



# UMHDI Hazelnut Performance Trials

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**Hazelnut  
Improvement  
Program**

**Upper Midwest  
Hazelnut  
Development Initiative**

**Upper Midwest  
Hazelnut  
Development Initiative**

Research Plan and Resource Needs  
For Commercialization of Hazelnuts in  
the Upper Midwest

2013-2023



**Upper Midwest  
Hazelnut  
Development Initiative**



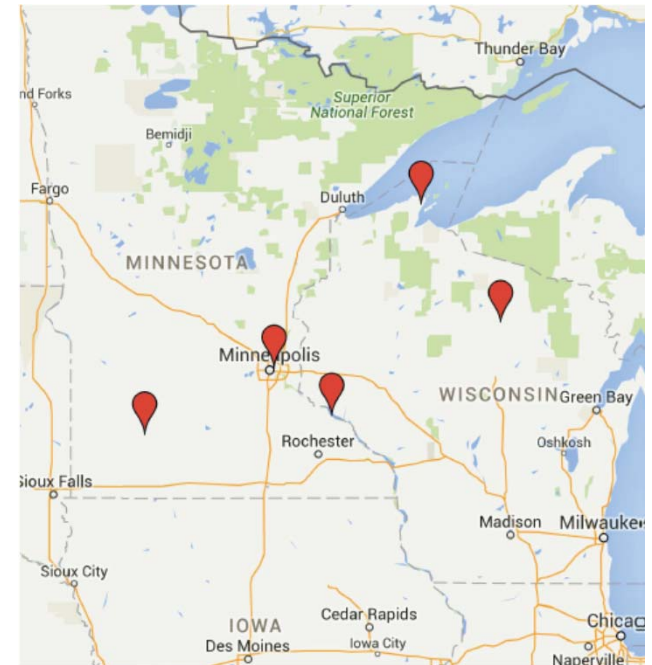
**Growers Are Leading the Way**

# Goals of the UMHDI

- ❖ Breed/find better improved genetics
- ❖ Develop propagation protocols
- ❖ Develop best management practices
- ❖ Provide outreach education
- ❖ Assist with industry development

# UMHDI Performance Trials

- Evaluation of promising hybrid genotypes selected from on-farm plantings in the Upper Midwest
- Starting to make selections for propagation and on-farm trial



# Plant Material For Midwest Growers

- Clonal European cultivars (probably not)
- Seedlings from *C. avellana* x *C. americana* hybrids
- *C. americana* seedlings
- Conal hybrids (hopefully soon)

# Hybrid Hazelnuts



**Beaked Hazel**  
(*C. cornuta*)

X



**American Hazel**  
(*C. americana*)

X



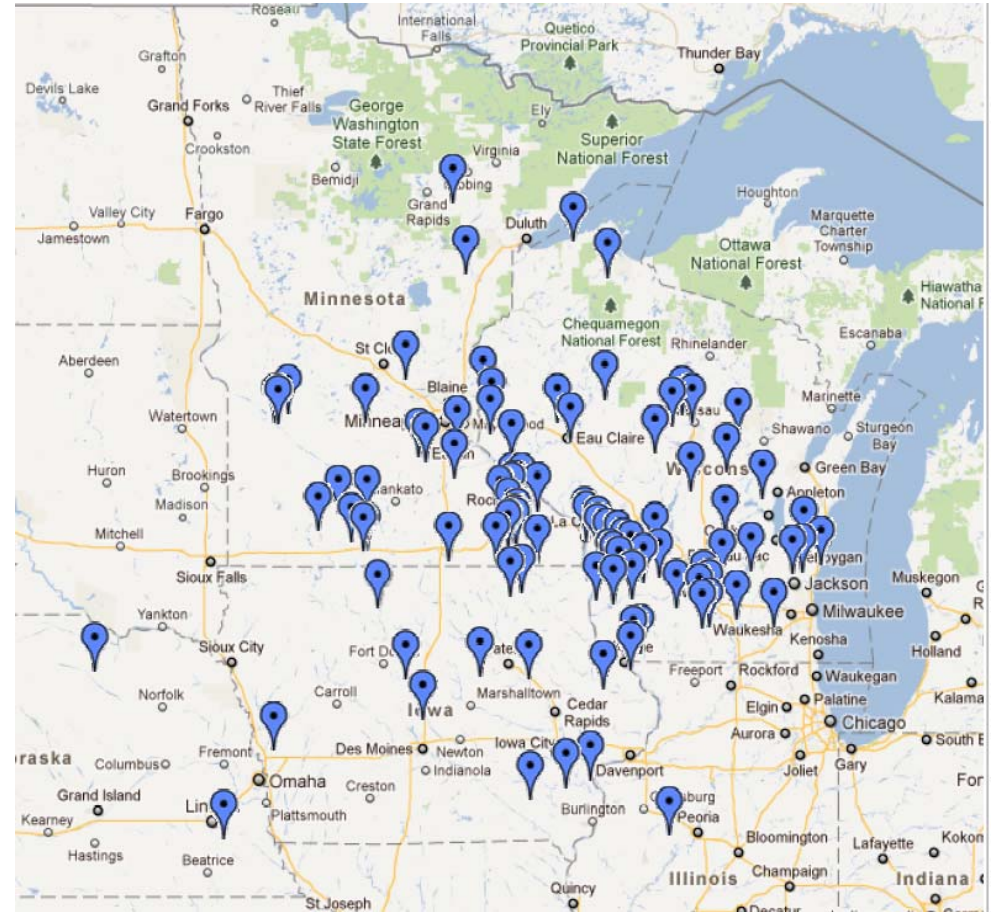
**European Hazel**  
(*C. avellana*)





