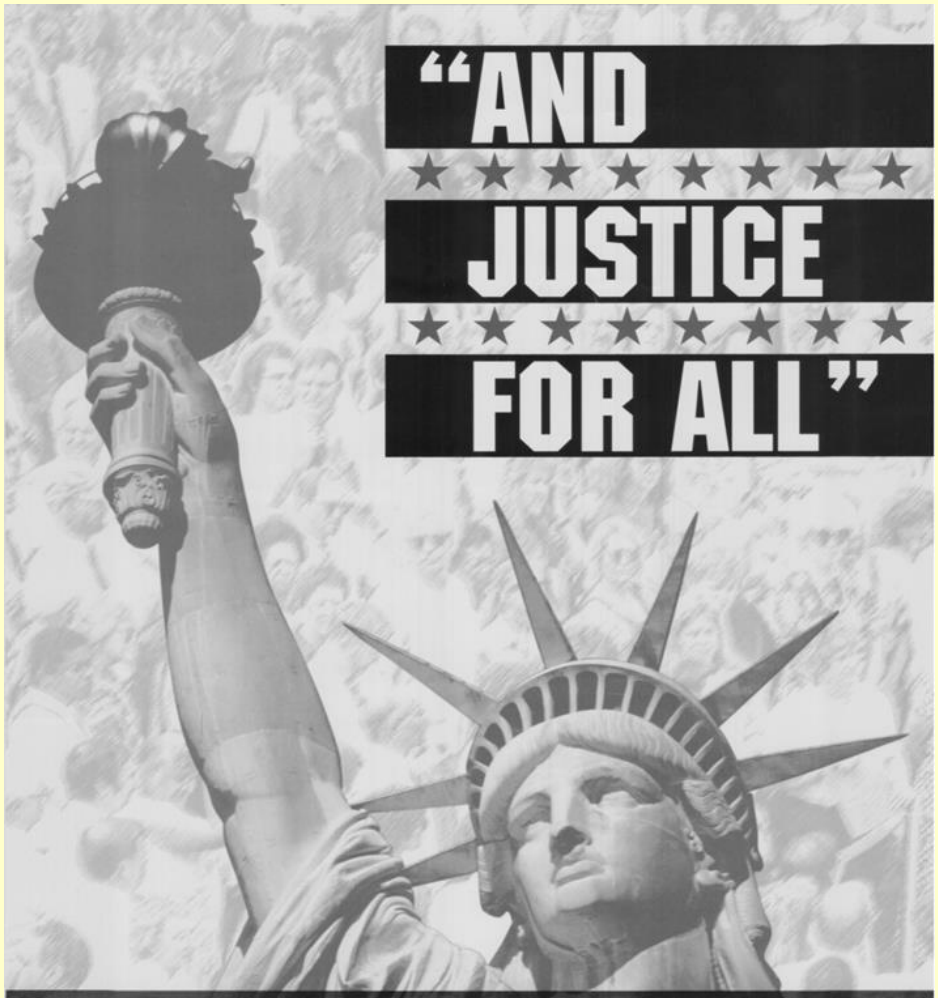

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USDA
UNITED STATES DEPARTMENT OF AGRICULTURE

FORM AD-475-A (REVISED 9/2006)

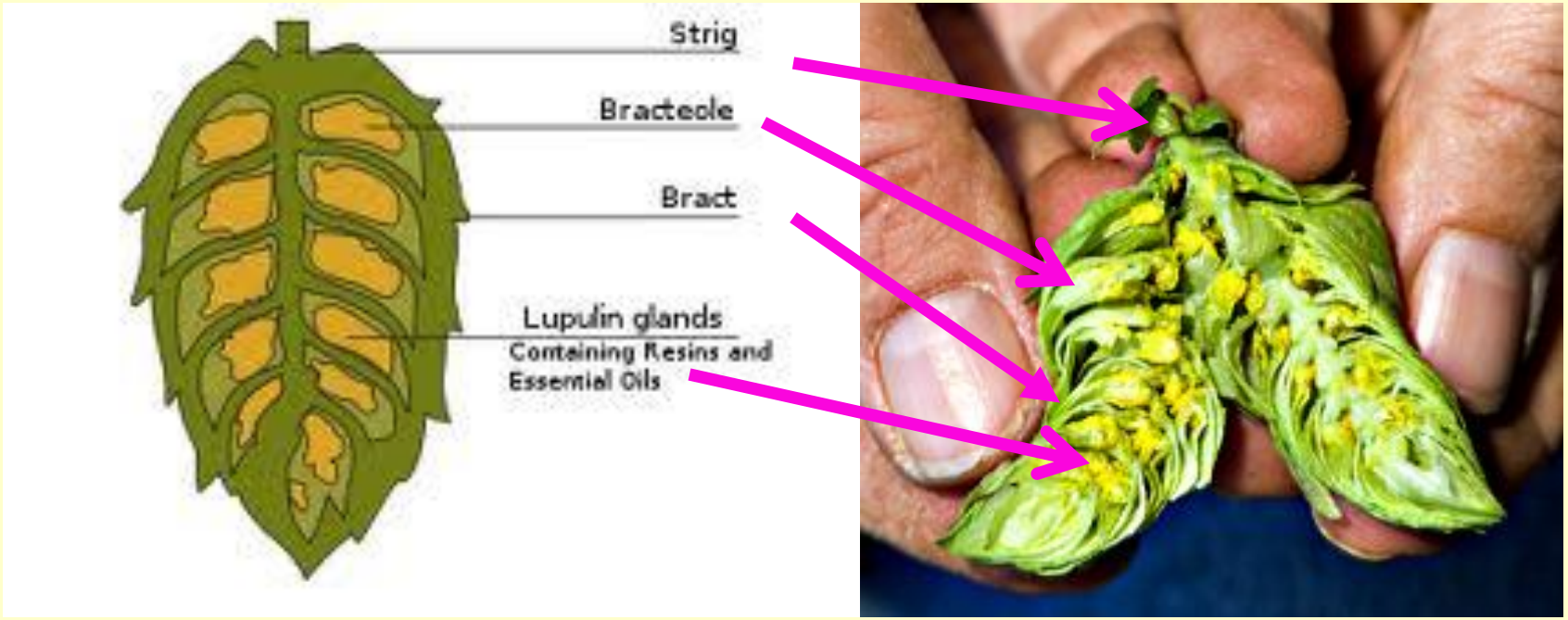
A guide to growing hops in the home garden

Diane Brown
Extension Educator, MSUE

Hop *Humulus lupulus*

- Hop is a perennial that regrows each spring from the rhizomes of an underground rootstock
- Hops produce annual stems called bines from a perennial rootstock- twine clockwise- grow 18-25’
- Hop is native to North America and Europe
- Hops grow only at certain latitudes (38º to 51º latitude)
- There are male and female plants

Anatomy of a hop cone

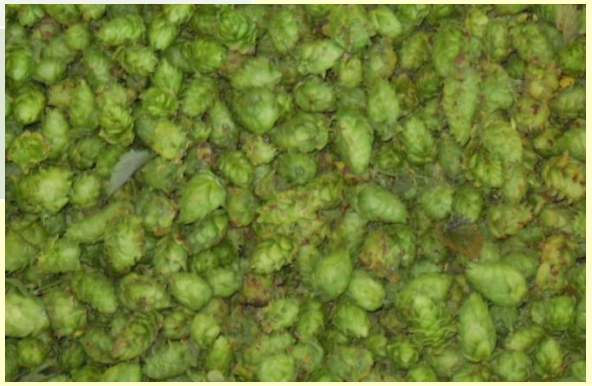


Important chemical components of hops

- Alpha acids-contribute to the bitter flavor of beer, help prevent unwanted growth of bacteria, and enhance the ability of yeast to grow and ferment the wort to beer.
- Beta acids- contribute very little to bittering, but have strong antimicrobial properties
- Essential oils- contribute aromas and flavors to beers and ales

