Growing Container Seedlings: Three Considerations

R. Kasten Dumroese and Thomas D. Landis

Research Plant Physiologist, U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, Moscow, ID; Native Plant Nursery Consultant, Medford, OR

Abstract

The science of growing reforestation and conservation plants in containers has continually evolved, and three simple observations may greatly improve seedling quality. First, retaining stock in its original container for more than one growing season should be avoided. Second, strongly taprooted species now being grown as bareroot stock may be good candidates for container production. Third, miniplug seedlings that combine growth in containers followed by bareroot culturing may be a way to improve bareroot bed density and shorten production cycles. This paper was presented at a joint meeting of the Northeast Forest and Conservation Nursery Association and Southern Forest Nursery Association (Williamsburg, VA, July 21–24, 2014).

Introduction

Seedling production in containers in the Southern United States can be traced back more than two centuries (South 2015). More recently, Balmer (1974) reported more than two dozen tree species had been grown in containers in the South by a variety of public and private nurseries, including seven species of pines (*Pinus* spp.) and six species of oaks (*Quercus* L. spp.). Within a decade, Barber (1982), as keynote speaker to the 1981 Southern Containerized Forest Tree Seedling Conference (Guilin and Barnett 1982), envisioned how container seedlings and their mechanized deployment could be used in the South to improve forest productivity, especially on harsh sites. Appreciable research and guidelines followed, especially for container pines (e.g., Barnett and Brissette 1986, Barnett and McGilvray 1997, Dumroese et al. 2009). The improvements in survival and growth of container seedlings, longleaf pine (*Pinus palustris* Mill.) in particular, fueled a large increase in container seedling production in the Southern United States (Dumroese and Barnett 2004). In 2014, the joint meeting of the Southern Forest Nursery Association and Northeast Forest and Conservation Nursery Association once again had container seedling production as its theme. For nursery managers considering adding container seedling production to their nursery operations, we offer three thoughts for consideration: (1) the problem with holdover stock, (2) the potential to grow strongly taprooted species in containers to higher quality than can be achieved by bareroot culture, and (3) the potential use of minicontainers to grow transplants for plug+1 stock types that could improve seedling quality and reduce production time.

Holdover Stock

For a variety of reasons, nursery managers often find themselves with surplus container stock at the end of the shipping season. This surplus may occur because of shifts in the market, late orders that delay sowing, inaccurate inventories, or poor outplanting conditions. Nursery managers generally have an aversion to throwing away good seedlings because it means throwing away dollars. Although it is tempting, holding stock over from one growing season to the next without either transplanting it to a larger container or growing it as plug+1 seedling is not recommended (Landis 2010). Although only a few studies in the literature address this topic, the conclusions are the same: holding stock over in the same container reduces seedling quality and can result in reduced growth after outplanting or even seedling mortality. Salonius et al. (2002) found that seedling size was significantly reduced 4 years after outplanting when three conifer species (white spruce [*Picea glauca* (Moench) Voss], red spruce [*Picea rubens* Sarg.], and eastern white pine [*Pinus strobus* L.]) were held over in their same containers (figure 1). South and Mitchell (2006) concluded that when stem diameter exceeded a critical threshold in a specific container size (root-bound index), survival of longleaf pine seedlings declined drastically (figure 2). Outplanting survival of Scots pine (*Pinus sylvestris* L.) seedlings grown too long in their containers in Sweden also declined, especially during the second season after outplanting (Josefsson 1991) (figure 3). Because most growers often use a single container type, the solution that would seem to make the most sense, especially in the Southern United States, is to transplant container stock to bareroot beds and grow them as plug+1 seedlings. Given that word of mouth is one of the best marketing tools that nursery managers have, it is unwise to sell poor-quality, held-over stock to customers.