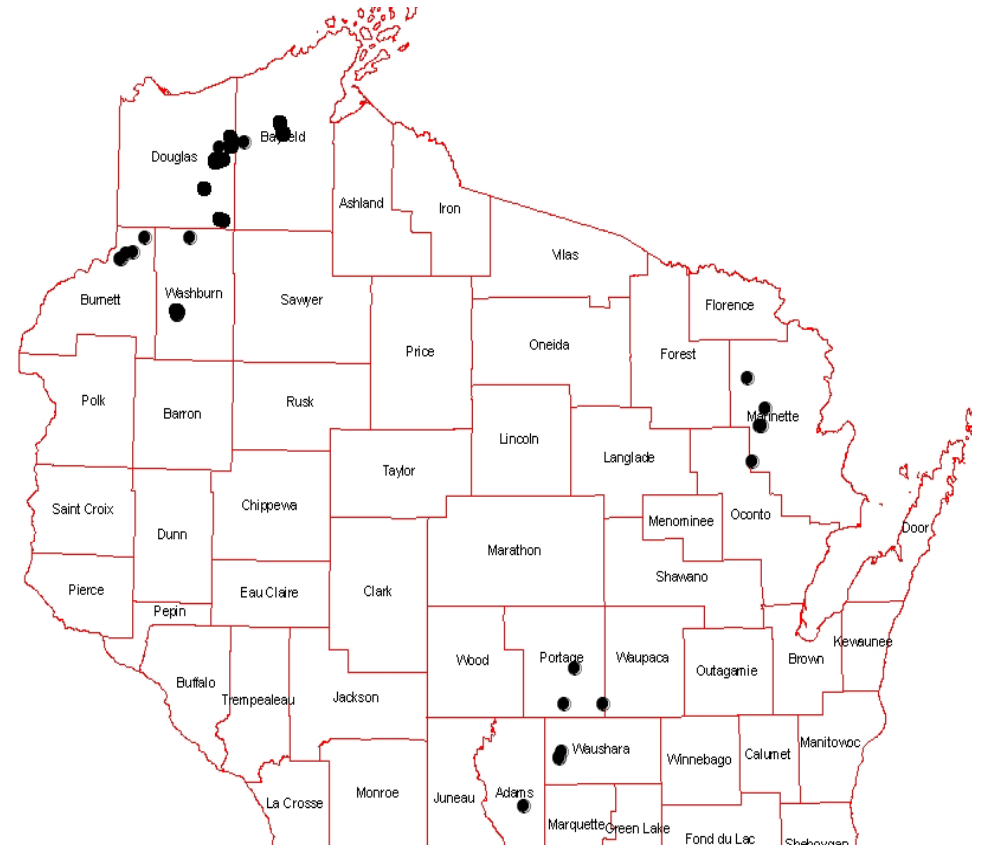
# On-Farm Hybrid Seedling Populations

State	Plants	Growers
IA	4044	16
IL	319	1
MN	22403	30
WI	39064	82
<b>Total</b>	<b>65830</b>	<b>129</b>



