The Effects of Containers and Media on Sugar Maple Seedling Growth

T. M. Ward, J. R. Donnelly, and C. M. Carl, Jr.
Research Technician and Associate Professor, Department of Forestry, University of Vermont, Burlington; and Research Forester, USDA Forest Service, Northeastern Forest Experiment Station, Burlington, Vt.

Sugar maple seedlings grown for 20 weeks in 9.0-liter plastic containers filled with a peat-perlite-sand medium were larger than those grown in any of eight other container-medium combinations.

Although sugar maple *(Acer saccharum* Marsh.) is the most important commercial hardwood in Vermont, competing vegetation and preferential deer browsing limit plantation establishment (*3*). Greenhouse production of larger planting stock may help alleviate problems associated with deer browsing. Containerized seedlings may further aid plantation establishment by promoting rapid early growth and extending the planting season. This report compares combinations of growing media and containers to identify which produces maximum growth of sugar maple seedlings.

Methods

A total of 162 sugar maple seedlings were grown in a greenhouse for 20 weeks in nine container-medium combinations (all combinations of three media and three containers). The three media were: (1) greenhouse medium—one-third peat, one-third perlite, one-third loamy sand; (2) bark medium—one-half sand, one-half rotted bark with some undecomposed wood fragments; and (3) peat medium—seven-twelfths peat, three-twelfths fine gravel, two-twelfths loamy sand. The three containers were: (1) 1-liter compressed peat and fiber Fertil Pot[1], (2) 4.5-liter Fertil pot, and (3) 9-liter heavy flexible plastic Tuf-Tainer.[2] Two germinated sugar maple seeds were sown in each container on January 11, 1977, and when satisfactorily established, were thinned to one seedling per container. The 162 seedlings were divided into two blocks of 81 seedlings. Plants within a block were arranged in a Latin-square design, nine replications of the nine container-medium combinations, to remove statistically the effects of environmental differences within the greenhouse.

All seedlings were hand-watered as necessary to keep media moist to the touch, but overwatering of some treatments may have occurred because of the close proximity of containers within blocks. Overhead artificial lights, a combination of incandescent and fluorescent bulbs, provided a 16-hour daylength for the first 12 weeks of the study. Diurnal temperatures ranged from approximately 20 to 30 ° C.

[1]Fertil Pots are made by H. Boucher F. et cie, Rambervillers, France.
[2]Tuf-Tainers were made by Dayton Bag and Burlap, Inc., .Dayton, Ohio.

All seedlings were fertilized weekly with liquid fertilizer: Rapid-Gro[3] (23-19-17) during the first 12 weeks, Universal[4] (16 25-16) during the next 4 weeks, and Peters[5] (0-51-34) during the final 4 weeks. All fertilizers were applied at a rate of approximately 2,250 parts per million. After 12 weeks, many plants required support because of extreme succulence, which was attributed to excessive nitrogen. Fertilizers were changed to reduce the amount of nitrogen applied.

After 20 weeks, seedlings were harvested for measurement. Height, diameter (at root collar), shoot weight, and root weight were recorded for all seedlings. Shoot to root ratio was calculated from shoot weight and root weight data.

Results and Discussion

Seedlings attained the greatest size when grown in the greenhouse medium (peat-perlite-loamy sand) in the 9-liter Tuf-Tainer. These seedlings were significantly taller and had a significantly greater shoot weight and root weight than seedlings in any other container-medium combination (table 1). Seedlings growing in the same medium,

[3]Rapid-Gro Distributors, Dansville, N.Y.
[4]Universal Chemical Co., West Lynn, Mass.
[5]Peters Fertilizer Products, W.R. Grace & Co., Allentown, Pa.

Table 1.—*Mean height, diameter, shoot weight, root weight, and shoot to root ratio of 20-week-old sugar maple seedlings (n=18)*[1]

Growth parameter	9-liter Tuf-Tainer with bark medium	1-liter Fertil Pot with bark medium	4.5-liter Fertil Pot with bark medium	1-liter Fertil Pot with greenhouse medium	1-liter Fertil Pot with peat medium	9-liter Tuf-Tainer with peat medium	4.5-liter Fertil Pot with peat medium	4.5-liter Fertil Pot with greenhouse medium	9-liter Tuf-Tainer with greenhouse medium
Height (cm)	8.6	8.4	8.9	20.7	20.7	45.8	75.7	104.6	134.9
Diameter (cm)	0.20	0.21	0.20	0.34	0.33	0.39	0.55	0.62	0.64
Shoot weight (g)	0.29	0.40	0.52	3.84	3.69	8.25	16.38	27.33	33.22
Root weight (g)	0.67	0.72	0.72	2.30	1.95	2.72	4.60	6.63	8.42
Shoot to root ratio	0.43	0.56	0.72	1.67	1.89	3.03	3.56	4.12	3.95

[1]Values connected by the same line are not significantly different at the 0.05 level according to Duncan's new multiple range test.

but in 4.5-liter Fertil Pots, were only slightly smaller.

The effects of container size were readily apparent when results from plants grown in Fertil Pots were examined. Except for seedlings in the bark medium, plants in the 4.5-liter Fertil Pot were significantly larger than those in the 1-liter Fertil Pot. The additional water and nutrients available in the larger pot apparently provided a significantly better environment for seedling growth.

Media effect was most evident in the bark medium. Seedlings in this medium grew only slightly after cotyledons and primary leaves developed. Most of these retained their cotyledons throughout the study. Seedlings were chlorotic and uniformly the smallest, regardless of container size or type. This condition is indicative of a nitrogen deficiency and was probably caused by an overly large fraction of woody material processed with the bark. This resulted in a medium with a high carbon to nitrogen ratio and probably aided a subsequent buildup in micro-organisms, which tie up the available nitrogen. Saprophytic fungal fruiting bodies were common on the woody fragments of this medium. Other studies have shown good results with bark media (*1, 2*), but bark should be separated from wood fragments by seiving during media preparation.

There was a significant interaction between medium and container. Seedlings in the well-drained greenhouse medium grew best in the largest container, the 9-liter nonporous Tuf-Tainer. In contrast, seedlings in the less well-drained peat medium grew best in the smaller, but more porous 4.5-liter Fertil Pot. Algae formed on the surface of peat medium in the Tuf-Tainer, but not in the Fertil Pot. This demonstrates the beneficial effects of porous containers in wicking excess moisture from the imperfectly drained peat medium.

The best container-medium combinations promoted shoot growth more than root growth, i.e., average shoot weight increased by 32.93 grams from the smallest (0.29 g) to the largest (33.22 g) seedlings, whereas average root weight of these same seedlings increased by only 7.75 grams (table 1). Consequently, large seedlings had a significantly higher shoot to root ratio. These seedlings remained vigorous when grown under controlled greenhouse conditions, but their root systems may not be adequate to absorb the necessary water and nutrients after outplanting. Consequently, growers should exercise caution when attempting to predict outplanting success with greenhouse-grown stock.

Literature Cited

1. Benkendorf, A., G. D. Coorts, and R. R. Maleike. 1977. The evaluation of hardwood bark as a propagation medium for some selected herbaceous ornamental plants. Plant Progag. 23:3-4.
2. Mazur, A. R., T. D. Hughes, and J. B. Gartner. 1975. Physical properties of hardwood bark growth media. Hort. Sci. 10:30-33.
3. Yawney, H. W., and C. M. Carl, Jr. 1970. A sugar maple planting study in Vermont. USDA For. Serv. Res. Paper NE-175.14 p. Northeast. For. Exp. Stn.