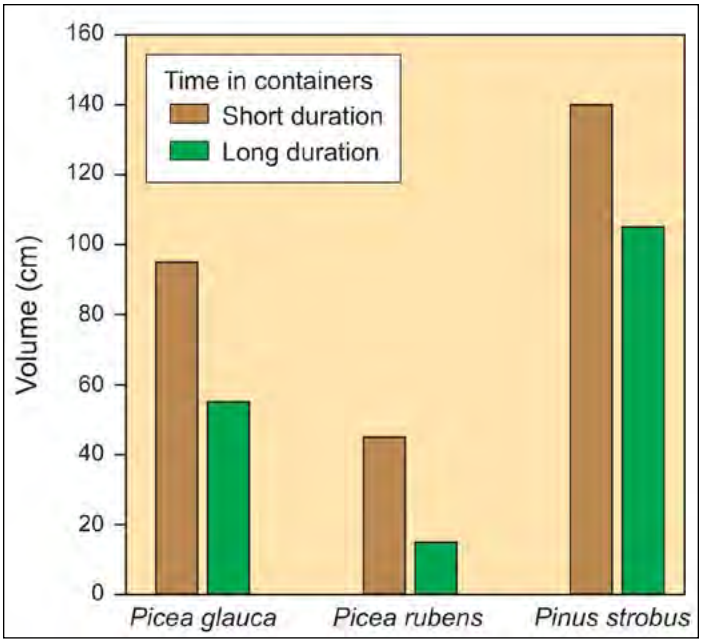

Figure 1. After 4 years on the outplanting site, white spruce (*Picea glauca*), red spruce (*P. rubens*), and eastern white pine (*Pinus strobus*) seedlings kept in their Styrofoam™ containers (170 cm^3 [10 in^3]) for the longest duration (11 months) during nursery production grew less than seedlings grown for a shorter duration (6 months). Adapted from Salonius et al. (2002).

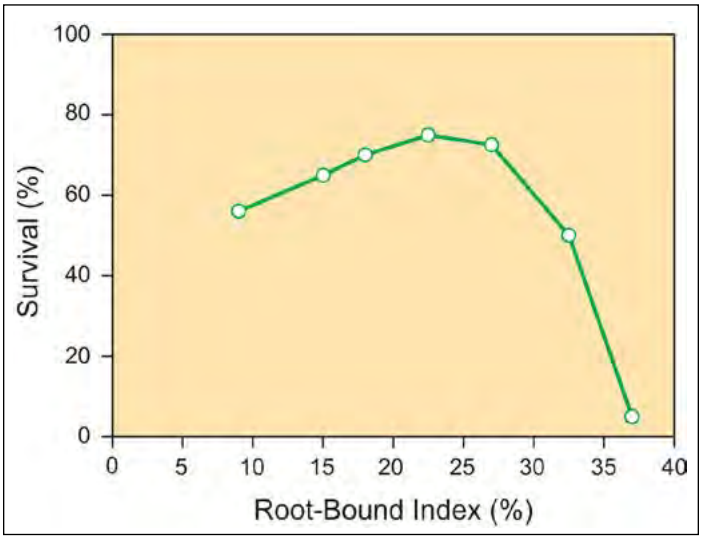

Figure 2. Longleaf pine seedlings that have a root-bound index (ratio of stem diameter to container diameter) exceeding 22 percent had reduced survival after outplanting. Adapted from South and Mitchell (2006).

Taprooted Species

A niche that container nursery managers in the South could explore is production of species with strong taproots, such as oaks and hickories (*Carya* L. spp.). One reason that container production of the strongly taprooted species longleaf pine increased dramatically during the past two decades is because seedling survival and growth exceeded that found with bareroot seedlings (South et al. 2005). It is possible that other taprooted species may respond similarly. For example, Wilson et al. (2007) found that first order lateral root (FOLR) production was much greater in container northern red oak (*Quercus rubra* L.) seedlings than in their bareroot cohorts (figure 4). FOLR proved to be a good prediction of height and diameter growth after outplanting, although not as good as that obtained by root volume (Jacobs et al. 2005). Woolery and Jacobs (2014) found that second year survival of 1-year-old container northern red oak seedlings equaled or exceeded that of 2+0 bareroot seedlings, as did relative height growth (figure 5). Taprooted species, such as hickory, that are challenging to grow as 2+0 bareroot stock (Luna et al. 2014), may respond well to container culture.

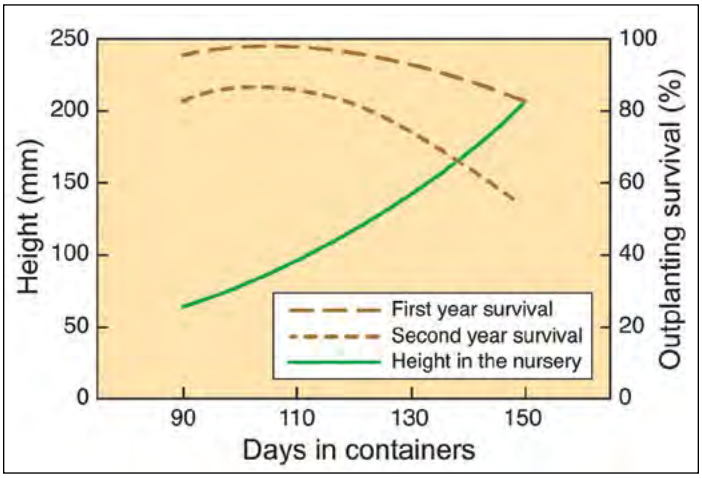

Figure 3. Research done in Sweden with Scots pine shows that survival declined the longer seedlings grew in their containers before outplanting. Adapted from Josefsson (1991) *fide* Rikala (2015).

