Hybrid Hazelnuts in Nebraska

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Hybrid Hazelnut Consortium

- Nebraska Forest Service (NFS).
- Arbor Day Foundation.
- Oregon State University (OSU).
- Rutgers University.
- Started in 2008.
- Develop disease resistant, cold hardy hazelnuts.
Hybrid Hazelnut Consortium

- Hybrid crosses made at OSU and Rutgers.
- NFS propagates and screens in test plots.
- Eastern Filbert Blight (EFB) resistance.
- Cold hardiness.
- Insect pests.
- Yield and quality.
- Flowering and other phenotypic data.
Section 1: Facts and Characteristics

In this Section we will cover:

- Hazelnut Species
- World Production
- Plant characteristics
- Flowering
- Nut development
- Pollenizers
## Hazelnut Species – Corylus

### Leafy-husks
- **Corylus avellana**  
  European hazelnut – Europe, Turkey, Caucasia
- **C. americana**  
  American hazelnut – Eastern North America
- **C. heterophylla**  
  NE China, Korea, Japan
- **C. yunnanensis**  
  S China

### Spiny-husks
- **C. cornuta**  
  E & N North America
- **C. californica**  
  Pacific States
- **C. sieboldiana**  
  E Asia

### Tree hazels
- **C. colurna**  
  Turkey and Balkans
- **C. Jacquemontii**  
  N India and Pakistan
- **C. chinensis**  
  S & C China
- **C. fargesii**  
  S & C China
- **C. ferox**  
  C China & Himalayas
World Production

- European hazelnut primarily.
- Turkey and southern Europe.
- Majority are grown as shrubs.
- As of 2017, 64% of world supply produced in Turkey.
- 50% of that produced in Ordu province of Turkey, along the Black Sea.
US Production

- Oregon 99% of US production, but only 5% of world market.
- Industry now exceeds 70K acres.
- Willamette Valley in West-Central Oregon.
- Grown as single trunk trees in large orchards.
- Nuts fall free, and are swept up by machines.
Hazelnut characteristics

- Large shrub to small tree.
- 10-25’ in height.
- 15-20’ in spread.
- Some can reach 40’ in height.
- Can live for decades.
- Will grow suckers.
Bush form VS. Tree form
Hazelnut characteristics

- Nuts grow on previous year’s growth in clusters of 2-6 nuts
- Nuts are enclosed in a leafy husk, called an involucre
European hazelnut - *Corylus avellana*

- Primary species of consumption in world.
- Native to many parts of Europe and Asia.
- Food source for prehistoric humans.
- Hazelnut shells found in Stone Age sites (8000–2700 BCE) in what is now Sweden, Denmark, and Germany.
- Manuscript from the year 2838 BCE lists hazelnuts as one of China’s five sacred foods.

European hazelnut – *Corylus avellana*

**Pros**
- Large, high quality nuts with thin shells.
- ‘Open’ husks.
- Nuts fall free from tree.
- Easily trained as a single-stemmed tree.

**Cons**
- Susceptible to Eastern Filbert Blight (EFB).
- Not hardy to Great Plains, Midwest and Northeast US.
- Catkins don’t survive winters.
Eastern Filbert Blight (EFB)
American hazelnut – *C. americana*

- Native to the eastern half of the United States and southern Canada.
- Habitat and food for wildlife.
- Small scale growers in many states.
- Native Americans historically used the nuts for medicinal purposes, as well as for food.
American hazelnut – *C. americana*

- **Pros**
  - EFB resistant.
  - Adapted to Midwest climates.
  - Compact growth habit.

- **Cons**
  - Small nuts.
  - Thick shells.
  - Clasping, clam-shell husks.
  - Inconsistent yields.
  - Nuts don’t all fall free.
Hybrid Hazelnuts

- *C. avellana x americana*
- Get best of both worlds
- High quality nuts
- EFB resistance
- Climate adaptations
Hazelnut Cultivars for Nebraska

• ‘Grand Traverse’
• ‘The Beast’
• Pollen compatible and need to be planted together.
• Hardy to Nebraska (Zone 5).
• Good nut characteristics and yield.
• Highly EFB resistant.
‘Grand Traverse’

- 75% European, 25% Tree hazel.
- Tested for many years in NE.
- Currently being tested in other Great Plains states.
- Already in public domain, so no patent protection needed.
- Clonal material available.
‘Grand Traverse’