Aroma descriptors for hop cultivars

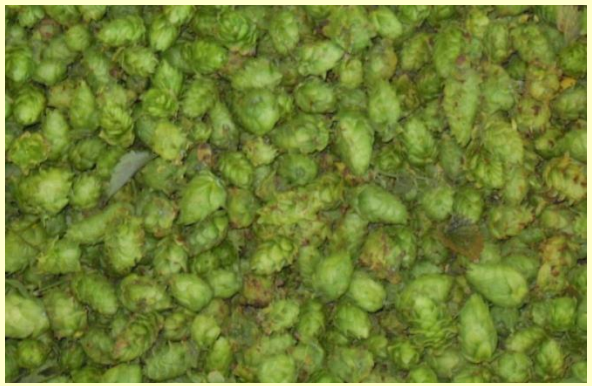
Hop cultivar	aroma
Cascade	Flowery, citrus, grapefruit
Chinook	Spicy, piney, grapefruit
Citra	Grapefruit, lime, tropical fruit
Willamette	Mild, slightly spicy, black currant/herbal
Fuggle	Delicate, minty, grassy, slightly floral
Hallertau	Mild and pleasant
Brewer's Gold	Black currant, fruity, spicy



Source: Grape vs. Grain, p. 97 Bamforth, 2008

Aroma descriptors for hop cultivars

Hop cultivar	aroma
Idaho 7	Pine, stone fruit, pineapple and mango
Azacca	Papaya, mango and orange
Cashmere	Pine, tropical fruit
Jester	Lychee, grapefruit, black currant
Comet	Citrus, grapefruit, tropical fruit
Lemondrop	Citrus, herbaceous notes
Mosaic	Dank, earthy, herbal, tropical fruit



Source: Grape vs. Grain, p. 97 Bamforth, 2008

Popular American hops

- Cascade –flavor/ aroma
- Citra- bittering/tropical fruit flavor/aroma
- Centennial- bittering/flavor (sim. to Cascade)
- Chinook-bittering, herbal, smoky flavor
- Warrior-bittering
- Nugget-bittering/ floral aroma
- Columbus, Tomahawk, Zeus- super alpha hops
- Simcoe- bittering, resiny flavor and aroma
- Crystal-bittering, aroma- spicy floral
- Willamette- earthy, woody flavor

A hop with unusual characteristics

- ‘Teamaker’ hop-released in 2008 ARS by scientists in the ARS Forage, Seed and Cereal Research Unit (FSCRU) in Corvallis, Ore.
- lowest alpha acid concentration of any commercially available hop (0.6 to 1.8 %)
- beta acid levels (5.4 to 13.2 %) significantly higher than most varieties.
- High aroma- spicy, floral

Hop: traditional & current usage

BREWERY: 98%

Natural preservative

Bitter taste

Hoppy flavor

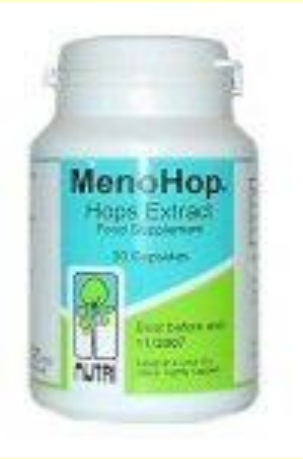
Stable foam head

Hop: traditional & current usage

MEDICINAL

Sedative

Anti-inflammatory



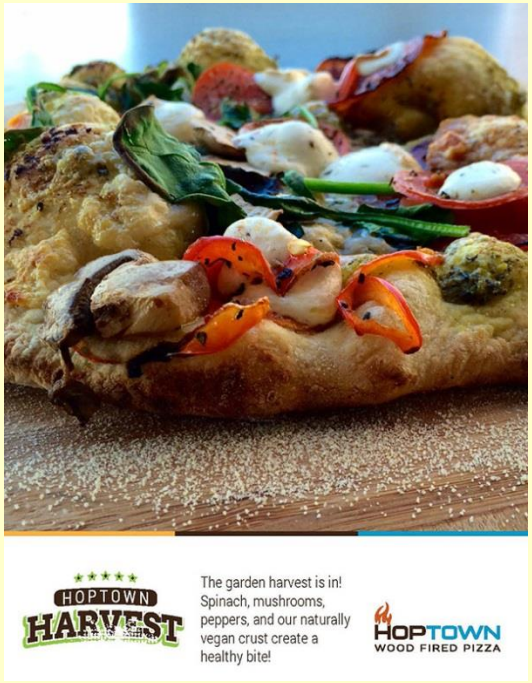
Estrogenic

Cosmetics

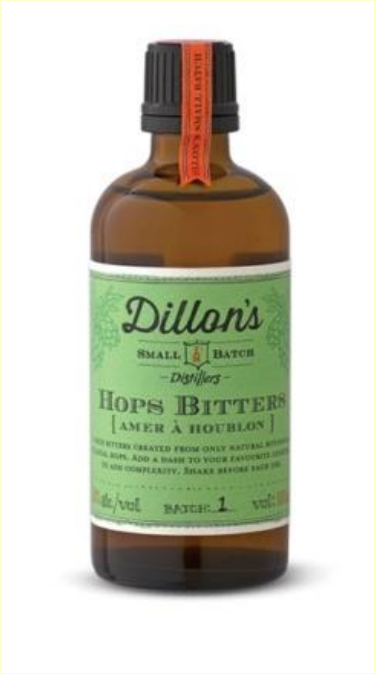

Hops Tea
Crafted from Organic Hops Flowers
BUDDHA TEAS
USDA ORGANIC


HOPPED
HOPPED
RWANDA
RWANDA


CRAFT SODA MADE
WITH REAL HOPS!
HOP POP
CRAFT SODA MADE
WITH REAL HOPS
CITRA & GALAXY
HOP BLEND



Pizza with hops as an ingredient



Hop bitters

Cheese with hops

Hop candy

current/future pharmaceutical uses for hops

- Anti-oxidants
- Phytoestrogenic
- Anti-carcinogenic
- Anti-viral
- Anti-inflammatory
- Treatment of diabetes symptoms

current/future uses for hops-food processing

- Hop compounds used as an antibiotic for beet sugar processing
- Antibiotic for animal feed
- Hop compounds can replace antibiotics in the production of ethanol
- Used to control bacteria in the production of several foods-processed meats, corn starch, baker’s yeast

Uses for hops for the back yard grower

- Shoots harvested for use as a vegetable
- Herbal teas
- Hop pillows-sleep aid
- Handmade soaps
- Wreaths and garlands
- For home brewers

Young hop shoots harvested and eaten as a vegetable in spring

Recipes(handout)

- Risotto di bruscandoli (hop shoots risotto)
- Hop shoots with poached egg and smoked salmon
- Hop shoot frittata
- Hoppy citrus-IPA glazed chicken wings
- Adult beverages made with Hop Pop

Hop tea

- Teamaker hop- aroma with much less bitterness
- Use one ounce dried hops per quart jar
- Fill with boiling water
- Steep for 10-20 minutes for a milder flavored tea, 4 hrs. to overnight for a stronger infusion
- Other herbal additions to hop tea: mint, lemongrass, chamomile, ginger

Hop pillows

- Sleep aid
- Use dried hop cones
- Add lavender, chamomile
- Place by your pillow at night to reduce nighttime restlessness and promote sleep

Other uses for hops

- Bines used for making paper- California Farmer and Journal of Useful Sciences, Volume 7, Number 16, 1 May 1857
- Bines made into cloth
- Bines made into rope
- Bines made into baskets

Why did hops come to be used in beer and ale?

- Hops acted as a preservative to prevent spoilage
- Helped to clarify the wort
- Gave the finished beer a good head
- Allowed for better storage and shipping
- Added flavor

Before there was hopped beer

- -There was “gruit” beer- an herb mixture to provide flavor and bitterness
- The exclusive use of gruit in Europe was phased out in favor of hops alone between the 11th century to the late 16th century (Great Britain)
- hops preservative quality enabled brewing, storing and eventual shipping of German lager style beer possible

Hops in the American colonies (1629)

- The hop cones were used for beer brewing
- The young shoots in the spring were eaten as a special treat in salads
- A wax from the tendrils provided a reddish-brown vegetable dye
- The fibers were used in textiles as a substitute for flax
- The stalks were used for basket and wicker-work
- Leaves and spent hops provided food for sheep.

