The Beer Garden

Growing Hops in the Foothills

Presented by

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University of California
Agriculture and Natural Resources

UCCE Master Gardener Program
El Dorado County

Class Objectives

- Growing: Propagating, planting
- Integrated Pest Management
- Harvest
- Preservation

The Hop Plant: *Humulus Lupulus*

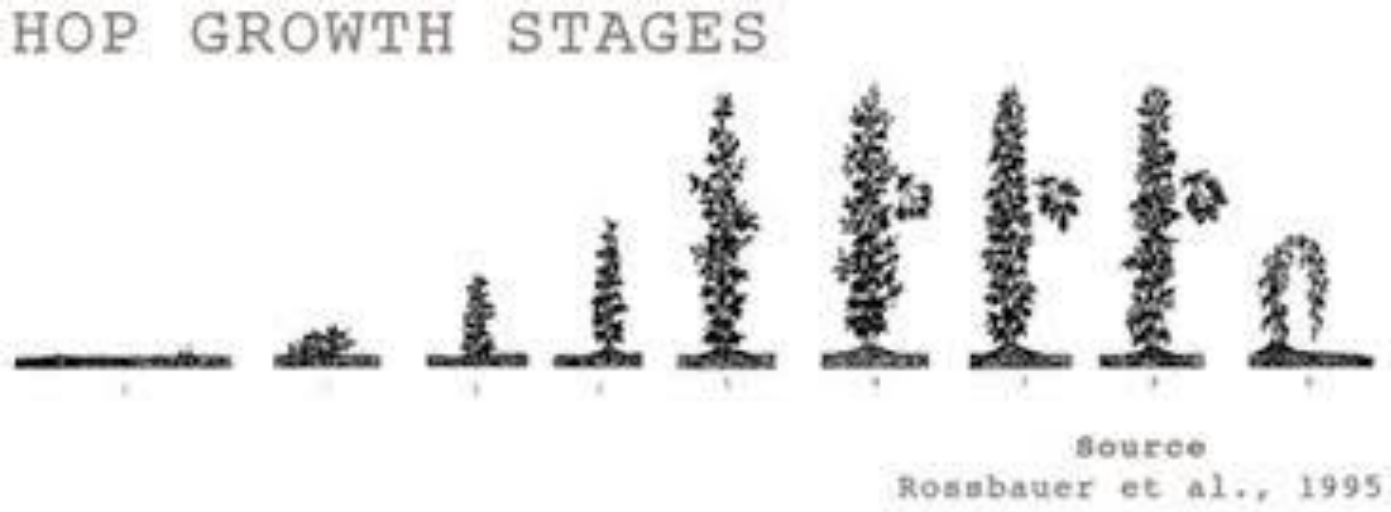
- Herbaceous perennial (roots overwinter) with annual bines
- Dioecious, meaning male and female plants
- Only the female plants produce cones, do not need male flowers/pollen for production
- Underground structure consists of rhizomes (has buds) and true roots (no buds). This structure is referred to as the crown
- International Herb Association's Herb of the Year, 2018

Climate

- Direct sun and long day length
- Minimum of 120 frost free days
- Pretty limited to latitudes 35 to 55 degrees North or South
- Water
- USDA Zones 3-9
- Washington and Oregon produce 75% of the world’s hops

Support System, Trellis System

- Beyond the scope of this class to discuss how to build a trellis system
- Many design ideas with specifications are available on-line
- Heights of 30 feet are easily reached
- Can be used to shade a south facing window
- Coir, or any type of rope that is NOT smooth should be used for the bines to climb.
- Make sure support structure is strong



- Dormancy
- Spring regrowth
- Vegetative growth
- Reproductive growth (Cone production)
- Preparation for dormancy

Fall/Winter

Dormancy (Oct-March)

- In late summer the plant sends photosynthetically derived starches to the roots for storage
- The starch is converted into soluble sugars
- These sugars supply the energy needed for spring regrowth

In the field

- Not much is happening
- Plan for next season

Spring

- Planting
  - Last frost
    - 1000 ft April 15
    - 2000 ft April 22
    - 3000 ft April 30
    - 4000 ft May 7
- Divide or prune roots of established plants
- Manage vegetative growth (May-July)
- IPM, monitor
- Fertilization
- Irrigation

