Hop Breeding: Let’s Get It On

Charlie Rohwer
H. yunnanensis
H. japonicus
H. lupulus

Noble
Mt. Hood, Hall. Mfr.
Fuggle, Strisselspalter, Sp. Select
Spalter, Saazer, Tettnanger

Northern Brewer
Hall. Tradition, Perle
Northern Brewer, Challenger, Vojvodina, Viking
First Gold, Zenith

Some Alpha
Yeoman
Horizon

Source: Seefelder et al., 2000
NA-EU

- Cascade
- Brewer’s Gold, Galena, Columbus, Chinook
- Cluster

Source: Seefelder et al., 2000
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- Yeoman, Nugget
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- Horizon

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- Cascade
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Source: Seefelder et al., 2000
Selecting hops for Indiana

Yakima Gold
Cashmere
Tahoma
Triple Pearl
Newport

Equinox  Citra  Mosaic  Simcoe  Amarillo  Ahtanum  Hull Melon  Hallertau Blanc  Nelson Sauvin

Mandarina Bavaria  Jaryllo  Azacca  El Dorado  Equinox  Belma  Delta  Galaxy  Lemon Drop

NEW!!
Selecting hops for Indiana

NEW!!

Yakima Gold
Cashmere
Tahoma
Triple Pearl
Newport

Equinox  Mandarina Bavaria
Citra     Jaryllo
Mosaic    Azacca
Simcoe    El Dorado
Amarillo  Equinox
Ahtanum   Belma
Hull Melon Delta
Hallertau Blanc Galaxy
Nelson Sauvin Lemon Drop
Why breed hops here?
Why breed hops *here*?

Breeding... and *SELECTION*
Why breed hops *here*?

*Here* is not *there*
Let’s Get It On

Phillip Reinagle - Cupid Inspiring the Plants with Love
Let’s Get it On
Hops are Dioecious
Hops are Dioecious
Let’s Get It On
Hops make seeds
Hops make seeds
Hop Breeding

1. Set goals
2. Select parents
3. Make crosses
4. Select seedlings
5. Single-hill selections
6. Multi-hill selections
7. Propagate and distribute
Does it grow OK at all?
Does it grow OK at all?

Is it female and perhaps what I am looking for?
Does it grow OK at all?

Is it female and perhaps what I am looking for?

Does it seem to grow consistently well?
Does it grow OK at all?

Is it female and perhaps what I am looking for?

Does it seem to grow consistently well and have decent chemistry?

Does it continue to grow well, and is the chemistry / brewing good?
Does it grow OK at all?

Is it female and perhaps what I am looking for?

Does it seem to grow consistently well and have decent chemistry?

Does it continue to grow well, and is the chemistry / brewing good?

Still good growing and brewing? Better than / different from anything else?
Does it grow OK at all?

Is it female and perhaps what I am looking for?

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Does it continue to grow well, and is the chemistry / brewing good?

Still good growing and brewing? Better than / different from anything else?

Make more!!!
Hop Breeding

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> 10 YEARS
Let’s Get It On

- Goals
  - Yield?
  - Diseases?
  - Height?
  - Fertilizer use?
  - Irrigation efficiency?
  - Color?
  - Alpha & Beta?
Let’s Get It On

- **Goals**
  - Yield?
  - Diseases?
  - Height?
  - Fertilizer use?
  - Irrigation efficiency?
  - Color?
  - Alpha & Beta?

- **Choose parent(s)**
  - Citra
  - Cascade
  - Amarillo
Where to get parents?

- Females
  - You already have them
Where to get parents?

- Females
  - You already have them
  - Find them
Where to get parents?

- Males
  - Find them
Where to get parents?

- **Males**
- **Find them**
- **Grow from seed**
Where to get parents?

- Females, males
- USDA GRIN?
Principles of Parent Selection

- “It would behoove hop breeders to maximize heterozygosity when developing new varieties.”
  - J. Henning et al., 2004
Tips

- Choose at least 1 vigorous parent
1. Open pollination ("OP")

-- OR --

2. Directed cross
Fig. 1. Pollen collection. (a) Plexiglas cylinder, with male flowers shedding pollen. (b) Layer of fresh pollen deposited on wax paper; debris, flowers, and occasional insects (irregular tracks) should be removed before collecting pollen in vial. (c) Desiccator with freshly collected pollen samples.
Seed Dormancy

- Stratification
Tips

- Healthy mother = better germination
- Old seed = difficult germination
Seedlings...
Seedlings...in the field
1401

