

Fact Sheet #1—Choosing Hazelnut Plants

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Introduction

The focus of this fact sheet is to help beginning hazelnut growers in the Upper Midwest 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 an understanding of basic nursery terminology to



make good purchasing decisions. For information about establishment, economics, and production of hazelnuts be sure to check out the other fact sheets in this Hazelnuts 101 series at www.midwesthazelnut.org.

Which Hazelnut Species Should I Grow?

European Hazelnut (*Corylus avellana*)

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 are not sufficiently resistant to Eastern Filbert Blight, a lethal fungal disease endemic to the Upper Midwest. Tom Molnar of Rutgers University has been breeding disease resistant *C. avellana* for the Mid-Atlantic region of the Eastern USA. His new cultivars might be an option for the warmer areas of the Upper Midwest (Table 1), but they have not yet been tested in our region.

American (*C. americana*), Beaked (*C. cornuta*)

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 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 just in wildlife plantings.

Hybrids

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, Forest Agriculture Enterprises, 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 thus most plantings are less than an acre and grown as a hobby.

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 2021. 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. They will be releasing two cultivars along with '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.

What's the Difference Between Seedlings and Cultivars?

Seedlings

The term "seedling" can have different meanings. Any young plant is sometimes called a seedling, but in the nursery industry a "seedling" is a plant that originates from a seed, as opposed to a plant that originates from vegetative propagation such as from a cutting. 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



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.

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 and performance is not important, such as in tree reforestation or wildlife plantings. The high level of variability among hazelnut seedlings makes it difficult to make money growing them commercially as a crop, as has been the case in the Upper Midwest. Evaluation of mature plantings of hybrid seedlings has measured average yield of around 260 lbs of kernel per acre (Fischbach et al, 2011), which is not sufficient to support profitability. That said, there are more than 150 growers in the Upper Midwest growing the seedlings on a small scale and they can be a nice fit for subsistence production or as part of a diversified farming system that integrates forage, vegetable, or fruit production within the hazelnut planting. Regardless, there has been no significant scale up of plantings as growers are waiting for higher-yielding and more uniform plants.

If buying seedlings, it is a good idea to ask about the parentage of the seedlings. 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 from 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 unlike full-sibs 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.

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, whereas a cultivar is a plant created through intentional breeding with specific desirable traits.

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

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 ‘Barcelona’ hazelnut, for example, was a seedling that happened to produce large yields of beautiful hazelnuts. Using stem cuttings, grafting, and layering, hundreds of thousands of copies of that one seedling have been made and sold all over the world. For years, ‘Barcelona’ was the main cultivar grown in Oregon. The main reason cultivars are used is that performance for one or more traits (yield, kernel quality, disease resistance, etc.) is superior and every plant of a given cultivar will perform the same way and produce the same nut. This makes the crop much easier to grow, harvest, and sell. For example, mechanical harvesting with seedlings is a challenge because every plant in a row ripens at slightly different times. Harvesting requires multiple passes which means more expense and more damage to the plant. In contrast, if a row has a single cultivar, all the plants will ripen at the same time, making harvesting much more efficient. The risk of cultivars, though, is the planting is more susceptible to catastrophic loss. If one plant is susceptible to a new disease, for example, they all are. ‘Barcelona’ is susceptible to Eastern Filbert Blight, so when the fungus moved into the Willamette Valley of Oregon it almost destroyed the Oregon hazelnut industry. It took new disease resistant cultivars to save the industry.

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. 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.

There are many 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 in Southern Ontario 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



Hazelnut kernels from the hybrid seedlings currently being grown in the Upper Midwest tend to be smaller than European hazelnuts, but larger than American hazelnuts. The size and shape are variable, but in general, the flavor is excellent. The new cultivars selected from these seedlings retain that same great flavor.

shown that, although 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.

