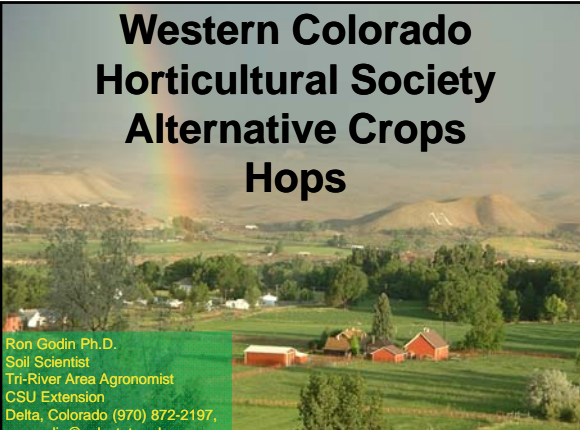


Western Colorado Horticultural Society Alternative Crops Hops




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Growing Hops

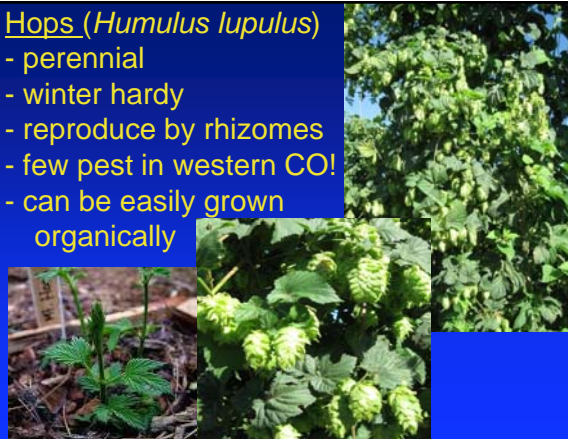
- What are hops?
- Hop yard & growing requirements
- Planting Hops
 - care and feeding
- Infrastructure – trellising & irrigation
- Hop cone development
- Harvesting & picking
- Drying & packing
- Storage
- Beer

Hops Production Overview



Hops (*Humulus lupulus*)

- perennial
- winter hardy
- reproduce by rhizomes
- few pest in western CO!
- can be easily grown organically





Hops Production for Brewers

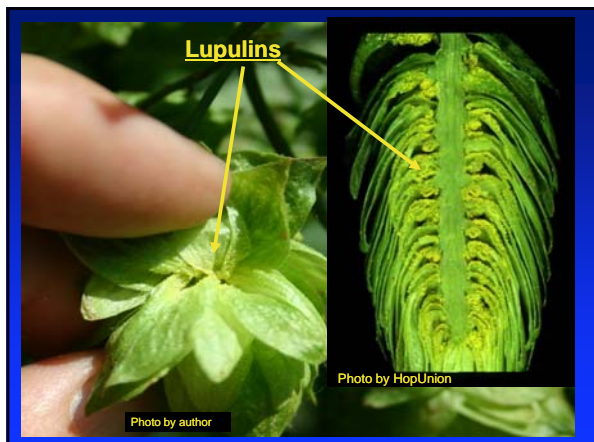


Hops

What are hops?

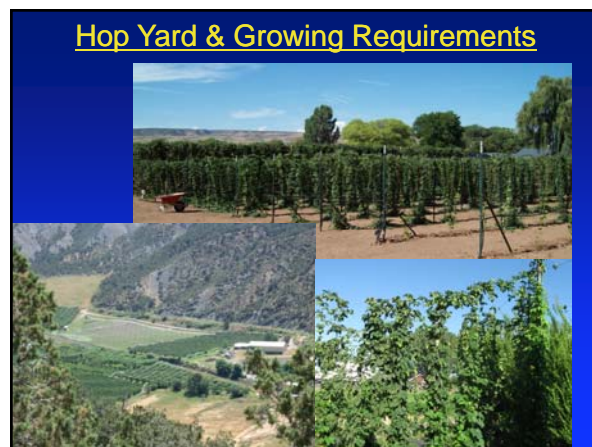
- Hops are the female flower cones of the hop plant (*Humulus lupulus*)
- They are used primarily as a flavoring and stability agent in beer, other beverages and in herbal medicine.
- The first documented use in beer is from the eleventh century.
- Hops contain several characteristics favorable to beer, balancing the sweetness of the malt with bitterness, contributing flowery, citrus, fruity or herbal aromas, and have an antibiotic effect that favors the activity of brewer's yeast over less desirable microorganisms.
- The hop plant is a vigorous climbing herbaceous perennial.
- Many different varieties of hops are grown by farmers all around the world, with different types being used for particular styles of beer.




