Hop Botany and Production

Jason Perrault
Perrault Farms, Inc.
Select Botanicals Group, LLC
Hop Botany and Production

- Importance of hops.
- Basic botanical information.
- Crop development and cultivation.
- Impact of hop varieties.
Regional Economic Importance

- U.S. Production centered in the PNW.
  - 46,633 WA, OR, ID
  - 1249 rest of NA
- 2015 value (US) = $345 million
Humulus spp. Overview

- **Family:** Cannabaceae
  - **Cannabis**
    - C. sativa
  - **Humulus**
    - H. japonicus
    - H. yunnanensis
    - H. lupulus

(Neve 1991)
Humulus lupulus

- “Hops”
- Dioecious, perennial, climbing vine
- Indigenous to the Northern Hemisphere
  - Origins in Europe:
    - H. lupulus var. lupulus
  - Origins in Asia (mainly Japan):
    - H. lupulus var. cordifolius
  - Origins in North America:
    - H. lupulus var. pubescens
    - H. lupulus var. neomexicanus
    - H. lupulus var. lupuloides
Hop Basics

- Dioecious (male and female plants).
  - Genetically complex.
  - Male-no commercial value
  - Female- Produces the valued strobiles, “cones”
- Annual above ground.
- Perennial below.
  - Allows for clonal propagation.
- Climbing bine requiring a support system.
- Photoperiod sensitive
Dioecious Plants

- Separate male and female plants
- Commercial value derived from the strobiles or “cones” of the female plant
- Male plants utilized only for hybridization
- Pollination results in:
  - Unwanted seeds
  - Increased cone size
The “Cones”

- These are the manufacturing unit of the commercial hop plant.
  - The cones contain lupulin glands (actually modified vine hairs).
  - These glands contain the chemistry we are after:
    - Essential oils: over 300 compounds, contribution to aroma.
    - Soft resins: beta acids, and the all important alpha acids.
  - Lupulin accounts for 20 – 30 % of cone weight.
Mature Female “Cones”

Male flowers at anthesis
The above ground portion of the stem is annual.
  - Dies off at dormancy.
- The root is perennial, can survive low winter temps.
  - Requires a dormant period.
- The plant also produces rhizomes (below ground stems).
  - Buds become new spring growth.
  - Easily propagated from cuttings.
Clonal Propagation

- Propagation of hops purely vegetative
  - Root cuttings
  - Layering
  - Softwood cuttings
- Resulting plants genetically identical to parent material
Climbing Bines

- In the wild—usually found climbing on companion species.
  - In cultivation, trellis is used.
  - Typical Field Setup:
    - Trellis 18’ high
    - Plant spacing at 3.5’ x 14’ or 7’ x 7’.
    - Result is 889 plants per acre
    - Anchored twine is used to support plant growth.

- The vine wraps clockwise around string.
  - Function of phototropism and thigmotropism (Light and Touch).

- Rapid growth: The hop plant will grow a foot or more a day under ideal conditions. 18-25’ in a season.
Photoperiod Sensitive

- Hops are a short day plant.
  - Under a critical number of light hours - floral initiation.
    - Also node dependant.
  - Over the critical amount, vegetative growth.
  - In shorter day areas, flowering occurs as soon as the node requirement in met-yield not maximized.
  - In longer day areas-vegetative growth is maximized prior to shortening days of mid to late summer.

- Results in defined “Production Stages”
Developmental Physiology of the Hop Plant (or Production Stages)

- The hop plant goes through numerous stages of growth throughout the year.
  - Each stage has its own unique characteristics.
  - Therefore each stage of growth requires its own unique management scheme.

- Main Stages of Growth
  - Dormancy
  - Spring regrowth
  - Vegetative Growth
  - Reproductive Growth
  - Preparation for Dormancy
Comments on Development

- The stages of hop plant growth need to be understood to properly manage the crop.
  - Each stage is unique, thus unique management requirements.
- Yield is already being determined as early as April and May.
- To complicate things further: Much of this is variety dependant.
Varietal Impact

- Physiology and development are impacted by variety.
- Crop management is varietal dependant.
- There is a strong genetic x environmental interaction.
- The goal: Realize the maximum genetic potential.
- The problem: Maximum genetic potential cannot be reached in all environments.
The solution: Breeding varieties to match the environment and meet the industry needs.

- Breeding objectives based on the needs of all stakeholders.
  - Objectives meant to provide brewers with hops/hop products which enhance their brews, while being agronomically efficient.
  - Performance of a variety at every level, from the farm to the brewery, adds to the overall health of the industry.
How important is this?

- Hop Supply Chain: Each link on the supply chain affects subsequent links.
  - The efficiency of a hop has a corresponding impact on the chain.

<table>
<thead>
<tr>
<th>Breeding Program</th>
<th>Farm</th>
<th>Handler</th>
<th>Brewery</th>
</tr>
</thead>
<tbody>
<tr>
<td>New Variety:</td>
<td>Cost/Acre</td>
<td>Cost</td>
<td>Efficiency</td>
</tr>
<tr>
<td>- Good yield</td>
<td>Yield</td>
<td>Storage</td>
<td>Quality</td>
</tr>
<tr>
<td>- Disease resistant</td>
<td></td>
<td>Pellet Recoveries</td>
<td>Flavor</td>
</tr>
<tr>
<td>- Good quality</td>
<td></td>
<td>Extract</td>
<td>Cost</td>
</tr>
<tr>
<td>- Stores well</td>
<td></td>
<td>Recoveries</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Shipping</td>
<td></td>
</tr>
</tbody>
</table>
Aromatic Variability

![Diagram showing aromatic variability with different hops marked by HBC codes.](Diagram)
Future Trends in Hop Breeding

- Molecular research
  - Marker assisted selection
  - Gene mapping
  - Gene functionality
- Non-brewery usage
- Continuing conversion to new varieties
  - Driven by disease pressure, storage issues, basic economic pressures, and continued growth in craft brewing.
  - Increases focus on AROMA
Acreage Trend: aroma versus alpha

- Trend has been toward growth in aroma hops
  - Role reversal
- Bitter/Alpha hops declining cyclically
- Acreage at near record high
Thank you for your time. Questions?