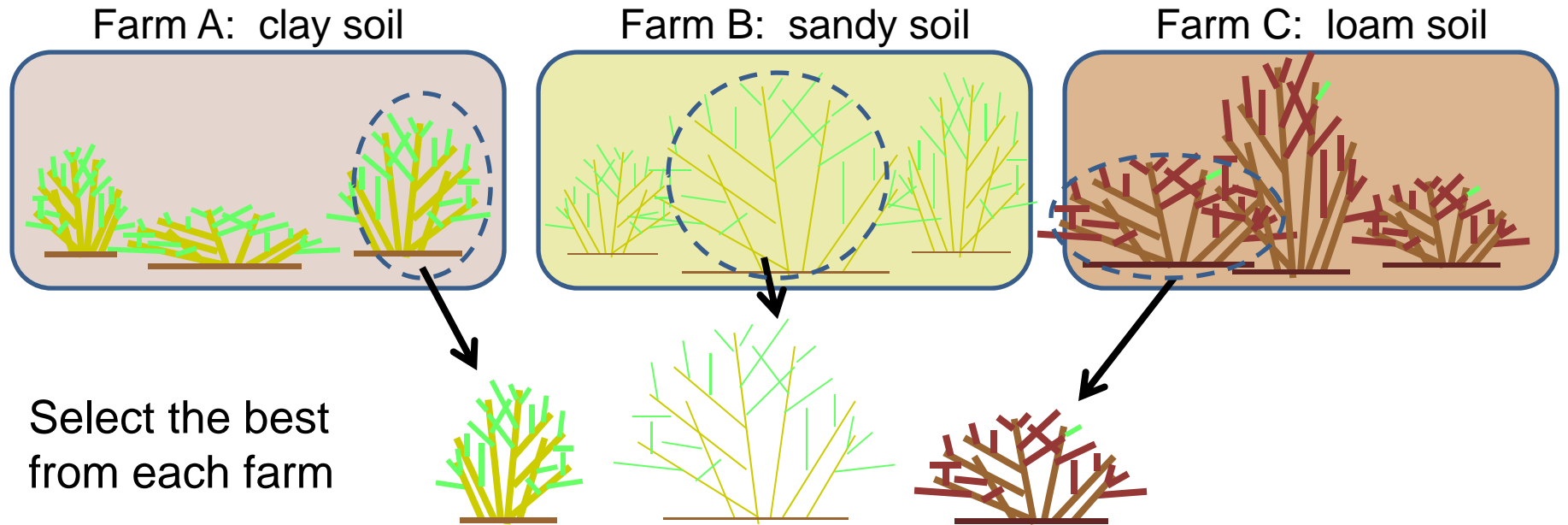
# Wild *C. americana* Populations

County	Sites
Adams	1
Bayfield	3
Burnett	5
Douglas	10
Juneau	1
Marinette	5
Portage	1
Washburn	6
Waushara	1
Wood	2

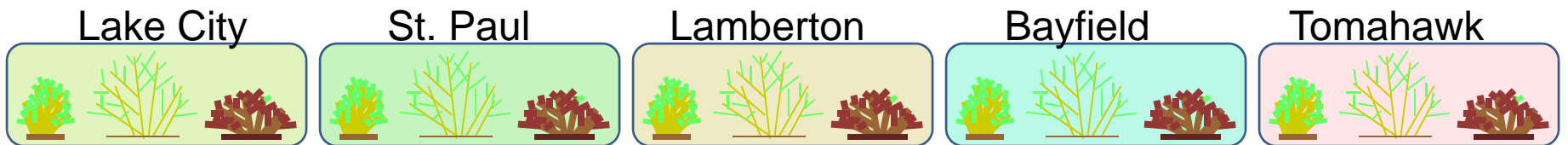


**To Date: 80 accessions collected**

# Selection Process



Replicate and evaluate in five performance trials:



# What Are We Measuring?

- Winter hardiness
- In-shell yield and kernel yield
- Kernel size (weight)
- Severity of EFB
- Bush shape
- (Taste, ease of propagation)

# EFB Resistance and Winter Hardiness are not solved issues!!!

Staples MN



Hybrids are not immune to EFB, but how tolerant are they?



# Yield – Speaking a Common Language

- Comparing plants based on total pounds of nuts per plant alone does not control for plant size
- To control for plant size we:
  - Measure the width of the plant canopy at its widest point after the nuts are harvested
  - Calculate the cross-sectional area of the canopy (canopy coverage) based on a circle
  - Calculate pounds of kernel per square foot of canopy coverage (lbs/sq ft)



**Some plants are good, some plants are not**



Orca

Hease D  
(Port Wing)