• Avg. kernel wt. of 1.3g
• 40% kernel
• Available at Great Plains Nursery in Weston, NE
OSU 541.147 ‘The Beast’

- 75% European, 25% American.
- Vigorously growing, upright tree.
- Tested extensively in New Jersey.
- Also being tested in other states.
OSU 541.147 ‘The Beast’

• Avg. kernel wt. of 1.16g.
• 44% kernel.
• Open husk.
• 85% nut fall free at harvest.
• ‘Plant patent applied for’ status.
• Available at Great Plains Nursery.
Female Flowers – Florets

- Hazelnuts have separate male & female flowers on each plant.
- Female flowers are called florets.
- Found in round buds close to stem.
- Florets open in late February through March.
Female Flowers – Florets

Dormant  ‘Red Dot’  ‘Spider’
Male Flowers – Catkins

• Male flowers are called catkins.
• Appear on the plant in June.
• Open in late February through March.
Male Flowers – Catkins

Dormant | Elongating | Shedding | Spent
Nut development

• Pollination occurs in late February through March.
• Pollen lands on the red stigma of the floret.
• Pollen tube grows down into the floret and rests.
• Ovary slowly develops and eggs are ready in June.
• Sperm activates, and fertilization takes place.
• Nuts begin development and reach maturity in August through September.
Pollen Compatibility

- Hazelnuts are not self-pollinating.
- Special gene pair controls compatibility.
- 30 different alleles (forms) of the gene. – $S_xS_y$
- Can’t have same S-alleles and produce nuts!
### Pollen Compatibility

- **Example:**
  - ‘Jefferson’ has S1S3,
  - ‘Lewis’ has S3S8 – won’t work!

- Some combinations of S-alleles won’t produce nuts either.

- Timing of pollen shed and opening of the female flowers needs to line up
Pollen Compatibility

• ‘Grand Traverse’ – 11 & 25

• ‘The Beast’ – 8 & 23

• Currently evaluating additional pollenizers
541 ‘The Beast’ Pollen Shed

Gran Traverse Pollen Shed
Section 2: Orchard Establishment

In this Section we will cover:

• Site Selection / Soils
• Orchard Design
• Site prep
• Planting
• Irrigation
• Weed Control
Site Selection: Soils

- Get soil tested.
- Too high or too low pH can lock up nutrients.
- Deep, medium-textured soils are most productive.
- Do not locate a hazelnut orchard where soil is poorly drained, shallow, or too heavy.
- Proper drainage is necessary, as hazelnuts don’t like ‘wet feet’.
Site Selection: Soils

- Sandy soil might not hold enough water for good hazelnut growth.
- Most hazelnut roots are found in the first 2 feet of soil.
- Suitable soils allow root systems to depths of 6–10 feet.
- Shallow, rocky, impermeable layer or hardpan, high water table, or lack aeration, inhibit root penetration and growth
- ‘Heavy Clay’ is not ideal, but can be amended by incorporating organic matter like compost or wood chips.
Site Selection: Topography

• Air drainage is important.

• Late frosts in low-lying areas can damage buds and succulent green shoots.

• Slope affects soil depth and moisture retention

• Hazelnut orchards on steep slopes often produce less than those on more level ground, even with the same soil types.

• Harvest is often more difficult on a steeper slope.
Orchard Layout

• Standard density:
  • 20’ × 20’ tree spacing
  • 108 trees per acre
  • Best yield because plenty of light for trees

• Double density:
  • 20’ × 10’ spacing
  • 216 trees per acre
  • More nuts early on, but needs to be thinned down to 20’ × 20’ after year 10

• Leave room for any machines you plan to use for mowing, weed control, or harvesting.
Orchard Layout – Double Density

You can see how the trees will be touching crowns in just a few more years.
Orchard Layout

• One cultivar per row.
• Alternate rows of cultivars.
• Add open-pollinated seedlings as a perimeter.
• Ensures extra pollen available.
• Get seedlings from NRD tree program or NSA.
Urban Planting

• Work with space you have.
• Arrange plants to receive pollen.
• Pollen can travel about 30-40’.
• Dispersed by winds.
• Tuck pollenizers at edges.
• Cultivars where they can get most sunlight.
Urban Planting