Summer

Cone production

- Continue to trim excess bine growth
- IPM, once a week scouting expeditions
- Fertilization

Harvest

- Brew a batch with fresh hops, within 4 hours of picking to maximize aroma and alpha acids
- Dry/preserve

Site Preparation

- Clear area of debris and excess rock
- Soil test before planting
- Amend soil with organic matter, such as compost or manure
- Small hills can be formed to assist with drainage and propagation, this also helps prevent soil compaction around the newly planted hops
- Plenty of vertical space is needed
- Lots of sun

Planting

- Soil test before planting
- Plant the rhizome horizontally about 1 inch below the surface
- Allow 2-3 feet between rhizomes
- If planting different varieties, space hops at least 3 feet apart
- Label varieties
- Consider gopher protection
- Frost Protection

Frost Protection

- Check that plants are well watered because dry plants are more susceptible to damage, and moist soil retains heat better than dry soil.
- Cover plants before sunset to capture ground heat radiating upward at night. Remove sheets, blankets and other covers daily if it is sunny and above freezing to allow soil to absorb heat.

First Year Plants

- Focus is on root establishment, very few cones
- Do not remove foliage during the first year, the plant requires as much leaf material as possible to produce and store carbohydrates in the root system for the next year’s growth
- Prune to the crown in fall after foliage has died
- Cover crown with mulch for the winter

Soil and Plant Nutrition

- Well drained sandy loam
- Amend with compost, aged manure
- pH of 6-7
- Heavy nitrogen feeder, needs 3 lbs N/1000 sq ft total applied over 2-3 times between March and mid-July.
- Weed free area as much as possible
- Clear debris and excess rock
- Mulch with organic materials

Mmm good, Feed those plants

- Recommended fertilization rates
  - Nitrogen (N), 100-140 lbs/acre
    - Mid-April with urea (40-0-0) every 2-3 weeks, follow with 16-16-16
    - Stop late June
    - Do not exceed 25 lbs/acre at one time
  - Phosphorous (P), 60-100 lbs/acre
  - Potassium (K), 100 lbs/acre

- N=Roots
- P=Shoots
- K=Fruits

Pruning and training the bines

- Let bines grow 8-12 inches before deciding which bines will be pruned off.
- Select 3-5 of the healthiest bines and trim the rest back to the crown
- Continue to trim new growth from the crown throughout the growing season. This gives more of the plant's resources to cone production.
- Use clean tools, a knife or sharp pruners
- Train the bines clockwise around your twine

Irrigation

- Use an in-line drip system to provide a consistent and even amount of watering
- Consider a micro spray system if your garden area is dry, hot, or dusty. This can assist with management of spider mites. Do not use sprayers in areas where consistent moisture remains as Downey mildew is a potential problem.
- Hops require constant moisture throughout the growing season. Overwatering can be worse than under watering. Nitrogen and other nutrients can easily be washed from the root system and into the groundwater. They do not like to sit in water.

Drip system with new planting

Micro spray head with irrigation

Irrigation

- First year plantings have a minimal root system and should not be allowed to dry out.
- Deep watering techniques are recommended
- Mulch to conserve moisture, control weeds, add organic matter to soil.

Pruning the roots

- Plants should be divided or severely root pruned every three years
- Annual spring root pruning is typical in an established hop yard
- Hops are not fussy about how they are pruned
  - Use clean tools
  - Pull out outer roots and dispose
- Cut back roots to a 1 foot square around the crown
- Do not leave severed root pieces in the ground as they will continue to grow
- Rhizomes may also be cut into smaller pieces with a sprout and roots to propagate new plants

Propagation

Plant Sale

Saturday, April 21, 2018

Sherwood Demonstration Garden
6699 Campus Drive
Placerville

Hops Plants will be available

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Integrated Pest Management

- Monitoring and Sampling (scouting protocol)
- Identification of primary pests
- Decision making, what action is necessary
- Intervention, take action
- Record-keeping, write it down
- Education, IPM Resources
- Beneficials

Scouting protocol

- The more you look, the more you see
- How many leaves you collect or evaluate should depend on the pest and the size of your garden
- Be sure to look in different places at different times, re-check problem areas
- Keep records

What am I looking for?