Gibs 2-30

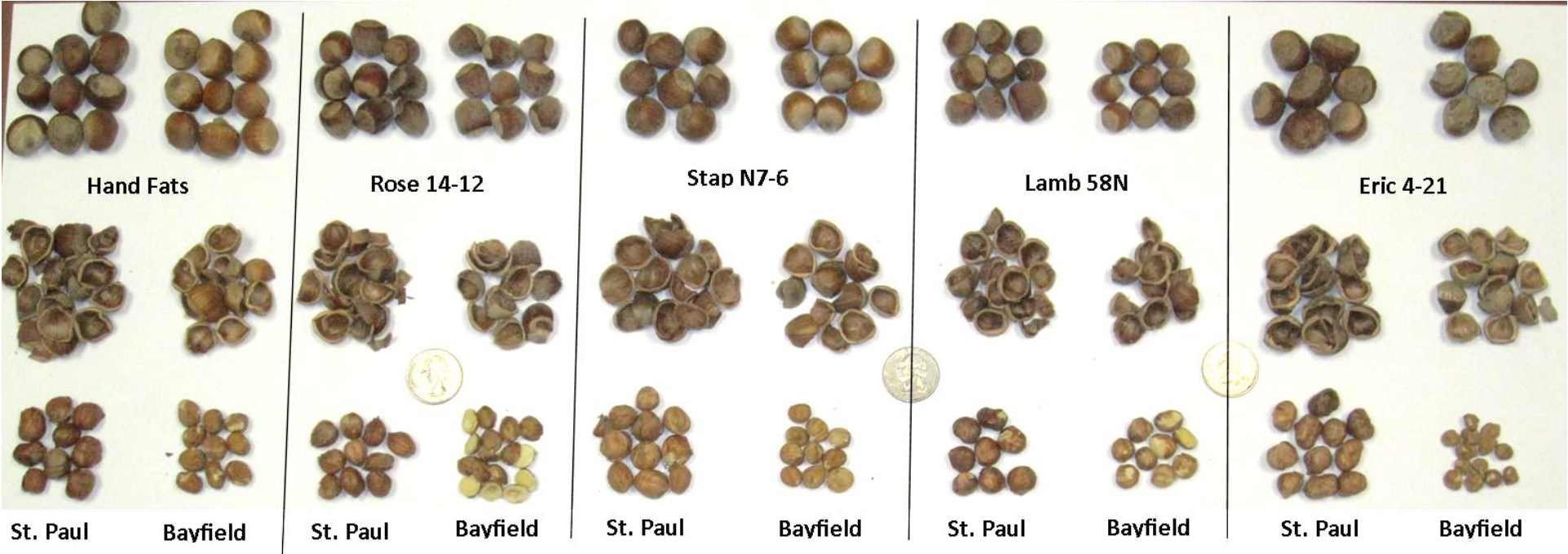
Gibs 3-26

Stap S2-7

Pebbles



# Some are consistent across sites, some are not



# Kernel Size is Small, But Quality is High



# 2014-2015 Average Yields of Top 19 Genotypes

Bayfield, Lake City, St. Paul  
(6 and 7 year old plants)

Oregon Yields: 600lbs, Age 6, 1400 lbs Age 12

\*per acre yield extrapolations are based on 66% canopy coverage; ND=genotype not included in the trial

Genotype	Bayfield		St. Paul		Lake City
	2014	2015	2014	2015	2015
	-----lbs kernel/acre*-----				
PriceW41	67	633	1642	200	ND
StapN7-6	417	876	697	233	ND
Lamb58N	748	508	890	439	72
HeasB	486	557	572	825	49
Cuddy2-28	160	945	437	835	97
HandFats	285	480	596	217	ND
Gibs6-23	484	513	206	504	212
Rose14-12	139	625	981	127	25
7Mile2-34	289	405	655	138	ND
7Mile1-9	ND	ND	612	252	131
HeasE	369	515	403	148	206
Arb7-1	115	ND	350	704	127
GunthPC	207	460	491	112	254
Eric4-21	254	471	404	215	123
Rose9-2	267	298	ND	485	92
Rose17-4	257	563	172	304	30
7Mile1-4	108	408	505	282	5
Eric5-13	114	276	287	405	213
Minar342	58	536	ND	174	ND

## 2015 Average Kernel Weight of Top 19 Genotypes (sorted by average kernel weight)

Bayfield, Lake City, and St. Paul  
(6 and 7 year old plants)

Genotype	Bayfield	St. Paul	Lake City
	-----grams-----		
Minar342	0.73	0.83	
Rose9-2	0.49	0.74	0.93
HandFats	0.62	0.73	
PriceW41	0.59	0.63	
StapN7-6	0.56	0.58	
Arb7-1		0.61	0.50
HeasE	0.52	0.55	0.57
7Mile1-9		0.52	0.57
Rose17-4	0.42	0.54	0.67
Eric4-21	0.49	0.59	0.54
Rose14-12	0.47	0.56	0.57
Gibs6-23	0.51	0.50	0.56
7Mile1-4	0.43	0.55	0.57
Cuddy2-28	0.40	0.50	0.63
HeasB	0.43	0.52	0.50
Lamb58N	0.39	0.49	0.56
Eric5-13	0.39	0.49	0.54
GunthPC	0.39	0.46	0.54
7Mile2-34	0.44	0.45	

# Photos and Data From Individual Plants in 2015 at the Bayfield Hazelnut Performance Trial



**Plant ID: 7 Mile 1-4** (Bayfield B #17)

Harvest Date	9/11/2015
Plant Height	52 in.
Total In-shell Weight	0.59 lbs.
Percent Kernel	34%
Total In-shell Yield/Acre	1,204 lbs./acre
Total Kernel Yield/Acre	414 lbs./acre





**Plant ID: 7Mile 2-43** (Bayfield A #7)

Harvest Date	9/11/2015
Plant Height	41 in.
Total In-shell Weight	0.55 lbs.
Percent Kernel	31%
Total In-shell Yield/Acre	1993 lbs./acre
Total Kernel Yield/Acre	627 lbs./acre





**Plant ID: Arb 7-1** (Bayfield R #25)

Harvest Date	9/9/2015
Plant Height	36 in.
Total In-shell Weight	0.57 lbs.
Percent Kernel	21%
Total In-shell Yield/Acre	2,744 lbs./acre
Total Kernel Yield/Acre	1,000 lbs./acre







**Plant ID: Cuddy 2-28** (Bayfield A #26)

Harvest Date	9/11/2015
Plant Height	67 in.
Total In-shell Weight	2.52 lbs.
Percent Kernel	37%
Total In-shell Yield/Acre	3347 lbs./acre
Total Kernel Yield/Acre	1237 lbs./acre