Hop cone components (dry)

- 10% water
- 15% total resins
- 0.5% essential oil
- 4% tannins
- 2% monosaccharides
- 2% pectins
- 0.1% amino acid
- 3% lipids and wax
- 15% proteins
- 8% ash
- 40.4% residual carbohydrate (cellulose, lignin)

Total resins = hard resins + soft resins + uncharacterized soft resins
 Soft resins = Alpha acids (>50% but insoluble) + Beta acids



Alpha & Beta Acids contained in Lupulins



- Alpha acids add bitterness to beer
- take approx. 1 hr of boiling to release (Isomerize & solubilize)
- high and ultra high alpha acid hops used for bittering
- low alpha acid hops used for flavoring and aroma
- Take approx. 2 - 10 mins or can be dry hopped
- Generally, plant 1/3 bittering & 2/3 aroma
- Dual purpose hops

Hop Yard Requirements



Space
 Infrastructure
 Trellising
 Main poles & cables
 Trolley wires
 Cords for growing bines
 Irrigation (hops like to be moist)(30-36")
 Fertile soil - high nitrogen feeders (150-200 lbs/ac)
 Heat & SUNSHINE!

Hop Yard Requirements

Space Requirements
 Vertical Space: 18 - 20 ft unobstructed
 Field Space: Acres?
 Typically: 1100 plants per acre (12 x 3.5 ft)

Infrastructure (excruciating details next)

Trellising
 Main poles 21 - 24 ft tall
 Main cables connect poles
 Trolley wires (top wire)
 Strings (for growing bines)

Irrigation
 Drip
 Micro-jet sprinkler
 Furrow




Hop Growing Requirements Hop Care & Feeding

******Soil test BEFORE you plant!!! Avoids train wrecks!**

Recommended first year fertilization rates:

- Nitrogen (N) = 75 lbs/ac (2 - 3 tons compost/ac)
- Phosphorus (P) = 50 lbs/ac (included in compost)
- Potassium (K) = 75 lbs/ac (included in compost)

Subsequent years based on 8 - 10 bale yield (1600 - 2000 lbs/ac)
 (bale = 200 lbs dry cones)

- Nitrogen (N) = 150 - 200 lbs/ac (5 - 6 tons compost/ac)
- Phosphorus (P) = 60 - 100 lbs/ac (included in compost)
- Potassium (K) = 100 lbs/ac (included in soil & compost)

Typical hop yard

Pole spacing
30 - 36 ft x 40 ft


Row spacing
10 - 12 ft

Plant spacing
3 - 4 ft in row

Cables run
perpendicular to rows

Trolley wires run
with the rows and are typically V'd

One cord to each side of V and 2 - 3 bines per cord

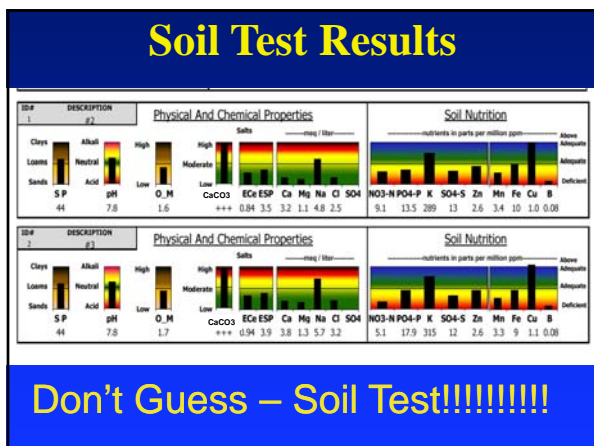


Hop Growing Requirements Hop Care & Feeding

Essential Plant Nutrients

Essential: A plant can not complete its life cycle without all of these nutrients

C - Carbon	<u>Macro</u>	<u>Micro</u>
H - Hydrogen	N - Nitrogen	Fe - Iron*
O - Oxygen	P - Phosphorus	Mn - Manganese*
	K - Potassium*	Cu - Copper*
	S - Sulfur	Zn - Zinc*
* Cations	Ca - Calcium*	B - Boron
- Anions	Mg - Magnesium*	Cl - Chloride
		Mo - Molybdenum



