

Fact Sheet #1—Choosing Hazelnut Plants

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Introduction

The focus of this fact sheet is to help beginning hazelnut growers decide what plants to buy and grow. Until recently, the only option for growers in the Upper Midwest has been American hazelnut or hybrid seedlings, as there have been no proven cultivars available. This is changing fast, however, as private and public breeding programs are in the process of releasing new cultivars with plants becoming available as early as 2020. With these new options coming, it is important for growers to have a good understanding of some basic nursery terminology to make good purchasing decisions.



Understanding Your Options

Hazelnut Species

The global hazelnut industry is based on European hazelnut (*Corylus avellana*), but the currently available cultivars of European hazelnut are not reliably hardy in the Upper Midwest and, thus, have not been widely planted. European hazelnut does occur in the wild in colder regions of Eastern Europe. Tom Molnar of Rutgers University has collected seed in those areas and maintains a collection of that germplasm, but as of yet, there are no hardy *C. avellana* cultivars for the Upper Midwest.

There are two species of hazelnut native to the Upper Midwest, American hazelnut (*Corylus americana*) and beaked hazelnut (*Corylus cornuta*). Both are small shrubs with American hazelnut found mainly on sandier soils in open sun and beaked hazelnut on richer soils in part shade. Both produce small edible nuts, but American hazelnut tends to be more productive. Open pollinated seedlings of American hazelnut are widely available from private and public sources, including the Department of Natural Resources (DNR) and are typically inexpensive. Although beaked hazelnut seedlings are available, they typically are not as widely planted, because they don't produce the same volume of nuts. Because of the small nut size, both species are mainly used in wildlife plantings.

Breeding for the Upper Midwest has focused on hybrid hazelnuts. The idea has been to cross American hazelnuts with European hazelnuts in order to combine the winter hardiness and disease resistance of

American hazelnut with the yield and nut size of European hazelnut. Private and public breeders started making such crosses in the early 1900s largely as hobbies and progress and distribution of the material was sporadic and very limited. Starting in the 1990s, Badgersett Research Corporation and Forest Agriculture Enterprises, the Arbor Day Foundation, and others began selling hybrid seedlings to growers in the Midwest in significant numbers. Though individual plants can produce impressive yields, the average yields of these seedlings have been too low to support commercial nut production and the industry has stalled. The focus by breeders has been to find the best seedlings to produce cultivars.



Most hazelnuts grown in the Upper Midwest right now are hybrid seedlings from crosses between American hazelnut (*Corylus americana*) and European hazelnut (*Corylus avellana*). Though the yields of individual plants can be impressive, the average yields have not been high enough to support commercial production.

In 2007, the University of Minnesota and University of Wisconsin launched the Upper Midwest Hazelnut Development Initiative (UMHDI) to work with the seedling growers to identify their very best seedlings and evaluate copies of them in replicated performance trials. The top 12 of these seedlings are now being propagated through tissue culture and will be made available to growers as cultivars starting in 2020. At the same time, the Arbor Day Foundation and the University of Nebraska, in cooperation with Rutgers University and Oregon State University began evaluating the best hybrid material from their collections and they will be releasing two cultivars in 2020. They are also propagating 'Grand Traverse', an earlier hybrid selection, for distribution to growers. Private breeders including Grimo Nut Nursery in Ontario, Canada and Z's Nutty Ridge in Cortland, New York, have also been propagating their best selections for distribution to growers. In anticipation of the release of this new material, the UMHDI has established Joint Performance Trials at six locations in the Upper Midwest (two each in IA, MN, WI) to evaluate the comparative performance of the material.

Understanding Seedlings

In the nursery industry a "seedling" is a plant that originates from a seed. Each seedling is genetically unique and will not have exactly the same characteristics as the mother plant that produced the seed, nor will it have the exact same characteristics as other seedlings (siblings) from the same mother plant. Because seedlings are relatively cheap to produce they are most often used in plantings where uniformity is not important, such as in tree reforestation or wildlife plantings. However, the high level of variability among seedlings makes it difficult to make money growing them commercially as a crop, as has been the case in the Upper Midwest. Survey of over 150 plantings of seedlings across WI, MN, and IA between 2008 and 2014, showed that within a given planting, some plants are very high performers, some are ok, and some hardly produce any nuts at all. As such, there has been no significant increase in plantings as growers are waiting for better and more uniform plants.