- Anything out of the ordinary
  - Stunted plants
  - Damaged or cupped leaves
  - Discoloration, chlorosis, bronzing
  - Failure to thrive
  - Large group of insects (usually not valuable to worry about the individual insect you spot now and then)

General Protocol

- Remove leaves as you move through the yard, turn them over and give a close inspection using a hand lens
- Check leaves from all reachable heights, but favor the lower, denser portion of the canopy
- If checking for a specific pest threshold, establish a sampling protocol

Primary Pests

- Powdery Mildew
- Verticullum Wilt
- Mites
- Aphids
- Gophers

Powdery Mildew

- Caused by Podosphaera macularis, affects hops and cannabis
- Can develop and spread during dry weather because it does not need direct contact with water to reproduce or infiltrate the plant.
- 64-70 F is ideal temperature (can go 46-82 F)
- Infection can be greatly reduced by short intervals (>2 hours) of temperatures above 86 F
- Overwinters on the buds on the rhizomes, in the soil, on plant litter, and the ground around the plant

Powdery Mildew

- Makes appearance in early spring on emerging shoots
- Shoots are stunted, pale yellow, look dusty
- This white powdery substance is the spore producing mass
- Spores are released and spread by wind, water splash, people and equipment moving through the yard

Powdery Mildew

- Perfect conditions
  - Cloud cover, late spring rains
  - Too much moisture in the soil
  - Over abundance of nitrogen
  - Dense vegetation
  - Day time and nighttime temperatures are similar and range 50-68 F

Powdery Mildew

- Late season
  - May appear as small yellowish spots on leaves, chlorosis
  - Lack of chlorophyll reduces plants ability to feed itself, slowing growth and killing off leaves
  - As the infection takes hold, white spots appear generally on underside of leaves
  - These white spots produce spores, grow, produce more spores…

- Unlikely to kill the plant, reduces yield and quality of cones

Powdery Mildew Management

- Varietal Resistance
  - Nugget Cascade Mt. Hood
- Moderately Resistant
  - Fuggle Perle Tettnang Hallertau
- Do not overfeed, plant growth can become spongy which is conducive to powdery mildew
- Sunshine and good air circulation
- Keep plant well pruned, especially early pruning, and dispose of trimmings
- Cut back on irrigation times during rains
- Weed control
- Fungicide

Vertcillium Wilt

- Fungus, *verticillium albo-atrum* and *verticillium dahlia*
- Can survive in soil from 4-15 years
- Remains dormant until potential host root is in near proximity
- First symptom is yellowing of plant's lower leaves
  - Starts on section of leaves that lie between the leaf vein, can lead to a streaked appearance
- Leaves begin to curl upward
- Bine becomes swollen
- Leaves become totally brown and fall from the bine

Vertcillium Wilt

Verticillium Wilt Management

- If you have in your soil, don’t plant hops in this location
- Tolerant varieties
  - Cascade Perle
- Do not compost infected plants

Two spotted spider mites, TSSM

- *Tetranychus urticae*, red spider mite
- Arthropod, barely visible
- Normally found on underside of leaves
- Feed by puncturing and sucking out the plant juice
- Vegetation weakens and bronzes (or a whitish appearance), reproduce rapidly
- Numbers become high they cause defoliation
- Feeding on cones causes the cones to turn red, dry, and brittle. They will not hold up to drying process, lower alpha levels, shorter storage

Two spotted spider mites, TSSM

- Mated females overwinter in the hop yard, taking shelter in hop crown, cracks in hop poles or mulch.
- Emerge in early spring ready to lay eggs
- Appears particularly orange at this time, as temperatures warms the females feed and begin to lay eggs