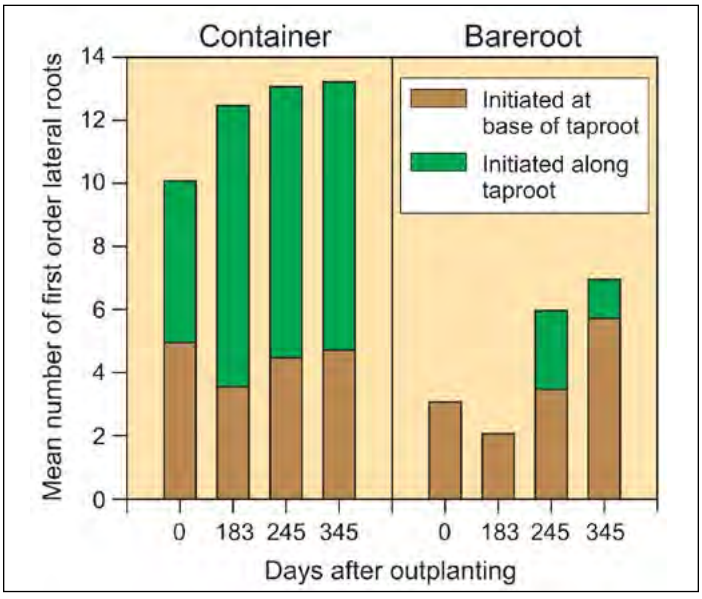

Figure 4. One-year-old northern red oak seedlings grown in containers (Jiffy 5090 Forestry Pellets™; Jiffy Products (N.B.) Ltd., Shippegan, New Brunswick, Canada) had more first order lateral roots originating along, and at the base of, their taproot compared with 2+0 bareroot seedlings at the time of outplanting and 1 year later. Adapted from Wilson et al. (2007).