That might be changing, however. After nearly two decades of breeding and evaluation, Rutgers University will be releasing four new cultivars of *C. avellana* selected for resistance to Eastern Filbert Blight and intended for Eastern North America. But, because of their *C. avellana*

parentage, these cultivars are being recommended for USDA hardiness zones 6-7 and for trial in zone 5 (Table 1). Until trials have been conducted in the Upper Midwest to evaluate hardiness, growers should be cautious in planting these new cultivars. Also, male flowers (catkins) of *C. avellana* are very sensitive to spring freezes, so these new cultivars should be mixed with *C. americana* or hybrid plants to ensure pollination.

There have been efforts since the early 1900s to develop cultivars of hybrid hazelnuts for the eastern United States, but no proven cultivars resulted from these early efforts. Within the last 20 years, however, there has been a concerted effort by both private and public breeders to develop proven hybrid 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).

What Should I Grow, Seedlings or Cultivars?

Although there are many small plantings of 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 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. Hazelnuts do not self-pollinate, so a minimum of two compatible cultivars would be needed. 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



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.

too little genetic diversity. This approach involves planting hybrid seedlings from seed collected from high-performing 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-generating crops like small fruits, vegetables, forages, and livestock. Over time, the idea is to remove the worst performing plants and replace them with new seedlings grown from seed collected from the best plants. Such an approach could be successful, but requires a very long-term commitment as it can take 8-10 years to know how well a seedling is performing.

The third approach, and the one recommended by the UMHDI, is to combine the best of the two approaches. Plant proven cultivars as the main planting, for productivity, and also plant seedlings to provide a dependable pollen cloud and to help develop the next generation of locally adapted cultivars. Plant a minimum of five different cultivars, to increase ecological resilience. Plant cultivars with similar growth forms and ripening times in the same rows to facilitate mechanical harvest. The seedlings can be planted on the border and in interior rows. Intercrops can be planted in the alleys during establishment to offset establishment costs. Which approach a grower takes will depend largely on grower objectives and goals.



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.

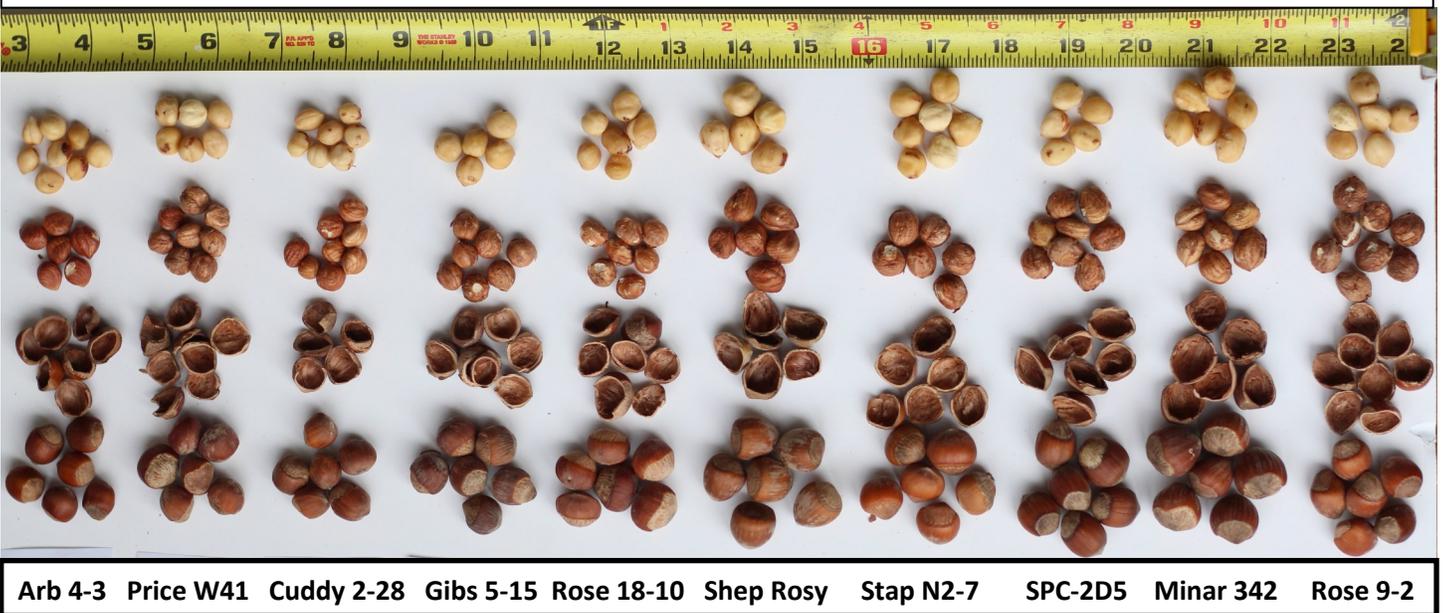
Containerized plants are grown in a wide range of container sizes. The larger the container the more room for good root development, but the more expensive the plant. They are most often used for vegetatively propagated plants as rooting and early growth is done in a greenhouse, but seedlings too can be grown in containers. Transport and storage of potted plants is expensive, but the soil allows for more flexibility in storage. A potential problem of containerized stock is roots can start circling in the pots and become root-bound. This leads 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.