Two spotted spider mites, TSSM

- Like it hot, with the pace of development increasing until an upper threshold around 100F is reached. Cold and wet weather is not conducive to development
- TSSM are very small but can be observed on the underside of leaves using a hand lens
- As the season progresses cast skins and old webbing give infested leaves a dusty and dirty appearance
- The eggs look like tiny clear spheres and are most commonly found in close proximity to adults and larvae
- Larvae are small, translucent versions of the adults
- Adults and larvae have two dark spots

TSSM Management

- Check undersides of leaves for TSSM in May, look for mites as well as eggs. Take samples from 3-6’ up the bine. As the season progresses samples should be taken from higher up as the mites migrate
- Use a hand lens to evaluate leaves
- Thresholds developed in Pacific Northwest
  - Two adults per leaf in June
  - Mid-July, 5-10 adults per leaf
- Goal is to prevent cone infestation, not 100% control

TSSM Management

- Only manage for mites when absolutely necessary, management disturbs beneficial populations that help keep numbers in check
- Cultural Control
  - Dusty conditions often lead to mite outbreaks
    - Consider micro sprayers as part of your irrigation system
    - Hand spray bines with strong water stream if possible
  - Water stressed plants are less tolerant of spider mite damage
    - Adequate irrigation, water deeply and less often to help conserve water and keep plants healthy

Early Warning Signs

TSSM Management

- Chemical Control
  - Labeled miticides will kill fewer beneficials than a general insecticide.
  - Carbaryl (Sevin), some organophosphates, and some pyrthroids favor spider mites by increasing the level of nitrogen in leaves. Insecticides applied during hot weather can cause dramatic spider mite outbreaks within a few days.
  - OMRI-approved products containing oils, befenazate, and azadirachtin are labeled for mites. Organic does not mean selective.
  - Don’t use soaps or oils on water stressed plants or when temperatures exceed 90 F.
  - Consider pre-harvest interval (number of days between spray and harvest)

Aphids, hop aphid

- Can reduce plant productivity
- Excrete “honeydew” which makes an excellent growth medium for sooty mold and can greatly reduce the quality of the crop
- Under extreme infestation, defoliation can occur
- Aphids may also feed within cones
- Leaf cupping
- Hop aphids can be found on the upper and lower surface of the leaves

Aphids

- Soft, pear shaped bodies with long legs and antennae
- “tailpipe” structure that comes off the back end, this is where the honeydew is excreted
- May be green, yellow, brown, red, or black
- Wingless; however, produce a winged generation in order to move from wintering shelter to plant

Aphid Management

- Control before the flowering stage may be important to protect crop quality when populations are high
- 8-10 per leaf are tolerated in the Pacific Northwest until cones are present
- Insecticides containing neem, neonicitinoids, flonicamid, or spirotetramat all have activity against hop aphid

Attracting Natural Enemies

- Natural enemies are more likely to thrive in undisturbed areas that provide overwintering habitat, flowers to support their survival and reproduction, and refuge from pesticide applications in crops
- Natural enemies may be conserved with the same plantings that support pollinators

Resources for beneficial insects

- UC IPM
  - Natural Enemies Gallery
  - Beneficial Predators
  - Biological Control

Bye, bye aphids

Date: February 14, 2018 Eco-Gardening: Attracting Pollinators, Beneficials, and Predatory Incsects
Time: 9:00 AM - 12:00 PM
Contact: UCCE Master Gardeners 530-621-5512
Sponsor: UCCE Master Gardeners of El Dorado County
Location: Cameron Park Community Center

Gophers

- Rodents, *Thomomys* species
- Digging, tunneling lifestyle
- Active year round
- Most commonly feed on roots

Gopher Management

- Wire baskets until plants become established
- Raised beds with wire bottoms
- Traps
- Poison
  - Harmful to children and pets
  - Harmful to species that eat dead rodents
- Control sooner rather than later
- If possible remove weedy areas adjacent to hop yard to create buffer strip of unsuitable habitat

Cone Production

- End of July
  - Plant shifts energy into cone production
  - Vegetative production slows
  - Photosynthetic capacity of the plant is maximized
  - By time cones mature they account for up to 50% of the total above ground dry matter
  - Cannot increase cone numbers
  - Focus on plant health to maximize cone weight and resin/oil content
  - Water management in July and August, most of water is used
  - Nutrient management, cut off Nitrogen, add Potassium (K)