USDA list of most of the hop varieties

Abbreviation	Year	Parentage	Characteristics
Abn 1	1910	Abn 1 x Abn 2	...
Abn 2	1910	Abn 1 x Abn 3	...
Abn 3	1910	Abn 1 x Abn 4	...
Abn 4	1910	Abn 1 x Abn 5	...
Abn 5	1910	Abn 1 x Abn 6	...
Abn 6	1910	Abn 1 x Abn 7	...
Abn 7	1910	Abn 1 x Abn 8	...
Abn 8	1910	Abn 1 x Abn 9	...
Abn 9	1910	Abn 1 x Abn 10	...
Abn 10	1910	Abn 1 x Abn 11	...
Abn 11	1910	Abn 1 x Abn 12	...
Abn 12	1910	Abn 1 x Abn 13	...
Abn 13	1910	Abn 1 x Abn 14	...
Abn 14	1910	Abn 1 x Abn 15	...
Abn 15	1910	Abn 1 x Abn 16	...
Abn 16	1910	Abn 1 x Abn 17	...
Abn 17	1910	Abn 1 x Abn 18	...
Abn 18	1910	Abn 1 x Abn 19	...
Abn 19	1910	Abn 1 x Abn 20	...
Abn 20	1910	Abn 1 x Abn 21	...
Abn 21	1910	Abn 1 x Abn 22	...
Abn 22	1910	Abn 1 x Abn 23	...
Abn 23	1910	Abn 1 x Abn 24	...
Abn 24	1910	Abn 1 x Abn 25	...
Abn 25	1910	Abn 1 x Abn 26	...
Abn 26	1910	Abn 1 x Abn 27	...
Abn 27	1910	Abn 1 x Abn 28	...
Abn 28	1910	Abn 1 x Abn 29	...
Abn 29	1910	Abn 1 x Abn 30	...
Abn 30	1910	Abn 1 x Abn 31	...
Abn 31	1910	Abn 1 x Abn 32	...
Abn 32	1910	Abn 1 x Abn 33	...
Abn 33	1910	Abn 1 x Abn 34	...
Abn 34	1910	Abn 1 x Abn 35	...
Abn 35	1910	Abn 1 x Abn 36	...
Abn 36	1910	Abn 1 x Abn 37	...
Abn 37	1910	Abn 1 x Abn 38	...
Abn 38	1910	Abn 1 x Abn 39	...
Abn 39	1910	Abn 1 x Abn 40	...
Abn 40	1910	Abn 1 x Abn 41	...
Abn 41	1910	Abn 1 x Abn 42	...
Abn 42	1910	Abn 1 x Abn 43	...
Abn 43	1910	Abn 1 x Abn 44	...
Abn 44	1910	Abn 1 x Abn 45	...
Abn 45	1910	Abn 1 x Abn 46	...
Abn 46	1910	Abn 1 x Abn 47	...
Abn 47	1910	Abn 1 x Abn 48	...
Abn 48	1910	Abn 1 x Abn 49	...
Abn 49	1910	Abn 1 x Abn 50	...

Hop Soil & Petiole Nutrient Levels for Western Colorado

Hop Soil Test Levels Adequate Levels for Spring for 2+ year old vines
Soil samples taken from top foot of soil in and near the bine row

Nutrient	Adequate Levels
NO ₃ -N	40 - 50 ppm* †
P	> 25 ppm
K	> 250 ppm
Ca	> 4000 ppm
Mg	> 500 ppm
SO ₄ -S	> 25 ppm
Zn	> 5 ppm
Fe	> 10 ppm
Mn	> 4 ppm
Cu	> 1 ppm
B	> 1.5 ppm

* Nitrogen can be applied in separate applications through the first week of July for western Colorado.
† ppm x 4 = lbs/ac.

Selecting Hop Varieties

Better performers in growth, vigor and cone production

Variety	A.A.	Purpose
Chinook	12 - 15	Bittering
Nugget	12 - 15	Bittering
Cascade	7 - 9!	Dual/Aroma
Centennial	9	Dual/Aroma
Crystal	4 - 6	Aroma
Mt. Hood	4 - 7	Aroma
Willamette	4 - 7	Aroma

Recommend starting from transplants that are disease free
Rather than starting from rhizomes (know to carry apple mosaic virus among other pathogens)



Selecting Hop Varieties

Hops that do well in wetter conditions do not do well in Colorado's hot dry climate

Noble Hops – low bitterness strong aroma

- Hallertau
- Tettnang
- Saaz
- Spalt
- Northern Brewer
- Fuggle

Hop Thinning and Training

Thinning, strings, and training

Thinning: Typically - thin to 4 - 6 bines per plant

Strings: Typically - two strings per plant
2 - 3 bines per string

Training: East to West - round and round we go!