‘The Beast’

‘Grand Traverse’
Wildlife Damage

• May want to consider putting up a wildlife barrier.
• Depends on animal pressure in your area.
• 6-8’ woven wire fence for deer.
• Plastic fencing not durable enough from our experience.
• At least protect with cage of some kind.
• Rodents can damage base of stems and burrow into root zone.
Site Preparation

• Test your soil for pH and existing nutrients.
• Use the recommendations for hazelnuts, otherwise peaches.
• Lay out the locations of plants with measuring tape and flags or paint.
• Kill or remove existing vegetation where planting.
• Competition-free zone for roots.
• Tilling can loosen soil if dense and compacted, but it can also stir up dormant weed seeds.
Planting Methods

• Basic tree planting procedures apply.

• Hand dig with a spade.

• Post hole auger.
  • Easy to plant large numbers in short time.
  • Don’t drill too deep. The soil WILL settle and the plants can end up too deep.
  • Smearing of the sides of the holes reduced aeration and water movement.
  • Breaking up the sides of the hole helps reopen pores.

• Water the plants thoroughly after planting.
Watering During Establishment

• 1 inch of water (~4 gal) per week during first 2 years of establishment.
• Most roots are mostly in the upper 2’ of the soil.
• Drip irrigation is the most efficient, but more initial setup & cost.
• Overhead watering only ~60% efficient, but does water a larger area.
• Watering by hand is most time consuming.
• Mulch 3” deep in a 2-3 foot diameter circle around the plants.
Tree shelters

• If your orchard doesn’t have any nearby windbreaks, consider using tree shelters.
• Tree shelters can protect from dry winds in height of summer and winter.
• Tomato cages wrapped in white 40% shade cloth from nursery supply company
• Wooden stakes nice and sturdy, but degrade
• ½” PVC Conduit cheap and flexible
Weed control

• Very important during establishment years.
• Weeds and grasses like brome compete for nutrients and water.
• Competition in root zone will stunt growth.
• Mulching with woodchips or sawdust can help keep weeds down.
• Pre-emergent herbicide can prevent new weeds from sprouting.
• Manual weed controls include hand-pulling and string trimmers.
• Chickens, turkeys, or goats may be an effective option.
Pruning for Tree Form

• Top trees with a heading cut 28–34” from the ground at planting time.
• Helps reduce moisture demand since roots have been disturbed.
• Topped hazelnuts generally grow larger more quickly.
• Promotes growth of lateral branches.
• Following winter, choose 3-5 laterals to become scaffold branches.
• Subsequent years continue to open up center of tree to light penetration.
Questions?
More Information:

- Hybrid Hazelnut Consortium
  https://www.arborday.org/programs/hazelnuts/consortium/

- Oregon State Extension Catalog
  https://extension.oregonstate.edu/topic/crop-production/nuts/resources
Section 3: Processing, Pests & Problems

In this Section we will cover:

- Harvesting
- Husking
- Drying
- Storage
- Roasting / Blanching
- Pests & Diseases
Harvest

• In Nebraska, nuts reach maturity in late August through September.
• Mature when base of the nut is loose from the husk
• Test by trying to roll the nut in the husk with your thumb
• May want to pick the nuts as soon as they are mature
• Wait too long, and animals will get many of the nuts
Picking By Hand

• More time consuming and requires more human labor

• Grab clusters and pinch off at the base

• Be careful to not tear off any new catkins that may be there
Picking By Hand

• Gently bend down branches to reach nuts that are higher up.

• This is especially true with large shrubs rather than tree form.

• There are three-legged ladders that a person can use.
Mechanical Harvesting

• Some growers have tried using a modified blueberry picker over bushes

• Rubber paddles beat the branches to knock off the nut clusters

• Rare, and will need to be modified
Mechanical Harvesting

• In Oregon they use self-propelled sweeping machines

• Uses less labor, but costs more up front

• Need to have flat, even orchard floor with little to no vegetation or debris
Husking

- Need to remove the nuts from the husks
- Can do it by hand
- Don’t let husks get too dry
- Southern Nut N Tree Equipment DS-30
- Testing whether to husk green or let dry
Husking

- Run through an aspirator to separate the nuts and husks
- The aspirator uses air to blow off the lighter husks and blanks.
- Custom machine built by UNL’s Biological Systems Engineering Dept
Drying Nuts

• Hazelnuts should be dried within 24 hours of harvest.
• Usually are dried in the shell, but you can save time and use less heat if you shell them first.
• Optimum drying temperatures are 95 to 105°F
• >110°F will negatively affect nut quality
• Air circulation is as important as temperature during drying.
• Screen-bottomed tray, onion sack, or any other container that will permit free air passage
Drying Nuts

• Hazelnut kernels are firm at first, and become spongy during the drying process.