Hazelnuts do not self-pollinate, thus the diversity within a batch of seedlings depends primarily on the

parentage of the seedlings. Breeders use the terms: full-siblings (full-sibs), half-siblings (half-sibs), or open pollinated (OP) progeny. **Full-sibs** are seedlings with the same two parents, usually from a controlled cross made by hand or in isolated crossing blocks. A population of such seedlings is sometimes called a “full-sib family” or an “F1 population”. If buying seedlings, full-sibs will generally have the most uniformity, though the diversity within a full-sib family depends greatly on the similarity of the parents. **Half-sibs** come from the same mother plant, but the pollen source (father) is unknown because pollination was not controlled. Half-sib families are more genetically diverse than full-sib families, though by limiting the pollen cloud to a small number of select fathers, it is theoretically possible to reduce the diversity in the half-sib population. **Open pollinated** seedlings are a mix of half-sib seedlings from several mother plants. Essentially, the nuts (seeds) are harvested from the best plants and mixed into a single seed lot.

It is very difficult to predict how seedlings from even full-sib families will perform unless trials with the families have been conducted. As such, buyers should be skeptical about any claims made about the performance of seedlings and if claims are made, growers should ask for supporting data from the sellers.

Understanding Cultivars

Most woody crop industries (apples, blueberries, grapes, cherries) are based on a limited number of “cultivars”. Cultivars are selected seedlings that have been given a name and vegetatively propagated (cloned) to produce copies that are genetically identical. The ‘Honeycrisp’ apple, for example, was a seedling that happened to produce an amazing apple. Using stem cuttings, grafting, and layering, hundreds of thousands of copies of that one seedling have been made and sold all over the world. The main reason cultivars are used is that every plant will perform the same way and produce the same fruit or nut. This makes the crop much easier to grow and sell, though, it also makes a planting more susceptible to catastrophic loss. If one plant is susceptible to a new disease, for example, they all are.

Know Your Plants

Open-pollinated seedlings have unknown mothers and fathers due mainly because the seeds are harvested from a bunch of different plants and mixed together. Most hazelnut plants grown in the Upper Midwest right now are open-pollinated seedlings from breeders and nurseries that collect seed from their best plants, mix them together, grow out the plants, and ship them to growers.

Half-Sibling seedling have one parent in common, but not the other. If you collected seed from a single hazelnut plant and grew out the seed all those plants would be half-siblings. It is possible many of those seed have the same father, but unless one is absolutely sure of where the pollen came from the plants are considered to be half-siblings.

Full-Sibling seedlings have the same mother and father and are derived from hand-pollinations or crossing blocks where all other pollen is excluded.

A **hybrid** plant is derived from a cross between two distinct parental lines or, with respect to hazelnuts, a cross between two different species, usually between a *Corylus americana* and a *Corylus avellana* plant. In the Upper Midwest, “hybrid hazelnuts” is used generically to describe any hazelnut plant with mixed parentage as opposed to a pure *Corylus americana* or *Corylus avellana*.

A **cultivar** is a plant derived from intentional selection or breeding with distinct and desirable traits. These traits are maintained through vegetative propagation and many cultivars are patented and named.

Although **variety** and cultivar are often used interchangeably, technically a variety is a plant within a given species with a naturally occurring trait that carries through to the offspring and a cultivar is a plant created through intentional breeding with specific desirable traits.

There are hazelnut cultivars currently available that were developed for Europe and Oregon, but they are not reliably winter-hardy for our region. University of Guelph has conducted trials at a site near Toronto with some of the *C. avellana* cultivars developed by Oregon State University including ‘Yamhill’, ‘Jefferson’, ‘Theta’, ‘Felix’, ‘McDonald’, ‘Wepster’, ‘York’. Based on performance to-date they are only recommending them for Zone 7, which excludes almost all of the Upper Midwest. Further, work at Rutgers University has shown that, while they are resistant to the strain of EFB found in the Pacific Northwest, they succumb to EFB found in New Jersey and other eastern locations. Between concerns about winter-hardiness and the breakdown of EFB resistance to eastern strains of EFB, existing cultivars of *C. avellana* are simply not recommended for anywhere in the Upper Midwest.

