

Hybrid Hazelnuts in Nebraska

Aaron Clare 10.1.2020

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, Caucuasia
- *C. americana* American hazelnut Eastern North America
- *C. heterophylla* NE China, Korea, Japan
- C. yunnanensis S China

Spiny-husks

- C. cornuta
- C. californica
- C. sieboldiana

- E & N North America Pacific States
- E Asia

Tree hazels

- C. colurna
- C. jacquemontii
- C. chinensis
- C. fargesii
- C. ferox

Turkey and Balkans N India and Pakistan

- S & C China
- S & C China
- 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.





HazeInut 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





NEBRASKA

SERVICE

Tree form



HazeInut characteristics



N E B R A S K A FOREST S E R V I C E University of Nebraska-Lincoln

- 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



Image: Giovanni Caudullo - Caudullo, G., Welk, E., San-Miguel-Ayanz, J., 2017. Chorological maps for the main European woody species.

- 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



By USDA-NRCS PLANTS Database - [1], Public Domain, https://commons.wikimedia.org/w/index.php?curid=12199060

- 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.



Are they compatible?

		Alle	les Exp	ressed In:	The Rules
teleased		♀ Fl	owers	o [™] Pollen	
	Barcelona	1	2	1	1. Both alleles ALWAYS expressed in female flowers
	barceiona			<u> </u>	- Like repels like, familiarity breeds contempt
1997 276.142	Clark	<u>3</u>	<u>8</u>	Both	Females reject any pollen with a same allele as their own
	Casina	<u>10</u>	<u>21</u>	Both	 One or both alleles may be expressed in pollen Single or double barrel shotgun
2012	Dorris	1	<u>12</u>	Both	Pecking order determines which allele is dominant *Underline tells which allele(s) are expressed in the pollen
	Ennis	1	11	1	3. Timing Matters!
2001	Epsilon	1	4	1	 Right place, right time vs two ships passing in the night Pollen shed MUST overlap female bloom
2009 984.075	Eta	<u>11</u>	<u>26</u>	Both	Female bloom 4-8 weeks: Trees shed pollen for 2-3 weeks
2012 941.016	Felix	<u>15</u>	<u>21</u>	Both	Hint: Diversify, do your homework Plant several selections that have different alleles.
2001 589.028	Gamma	2	<u>10</u>	<u>10</u>	Pecking order for pollen alleles.
2009 703.007	Jefferson	1	<u>3</u>	<u>3</u>	If on the same level, then both alleles expressed in pollen. Otherwise only the allele in highest level counts
1997 243.002	Lewis	<u>3</u>	<u>8</u>	Both	3,8
2014 380.027	McDonald	2	<u>15</u>	<u>15</u>	6
2018 1108	PollyO	2	<u>10</u>	<u>10</u>	1, 5, 7, 10, 12, 14, 15, 16, 17, 18, 20, 21, 24, 27
2006 540.13	Sacajawea	1	22	1	2,25
2005 509.064	Santiam	<u>3</u>	15	<u>3</u>	19
2009 1001.01	Theta	<u>5</u>	<u>15</u>	Both	9, 11, 22, 26
2013 894.03	Wepster	1	2	1	23
	Willamette	1	<u>3</u>	<u>3</u>	
2008 542.102	Yamhill	<u>8</u>	26	<u>8</u>	Hand-out from Rebecca McCluskey, OSU, for summer tour at
00/2	Vork	2	24	01	Birkemeier Farms Inc, August 2007

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!



Are they compatible?

		A 11a	loc Eve	record In:		The Dules
		Alleles Expressed In:		Z Deller		
eleased		+ rl	owers	o Pollen		
	Barcelona	1	2	1		1. Both alleles ALWAYS expressed in female flowers
						 Like repels like, familiarity breeds contempt
1997	Clark	3	8	Both		Females reject any pollen with a same allele as their own
276.142		_	-			
	Casina	10	21	Both		One or both alleles may be expressed in pollen
	ouomu	10	<u></u>	<u></u>		- Single or double barrel shotgun
2012	Dorris	1	<u>12</u>	Both		Pecking order determines which allele is dominant
876.041						*Underline tells which allele(s) are expressed in the pollen
	Ennie	4	11	4		
	Ennis	1		1 <u>1</u>		3. Timing Matters!
2001	Englight	1	4	1		- Right place, right time vs two ships passing in the night
	Epsilon					Pollen shed MUST overlap female bloom
2009	-					Female bloom 4-8 weeks: Trees shed nollen for 2-3 weeks
984 075	Eta	<u>11</u>	<u>26</u>	Both		
2012						Hint: Diversify do your homework
2012	Felix	<u>15</u>	<u>21</u>	Both		Plant several selections that have different alleles
2001						Fiant several selections that have different afferes.
2001	Gamma	2	<u>10</u>	10		Booking order for pollon alleles
0000						Fecking order for pollen alleles.
2009	Jefferson	1	<u>3</u>	3		If on the same level, then both alleles expressed in pollen.
/03.007						Otherwise only the allele in highest level counts
1997	Lewis	3	8	Both		
243.002		_	_		U	3,8
2014	McDonald	2	15	15		
880.027						6
2018	PollyO	2	<u>10</u>	<u>10</u>		
1108	,.					1, 5, 7, 10, 12, 14, 15, 16, 17, 18, 20, 21, 24, 27
2006	Sacaiawea	1	22	1		
540.13		-		- ·		2,25
2005	Santiam	<u>3</u>	15	3		
509.064						19
2009	Theta	5	15	Both		
1001.01		≚	<u>.</u>			9, 11, 22, 26
2013	Wepster	1	2	1		
894.03		-	-	- <u>-</u>		23
	Willamette	1	3	3		
	••mamette	· ·	2	2		4
2008	Yamhill	8	26	8		
542.102	1 annin	2	20	2		Hand-out from Rebecca McCluskey, OSU, for summer tour at
2012	York	2	21	21		Birkemeier Farms Inc, August 2007
878.048	New Varieties		New Varieties added			

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





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' x 10' spacing
 - 216 trees per acre
 - More nuts early on, but needs to be thinned down to 20' x 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.





'The Beast' Grand Traverse'

Seedlings



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 to 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
- ¹/₂" 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
 bttps://ovtopsion.orggonstate.odu/topic
 - https://extension.oregonstate.edu/topic/crop-production/nuts/resources



"All things green"

Join us for First Thursdays online at noon Sept 3 / Oct. 1 / Nov. 5 / Dec. 3

facebook.com/NeArb/ plantnebraska.org

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 selfpropelled 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

Blower Fan



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



By Hectonichus - Own work, CC BY-SA 4.0, https://commons.wikimedia.org/w/index.php?curid=63056893





By PintCanMan - Own work, CC BY-SA 4.0, https://commons.wikimedia.org/w/index.php?curid=45492779

Brown Marmorated Stink Bug





David R. Lance, USDA APHIS PPQ, Bugwood.org

David R. Lance, USDA APHIS PPQ, Bugwood.org


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