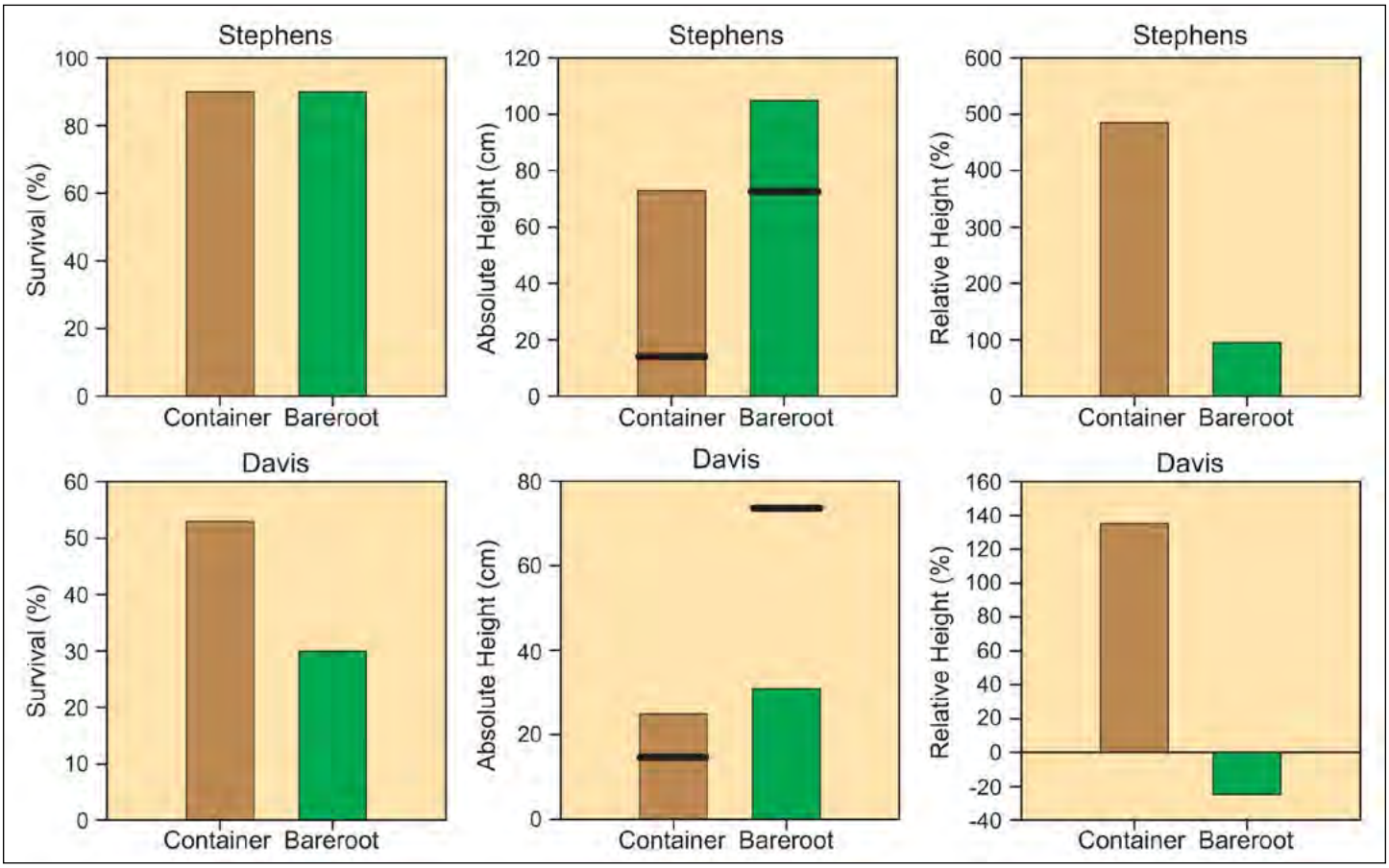

Figure 5. On two upland sites in Indiana (Stephens and Davis), nonbrowsed, 1-year-old container northern red oak (164 m^3 [10 in^3]) had equal or better survival than 1+0 bareroot stock, greater absolute growth (the black horizontal bars indicate height at outplanting), and greater relative growth. (Data courtesy of D.F. Jacobs, from Woolery and Jacobs 2014).

Miniplugs To Improve 1+0s Bed Density and Seedling Quality

In the Western United States, miniplugs developed as a new stock type in the early 1990s continue to be popular for three reasons (Landis 1999, 2007). First, plug+1 seedlings grown entirely in one growing season (6 weeks or so in the greenhouse and the remainder of the growing season in a bareroot bed) can often exceed the quality of traditional 2+0 seedlings. In particular, this stock type develops a very fibrous root system. Second, miniplugs can be transplanted at a more uniform density than can be achieved with machine sowing of seeds (figure 6). Third, nurseries generally do not have to fumigate transplant beds, which, given the increasing costs and restrictions surrounding soil fumigation, adds to the popularity of miniplugs. For seed lots or species with low seed germination or slow growth rates, miniplug transplants may be a way to improve bed density and reduce production time. Although much of the work has been done with conifers, broadleaved trees also thrive as plug+1s; for example, blue oak (*Quercus douglasii* Hook & Arn.) miniplug transplants had similar height and stem diameters compared with 2+0 seedlings, but they had a more fibrous root system (McCreary and Lippitt 1996). The U.S. Department of Agriculture, Forest Service, J. Herbert Stone Nursery (Central Point, OR) is growing some deciduous shrubs as plug+1s (personal observations).