Brewer's Gold

BB1 (Manitoba)  ?  Strisselspalter  Cluster seedling

19173M
Questions?

z.umn.edu/hops
From U to You

Pre-stratified, ready to germinate hop breeding starter kit

What I plan to do with 1403

- Select vigorous females with high yield potential for further evaluation. Early maturation?
From **U** to **You**

Pre-stratified, ready to germinate hop breeding starter kit

What *I* plan to do with 1403

- Select vigorous females with high yield potential for further evaluation. Early maturation?
- Select a vigorous, floriferous, disease-tolerant male for further breeding
  - × Challenger
  - × Yeoman
Hop seeds after brewing...
Hop seeds after brewing...

- **Research says:** brewers don’t know what they’re talking about
  - J. Inst. Brew. 77:350-352
  - J. Inst. Brew. 78:276-277
  - J. Inst. Brew. 86:84-86
“The townlands were rich, with wide tilth and many orchards, and homesteads there were with oast and garner...”

—Return of the King
1. Make crosses
   - Collect seed, germinate
   - Vigor, disease evaluation

2. Plant in field


4. String plants, evaluate again.
   - Pick best plants

5. Propagate best plants

6. Distribute plants to collaborators. String plants, evaluate for agronomic and chemical properties. Pilot brewing?

7. Evaluate agronomic and chemical properties.


10?. Release new variety.

Timeline source: HRC
Let’s Get It On

- Pollen Grain
- Generative nucleus
- Sperm nuclei
Let’s Get It On

- Pollen Grain
- Generative nucleus
- Sperm nuclei

2classnotes.com (left), Ohio State Biology (right)
Let’s Get It On
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Why breed hops *here*?

*Here* is not *there*

<table>
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<tr>
<th>km</th>
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<tr>
<td>5800</td>
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<td>2800</td>
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<tr>
<td></td>
<td>West Lafayette, IN</td>
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West Lafayette, IN

Salem, OR

weatherspark.com
West Lafayette, IN

- Less cloudy than Germany
- More cloudy in the summer than Washington and Oregon
West Lafayette, IN

Salem, OR

weatherspark.com
West Lafayette, IN

Yakima, WA
Source: Seefelder et al., 2000
Source: Seefelder et al., 2000
Group A

Noble

Mt. Hood, Hall. Mfr.

Fuggle, Strisselspalter, Sp. Select

Spalter, Saazer, Tettnanger

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Group A

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Alpha
- Yeoman, Nugget
- Magnum
- Horizon

Source: Seefelder et al., 2000
Group B

**NA-EU**

- Cascade, Crystal
- Brewer’s Gold, Galena, Columbus, Chinook
- Cluster

Source: Seefelder et al., 2000
Source: Seefelder et al., 2000
Source: Seefelder et al., 2000
Group B

NA-EU

Source: Seefelder et al., 2000
Group B

NA-EU

- Cascade, Crystal
- Brewer’s Gold, Galena, Columbus, Chinook
- Cluster

Source: Seefelder et al., 2000
West Lafayette

- Temperature
  - Warmer than Germany and Oregon
  - More reliably warm than WA
- Cloud cover
  - More than WA and OR
  - Less than Germany
- Precipitation
  - Less moderate than Germany
  - Much greater than OR and WA in the summer
19058M
- Contributes high yield potential, high alpha acids, and low cohumulone
- Father of Mt. Hood and Super Galena
- Grandfather of Nugget, Horizon, Apollo, Bravo, and Summit.
1402

Sterling

Saaz

Cascade

(Cascade is 31% Fuggle)

21361M

64035M

65009

19058M

Brewer’s Gold

Fuggle
1402

- 30% Fuggle
- 25% Saaz
- 3% Brewer’s Gold
- 3% German
- 13% Cascade
Principles of Parent Selection

“The benefit of using pedigree analysis is that breeders do not require the use of molecular tools and the expense associated with such procedures….this benefit is of great value for cash-strapped breeding companies and poorly funded research programs.”

-J. Henning et al., 2004
Selecting hops for Indiana

Cashmere

(a mix of stuff, 25% Northern Brewer)

Cascade
Selecting hops for Indiana

Yakima Gold

Slovenian Cluster selection
Hop Breeding

1. Set goals
2. Select parents
3. Make crosses 500
4. Select seedlings 300
5. Single-hill selections 75
6. Multi-hill selections 6
7. Propagate and distribute 1
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A) AGRONOMY
B) BREWING
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Breeding... and SELECTION
Let’s Get It On

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