**Plant ID: Eric 4-21** (Bayfield D # 14)

Harvest Date	9/10/2015
Plant Height	42 in.
Total In-shell Weight	1.04 lbs.
Percent Kernel	26%
Total In-shell Yield/Acre	2,823 lbs./acre
Total Kernel Yield/Acre	744 lbs./acre



**Eric 4-21  
(2014)  
Planted Fall  
2010)**





**Plant ID: Eric 5-13** (Bayfield C #25)

Harvest Date	9/11/2015
Plant Height	51 in.
Total In-shell Weight	0.52 lbs.
Percent Kernel	37%
Total In-shell Yield/Acre	769 lbs./acre
Total Kernel Yield/Acre	285 lbs./acre





**Plant ID: Gibs 6-23** (Bayfield F #12)

Harvest Date 9/10/2015

Plant Height 42 in.

Total In-shell Weight 0.83 lbs.

Percent Kernel 38%

Total In-shell Yield/Acre 1,984 lbs./acre

Total Kernel Yield/Acre 761 lbs./acre





**Plant ID: Gunth PC** (Bayfield A #18)

Harvest Date	9/11/2015
Plant Height	62 in.
Total In-shell Weight	0.70 lbs.
Percent Kernel	31%
Total In-shell Yield/Acre	2,300 lbs./acre
Total Kernel Yield/Acre	702 lbs./acre





**Plant ID: Heas B** (Bayfield B #8)

Harvest Date	9/11/2015
Plant Height	53 in.
Total In-shell Weight	1.94 lbs.
Percent Kernel	36%
Total In-shell Yield/Acre	2837 lbs./acre
Total Kernel Yield/Acre	1029 lbs./acre





**Plant ID: Heas E** (Bayfield B #26)

Harvest Date	9/11/2015
Plant Height	51 in.
Total In-shell Weight	1.54 lbs.
Percent Kernel	24%
Total In-shell Yield/Acre	3,258 lbs./acre
Total Kernel Yield/Acre	787 lbs./acre







**Plant ID: Lamb 58N** (Bayfield C #9)



Harvest Date: 09/11/15	Plant Height: 64 in.
Total In-Shell Weight: 0.66 lbs	
Percent Kernel: 36%	
Total In-Shell Yield/Acre: 1192 lbs/ac	
Total Kernel Yield/Acre: 428 lbs/acre	





**Plant ID: Minar 342** (Bayfield C #10)

Harvest Date	9/09/2015
Plant Height	58 in.
Total In-shell Weight	1.39 lbs.
Percent Kernel	35%
Total In-shell Yield/Acre	2041 lbs./acre
Total Kernel Yield/Acre	715 lbs./acre



**Plant ID: Price W41** (Bayfield D #24)

Harvest Date	9/11/2015
Plant Height	59 in.
Total In-shell Weight	0.70 lbs.
Percent Kernel	37%
Total In-shell Yield/Acre	1,318 lbs./acre
Total Kernel Yield/Acre	488 lbs./acre

Photo not available





**Plant ID: Rose 9-2** (Bayfield F #13)

Harvest Date	9/11/2015
Plant Height	52 in.
Total In-shell Weight	0.98 lbs.
Percent Kernel	32%
Total In-shell Yield/Acre	1,229 lbs./acre
Total Kernel Yield/Acre	389 lbs./acre





**Plant ID: Rose 14-12** (Bayfield B #16)

Harvest Date	9/11/2015
Plant Height	50.5 in.
Total In-shell Weight	0.95 lbs.
Percent Kernel	37%
Total In-shell Yield/Acre	2,004 lbs./acre
Total Kernel Yield/Acre	736 lbs./acre





**Plant ID: Rose 17-4** (Bayfield A #33)

Harvest Date	9/14/2015
Plant Height	51 in.
Total In-shell Weight	0.88 lbs.
Percent Kernel	25%
Total In-shell Yield/Acre	2,095 lbs./acre
Total Kernel Yield/Acre	516 lbs./acre





**Plant ID: Stap N7-6** (Bayfield F #18)

Harvest Date	9/10/2015
Plant Height	45 in.
Total In-shell Weight	1.34 lbs.
Percent Kernel	36%
Total In-shell Yield/Acre	2,105 lbs./acre
Total Kernel Yield/Acre	762 lbs./acre



# Next Steps

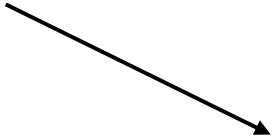
- Continue evaluating plants in trials
- 19 hybrid genotypes are now in micro-propagation
- On-farm trial plantings starting in 2017 through Growers Wanted program (SARE)
- Possible wider evaluation depending on propagation success and grower risk tolerance
- Expanded breeding program