There have been efforts since the early 1900s to develop cultivars of hybrid hazelnuts for the eastern United States and more recently the Upper Midwest, but as of yet nothing proven is available for growers. Within the last 20 years, however, there has been a concerted effort by both private and public breeders to develop proven hazelnut cultivars and their efforts are coming to fruition with at least four different breeders already or planning to offer cultivars starting in 2020 (Table 1).

Even though all plants of a given cultivar are genetically identical, the performance of the cultivar may vary considerably across environments. For this reason, a cultivar is usually evaluated at multiple sites before it is commercially released to growers. The more places the cultivar has been tested the more confidence the grower can have that the cultivar will perform as advertised. For example, although it would have been tempting for the University of Minnesota to immediately clone and sell thousands of copies of the ‘Honeycrisp’ seedling, they first made a limited number of copies and evaluated the performance at many different locations. Otherwise, the breeders would not have known if the plant’s amazing apple was due to the genetics of the plant or the site in which it was growing. Likewise, the breeders needed to know whether the plant would produce the amazing apple in all environments it was grown in. This evaluation process takes years for woody plants, but is necessary, as “going clonal” with a seedling based on the performance of a single plant at a single location is too risky. Thus, growers should know to what extent a cultivar has been evaluated before making big purchasing decisions.



Containerized (left) and bare-root dormant (right) planting stock are both viable options for hazelnuts, but each has different needs for storage and planting.

Planting Stock Options

Plants that are ready to be planted into a grower’s field are called field-ready planting stock and come in many forms. There are two general categories: containerized or bare-root dormant. Both are good options for hazelnuts, as long as growers understand storage and plantings recommendations specific to each. See Fact Sheet #2—Establishing Hazelnut Plants for more specific information.

Bare-root dormant plants may come from seeds (seedlings) or via vegetative propagation in layer beds (layers). In both cases, the plants are grown in the ground in the nursery, lifted in the fall or very early in the

spring, stored cool, and shipped to growers before starting to grow. Bareroot dormant plants are the least expensive to ship and are most forgiving to establish as they are not as susceptible to transplant shock as long as the buds have not started opening. However, without soil around the roots, the plants must be handled carefully prior to planting to ensure the roots don't dry out and must be planted with care to ensure good soil-root contact.

Containerized plants are grown in a wide range of container sizes. The larger the container the more room for good root development, but the more expensive the plant. They are most often used for vegetatively propagated plants as rooting and early growth is done in a greenhouse, but seedlings too can be grown in containers. Transport and storage of potted plants is expensive, but the soil allows for more flexibility in storage. The main disadvantage of containerized stock is plants can start circling in the pots and become root-bound leading to root girdling and stagnated growth after transplanting. If containerized hazelnut plants are actively growing (leaf-on) at transplant, they are more susceptible to transplant shock, especially so with hazelnuts. Thus, it is advisable to plant leaf-on containerized material in the fall after the summer heat has passed. If they are planted soon after mid-September, their roots will have time to grow into the soil before winter, improving their survival chances. If planted while in growth, a tree tube is recommended to reduce shock and desiccation from drying winds.

Seedlings or Cultivars?

Though there are many small plantings of experimental hybrid seedlings across the Upper Midwest, there are no large-scale commercially viable plantings, mainly due to the low average yield of the seedlings. The new cultivars will make commercially viable production possible and this has triggered debate as to whether a grower should stick with seedlings, grow the new cultivars, or do both.

There are three general approaches to growing hazelnuts being considered right now in the Upper Midwest. The first approach follows the model of other woody crops, where growers would plant only proven high-performing cultivars with good disease resistance, consistently high yields, and excellent kernel quality. To mitigate the risks created by growing genetically identical plants, any given planting would have multiple cultivars. The plants would be grown in tightly spaced hedgerows to maximize per acre hazelnut production and allow for mechanized harvest.