• As they approach dryness, they become firm again.

• The internal color gradually changes from white to creamy color, starting at the outside.

• Crack a few nuts and carefully check both the color and texture to determine when the nuts are dry enough.

• When the color reaches the center of the kernel, the nut is dry.
Storing Nuts

• Dried hazelnuts will maintain eating quality for up to a year in the refrigerator.

• If frozen at 0°F, storage can extend to 2 years.

• If refrigeration or freezing is not possible, store hazelnuts and walnuts in as cool a room as possible.

• The air temperature should be 55°F or lower, and the air should be as dry as possible.
Storing Nuts

• Nuts stored in cool conditions will not maintain quality as long as those kept in a refrigerator or freezer.

• The greatest losses in storage come from rancidity, mold, and Indian meal moth infestations.

• If leaving hazelnuts in the shell, keep them in a closed container.

• Otherwise, the Indian meal moth will cause nuts to become wormy in one season.
Cracking Nuts

• Various hand operated cracking machines can be found online

• Commercial nut cracker currently on loan at Heartland Nuts ‘N More

• The Savage S238 cost just under $15,000, and uses compressed air to crack nuts.

• Passed through an aspirator to separate the debris from the kernels. The aspirator cost about $2700.
Roasting / Blanching

• Roast dried hazelnuts to bring out their flavor.
• Roast in a shallow pan at 275°F for ~ 20 to 30 minutes, until the skins crack.
• The roasted skins can be removed easily by rubbing the warm nuts with a rough cloth.
• Roasted nuts will not store as long.
• Consume them within a few months of roasting.
Eastern Filbert Blight – EFB

- Fungal disease that infects 1-2 year old branches
- Spores are spread by wind and rain during the wet season between April and May.
- Infection occurs at the apical bud during periods of high humidity.
Eastern Filbert Blight – EFB

• Spreads to the phloem, cambium, and even the outer xylem

• 18 month incubation period before visual signs appear

• Results in cankers that girdle branches, reducing nutrient and water flow

• Negatively affects nut yield and eventually kills the plant
Blanks

• Blanks are empty shells without kernels
• Occur when pollination stimulates the shell to develop but the kernel fails to develop normally
• The kernel either fails to grow at all or starts to grow and then aborts, often in the early stages of growth.
• Blanks are lighter in weight, so they can be separated out with an aspirator.
• Often stuck to the husk, and brown way before other nuts are.
• 47% of Barcelona nuts are blanks. Barcelona has been a primary cultivar in Oregon for decades.
Brown Stain

• Disorder of unknown cause that can result in severe crop loss in some seasons

• Brown stains are seen on the sides of nuts in early summer.

• Affected nut clusters often drop from the tree in July and August

• Many affected nuts are blanks, or only partially filled.
Brown Marmorated Stink Bug

• To obtain their food, stink bugs use their special mouth parts to pierce the plant tissue to extract the fluids.

• Plant loses necessary fluids, which can lead to deformation of nuts and other damage.

• The stink bug injects saliva into the nut, creating a dimpling of the nut’s surface, and rotting of the material underneath.
Brown Marmorated Stink Bug

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Japanese Beetle

• Feeds on leaves of plants

• Chooses plants at randomly initially, but then damaged plants’ own response chemicals suspected to draw in more beetles

• Can result in complete defoliation of plant

• Plants can survive defoliation, but repeated attacks may lead to death of plant.

• Hormone traps can be used if beetles are already there. Need to have a bucket of soapy water below trap to drown the beetles.

• Nut production unaffected so long as defoliation doesn’t exceed 1/3 of leaves
Japanese Beetle
More Information:

• Hybrid Hazelnut Consortium
  https://www.arborday.org/programs/hazelnuts/consortium/

• Oregon State Extension Catalog
  https://catalog.extension.oregonstate.edu/search/content/hazelnut