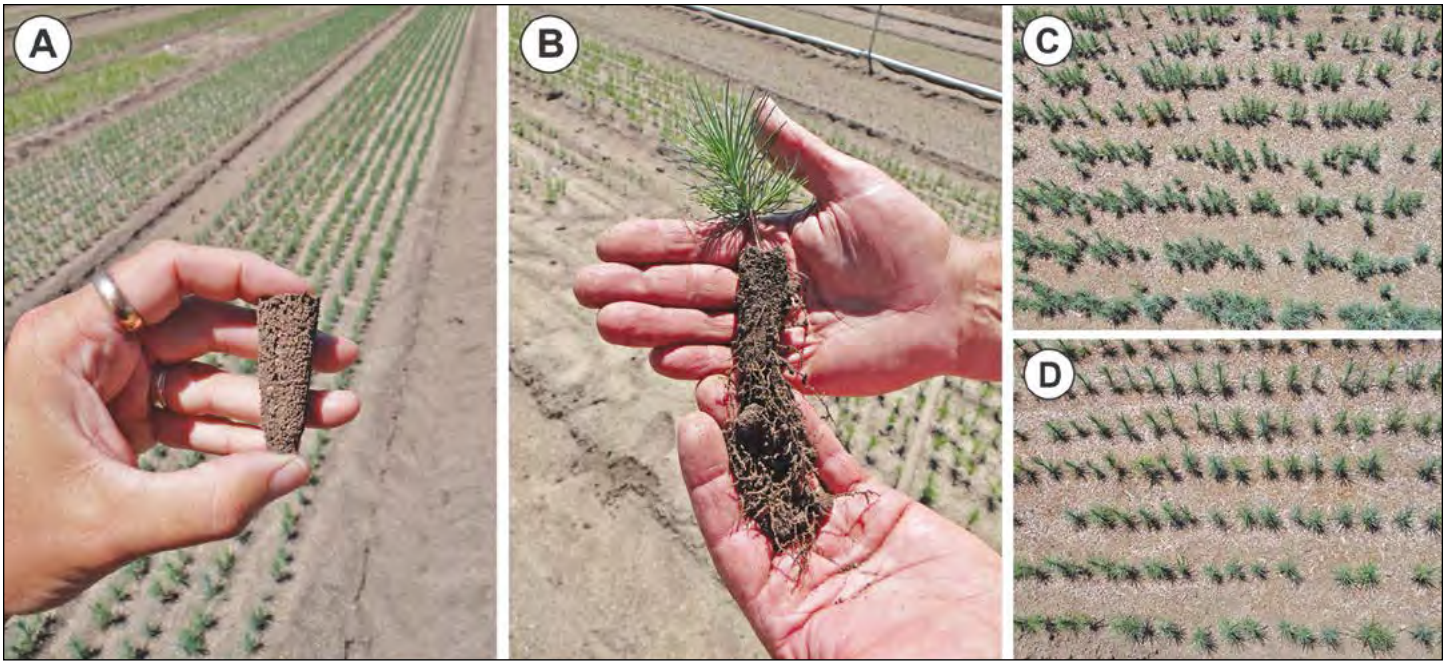

Figure 6. Plug+1 ponderosa pine (*Pinus ponderosa* Lawson & C. Lawson) seedlings growing at the USDA Forest Service, J. Herbert Stone Nursery (Central Point, OR). Production of this stock type begins in early February when stabilized rooting media (QPlug; International Horticulture Technologies, Hollister, CA) (A) is inserted into Hortiblock® 200/19R trays (Beaver Plastics Ltd., Acheson, Alberta, Canada). Plugs are subsequently transplanted into bareroot beds during mid to late April. Rapid growth is evident in the root development after 2 months in the bareroot bed (B). One advantage of transplanting miniplugs is improved bed uniformity; direct sown seeds (C) often have lower bed uniformity than transplants (D). (Photos by R. Kasten Dumroese)

Address correspondence to—

R. Kasten Dumroese, U.S. Department of Agriculture, Forest Service, 1221 South Main Street, Moscow, ID 83843; e-mail: kdumroese@fs.fed.us; phone: 208–883–2324.

Acknowledgments

Trade names are used for the information and convenience of the reader and do not imply endorsement or preferential treatment by the U.S. Department of Agriculture (USDA). This work was supported by the USDA Forest Service, Rocky Mountain Research Station and the National Center for Reforestation, Nurseries, and Genetic Resources.

REFERENCES

Balmer, W.E. 1974. Containerization in the Southeast. In: Tinus, R.W.; Stein, W.I.; Balmer, W.E., eds. Proceedings, North American containerized forest tree seedling symposium. Great Plains Agricultural Council Publication. 68: 38–41.

Barber, J.C. 1982. Reforestation: key to southern forest productivity. In: Guilin, R.W.; Barnett, J.P., eds. Proceedings, southern containerized forest tree seedling conference. Gen. Tech. Rep. SO-37. New Orleans, LA: U.S. Department of Agriculture, Forest Service, Southern Forest Experiment Station: 3–5.

Barnett, J.P.; Brissette, J.C. 1986. Producing southern pine seedlings in containers. Gen. Tech. Rep. SO-59. New Orleans, LA: U.S. Department of Agriculture, Forest Service, Southern Forest Experiment Station. 71 p.

