2019 Spring Webinar Series
2 p.m. CST
EXTENDING KNOWLEDGE ➔ CHANGING LIVES
NDSU EXTENSION
Upcoming Webinars

• February 20 – Growing Apples in North Dakota
  – Tom Kalb, NDSU Extension Horticulturist

• February 27 – Trendy and Healthy Houseplants
  – Esther McGinnis, Assistant Professor and NDSU Extension Horticulturist
Zoom Controls

- Mute/unmute
- Open chat box
- Chat box
- Question/Answer Controls
Please Complete the Survey

• Please complete the short online survey that will be emailed to you after today’s webinar. It will take just a couple minutes!

• Be sure to sign up for an opportunity to win a prize in the drawing. After submitting the survey, a form to fill out with your name/address will appear.

• Acknowledgement: This project was supported by the U.S. Department of Agriculture’s (USDA) Agricultural Marketing Service through grant 14-SCBGP-ND-0038.
Hops in North Dakota: What you need to know before you get started!

Field to Fork Webinar series
February 13, 2019
About me

Education:
• Master’s in Horticulture in Progress
• Bachelor of Science in Horticulture
  • Minor in Landscape Architecture-NDSU - 2010
• A.A.S. in Architectural Drafting and Estimating - NDSCS - 2007

Experience:
• Williston Research Extension Center - March 2013
• Prior greenhouse and landscaping employment
Why are hops in demand?
Today:

I. History
II. Botany
   1. Chemistry
   2. Stages of production
III. Plant Requirements
IV. Hops at the Williston REC
V. Pest Problems
Origins

First written records 736 AD from the Hallertau region in Bavaria, Germany
US History 101

- European explorers from England brought to America in 1629
- In 1808, first commercial hop yard was established in New York.
What about North Dakota?

North Dakota has a rich beer history that began long before statehood.

Trivia question: When did North Dakota become a state?
Glossary

Beer
Hop yard
Hops
Inflorescences
Resins
Perennial

- “An alcoholic beverage usually made from malted cereal grain (such as barley), flavored with hops, and brewed by slow fermentation.” - Merriam-Webster
- “A field in which hops are grown; also called hop field, hop garden” - MSU Extension Publication E3236
- “Female flowers of the perennial hop plant (Humulus lupulus)” - MSU Extension Publication E3236
- “The complete flower head of a plant including stems, stalks, bracts and flowers.” - Merriam-Webster
- Found only in the lupulin glands of hop plants, chemical compounds that make up the acid profile
- “A plant in which the vegetative structures live year after year” - Biology of Plants 6th Edition
Nomenclature
Hops belong to the family Cannabinaceae.
Three recognized species *Humulus lupulus*, *H. yunnanensis* and *H. japonicas*

Botany
Hops are *dioecious*-[di, two + oikos, house]”Unisexual; having the male and female elements on different individuals of the same species” – Biology of Plants 6th Edition
Figure 1.3 (a) ‘Pin’; young flowering shoots developing in the leaf axils, young female inflorescence with papillated stigmas. Mature cones of Wye Target; (e) Yeoman; (f) ‘Strig’; central axis of cone; (g) bract; (h) enclosed seed; (i) bracteole with seed; (j) removed (after R. F. Farrar).
Figure 1.3 (a) 'Pin'; young flowering shoots developing in the leaf axils; (b) 'Burr'; young female inflorescence with papillated stigmas. Mature cones of (c) Fuggle; (d) Wye Target; (e) Yeoman; (f) 'Strig'; central axis of cone; (g) bract; (h) bracteole with enclosed seed; (i) bracteole with seed; (j) removed (after R. F. Farrar).
The glands are packed with bitter substances which are also rich in essential oils. The glands are surrounded by the cone, which is the outer skin. The alpha acids (lupulones) are found in the glands and are responsible for the flavor and aroma of beer. The beta acids and resins are also found in the glands, contributing to the overall flavor profile of the beer.
Soft Resins

**α-acids**
- Humulone
- Cohumulone
- Adhumulone

**β-acids**
- Lupulone
- Colupulone
- Adlupulone

Both α-acid and β-acid impart bitterness to the beer!
Essential Oils

- Impart aroma and flavor to the beer
- Represents 0.5-1.5% of weight of dried cones
- Consists of complex mixture of 200 or more components
- Less is understood about the nature of the essential oil chemistry
Glossary

Perennial
Rhizome
Bine
Trichome
Tropism

- “A plant in which the vegetative structures live year after year” – Biology of Plants 6th Edition
- “Horizontal underground stem.” – Biology of Plants 6th Edition
- “The climbing stem of the hop” – Oxford English dictionary
- “[Gk. trichos, hair] An outgrowth of the epidermis, such as a hair, scale or water vesicle.” – Biology of Plants 6th Edition
- “The turning of all or part of an organism in a particular direction in response to an external stimulus”
Aboveground Growth

Bines grow 18-25’ per season
- Up to one foot per day!
- Clockwise direction around anything within reach
- Phototropic (light) and thigmotropic (touch)

Laterals extend from the bines
Trichomes

Plant Stages of Production

- Dormancy
- Spring growth
- Vegetative growth
- Reproductive growth
  - Harvest
- Back to dormancy
Dormancy

- Killing fall frost Late September to April?? March??
- Plant translocate nutrients from shoots down to the storage roots
- Above ground shoots die back to the ground
- Buds for next year are in the resting phase

Figure 1.7 Perennial storage organ of young plant consisting of new shoot, old stem of original trimmed sett and new storage roots (Williams, 1960).
Spring Growth

- Time to plant new
- Plant emerging March through May
- Increasing day length and temperatures