Harvest

- When is the right time?
  - Mid-August to Late September
    - Variety, harvest from early to late
    - Environmental conditions
- Too early, lupulin won't have reached optimal levels
- Too late, quality of the lupulin begins to degrade and cone does not remain intact through the drying process
- If you have a large yard, you will want to conduct a moisture level test to determine harvest time, see resource links

Harvest timing

- Unscientific and subjective methods for telling if a hop cone is ready to harvest:
  - Tear the cone down the middle. If it splits evenly along the center it is dry enough to harvest.
  - Give the cone a light squeeze. If the cone stays compressed, it’s not ripe enough. When they spring back after a squeeze, they’re ready.
  - Roll the cone next to your ear. If it makes a cricket sound, they’re ready.
  - Outer bracts should be dry and have a papery feel to them
  - Lupulin is bright yellow, turned orange? Too late

Harvest

- Limit the amount you harvest each day to match your drying capacity
- Plastic or metal container with holes which allow for air circulation
  - Colander
  - Laundry basket
- Have your drying station ready to go
- Break cones off at their base, try to avoid getting leaves and stems into your harvested cones…these will need to be sorted out at some point
- Have your kettle boiling and use fresh hops within 4 hours; 4-6 times the amount of dry hops called for in your recipe.

Harvest

- Hand pick directly off the bine
  - Small drying capacity
  - Small harvest
  - As a means to keep varieties separated
  - A greater amount of green matter is left for increased photosynthesis and stored carbohydrates
- Cut the coir
  - Cut 3 feet above the crown to insure ongoing photosynthesis
  - Drop onto a sheet or tarp to facilitate carrying/dragging the cut bine to a picking area

Preparation for Dormancy (September)

- Harvest
- Bines cut, leaving as much green matter as possible
- Cones dried to 10% moisture content
- Cool dried cones
- Cold storage

- Enjoy!

Dormancy, Winter

- Cut bines to crown
- Add fresh compost to surface soil
- Mulch heavily

Preservation

- When picking cones off the bine, filter out any overly mature cones which might not hold up to the drying process
  - Use these immediately in brewing
  - Preserve as an extract
  - Be creative: candy, tea, hops pillows for sleeping
- Important factors for drying hops:
  - Time: not more than 3 days
  - Light: direct sunlight will compromise the quality of the hops
  - Heat: temperatures should never exceed 140F
  - Moisture: too moist and dried hops will rot. If baled, there is a risk of fire.
    - Too dry, you've lost aroma and lowered alpha acids

Preservation

- Food Dehydrator
  - Trays should be clean and dry
  - Place fresh cones on trays and set between 120-140 F for 6-8 hours
- Oven
  - Place on clean and dry screens
  - Pre-heat oven on warm setting, temperature should never exceed 140 F
  - 6-8 hours
  - Check frequently to assure adequate air circulation
- Air drying on a screen
  - Clean and dry
  - Elevate like a tabletop so air can circulate from above and below
  - Enhance air circulation by setting up fans
  - Keep out of direct sunlight

Preservation

- When to tell if hops are dry
- When hops are first picked, their moisture level should be between 76-80% of their weight.
  - When properly dried, the moisture level has been reduced to between 8-10% of their weight.
  - Stem should snap
    - If stem bends, cones are not dry enough
  - Lupulin easily falls from the cone
- Cool, bag (removing as much air as possible), date and store in a cool, dark place (freezer is best).

Preservation Tools

Simple infusion using hops that were too fragile for drying

Important Links

- Field Guide for IPM in Hops: ipm.wsu.edu
- UC IPM
- Master Gardeners of El Dorado County
  - Presentations, The Beer Garden
- Drying Hops on a small scale, msu
  - http://msue.anr.msu.edu/news/drying_hops_on_a_small_scale
- Hops, Oregon State University
- Hops, Michigan State University
- Hops, Washington State University

Thank You

- Kelly Auville, UCCE Master Gardener of El Dorado County
- Roger Dillon, Master Food Preserver, Placer County
- Sarah Robinson, UCCE Master Gardener of El Dorado County

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