Source: Sanborn Brown, *Wines and Beers of Old New England*

Oast house or hop kiln

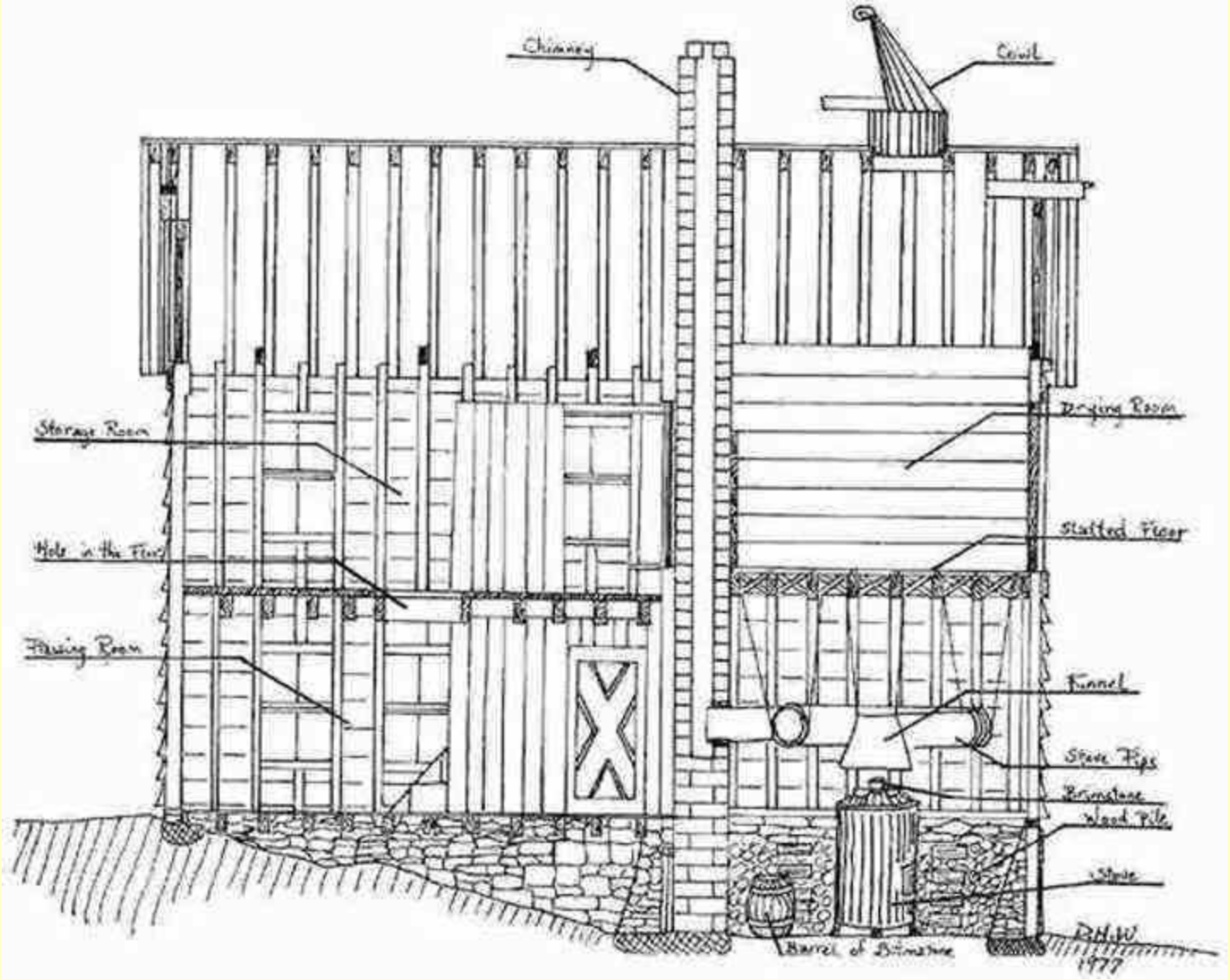
- Building designed for drying hops as part of the brewing process
- Hops were spread on a slatted floor
- The kiln furnace was lit to dry hops
- After drying, hops were pressed into sacks and sold to breweries

