Improving Adaptability of European Beech with Stress-tolerant Rootstocks

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Nature of Work: European beech (*Fagus sylvatica*) is grown throughout Europe and the United States for its ornamental characteristics, including majestic form, glossy leaves, and smooth, gray bark. Species, such as *Fagus sylvatica*, native to cooler, more temperate climates often decline when planted in hot, humid environments, including the southeastern United States. Fifteen years of ornamental plant adaptability trials at The JC Raulston Arboretum have suggested the critical limitation is root survival under wet, hot conditions (Raulston, 1995). Strong summer downpours on heavy clay soils result in soil that may remain saturated for several days. Repetition of these conditions in combination with warm temperatures can lead to a gradual decline in health, and eventually death.

Grafting can be used to produce compound plants that combine scions of superior ornamental quality with stress-tolerant rootstocks suitable for the area in which they will be grown. Cultivars of *Fagus sylvatica* are commonly grafted onto seedling rootstock of the same species. Other species of Fagus may tolerate conditions of high temperature and poor drainage better than *F. sylvatica.* Very little research, however, has been conducted on potential rootstocks for ornamental plants (Raulston, 1995). Therefore, the objective of this research was to evaluate the response of three species of Fagus (*F. sylvatica, F. grandifolia,* and *F. orientalis*) to high temperature and root-zone inundation for use as stress-tolerant rootstocks.

The experiment, a 3 x 2 x 3 factorial experiment in a randomized complete block design with 40 replications was conducted in glass greenhouses at the Southeastern Plant Environment Laboratory (Phytotron), Raleigh. Main factors were three Fagus species (*F. sylvatica, F. grandifolia,* and *F. orientalis*), two temperature regimes, and three levels of flooding (non-flooded, intermittent flooding, and flooded).

Temperature regimes consisted of 9 hr day/ 16 hr night thermoperiods of 30/26 °C (86/79 °F) and 22/18 °C (72/64 °F). Flooding treatments were accomplished by inserting the growing container into an identical container lacking drainage holes resulting in the substrate being covered by about 2 cm (0.8 inch) of water. The flooded treatment (F) lasted 30 days.

Intermittent flooding (I) consisted of a repeating sequence of 6 days flooded and 4 days non-flooded, respectively over a 30 day period. Non-flooded (NF) trees were never flooded.

Two-year old seedlings of *Fagus sylvatica, F. grandifolia*, and *F. orientalis* were purchased bareroot in January 1997, and stored at 4 °C (40 °F) until potting. On March 28, 1997, seedlings were potted into 3 quart containers with an 8 pinebark : 1 sand substrate (by vol.) amended on a yd3 basis with 5 lbs dolomitic limestone and 10 lbs of Osmocote 15-9-11 (with minors).

The dormant seedlings were moved to the Phytotron March 29, 1997. Trees were grown for 85 days in the respective temperatures before flooding treatments were initiated June 25 [0 Days After Flooding (DAF)] and terminated July 25 (30 DAF). Ten trees of each species from each temperature regime and flooding treatment combination were harvested on July 28-29. Prior to flooding (June 23-24), 10 plants of each species were harvested from each temperature regime.

At each harvest, trees were separated into leaves, stems, and roots for dry weight measurement. Total plant height, stem diameter at soil level, and leaf number and area were also determined. Net photosynthesis (P_n) and stomatal conductance (g_s) were determined nine times throughout the experiment. Leaf gas exchange was measured with a LI-COR LI-6200 closed portable infrared gas exchange system. An attached leaf was placed in a 0.25 liter (165.4 cm^3) cuvette for 30 sec. Measurements commenced immediately after CO_2 concentration decreased. CO_2 concentration ranged from 350 to 390 $mg.liter^{-1}$ (ppm). Data were subjected to analysis of variance (ANOVA). Mean separations were performed via least significant difference (LSD) procedure at $P = 0.05$.

The remaining trees were grown in non-flooded conditions for the rest of the experimental period at the designated temperature regimes. At the end of the growing season, trees were moved to an outdoor gravel pad and placed in an overwinter structure. Flooding treatments and measurements will be repeated in 1998 to examine the residual effects of flooding over time.

Results and Discussion: There was a significant species x flooding treatment interaction for most P_n and g_s measurements, whereas the flooding treatment x temperature interaction was not significant. Therefore, the response of each species to flooding is presented separately averaged over temperature (Fig. 1). Each species showed a significant decrease in g_s at 1 DAF (data not presented), whereas P_n was not affected by flooding until 4 DAF for *F. sylvatica* and *F. orientalis*. A decrease in Pn and gs are often the first signs of flooding stress (Ranney, 1994). Net photosynthesis of *F. grandifolia* that was flooded (F) was not significantly different from the non-flooded trees until 7 DAF . Highly significant decreases in both net Pn and gs were evident in flooded and intermittent flooded trees from 7 to 30 DAF in all species. Recovery of P_n from flooding treatments (F, I) differed by species. Thirteen days after flooding had been terminated (43 DAF), *F. grandifolia* that was intermittently flooded had returned to Pn levels in non-flooded trees. Net photosynthesis of flooded F. grandifolia had fully recovered 41 days after flooding had been relieved (71 DAF). Neither *F. sylvatica or F. orientalis* had recovered from either flooding treatment (F, I) by 41 days after flooding treatments were terminated (71 DAF). In addition, increase in total tree dry weight of F. grandifolia was greater than the other Fagus species in the 30/26 °C (data not presented).

Significance to Industry: Results herein suggest that of the three Fagus species in this study, *F. grandifolia* has the greatest tolerance of flooding and high temperature stress. Given the typical summer conditions in the southeastern United States, *F. grandifolia* may have potential as a superior stress-tolerant rootstock for European beech.

Literature Cited:

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