

Performance of the Container-Grown BC₃F₃ Generation Seedlings of American and Chinese Chestnuts in Central Louisiana

Shi-Jean Susana Sung¹, Stacy Clark², Scott Schlarbaum³, Daniel Dey⁴, Robert Makowski⁵, James D. Haywood¹

¹USDA Forest Service, Southern Research Station, Pineville, LA; ²USDA Forest Service, Southern Research Station, Knoxville, TN; ³University of Tennessee, Knoxville, TN; ⁴USDA Forest Service, Northern Research Station, Columbia, MO; ⁵USDA Forest Service, Southern Region, Atlanta, GA

The chestnut blight fungus (*Cryphonectria parasitica*) was first reported in New York City in 1904. Within 50 years, it killed 4 million American chestnut (*Castanea dentata*) trees over 200 million acres of its native range. Today, young trees (from stump sprouts) grow to 3-6 m but eventually succumb to the blight. The restoration strategy used by the American Chestnut Foundation include the following steps: (1) Backcrossing the American (timber type) and blight resistant Chinese (*C. mollissima*, orchard type) hybrid to the American parent to acquire the blight resistant genes from the Chinese parent and to recover the other traits of the American parent; (2) Intercrossing the blight-resistant backcross with another line of blight-resistant backcross to remove the blight susceptible traits while keeping maximum American traits; (3) BC₃F₃ -- sixth generation, 93.75% American timber characteristics, 16% seedlings with full blight resistance similar to Chinese parent; and (4) Small scale field deployments of the BC₃F₃ seedlings in NC, TN, KY, PA, CT, and IN.



5th Year BC3F3 chestnut saplings infected by the blight showing a sunken and dried spot on the stem, sometimes accompanied by orange fruiting bodies (photo by Stacy Clark).

Between 2009 and 2011, Clark outplanted over 4000 1-0 bareroot seedlings of American, Chinese, BC₁F₃, BC₂F₃, BC₃F₂, and BC₃F₃ on several National Forests in NC and TN. She found that one planting in 2010 and six plantings in 2011 were succumbing to a root rot disease (*Phytophthora cinnamomi*) and verified that this fungus was present in the bareroot nursery and in some of the planting sites.

This study tested feasibility of growing back-crossing seedlings of the American (*C. dentata*) and Chinese chestnut (*C. mollissima*) in containers to avoid root rot fungus (*P. cinnamomi*) in the bareroot nursery especially during wet years. Seedlings from two families of the BC3F3 generation, D3862 and W4938, were grown at the Forrest Keeling Nursery (Elsberry, MO) with their Root Production Method[®] in 2013. Seedling culling was conducted at the initial leaf formation in a greenhouse. All kept and culled seedlings were transplanted into open-end square containers of three sizes, 1.32 L, 1.58 L, and 2.64 L.



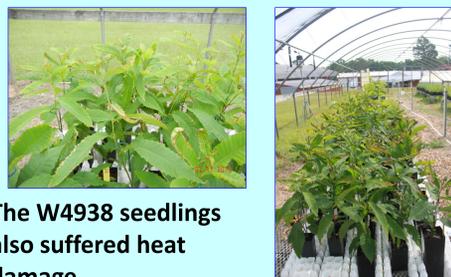
Open-end square containers used to grow chestnut seedlings until outplanting.
(L) 7.6 x 7.6 x 22.9 cm, 1.32 L;
(M) 10.2 x 10.2 x 15.2 cm, 1.58 L;
(R) 10.2 x 10.2 x 25.4 cm, 2.64 L.

Eighteen D3862 and 37 W4938 seedlings were transported in their original containers to Pineville, LA in mid-June, 2013 and cultured under field conditions. In late June, some seedlings began to show heat damage on their leaves. A layer of 30% shade cloth was used to cover the iron frame over the seedlings to lower the temperature and light intensity.



A D3862 seedling (L) and a W4938 seedling (M) in 1.58 L containers.

Seedlings #1-#4 (D3862) with leaves showing heat damage.



The W4938 seedlings also suffered heat damage.

Even with a 30% shade cloth, heat damage on leaves continued through late August.



The root system of a W4938 grown in the 1.32 L container was assessed in early September. Tap root was 3 cm long and with 3 sinkers.



The root system of a W4938 grown in the 1.58 L container was assessed in early September. Tap root was 3.1 cm long and with 4 sinkers.



The root system of a W4938 grown in the 2.64 L container was assessed in early September. Tap root was 2.1 cm long and with 5 sinkers.

Regardless of the container depth, taproots of the chestnut seedlings were similar in length yet very short. This was caused by damaging the root tip (open arrows) during transplanting young seedlings from a shallow germination tray (about 3 cm deep) into the open-end containers. Sinker roots were formed at the end of the damaged taproots during culture and most of them reached the container bottom.

By September, D3862 seedlings were about half in height (30 cm) and dry weight (13 g) compared to the W4938 seedlings. Most of the small-size D3862 seedlings also had small root systems except for a few (e.g., #15, R) that had similar root system size as most of the W4938 seedlings. Due to small sample size in each treatment combination, the effect of nut size, culling, or container volume on seedling development was not determined.



Seedling #15 with 79 cm height and 39 g dw.

Twenty-four seedlings were stored in a cold room until outplanted on the Palustris Experimental Forest in mid-March, 2014. By September of 2014, 53 and 67% of the W and D seedlings were dead. High summer temperature and local wet spots probably caused high seedling mortality.



Seedlings outplanted in March, 2014 (L); a D3862 (M) and a W4938 (R) seedling in May, 2014.



Like most of seedlings in row 1 (arrow) which is lower in topography than the other two rows, this W4938 seedling died between May and July, probably from the excessive rain in May.



Like the nursery seedlings, outplanted seedlings also suffered from high temperature in central Louisiana.



The root system of an outplanted W4938 seedling that died between May and July showing little new root growth.



Neither the hot, humid weather nor the less fertile Beauregard silt loam soil in central Louisiana is conducive to the growth of American chestnut seedlings.

Seedlings grown in containers of different dimensions did not differ in their root system morphology. It is not clear whether taproot length is critical for survival and growth in this study.