Oast House at Great Dixter, Sussex, UK built in 1890

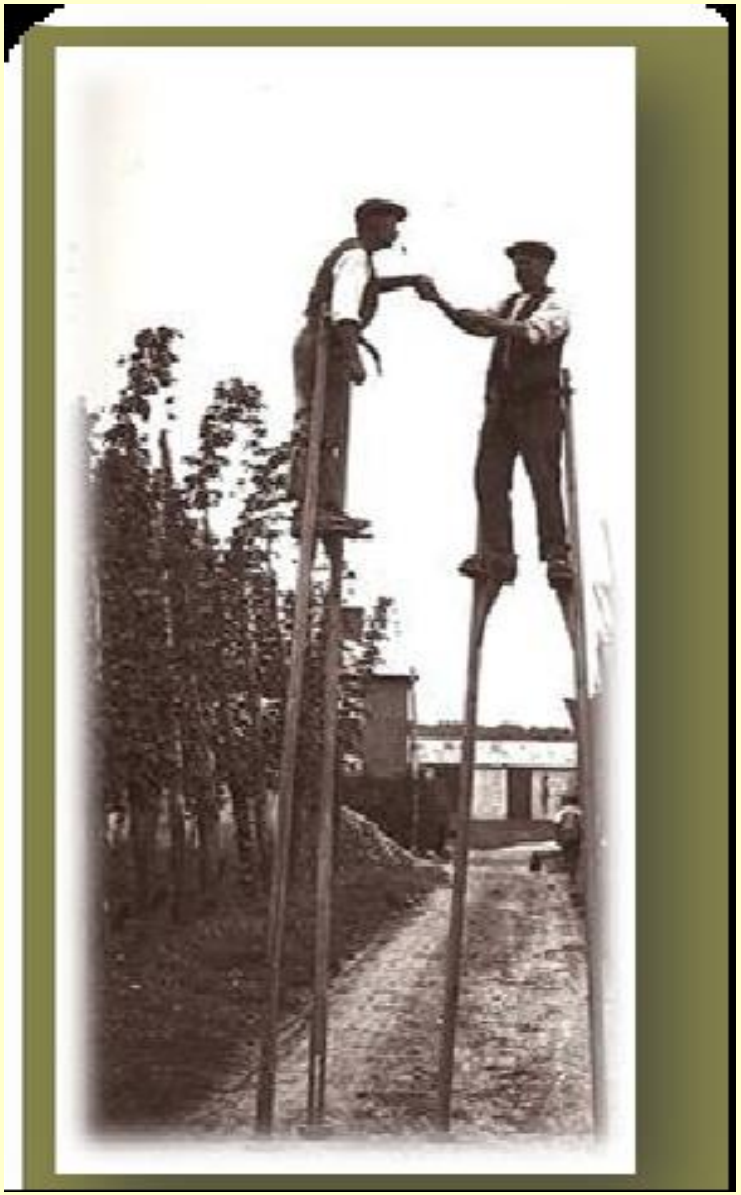
Hop kiln in New York state

Madison County, NY ca. 1870

Interior of a hop kiln



Hop stringing on stilts

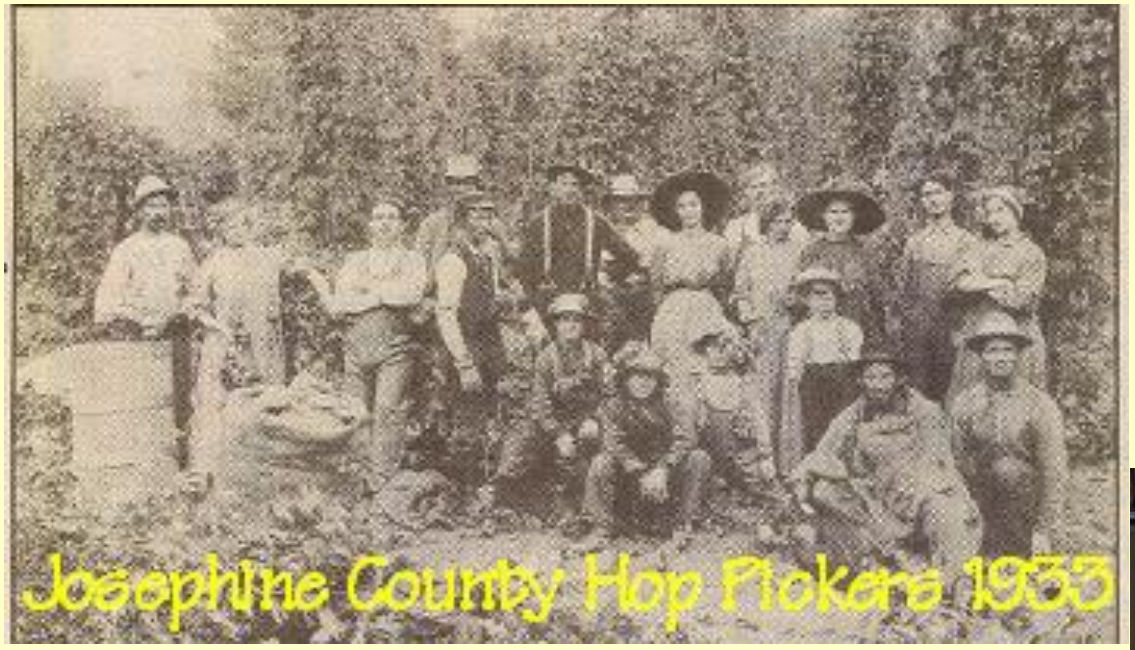


Hops in the United States

- First commercial hops harvested in Massachusetts in 1791
- New York State-first hops planted in Madison County in 1808.
- The first harvests sold for just 12 cents a pound.
- English crop failures increased the demand after 1822
- Erie Canal opened up transportation to the east and west in 1825.
- By 1859, seven-eighths of the nation's hops were harvested in New York State.

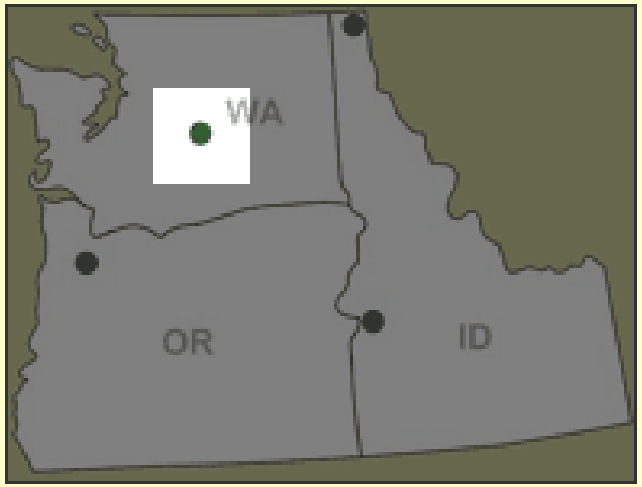
Hop picking in Oregon 1930-1960

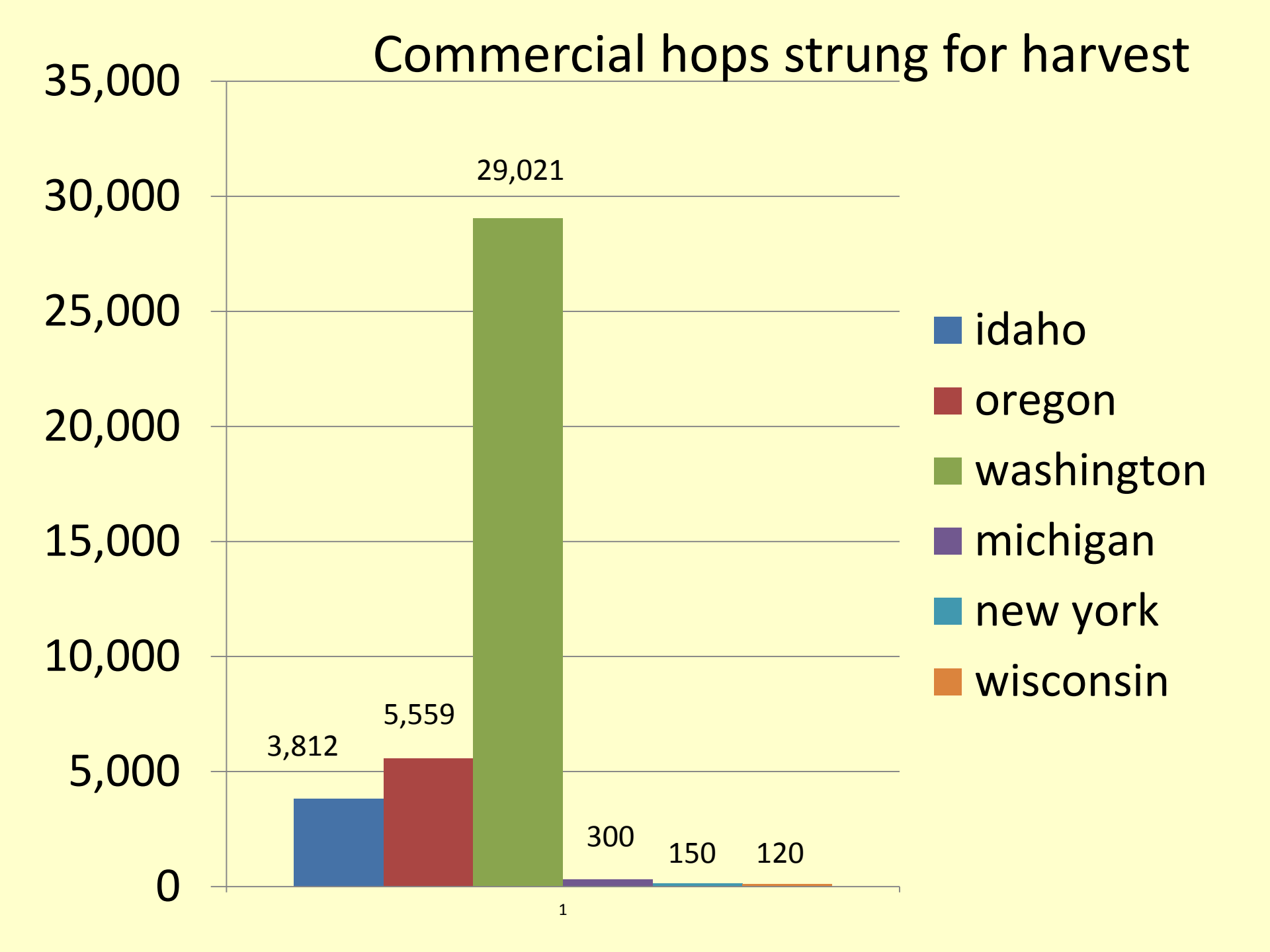
- Hop picking in Josephine County, Oregon



Current major hop production areas

- Washington, (Yakima Valley)
  - average farm size of 450 acres
- Oregon
- Idaho




Commercial hops strung for harvest
35,000
30,000
25,000
20,000
15,000
10,000
5,000
0
29,021
5,559
3,812
300
150
120
1
idaho
oregon
washington
michigan
new york
wisconsin

What do you need to grow hops in your backyard?