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 larger-scale plantings of these cultivars have been established, it will be hard to predict yields and economic returns for any given producer.

1st Generation Selections from the UMHDI breeding program. Selected in cooperation with early-adopter hazelnut growers in the Upper Midwest, these hybrid genotypes produce high yields of medium-sized nuts.



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@wisc.edu.

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Breeder	Cultivar	Species	USDA Hardiness	Nursery Supplier	Estimated Availability Date
Upper Midwest Hazelnut Development Initiative	Rose9-2	hybrids (parentage unknown)	Zone 3	TBD	spring 2021
	PriceW41				2021
	Minar342				spring 2021
	Rose18-10				2021
	SpC-2D5				2021
	StapN2-7				2021
	ShepRosy				2021
	Cuddy2-28				2021
	Arb4-3				TBD
	Gibs5-15				2021
Hybrid Hazelnut Consortium	Eric4-21				spring 2021
	HandFats				2021
	HHC1	hybrid	Zone 5	Arbor Day, Great Plains Nursery	fall 2020
Hybrid Hazelnut Consortium	Grand Traverse	hybrid from C. Ferris	Zone 5	Arbor Day, Great Plains Nursery	spring 2020
	HHC2	hybrid	Zone 5	TBD	TBD
Rutgers University	Raritan (Rutgers 1, H3FR03P33)	Corylus avellana	Zone 6-7, for trial Zone 5	TBD	fall 2020
	Monmouth (Rutgers 3, H3FR05P69)				fall 2020
	Hunterdon (Rutgers 5, CRXR04P43)				fall 2020
	Somerset (Rutgers 6, H3FR04P42)				fall 2020
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 2022
	Frank	(Saskatchewan American x NY hybrid) x open			spring 2020
	Kiara	(Saskatchewan American x NY hybrid) x open			spring 2022
Z's Nutty Ridge, LLC	Photon	hybrids (parentage unknown)	Zone 4	TBD	fall 2021
	Nitka				spring 2020

Table 1. New hazelnut cultivars available for the Upper Midwest.

Listed Nursery Supplier Contact Information:

Great Plains Nursery, www.greatplainsnursery.com, 402-540-4801

Grimo Nut Nursery, www.grimonut.com, 1-905-934-6887

Z's Nutty Ridge, www.znutty.com

Plants from the Arbor Day Foundation are available on a limited basis through their membership newsletter program : <https://www.arborday.org/programs/hazelnuts/learn/>.

Contact information for nurseries supplying seedling hazelnuts can be found at www.midwesthazelnuts.org.