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Hot Callusing for Propagation of American Beech by Grafting

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Abstract. **To increase grafting success rate, a hot callus grafting system was designed and implemented as part of a multiagency collaborative project to manage beech bark disease (BBD) through the establishment of regional BBD-resistant grafted seed orchards. Five years of data from over 2000 hot callus graft attempts were analyzed using a logistic regression model to determine which factors were important in graft success. Variables having the largest influence included scion genotype, technical problems, health issues (such as chlorosis or dwarfing), and contamination. Very few genotypes had significantly lower success compared with the average genotype, indicating that this method should be widely applicable. Comparison of the hot callus method with traditional grafting demonstrated that the odds of success using the hot callus method were 17 times greater than traditional grafting methods. Hot callus grafting is an efficient method for propagating American beech selections resistant to BBD for the establishment of seed orchards and superior clones with value as ornamentals.**

American beech (*Fagus grandifolia*) is a common, slow-growing deciduous tree native to most of the eastern United States. American beech is monoecious and generally outcrossing (Koch et al., 2010a), but root sprouts are also a common method of regeneration in the forest and may lead to clonal clumps within stands. Mature trees on good sites can reach 50 cm in diameter at breast height and attain heights of over 24 m and generally produce good nut crops on 2- to 8-year intervals after reaching 40 years of age (Tubbs and Houston, 1990). American beech provides food and habitat for over 40 different species of birds and mammals and is an important component of hardwood and mixed hardwood forests in eastern North America (Gysel, 1971; McCullough et al., 2001). It is a significant tree species in urban forests, identified as the species of greatest importance in Washington, DC (Nowak et al., 2006) and listed as one of the most important park trees in Boston (Welch, 1994). Increased public awareness of the value of planting native species has resulted in interest in the use of American beech as a landscape tree as well, recently being named a "problem-free tree for Virginia landscapes" by the Virginia Cooperative Extension (Hansen, 2009).

Beech bark disease has had a devastating impact on American beech in both natural and urban settings and is the most important health problem of beech, significantly limiting its life and use. BBD is a slow-spreading invasive disease complex consisting of the beech scale insect, *Cryptococcus fagisuga*, and either *Neonectria ditissima* or *Neonectria faginata* as the fungal component. Mortality levels in the initial wave of the disease are reported as high as 50%, and surviving trees are left deformed, resulting in the loss of merchantable timber, overall stand health, many wildlife and ecosystem services in forests, and reduced aesthetic value in landscape settings (Ehrlich, 1932; Houston, 1983; Morin et al., 2007). However, some trees are resistant to the insect portion of the complex, which is sufficient to prevent disease and this resistance is heritable (Koch et al., 2010b). Efficient vegetative propagation of scale-resistant American beech genotypes is required for seed orchard establishment for urban and natural forest reforestation, for cultivar development for the landscape and nursery industries, and for conserving germplasm.

Attempts at propagating American beech using vegetative techniques such as rooting of cuttings and micropropagation produced plantlets, but they failed to overwinter (Barker et al., 1997; Loo et al., 2005; Pond, 2008). Top grafting was more successful with take rates of 30% reported in the first year by Ramirez et al. (2007). However, this rate declined to 12% in the second year of their study. In 2002–04, our attempts at traditional grafting of American beech using both side veneer and top cleft graft methods yielded an overall take rate of 19%. In 2002, we contracted a nursery to graft scion that we supplied, and their graft success rate was 17% in the first year with second-year survival of less than 1%. For grafting to be feasible for seed orchard establishment and cultivar propagation, success rates need to be improved. Hot callus grafting (Lagerstedt, 1981), which heats the graft union while keeping the rootstock and scion cool, can significantly increase graft success of woody plants (Avanzato and Tamponi, 1987; Lagerstedt, 1984). Our objective was to use a hot callus system to improve the success rate of grafting BBD-resistant American beech trees and identify factors influencing success rates.

Materials and Methods

Propagation of rootstocks. American beech does not have standard rootstock types or varieties so each grower must collect or purchase nuts to produce seedlings for use as rootstocks. Beech nuts were hand-picked yearly in late September primarily from several large open-grown American beech trees located at the Dawes Arboretum, Newark, OH. Occasionally other nuts from Ludington State Park in Michigan or from cross-pollinations between Dawes and Ludington beech trees were available and used to produce rootstocks. The nuts were allowed to air-dry at room temperature until the burrs opened and the seed could easily be removed. Seeds were placed directly into cold, moist stratification at 4 to 8 °C. The stratification medium was sphagnum moss (NoDampOff; Miller Lee, Millston, WI) wetted with 0.5 g·L^{-1} of Banrot (The Scotts Company, Marysville, OH) and then hand-squeezed to remove excess water. Germination occurred after a minimum of 120 d in stratification with rates typically in the 75% to 90% range. Germinants were sown into small Deepots (D16; Steuwe and Sons, Inc., Tangent, OR). The growing media consisted of Metro Mix® 510 (The Scotts Company) amended with 47 g Micromax micronutrients (The Scotts Company), 477 g Osmocote® Plus 15N–3.9P–9.9K (The Scotts Company), 700 g coarse perlite, and 75 g aluminum sulfate per 2.8 cu. ft bag. The seedlings were fertilized once per week with soluble 17N–1.3P–14.1K at 200 ppm nitrogen. Seedlings were transplanted to larger 2.8-L round pots or square Treepots (TP49;

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