- Need full sun 6-8 hr.
- Space for a trellis- 12-18 ft.
- Source of water for irrigating hops
- Good air circulation– reduce mildew; avoid pooling of cold air
- Not too windy-
- Test the soil
- **well- drained** soil- sandy, or silty loam well structured clay ok
- Preferred pH range- 6-7
- Get below 6 or above 8, may have nutrient deficiency issues
- Organic matter 3-10%

Assess current soil fertility

- Take a Soil Sample
- Use a soil probe
- Sample to a depth of 12” – 15”
- Take 10 – 20 probes

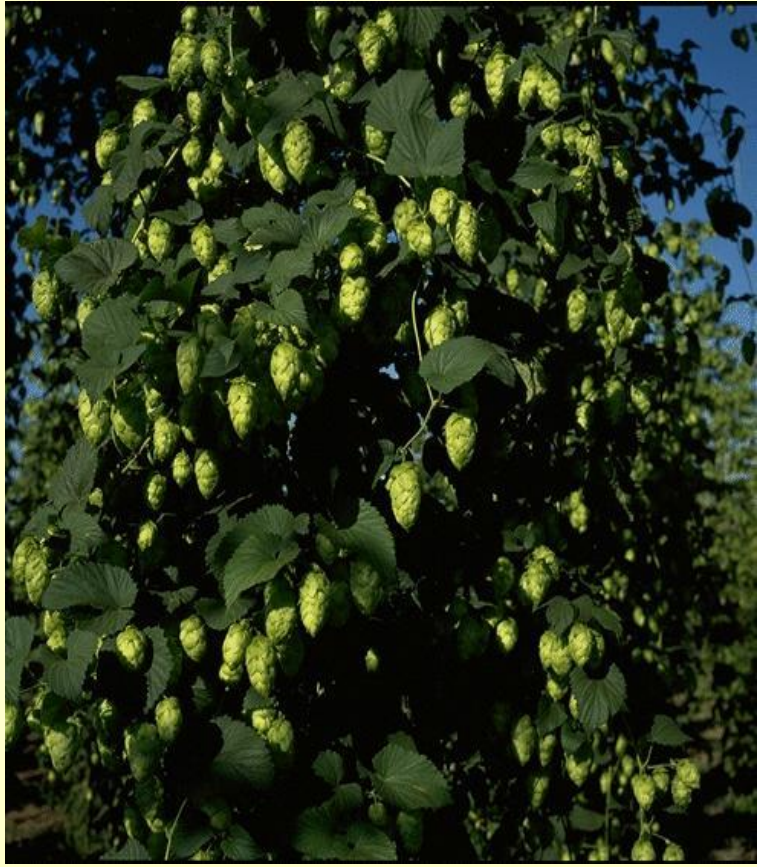
Hop Requirements

VARIES SLIGHTLY BY VARIETY

- 3% Nitrogen
- 2% Potassium
- 0.50% Phosphorus

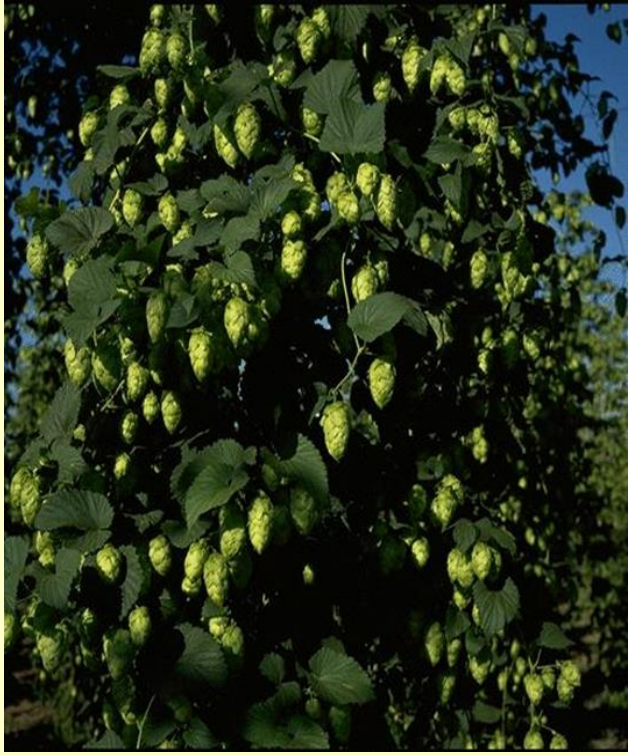
- Other important nutrients
  - Boron
  - Zinc

Nitrogen



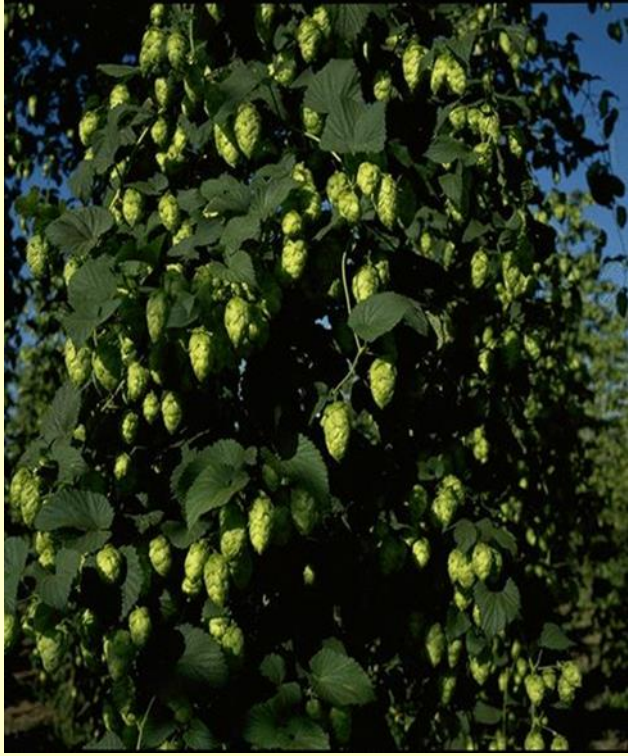
- Apply in late May to mid June
- Also consider soil type
- Will need about 1.25 to 2.5 ounces actual N per plant
- Example using Urea= 46-0-0
- 1.25/.46= about 2.75 ounces of urea
- 2.5/.46= about 5.4 ounces of urea

Phosphorus



- Phosphorus (0 to 80 lbs/acre)
- Will depend on Al levels in soil and pH
- Will depend on soil test levels
- Figure 900 plants/acre
- Range= 0 to about 1.25 oz actual P
- Triple superphosphate = 0-46-0
- Maximum of 2.75 oz per plant

Potassium



- Potassium –
- Will depend on soil type
- Will depend on yield
- Also depends on soil levels

For potash

Category	Low	Medium	Optimum	High	V. High
K (ppm)	0–50	51–100	101–130	131–160	>160
K to apply per plant	120-150 .13-.17 lb	80–120 .08-.13 lb	60-80 .07-08 lb	0 0	0 0

Potassium

potassium sulfate- 0-0-50

.13/.50=.26 lb=4.16 oz

For potash

	Category	Low	Medium	Optimum	High	V. High
	K (ppm)	0–50	51–100	101–130	131–160	>160
actual	K to apply	120-150	80–120	60-80	0	0
	per plant	.13-.17 lb	.08-.13 lb	.07-08 lb	0	0

Components of a commercial hopyard

- Poles-layout and install before planting
  - Usually 18-20 ft. tall
  - Rows spaced 10-14 feet with prevailing winds-
  - Best sun exposure- rows run north-south

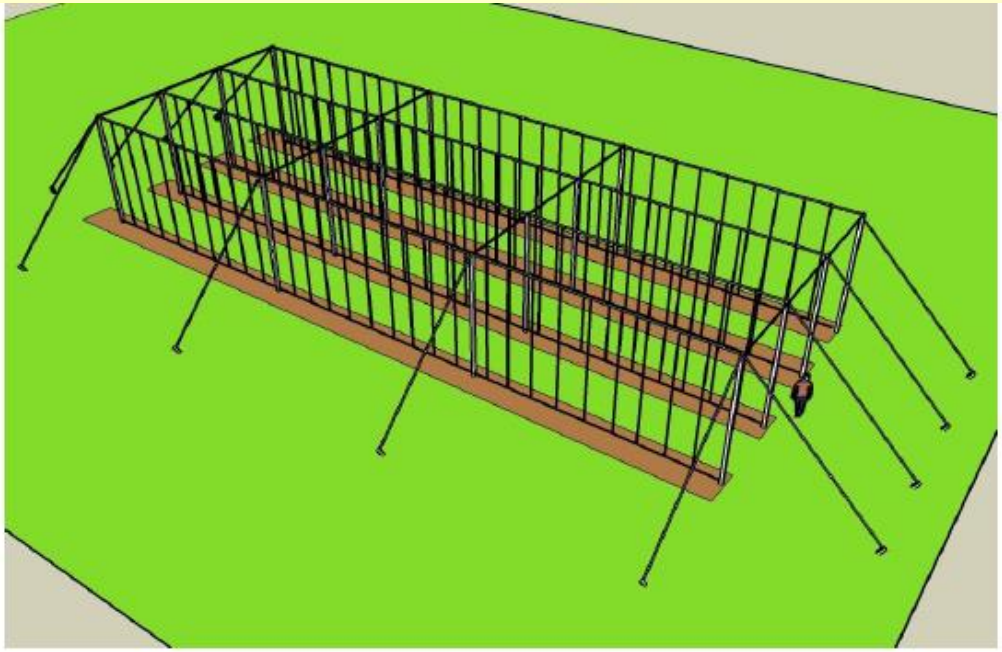
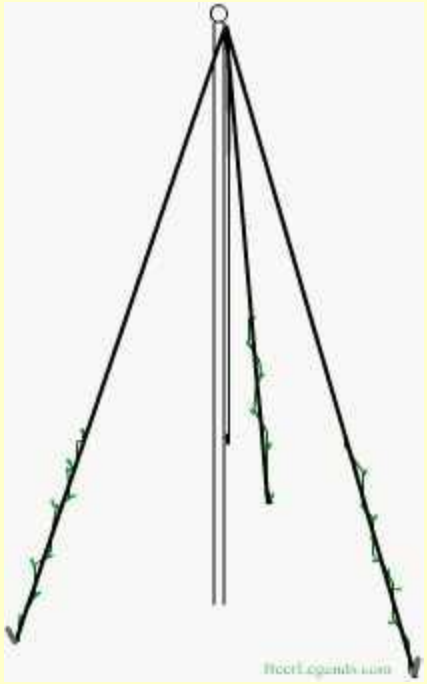


