—*Seedling* [1] *characteristics of 4-month-old jack pine*

Treatment [2]	Block size	Nutrient application	Average shoot weights (oven-dry)	Terminal growth	Stem diameter
			Gm.	*Cm.*	*Cm.*
A	Large	3 x/week, every week	1.40	6.51	.29
B	Large	3 x/week, every 2d week	2.06	8.65	.32
C	Small	3 x/week, every week	0.40	5.11	.16
D	Small	3 x/week, every 2d week	0.55	5.54	.18

[1] The seedlings were raised in small and large wood pulp containers for 8 weeks with two nutrient regimes and then planted in soil.

[2] Treatment B is significantly different (1-percent level) from treatments C and D for all categories. Treatment A is significantly different (1-percent level) from treatment C and D for stem diameter and from treatment C for shoot weights.

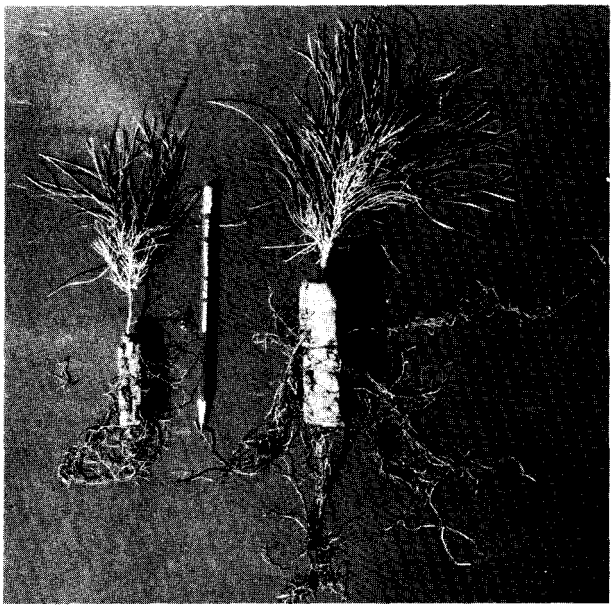

Figure 3.—Four-month old jack pine seedlings raised in small and large woodpulp containers. Seedlings were grown for 8 weeks in containers and then planted in soil.

The relative quality of the seedlings planted from soilless container grown stock can be demonstrated when the seedlings raised in BR-8 are compared with jack pine grown at optimum nutrient levels in sand culture (6). In the sand cultures, ovendry shoot weights were from 0.40 to 0.54 grams at 16 weeks to 2.12 grams at 26 weeks. Soilless container-grown seedlings at 16 weeks varied in ovendry shoot weight from 0.40 grams in the small blocks to 2.06 grams in the large. The seedlings in the large blocks had almost the same shoot growth in 16 weeks as was obtained in nutrient sand culture in 26 weeks.

Furthermore, container grown seedlings were already established in the soil and, under field conditions, would continue to grow with no planting shock as might be expected with bare rooted stock.

Summary

Jack pine seedlings were grown in two sizes of soilless, BR-8 wood pulp blocks for 8 weeks. They were fertilized with a balanced nutrient solution at 1-week and 2-week intervals. The container grown seedlings were then planted in soil and grown under controlled environmental conditions for another 8 weeks.

Best growth of both shoot, stem, and root growth occurred where seedlings were grown in the larger pulp blocks and fertilized every other week. There was no treatment difference, due to fertilization, in seedling growth in the smaller blocks. Growth in the smaller, basic block was comparable to that observed for tubelings grown in split-plastic containers. Following planting, new root development into the surrounding soil was acceptable from all block sizes but superior in the larger blocks.

Field planting of seedlings grown in BR-8 blocks offers an alternative to the conventional use of bare rooted nursery seedlings. Greater establishment success and more flexible planting plans, often in difficult site situations, favors this alternative production method.

Literature Cited

1. Anonymous.
1969. Proc. 60th Western Forestry Conf. Spokane, Wash.
2. Anonymous.
1968. Provisional instructions for growing and planting seedlings in tubes. Ontario Dep, of Lands and Forests, Toronto, Can. 73 p.
3. Beck, G. E., and Adams, J. W.
1966. Propagation and growth of ornamental plants in acrylonitrile stabilized wood pulp. Proc. XVII Int. Hort. Congr. Vol. 1, Summary No. 493, University of Maryland, College Park.
4. Ingestad, T.
1967. Methods for uniform optimum fertilization of forest tree plant. Proc. LU.F.R.O. Congress, Munich.
5. Siren, G.
1967. Mechanizing forest regeneration in Sweden. *In* World Symposium on Man-made forests and their industrial importance. Foreign Agriculture Organization (U.N.) FO/MMF: 67-6/5.
6. Swan, H. S. D.
1970. Relationships between nutrient supply, growth and nutrient concentrations in the foliage of black spruce and jack pine. Pulp and Pap. Res. Inst. Conf., Woodland Pap. No. 19, 46 p.
7. White, D. P., Schneider, G., Lemmien, W.
1970. Hardwood plantation establishment using container grown stock. 5 p.