Hop Development - Start to Finish





Cone development – mid-burr

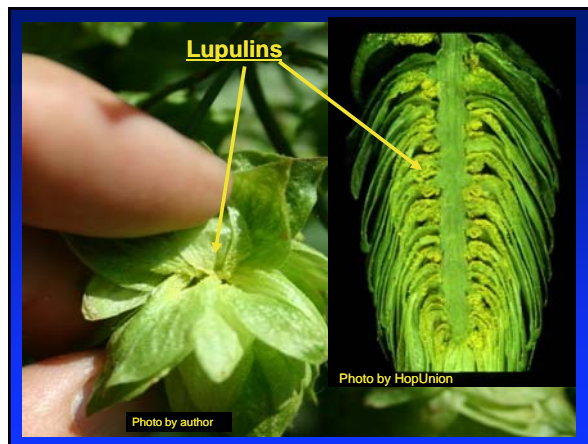


Photo by author

Photo by HopUnion



Mid-sized cones

Indicators of cone ripeness (time to harvest)

1. Bracts become papery
2. Cones become lighter
3. No grassy or alfalfa type smell to crushed cones
4. Lupulins turn from white/white yellow to golden
5. Dry matter content down to 20 – 25%

Typically have a 10 day harvest window
Harvest can start mid to late August to early September



Cone development – ripe cones

Commercially

- Harvest (cut bines from hop yard into shade)
- Picking (picking machine)
- Drying (8-10 hrs @ 140°F)
- Baling & warehousing
- Pelletized (extracts)
- Powdered & pelletized
- Sold & shipped

Small Scale

- Harvest
- Picking
- Drying (12 hrs @ 120°F)
- Vacuum packed and refrigerated

Harvesting and Picking



Hops Picking Fingers



Drying, packing & storing





Pests

Two spotted spider mite

Organic controls
insecticidal soaps
predatory insects



Hopyard Trellis Construction Costs

Based on 1 1/2 acres Based on 5 acres

	Per Acre Costs	Per Acre Costs
Posts	\$1,466.67	\$1,200.00
Cabling	\$1,400.00	-
Wires	\$1,000.00	\$1,500.00
Hardware	\$1,500.00	\$800.00
Anchors	\$300.00	\$150.00
Labor	\$4,000.00	\$3,000.00
Plants	\$3,000.00	\$3,000.00
Tillage Operations	\$750.00	\$700.00
Bobcat	\$700.00	\$500.00
Sissor Lift	\$250.00	-
Compost	\$500.00	\$500.00
Beer & Food for cheap labor	\$500.00	-
Total per Acre	\$15,366.67	\$11,350.00

**Does NOT include irrigation system

PPPPPP

Pre-Hops Planting
Land prep
Add organic matter & till
Plant legume cover crop
Till in rows
Plant & irrigate

Make a plan & write it down!!!!!!

Hops Income Estimates

Per Acre Calculations

		Chinook						
Average Yields (dry)		2200	\$10/lb	\$10 Running	\$12/lb	\$12 Running	\$15/lb	\$15 Running
Year	Yield Factor	Total		Total		Total		
Year 1	40%	880.00	8,800.00	8,800.00	10,560.00	10,560.00	13,200.00	13,200.00
Year 2	90%	1,980.00	19,800.00	28,600.00	23,760.00	34,320.00	29,700.00	42,900.00
Year 3	100%	2,200.00	22,000.00	50,600.00	26,400.00	60,720.00	33,000.00	75,900.00
Year 4	85%	1,870.00	18,700.00	69,300.00	22,440.00	83,160.00	28,050.00	103,950.00
Year 5	80%	1,760.00	17,600.00	86,900.00	21,120.00	104,280.00	26,400.00	130,350.00
Year 6	100%	2,200.00	22,000.00	108,900.00	26,400.00	130,680.00	33,000.00	163,350.00
Year 7	95%	2,090.00	20,900.00	129,800.00	25,080.00	155,760.00	31,350.00	194,700.00

Cascade

Average Yields (dry)		1800	\$10/lb	\$10 Running Total	\$12/lb	\$12 Running Total	\$15/lb	\$15 Running Total
Year 1	Yield Factor							
Year 2	40%	720.00	7,200.00	7,200.00	8,640.00	8,640.00	10,800.00	10,800.00
Year 3	90%	1,620.00	16,200.00	23,400.00	19,440.00	28,080.00	24,300.00	35,100.00
Year 4	100%	1,800.00	18,000.00	41,400.00	21,600.00	49,680.00	27,000.00	62,100.00
Year 5	85%	1,530.00	15,300.00	56,700.00	18,360.00	68,040.00	22,950.00	85,050.00
Year 6	80%	1,440.00	14,400.00	71,100.00	17,280.00	85,320.00	21,600.00	106,650.00
Year 7	100%	1,800.00	18,000.00	89,100.00	21,600.00	106,920.00	27,000.00	133,650.00
Year 8	95%	1,710.00	17,100.00	106,200.00	20,520.00	127,440.00	25,650.00	159,300.00