# **Evaluation and Selection From Existing Populations**

**(No crossing required)**

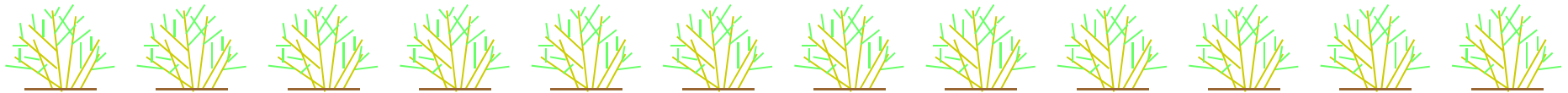
*C. hybrids (americana x avellana)*



Select the best

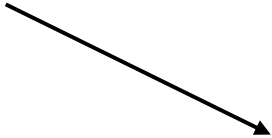
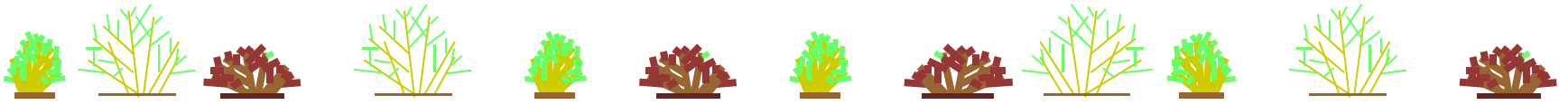


Propagate for dissemination  
to growers?



In progress

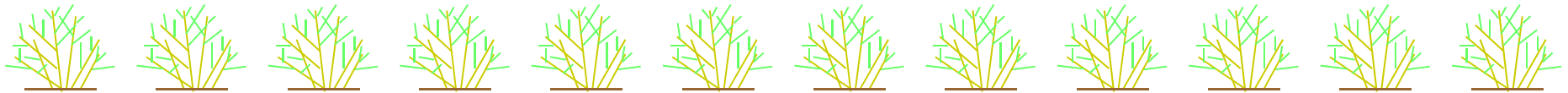
*C. americana*



Select the best



Propagate for dissemination  
to growers?