The second approach is in part a reaction to the standard woody crop model, which many growers feel has too little genetic diversity and puts too much control of the industry in the hands of plant breeders and the nurseries that grow the planting stock. In this approach, growers would plant hybrid seedlings from seed collected from their own plants. Because the average yields of the seedlings would be lower compared to proven cultivars, the plants would be grown in diversified agroforestry plantings with other income-



Whether planted with seedlings or cultivars, hazelnut production systems in the Upper Midwest will be based on shrubs and small trees grown in hedgerows with nuts harvested directly from the plant with straddle-type harvesters.

generating crops like small fruits, vegetables, forages, and livestock.

The third approach, and the one recommended by the UMHDI, is to combine the best of the two approaches by planting proven cultivars in hedgerows that can be mechanically harvested and growing at least five different cultivars in a planting with each hedgerow having cultivars with similar growth forms and ripening times. Livestock, vegetables, forages, or any other cash-crop could be grown between the hedgerows during the establishment years to off-set the establishment costs. In addition, perimeter and interior borders rows would be planted with seedlings in partnership with private or public breeders. The seedlings would provide a dependable pollen cloud each spring and would be used to find the next generation of locally adapted cultivars.

Summary

Prospective and early-adopter hazelnut growers in the Upper Midwest will soon have a number of new plant options to choose from (Table 1). Seedlings will continue to be an option, but growers should plan on lower yields than from cultivars and will likely need to generate income in other ways to make the overall system economically viable. Although some of the high-yielding new cultivars have been grown in replicate at multiple locations, until growers start planting larger-scale plantings of these cultivars it will be hard to predict yields and economic returns for any given producer.

The Upper Midwest Hazelnut Development Initiative is a collaboration of the University of Wisconsin, University of Minnesota, and early-adopter hazelnut growers across the Upper Midwest. For more information about the UMHDI visit www.midwesthazelnuts.org. For questions about this Fact Sheet contact jason.fischbach@ces.uwex.edu.

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Breeder	Cultivar	Species	USDA Hardiness	Nursery Supplier	Estimated Availability Date
Upper Midwest Hazelnut Development Initiative	Rose9-2	selected hybrid seedling	Zone 3	Knight Hollow Nursery, TBD	spring 2020
	PriceW41	selected hybrid seedling			2020
	Minar342	selected hybrid seedling			spring 2020
	Rose18-10	selected hybrid seedling			2020
	SpC-2D5	selected hybrid seedling			2021
	StapN2-7	selected hybrid seedling			2021
	ShepRosy	selected hybrid seedling			2021
	Cuddy2-28	selected hybrid seedling			spring 2020
	Arb4-3	selected hybrid seedling			TBD
	Gibs5-15	selected hybrid seedling			spring 2020
	Eric4-21	selected hybrid seedling			2020
	HandFats	selected hybrid seedling			spring 2020
Hybrid Hazelnut Consortium	HHC1	selected hybrid seedling	Zone 5	Arbor Day Foundation, Great Plains Nursery	fall 2020
	Grand Traverse	hybrid from C. Ferris	Zone 5		fall 2020
	HHC2	selected hybrid seedling	Zone 5		TBD
Rutgers University	4 cultivars	All are C. avellana selections	Zone 6, for trial in Zone 5	TBD	Fall 2020/Spring 2021
Grimo Nut Nursery	Andrew	(Asian x American) x open	Zone 4	Grimo Nut Nursery	spring 2020
	Aldara	(Asian x American) x open			spring 2020
	Marion	(Saskatchewan American x NY hybrid) x open			spring 2020
	Northern Blais	(Asian x American) x open			spring 2020
	Dermis	Skinner hybrid seedling			spring 2020
	Dawn	(Asian x American) x open			spring 2020
	Frank	(Saskatchewan American x NY hybrid) x open			spring 2020
	Kiara	(Saskatchewan American x NY hybrid) x open			spring 2021
Z's Nutty Ridge, LLC	Photon	selected hybrid seedling	Zone 4	TBD	fall 2021
	Nitka	selected hybrid seedling			fall 2021
Martin Hodgson, Butternut Farms	Chelsea	selected hybrid seedling	Zone 4	TBD	2021
	Norfolk	selected hybrid seedling			2021

Table 1. New hazelnut cultivars soon to be available to growers in the Upper Midwest.

Check with the listed nursery suppliers for updates on availability of individual selections. If no nursery is listed, check the UMHDI website: www.midwesthazelnuts.org for updates.