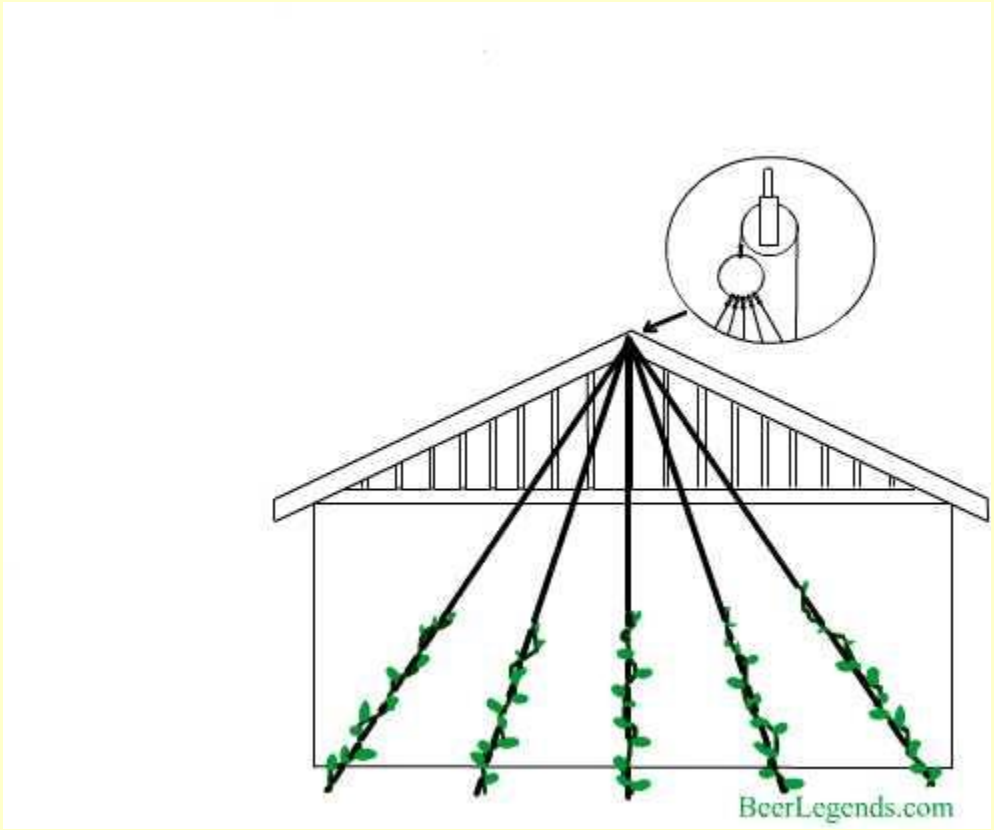
Figure 3.1 Illustration of high density trellis: 10ft row spacing with 3 ft plant spacing.