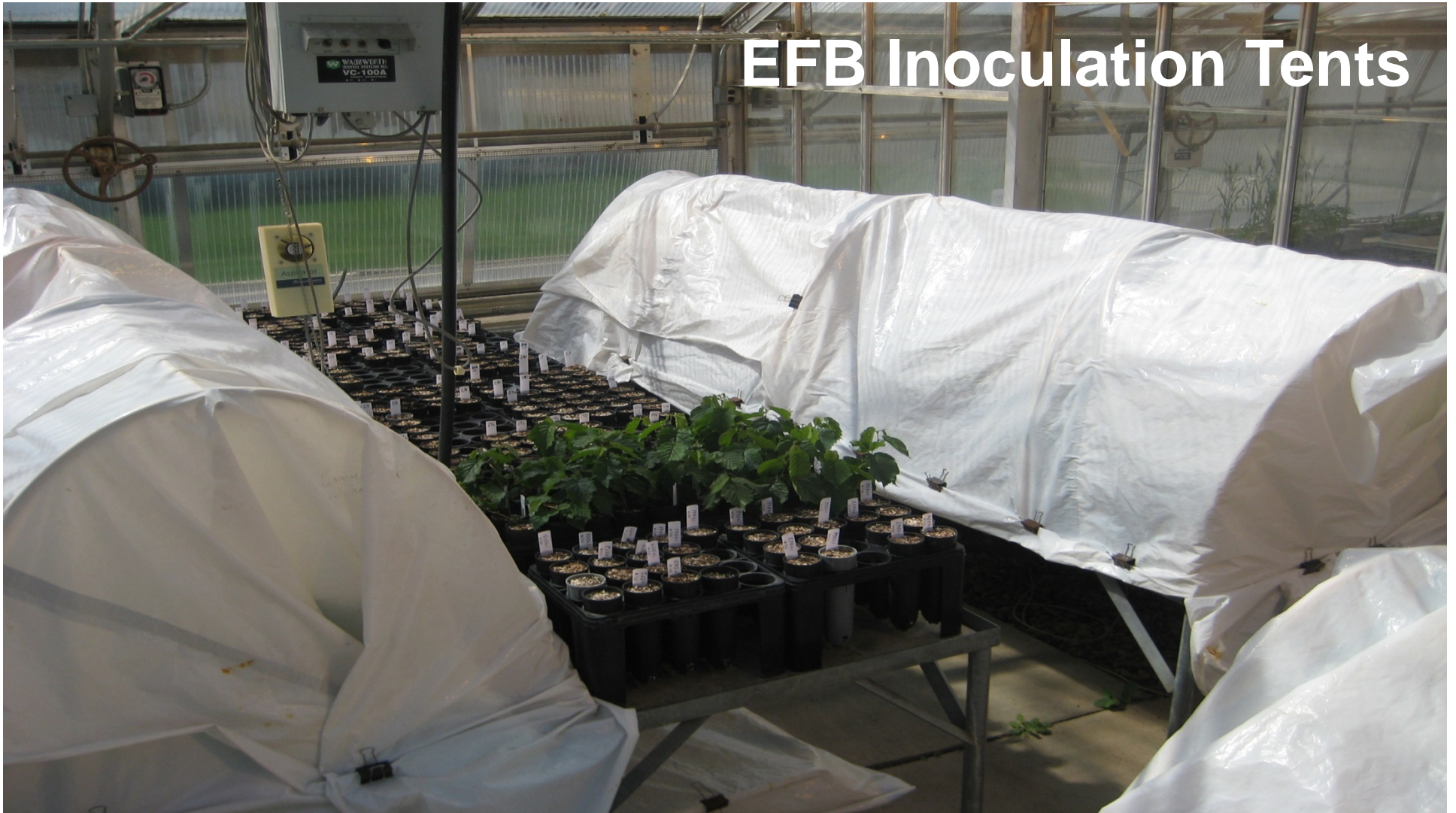


Just starting

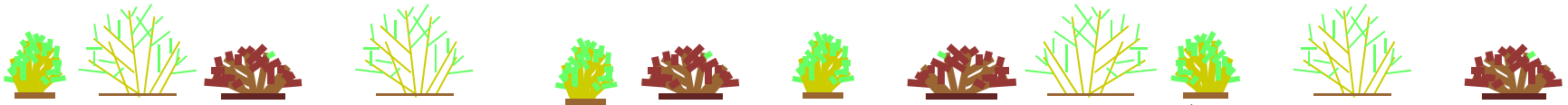
# Controlled Pollinations



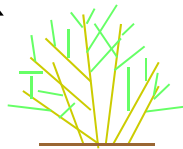
# EFB Inoculation Tents



C. hybrids



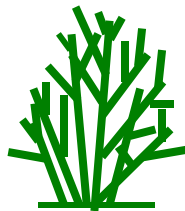
Select the best  
parents



**X**



C. hybrid x C. hybrid



Full-sibling seedlings (F1s) to growers

Maybe, but...



Yield Rating <sup>^</sup>		Stoughton		Bayfield		Spooner	
		C. americana*	F1 Hybrid**	C. americana*	F1 Hybrid**	C. americana*	F1 Hybrid**
0	No nuts	40.0%	35.0%	7.3%	21.8%	47.2%	67.4%
1	A few nuts	21.1%	21.8%	14.6%	21.5%	16.7%	17.7%
2	Some nuts, usually on one branch	9.5%	19.9%	16.7%	20.6%	16.7%	9.7%
3	Nuts on multiple branches	15.8%	16.5%	31.3%	26.6%	8.3%	1.7%
4	Many nuts all over shrub	11.6%	6.0%	17.7%	6.6%	8.3%	2.9%
5	Exceptional yield, branches weighted down	2.1%	0.8%	12.5%	3.0%	2.8%	0.6%
Total number of plants		95	266	96	335	72	175

Year 5 Hybrid x Hybrid F1s (possibly too much diversity)

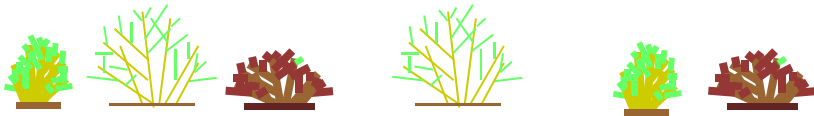
**Mehlenbacher and Sathuvalli, 2011** Characterization of American hazelnut (*Corylus americana*) accessions and *Corylus americana* x *Corylus avellana* hybrids using microsatellite markers.

- The genetic diversity of existing hybrids is relatively low. They fall into only three groups:
  1. New York State hybrids descended from “Rush”
  2. Badgersett/Wesckhe hybrids descended from “Winkler” from IA.
  3. Other Badgersett/Weschcke hybrids
- A high level of genetic diversity exists in *C. americana* populations.
- “Use of diverse American parents in breeding will broaden the genetic base of hybrid hazelnut selections, and avoid ... inbreeding depression.”

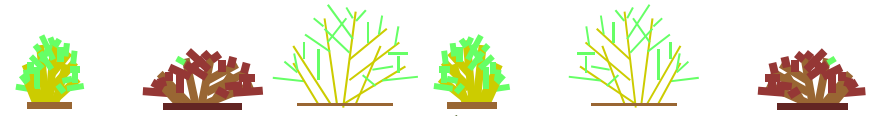


**Expand Use of *Corylus americana***  
**(Create new populations to select from)**

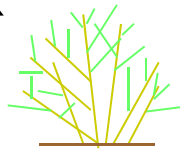
C. hybrids



C. americana



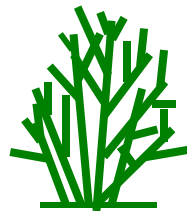
Select the best  
parents



**X**



C. americana x C. americana  
or  
C. americana x C. hybrids



Evaluate full sibling progeny

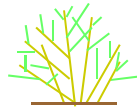
**Backcross Hybrids with *C. avellana*  
(Create new populations to select from)**

# Option 1

*C. hybrids (americana x avellana)*



Select the best hybrid parent(s)



**X**



Standard EFB-susceptible varieties of *C. avellana*.

