Hazelnuts, A Potential New Crop for the Northeast: An Update on the Rutgers University Breeding Program

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Rutgers University is committed to developing hazelnuts as a new commercial crop for New Jersey and the northeastern states. Hazelnuts rank fifth in tree nut production worldwide, behind cashews, walnuts, almonds, and chestnuts. We feel confident that new selections of hazelnut will be adapted for commercial production.

Having said that, the Rutgers hazelnut breeding program is still 2-3 years away from releasing our first Eastern Filbert Blight (EFB)-resistant cultivar. We are waiting for results of regional yield trials to make our final decisions. Our ultimate goal is to identify plants that will be consistently productive, disease-resistant, and well-adapted to a multitude of locations across the northeast states.

Turkey is the world's leading hazelnut grower, producing over 70% of the world's crop in some years. Only 4-5% of the world's crop is produced in the United States, 99% of which is grown in the Willamette Valley of Oregon (Figures 1 and 2). Commercial production of hazelnut has been limited in the eastern United States due to the fungal disease eastern filbert blight (EFB), which is endemic to this region. Today, this disease is also present in Oregon and adds significant expense and challenge to hazelnut production. It should be noted that EFB in not present anywhere in the world outside of North America.

The limitation for eastern growers of hazelnuts is

Figure 1. A hazelnut seedling block in the breeding program at Rutgers University. Photo credit: Thomas Molnar.

Table 1. The genetic populations resolved by simple sequence repeat markers when evaluating over 300 hazelnut cultivars and seedlings, and the number of eastern filbert blight-resistant accessions placed in each.

Table 1-Genetic Population/Group	Number of Eastern Filbert Blight resistant trees
Wild population 1	5
Wild Population 2	2
Wild Population 3	11
American x European hybrid group	44
Black Sea group 1	28
Black Sea group 2	25
Gellately hybrid group	15
Wild European species group	26
Spanish-Italian group	9
Moscow group	33
Central European group	25

the disease, Eastern filbert blight, which causes large cankers that girdle stems, which typically kill susceptible trees within a few years of infection. Although expensive fungicides and rigorous pruning regimes can be used to manage the disease, genetic resistance is the most promising and sustainable method of control. See the Hazelnut article in the Spring 2013 Issue of Horticultural News or Fruit Notes.

The Rutgers hazelnut breeding program has numerous promising selections that have resistance to EFB and look promising for adaptation in the Northeast.

History of the Rutgers Breeding Program

The hazelnut breeding program at Rutgers University, in close collaboration with Oregon State University, has made great strides over the past 10 years in identifying sources of resistance to EFB. Many of these resistant plants have come from seed collection trips made across the former Soviet Union, Eastern Europe, and Turkey. In many cases, nuts were simply purchased from local markets in rural areas where the European hazelnut is grown in backyard gardens. The nuts were brought back to Rutgers and germinated Resulting seedlings were grown in fields exposed to high levels of the disease. While most trees died, around 2% were found to be resistant or highly tolerant. The best of these disease-resistant trees are now being used in the Rutgers breeding program to develop cold-hardy, productive plants adapted to the northeastern United States (See Figure 1).

A study published in the July 2014 issue of the Journal of the American Society for Horticultural Science titled "Characterization of Eastern Filbert Blight-resistant Hazelnut Germplasm using Microsatellite Markers" illustrates the latest molecular tools being used at Rutgers University to elucidate the genetic relationships and origins of the new plants. The study included over 100 of the new seedlings as well as a wide representation of the world's hazelnut germplasm (cultivars from Turkey, Italy, Spain, France, Germany, etc.). The goal was to place the origin of the new seedlings and assess how they were related since many of them come from open-pollinated seed and have largely unknown origins.

In summary, the study grouped the collection of over 300 total plants into 11 distinct genetic populations (Table 1). It was found that seedlings from similar origins tended to group together with known cultivars of similar origins, providing support that the new plant material was regionally distinct and representative of local germplasm. Interestingly, each of the 11 "populations" held EFB-resistant seedlings and cultivars, which shows that EFB-resistance is found across a very wide diversity of plant material. This information has significant value for hazelnut breeders, as it suggests that disease resistance can be maintained in breeding efforts without sacrificing genetic diversity. Further, several of the genetic "populations" were comprised largely of the new EFB-resistant seedlings, suggesting that new sources of resistance were identified or, at the very least, resistance was found in plants from distinctly different genetic backgrounds.

In addition, the new genetic information can assist breeders in choosing which plants to keep or cull out of the breeding program to save field space and better manage large collections of trees. For example, Figure 2 shows three promising disease-resistant accessions

Figure 2. New eastern filbert blight-resistant hazelnut accessions from Russia and Crimea in comparison to known cultivars. Top row from left to right : Holmskij Market #1-1 (Holmskij, Russia), Simferopol Market #1B-3 (Simferopol, Crimea), and Nikita Botanical Garden #1-3 (Yalta, Crimea). Bottom row from left to right: 'Santiam', 'Barcelona', and 'Gasaway'. The genetic study showed that the top three accessions, although collected from different regions, were very closely related.

with improved nut quality (top row) in comparison to known cultivars (bottom row). Through the results of this study, it was shown that all three new seedlings are closely related despite being from different collection origins. Thus, only the best one of the three will be used in future breeding efforts, which frees valuable field space and helps concentrates breeding efforts towards using resistant plants from diverse genetic sources.

Female hazelnut flowers

Male hazelnut catkins shed pollen in late winter.