Supporting hops in a small planting

Most hops need to grow about 22 nodes before they start making cones

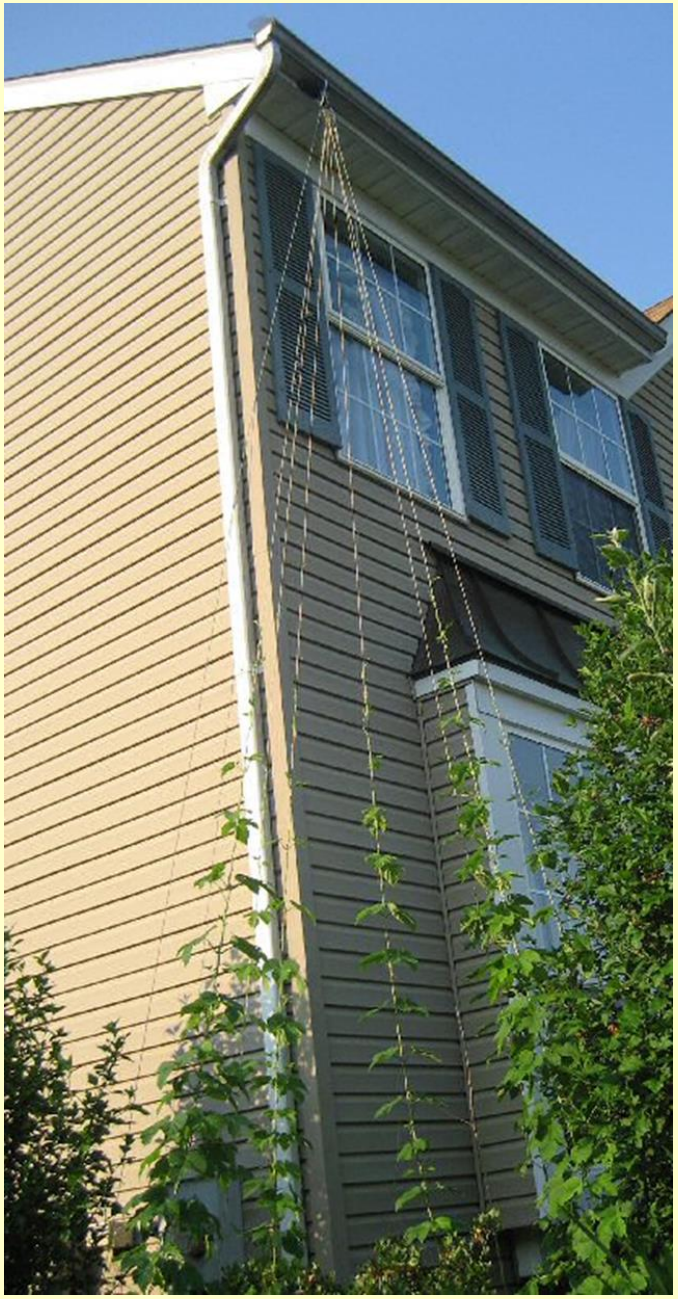


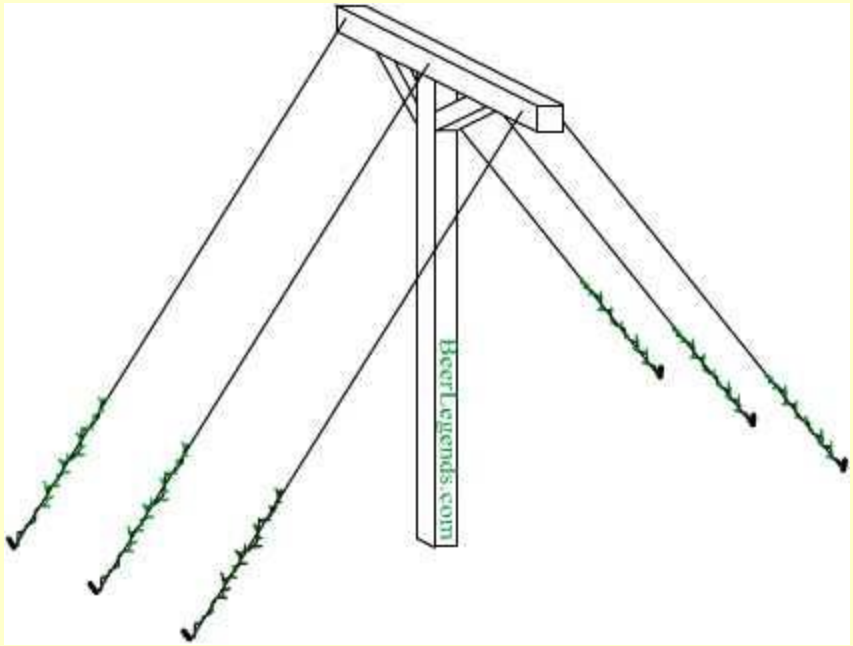
Using flagpole as center support



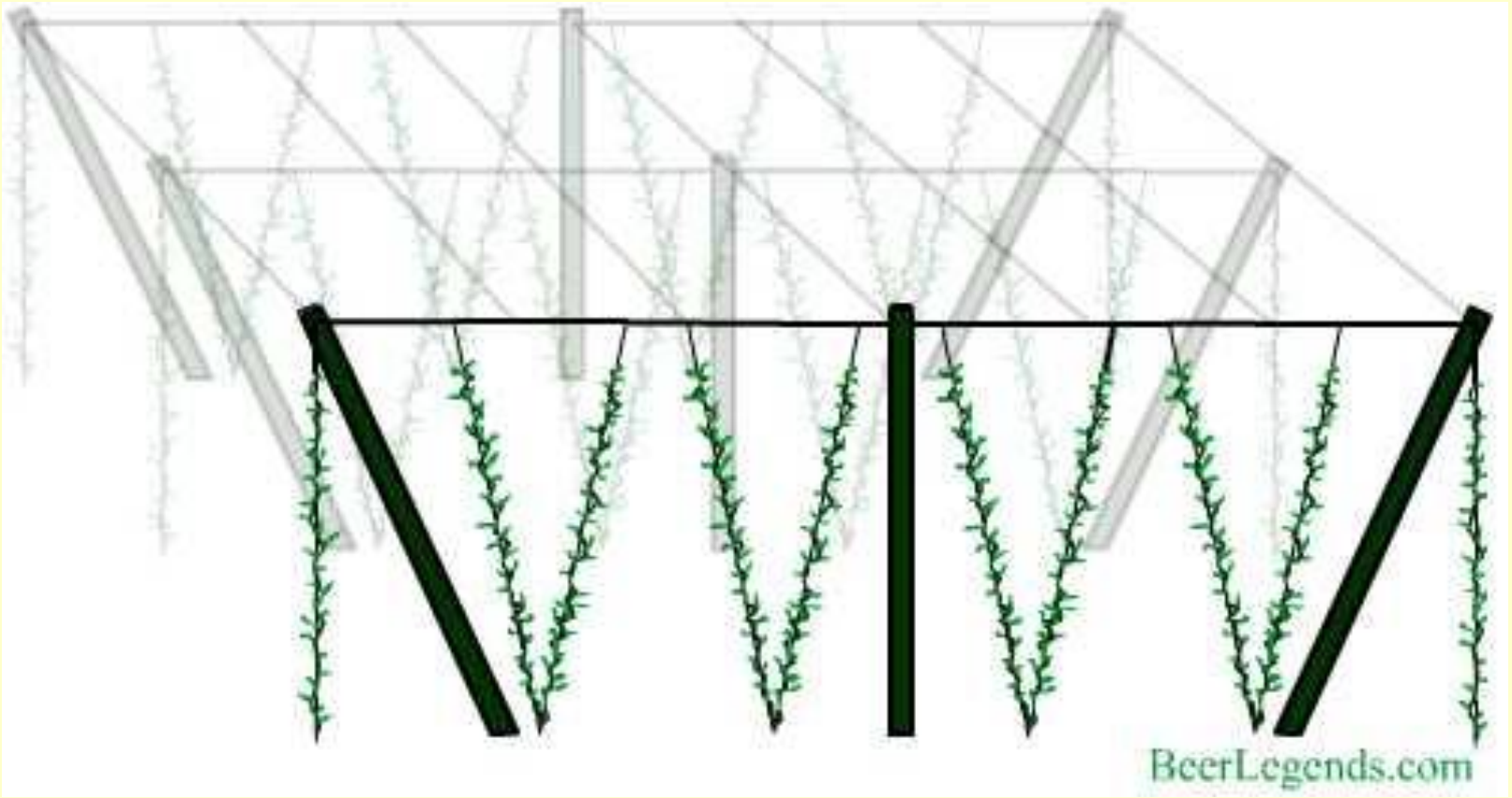
pulley with cords attached to gable end of house or garage

http://beerlegends.com/hops-planting-location-and-trellis-design





Clothesline style trellis


BeerLegends.com

PLANTS

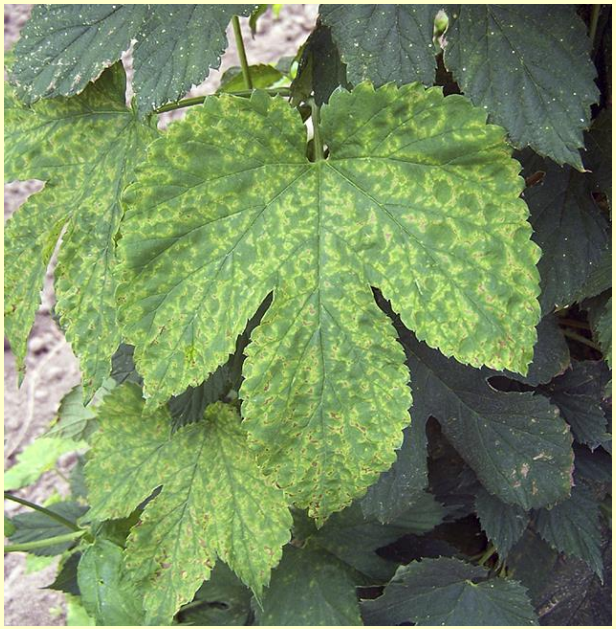
- Rhizomes- horizontal, underground stems
- Plant late April, early May
  - When soil can be worked
- Plant with buds facing up, cover with 2” of soil
- space 3- 3.5 ft apart

- Hop plugs -First year hops transplanted mid-May in the field typically grow to heights of 10-20 feet if trellised. Hops can be transplanted throughout the summer, right up until the first frost date.

Plants vs. rhizomes

- Rhizome quality highly variable
- Watch out for viruses (know your source, know your supplier)
- Virus indexed- started plants available
  - Great Lakes Hops http://www.greatlakeshops.com/
  - Sandy Ridge Hops http://www.mihops.com

viruses



How much water?

- Depends on soil type
- Newly planted vines 7 gallons of water/week.
- Best to split into 2 applications.
- Second year and beyond : 14-16 gallons per week split in two-four applications
- Amount needed for vines varies with age, vigor and weather.

- Coconut twine (Coir) is used to provide support for the hop bines to climb on

Can also use sisal, hemp, baling twine

diseases to keep out of your hopyard

- Viruses and viroids
  - Purchase virus indexed stock.
  - spread is by propagation from infected plants.
  - may take 3 to 5 growing seasons before obvious symptoms of the disease appear.