**BC1 Progeny**

**EFB-resistant?  
(probably not)**

# Molnar and Capik, 2012

Eastern Filbert Blight Susceptibility of American x European  
Hazelnut Progenies

Badgersett/Weshckhe  
hybrids  
(highly resistant or  
tolerant)

X

Advanced European  
Selections  
(highly susceptible)

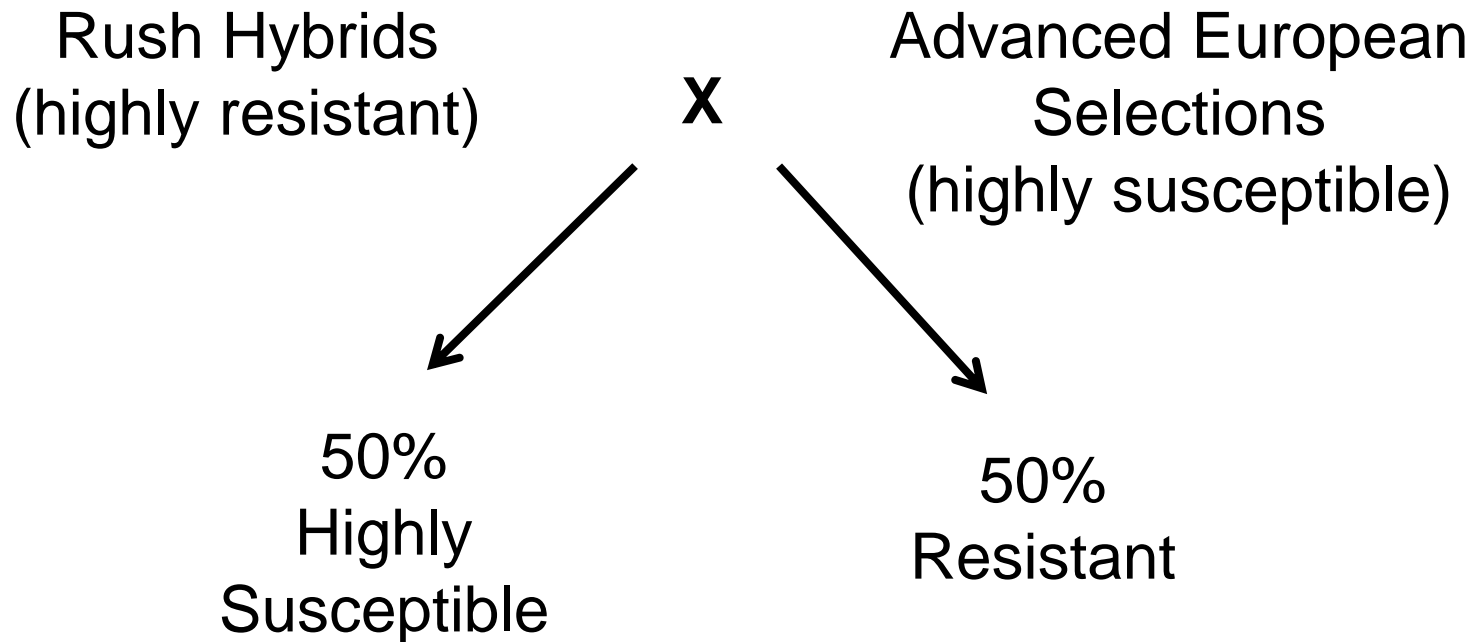


Highly Susceptible

Suggests quantitative inheritance of resistance.

# Molnar and Capik, 2012

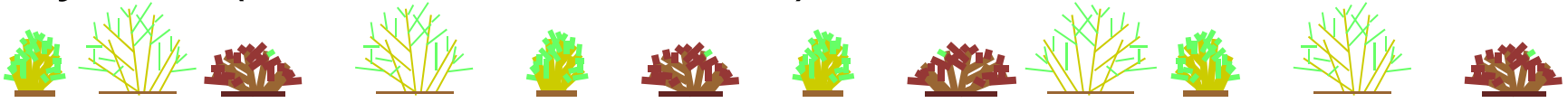
Eastern Filbert Blight Susceptibility of American x European  
Hazelnut Progenies



Suggests a single dominant R gene in Rush.

## Option 2

*C. hybrids (americana x avellana)*



Select the best



**X**



Recent releases of  
EFB-resistant  
*C. avellana*.



**X**



BC1  
50% EFB  
resistant

**BC1F1**

Recover *C. americana*  
EFB resistance?

# BC1 seedlings from crosses between our hybrids and OSU European selections









**Sept 2015  
1,200 BC1s  
(and F1s from Oregon State)  
being transplanted**



**Photo 3.** Hazelnut seedlings 113 days after planting in three different pots. The smaller tree bands (middle) may be the best choice for producing hazelnut seedlings.



# Improved Material Timeline

- Hybrid selections from us for trial – 2017
- Hybrid selections from Rutgers/OSU – limited trials in 2017
- *C. americana* selections from us – 2024?
- Backcross material from us – 2027?
- Clonal material from private breeders - ?