Breeding Ornamental Hazelnuts (*Corylus*)©

John Capik and Thomas J. Molnar
Plant Biology and Pathology Department, Rutgers University, Foran Hall, 59 Dudley Road, New Brunswick, New Jersey 08901 U.S.A.
Email: capik@aesop.rutgers.edu; molnar@aesop.rutgers.edu

INTRODUCTION

Hazelnuts are a highly underutilized plant in the U.S.A. primarily due to the presence of eastern filbert blight (EFB), a disease caused by the fungus *Anisogramma anomala*. Eastern filbert blight is a native North American disease that is tolerated by *Corylus americana*, the wild American hazel, but is lethal to *C. avellana*, the European hazel grown for nut production and ornamental use. Eastern filbert blight causes cankers with conspicuous stromata to form along stems, causing dieback from the tips and eventual girdling of the stem (Fig. 1). Eastern filbert blight can kill susceptible plants in 2–5 years, although some possess various degrees of tolerance.

Figure 1. Eastern filbert blight on 'Contorta' (Harry Lauder's Walking Stick).

Breeding at Rutgers University began in 1996, when Dr. C. Reed Funk and Thomas Molnar began a genetic improvement program for underutilized perennial crops. Hazelnuts were chosen for their hardiness, wide adaptive range, valuable nut crop, and ornamental value, among other characteristics (Fig. 2). After establishing hazelnuts as the primary focus of the program in 2000, the search for disease resistant germplasm began. Collection efforts ranged throughout Europe and Asia, while still obtaining native germplasm from the U.S.A. and Canada. These collections have enabled us to acquire over 15 unique sources of genetic resistance to EFB for use in our breeding program.

Figure 2. Eastern filbert blight resistant, high-yielding hazelnut selection from the Rutgers breeding program.

DISEASE SCREENING

Our seedlings undergo intensive greenhouse inoculations in a mist chamber designed to simulate optimal environmental conditions for infection by *A. anomala* (Fig. 3a, 3b) (Molnar et al., 2005; 2007). In addition, each spring, every plant that makes it to the field evaluation stage is further inoculated with diseased wood (Fig. 4) to create artificially high disease pressure, ensuring that resistant plants hold up under extreme conditions.

***Corylus avellana* 'Contorta'.** The contorted hazelnut, better known as Harry Lauder's walking stick, has been the most popular and well known ornamental hazelnut since its introduction in the mid 1800s (Fig. 5). The contorted habit is controlled by a single recessive gene (Smith and Mehlenbacher, 1996), making breeding efforts to recover contorted seedlings difficult and requires multiple generations. Unfortunately, 'Contorta' and the new purple-leaf release 'Red Majestic'[PBR] have both shown high susceptibility to EFB in our disease resistance trials at Rutgers (Figs. 6a and b). Our goal is to release both purple- and green-leaf contorted plants carrying complete EFB resistance.

We recovered green-leaf contorted seedlings for the first time in 2007, and purple-leaf contorted seedlings in 2008, and have been exposing them to severe disease pressure ever since. We are currently evaluating a number of new contorted hazelnut seedlings from our breeding program in the field that have undergone our greenhouse disease screening procedure and show no sign of infection (Figs. 7a, b, and c). Our EFB-resistant purple- and green-leaf contorted hazels are selected for vigor and hardiness, along with other ornamental traits, including leaf color and texture, degree of "contortedness," catkin, and nut cluster proliferation, etc. A new purple-leaf contorted hazel 'Red Dragon' PP20694 from Oregon State University

Figure 3a. Outer view of greenhouse inoculation chamber.

Figure 3b. Inner view of inoculation chamber.

Figure 4. Field inoculations of hazelnuts with diseased wood.

Figure 5. 'Contorta' at King Estate Winery, August 2011.

Figure 6a. Three-year-old 'Contorta' plant with EFB.

Figure 6b. Close-up view of eastern filbert blight on 'Red Majestic'[PBR]. Both 'Contorta' and 'Red Majestic' plants showed significant eastern filbert blight growth after disease screening at Rutgers.

Figure 7a. Three-year-old EFB-resistant contorted hazelnut in the field at Rutgers.

Figure 7b. New contorted seedlings in the greenhouse.

Figure 7c. Our first generation of red contorted seedlings were recovered in 2008.

contains a promising gene for EFB resistance, but the cultivar has not undergone testing at Rutgers yet (Mehlenbacher and Smith, 2009).

PURPLE-LEAF HAZELS

In addition to the standard green color, hazelnuts also come in purple. The purple color is vibrant in the spring and will fade to dark green during the hot summer months, with the duration depending on the genotype and weather conditions. We are presently testing several purple-leaf hazel clones with highly ornamental nut clusters for performance in multiple sites (Fig. 8a, 8b). These plants have undergone extensive disease screening and should be EFB resistant under any conditions. The nut clusters of these purple-leaf plants are also very striking and maintain their vibrant color throughout the entire season. Purple-leaf plants also have purple catkins in the fall and winter and they produce edible nuts.

We are currently screening a population of over 800 hybrid purple-leaf seedlings for a new trait, fall color (Fig. 9a, 9b). Fall color, which is derived from *C. americana*, shows up in late summer/early fall and can produce a striking array of colors for up to several weeks before leaves drop.

FUTURE POSSIBILITIES

We have begun breeding for several other ornamental *Corylus* traits to combine with strong EFB resistance. This includes cutleaf (Fig. 10a), weeping (Fig. 10b) (Mehlenbacher and Smith, 1995), and combinations of these with 'Contorta' and fall color, including weeping/cutleaf, contorted/cutleaf, and contorted, weeping, and cutleaf, all with fall color, among others. Tree forms also exist in *C. colurna*, *C. chi-*

Figure 8a. Purple-leaf selections in the field at Rutgers University.

Figure 8b. Ornamental, purple-leaf nut clusters.

Figure 9a and b. Fall color comes in shades of pink, orange, yellow, and red. These plants also have dark purple leaves in the spring. We are working to select the plants with superior fall color, persistent purple spring and summer color, attractive nut husks, and resistance to EFB.

Figure 10a. *Corylus avellana* 'Cutleaf'.

Figure 10b. *Corylus avellana* 'Pendula'.

nensis, and *C. fargesii*. We have bred hybrid seedlings of all 3, with the peeling bark trait *of C. fargesii,* corky bark of *C. colurna*, and single-stemmed growth habit of *C. chinensis* being of particular interest.

CONCLUSIONS

Eastern filbert blight is a lethal disease that takes several years to kill susceptible trees, while causing them to look increasingly blighted. At Rutgers University we have developed a diverse collection of EFB-resistant germplasm and have been using this in breeding ornamental hazelnuts for over 10 years. Eastern filbert blight resistance will help increase the market value and shelf life of ornamental hazels while decreasing loss due to disease. Upcoming, novel, widely adapted, and attractive cultivars will be released from Rutgers that contain stable EFB resistance from various sources across the world.

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