Fieldwork:
- Early season weed control
- Fertilizer application
- Stringing your trellis
- Irrigating
- Training
Training

• Too late—not achieving maximum yield
• Approximately 3 bines per string
Vegetative Growth

- Typically May through July

1. June 21\textsuperscript{st}
   Summer Solstice

2. Days get shorter signaling reproductive phase

- Side-arm (lateral) growth begins late June early July

Fieldwork:
- Another round of fertilizer
- Keep irrigating
- Scouting for pests and diseases
Reproductive Growth

- July to August
  - Hop bines have reached the top of trellis
- Cones develop
- Cannot increase the number of cones
  - Maintaining plant health will maximize cone weight and quality
Harvest

• Mid-August to late-September depending on cone moisture and variety
• Many harvest methods
  • Most common: cut and transport bines to a stationary picking machine
  • Other methods: mobile harvesters
  • Hand picking?
Back To Dormancy

• End of August through first hard freeze late-September, early October
• Autumnal equinox-days have gotten shorter until they are around the same as night
• Nutrient translocation to storage roots

Fieldwork:
• Take care of perennial weed issues
• Keep irrigating hops until freeze
• Prevent crown damage
Considerations…

• Site selection
  – Full sun
  – Protection from wind
  – Space to build trellis
  – Equipment access
  – Irrigation access
Economics

• Labor
• Pesticides and Fertilizers
• Equipment
• Infrastructure
  – Hop trellis
  – Harvesters
  – Dryers
  – Post harvest processing
Growth Requirements

• Grow best between 34-50° Latitude north or south
• Day length sensitive
• Soil preference: pH 6-7.5
• Fertilizer: First year 75 lb N/Acre
  1. Subsequent years 100-150 lb N/Acre
     20-30 lb P/Acre
     80-150 lb K/Acre
• Irrigation: 16 gallons/plant/week
  (1-acre hopyard, ~900 plants = 15,000 gallons)
  *During hottest months
48° 08' 21.90" N
At the Williston REC
<table>
<thead>
<tr>
<th>Variety</th>
<th>Alpha Acid %</th>
<th>Brew Usage</th>
<th>Typical Beer Style</th>
<th>Origin</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cascade</td>
<td>5-7%</td>
<td>Aroma</td>
<td>American Pale Ale</td>
<td>Domestic Variety</td>
</tr>
<tr>
<td>Centennial</td>
<td>9.5-11%</td>
<td>Dual</td>
<td>American Pale Ale</td>
<td>Domestic Variety</td>
</tr>
<tr>
<td>Challenger</td>
<td>6.5-9%</td>
<td>Dual</td>
<td>English Ale</td>
<td>UK Variety</td>
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<tr>
<td>Brewer’s Gold</td>
<td>8-10%</td>
<td>Bittering</td>
<td>Ale</td>
<td>Domestic Variety</td>
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<tr>
<td>Galena</td>
<td>10-15%</td>
<td>Bittering</td>
<td>English Ale</td>
<td>Domestic</td>
</tr>
<tr>
<td>Glacier</td>
<td>5.5%</td>
<td>Dual</td>
<td>American Pale Ale</td>
<td>Domestic</td>
</tr>
<tr>
<td>Mt. Hood</td>
<td>4-7%</td>
<td>Aroma</td>
<td>Lager</td>
<td>Domestic</td>
</tr>
<tr>
<td>Newport</td>
<td>13-17%</td>
<td>Bittering</td>
<td>Barley Wine</td>
<td>Domestic</td>
</tr>
<tr>
<td>Nugget</td>
<td>12-14%</td>
<td>Bittering</td>
<td>Barley Wine</td>
<td>Domestic</td>
</tr>
<tr>
<td>Willamette</td>
<td>4-6%</td>
<td>Aroma</td>
<td>English Style Ale</td>
<td>Domestic</td>
</tr>
<tr>
<td>Spalt Select</td>
<td>3-6.5%</td>
<td>Aroma</td>
<td>Bock</td>
<td>German</td>
</tr>
<tr>
<td>Zeus</td>
<td>20%</td>
<td>Bittering</td>
<td>Pale Ale</td>
<td>Domestic</td>
</tr>
</tbody>
</table>
Planted August 1st 2014
Diseases & Insects

Mildews
  - Downy mildew
  - Powdery mildew

Wilts
  - Verticillium
  - Fusarium
  - Sclerotinia

Viruses
  - American hop latent virus
  - Hop latent virus
  - Hop mosaic virus
  - Apple mosaic virus

Viroids
  - Hop stunt viroid

Hop Aphid
Hop Flea Beetle
Japanese Beetle
Potato Leafhopper
Spider Mites
Loopers
(Hop stunt viroid)
Two-spotted Spider Mite
Leaf hopper
• Verticillium Wilt
Viruses
Cone Disorders
Beneficial Insects

This generalized information is presented only for key groups of predatory arthropods.

Photographs depict adult stages.

Many other natural enemies occur in hop yards and can contribute to control of spider mites, aphids, and caterpillar pests.

See text for detailed information on the biology, life cycle, and importance of these and other beneficial organisms.

Dormancy Emergence Training Flowering Harvest Post-harvest

Figure 131. Seasonal development and activity of four key groups of predatory arthropods that occur on hop: predatory mites, aphid-eating lady beetles, mite-eating (Stethorus) lady beetles, and predatory bugs. Information is generalized; multiple factors influence the presence and abundance of beneficial arthropods in hop yards. Detailed sections for each of these predator groups and for other beneficial arthropods appear on the following pages. (Illustrations by Joel Floyd)
Questions?

Thank you!

www.ag.ndsu.edu/fieldtofork