Barnett, J.P.; McGilvray, J.M. 1997. Practical guidelines for producing longleaf pine seedlings in containers. Gen. Tech. Rep. SRS-14. Asheville, NC: U.S. Department of Agriculture, Forest Service, Southern Research Station. 28 p.

Dumroese, R.K.; Barnett, J.P. 2004. Container seedling handling and storage in the Southeastern States. In: Riley, L.E.; Dumroese, R.K.; Landis, T.D., tech coords. National proceedings, forest and conservation nursery associations—2003. Proceedings RMRS-P-33. Ogden, UT: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station: 22–25.

Dumroese, R.K.; Barnett, J.P.; Jackson, D.P.; Hainds, M.J. 2009. 2008 interim guidelines for growing longleaf pine seedlings in container nurseries. In: Riley, L.E.; Dumroese, R.K., tech coords. National proceedings, forest and conservation nursery associations—2008. Proceedings RMRS-P-58. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station: 101–107.

Guilin, R.W.; Barnett, J.P., eds. 1982. Proceedings of the southern containerized forest tree seedling conference. Gen. Tech. Rep. SO-37. New Orleans, LA: U.S. Department of Agriculture, Forest Service, Southern Forest Experiment Station. 156 p.

Jacobs, D.F.; Salifu, K.F.; Seifert, J.R. 2005. Relative contribution of initial root and shoot morphology in predicting field performance of hardwood seedlings. New Forests. 30: 235–251.

Josefsson, M. 1991. Plantstorlekens betydelse för tallplantornas etablering på biologiskt skilda ståndorter i Norrland—Resultat efter två tillväxtsäsonger i fält av 'Plantstorleksprojektets' Serie C. Sveriges Lantbruksuniversitet, Institutionen för skogsproduktion, Stencil 71. In Swedish.

Landis, T.D. 1999. Miniplug transplants. R6-CP-TP-03-99. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Region. Forest Nursery Notes. July (1999): 7–8.

Landis, T.D. 2007. Miniplug transplants: producing large plants quickly. R6-CP-TP-01-2007. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Region. Forest Nursery Notes. Winter (2007): 5–12. http://www.rngr.net/publications/fnn/2007-winter/2007-winter-forest-nursery-notes-1?searchterm=miniplugs. (January 2015).

Landis, T.D. 2010. Managing surplus or holdover nursery stock. Lincoln, NE: U.S. Department of Agriculture, Forest Service, National Agroforestry Center. Forest Nursery Notes. 30(1): 10–12.

Luna, T.; Lindner, D.L.; Dumroese, R.K. 2014. Growing hickories (*Carya* spp.) for roost trees: a method to support conservation of declining bat populations. Native Plants Journal. 15: 66–74.

McCreary, D.; Lippitt, L. 1996. Producing blue oak seedlings: comparing mini-plug transplants to standard bareroot and container stock. In: Landis, T.D.; South, D.B., tech. coords. National proceedings, forest and conservation nursery associations. Gen. Tech. Rep. PNW-GTR-389. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station: 253–254.

Rikala, R. 2015. Personal communication. Research scientist, retired. Suonenjoki, Finland: Finnish Forest Research Institute.

Salonius, P.; Hallett, R.; Beaton, K.; French, C. 2002. Extended nursery rearing compromises field performance of container-reared conifer seedlings. Info. Rep. M-X-214E. Fredricton, New Brunswick, Canada: Canadian Forest Service, Atlantic Forestry Centre. 21 p.

South, D.B. 2015. A history of container seedling production in the South. Tree Planters' Notes 58(2): 44–55.

South, D.B.; Harris, S.W.; Barnett, J.P.; Hainds, M.J.; Gjerstad, D.H. 2005. Effect of container type and seedling size on survival and early height growth of *Pinus palustris* seedlings in Alabama, U.S.A. Forest Ecology and Management. 204: 385–398.

South, D.B.; Mitchell, R.G. 2006. A root-bound index for evaluating planting stock quality of container-grown pines. Southern African Forestry Journal. 207: 47–54.

Wilson, E.R.; Vitols, K.C.; Park, A. 2007. Root characteristics and growth potential of container and bare-root seedlings of red oak (*Quercus rubra* L.) in Ontario, Canada. New Forests. 34: 163–176.

Woolery, P.O.; Jacobs, D.F. 2014. Planting stock type and seasonality of simulated browsing affect regeneration establishment of *Quercus rubra*. Canadian Journal of Forest Research. 44: 732–739.