Hop stunt viroid

Apple mosaic virus

Hop mosaic virus

David Gent, USDA Agricultural Research Service, Bugwood.org

Verticillium wilt

- Caused by a fungus
- Soil borne
- Form microsclerotia in the soil
- Multiple hosts
- Can live for long periods in the soil

David Gent, USDA Agricultural Research Service, Bugwood.org

Verticillium wilt

- No effective chemical controls
- Crop rotation- 4 years – grasses
- Rogue infected plants
- Limit nitrogen
- Reduced tillage
- Remove crop debris

David Gent, USDA Agricultural Research Service, Bugwood.org

Crown gall- *Agrobacterium tumefaciens*

- Caused by a soil inhabiting bacterium
- Broad host range
- Of most concern in new plantings

Gall symptoms on bines and crowns

Photos: Compendium of Hop Diseases and Pests

Crown gall- *Agrobacterium tumefaciens*

- Infection through wounds-Frost injury or mechanical
- Spread-planting stock, irrigation water, cutting tools
- Survives in infested soil, plant debris

Gall symptoms on bines and crowns

Photos: Compendium of Hop Diseases and Pests

Crown gall- *Agrobacterium tumefaciens*

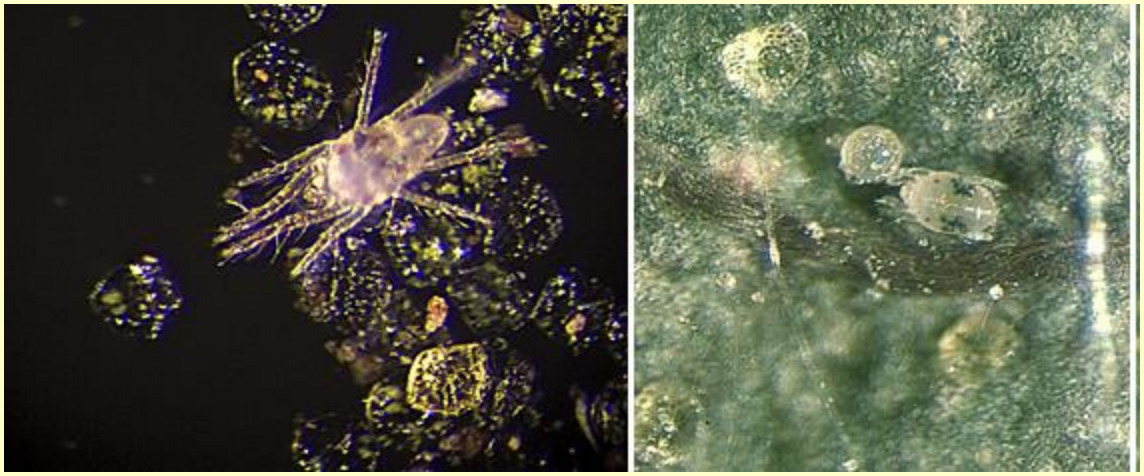
- Use healthy planting stock
- Remove and destroy infected plants

Gall symptoms on bines and crowns

Photos: Compendium of Hop Diseases and Pests

some common hop insects, mites and diseases

- 2-spotted spider mites
- Japanese beetles
- Potato leafhopper
- Downy mildew



Male spider mite , nymph with egg

Female spider mites

Photos: Compendium of hop diseases and pests

Two-spotted spider mite

- Sample regularly, beginning in late May or earlier if weather is very dry. 2 leaves from 20 plants
- Insecticidal soap-Use high volume applications to ensure complete coverage.
- Provisional threshold is
- 2 adults/leaf-June
- 5 to 10 mites/leaf mid-July

Potato leafhopper

PLH

- PLH will be found on the underside of leaves so flip leaves and shoots over
- Growers may also chose to place two-sided yellow sticky traps in the field to catch PLH
- hop plants can tolerate some level of feeding. Be conservative in the application of insecticides
- At this time there is no set economic threshold for PLH in hops.

Japanese beetle

- Foliage feeders
- little labeled specifically for Japanese beetle on hops
- Pyganic 3A

Downy mildew
Pseudoperonospora humuli

- Downy mildew overwinters in the crowns
- First appears as a primary “spike”
- The spike has pale green or light yellow, slightly downward-cupped leaves, and shortened internodes.

Downy mildew

- Favored by rainy weather and morning dew , ground fog
- Under favorable environmental conditions, the under surface of the leaves becomes blackened with spores, which spread the disease to other shoots, causing lesions to develop on the leaves.
- Secondary spikes are formed from these shoots.

Downy mildew
Pseudoperonospora humuli

- Can spread to leaves cones and flowers
- Cultural practices that increase air movement,
- decrease relative humidity, and increases summer temperatures will also help control downy mildew
- Spring pruning of spikes
- fungicide applications

Cultural management of powdery and downy mildew

- On plantings 2 yrs old or more
- Remove first shoots
- From 2nd flush of growth train 2-4 bines per string
- Remove and compost plant debris

When to harvest

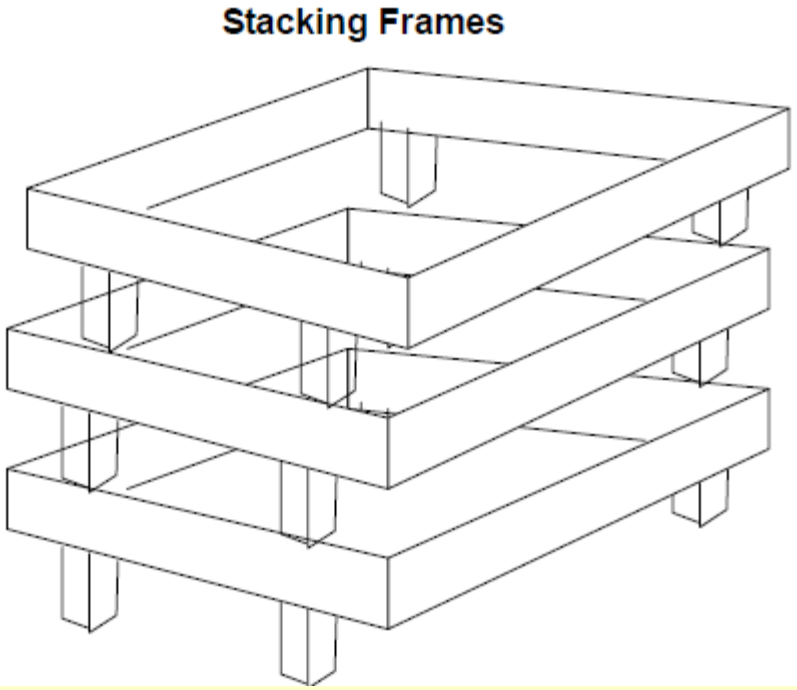
- Hops have strong aroma
- Lupulin is bright, school-bus yellow
- Cones feel dry and tips may be browning slightly- but mostly green
- Not crispy

Hand picking

- 90% of the mature flowers are in the top third of the plant- pick efficiently

Home made oasts

- Stacking wooden frames with screen bottoms



Frames are stacked on top of one another by standing the legs inside on the side supports

- Homemade hop dryer
- Made with 4X8 sheets of plywood
- 8 drying trays wood/hardware cloth bottoms
- Plastic screen liners
- Milkhouse heater
- Box fan on top to draw air

Summary: What to do when- the year growing hops

- October – March- plants are dormant
- Clean up weeds
- Prepare ground for planting hops
- Construct and install trellis- needs to be done before hops are trained

Spring Regrowth

- Spring pruning- -April- May- prune off first new shoots
- Weed control
- Applications of dry fertilizer
- Twining- train bines clockwise up string
- Train 2-4 vines per string.
- begin watering

vegetative growth stage

- Occurs from the end of May through the end of July.
- It can be separated into two phases:
  - From May to the end of June/early July: Plant growth is mainly found in the main vine and leaves.
  - July: The bulk of the above ground growth occurs in lateral production.

Vegetative growth

- critical period:
- The plants reserves are used up.
- manage plant health during this stage of growth.
- manage growth- want shorter internodes for more cones

Reproductive growth

- Flowering starts by the end of July.
- The plant shifts into production of cones.
- Vegetative production is greatly diminished.
- Photosynthetic capacity of the plant is maximized.
- By the time the cones mature, they can equal up to 50% of the above ground dry matter.
- Supply adequate water
- No fertilizer

End of August to beginning of September:

- important in the development next year's crop
- The excess carbohydrate transported to the roots for storage in the form of starch.
- Shorter days of late summer followed by cold October temperatures signal dormancy to start

Harvest season

- Mid August to early September:
- Harvest commences.

Harvest

- Cut the bines
- Pick cones
- Dry the cones to 8% to 10% moisture.
- Dried cones are cooled (ambient) for 12 to 24 hours.
- Store in the freezer after drying

For lots more information:

- Michigan State university extension hops website:
- http://www.canr.msu.edu/hops/

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