

# High Desert Hops Manual

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## Acknowledgements

We want to thank all the people and organizations who have helped in any way during the development and management of the High Desert Hops Project. In particular, we'd like to thank the Nevada Department of Agriculture for their support and administration of the SCBG program which made this project possible. University of Nevada, Reno (especially UNR Mainstation Farm personnel) for allowing their land to be used for the hopyard, local brewers and breweries for supporting local hops production, using the hops and continued development of the local craft beer movement, and all the volunteers who helped build and maintain the hopyard.

## Disclaimer:

This manual was drafted based on literature research and one year of experience managing a 1 acre hopyard during its fifth year in existence. We are grateful for the recent expansion of the hops growing industry into new regions and at smaller scales than historically cultivated. We have relied heavily on published information to develop this manual. In particular, we based format and necessary content on:

- Hops production calendar. 2017. Iowa State University Extension and Outreach.<sup>1</sup>
- Calendar of Hops Field Work. Dr. Ron Godin. Colorado State University Extension<sup>2</sup>
- Alternative Field Crops Manual. University of Wisconsin-Extension, Cooperative Extension. University of Minnesota: Center for Alternative Plant & Animal Products and the Minnesota Extension Service<sup>3</sup>
- Small Scale & Organic Hops Production. Rebecca Kneen. Left Fields.<sup>4</sup>

We recommend that anyone using this manual supplements the information found here by reading of the resources provided, contacting with University Extension services, connecting with commercial growers, conducting market research and crop and financial planning, and other due diligence.

## Introduction

The High Desert Hops Manual covers basic aspects of hops production in small scale systems for application in high desert climates commonly found in the Intermountain West of the USA.

Hops have been cultivated for hundreds of years and was introduced to the United States in 1629. Hopyards in the eastern USA were wiped out by Downy mildew in the 1920s, and commercial production moved to regions with drier summers and conditions less conducive to fungal diseases.

The arid climates of the Intermountain West provide good opportunities for hops production due to the decreased risk of fungal diseases and insect damage. Challenges present in these climates include: Short growing seasons and late frosts, cost of required irrigation water and distribution systems, and low soil fertility/quality

## General Hops Horticulture

Hops (*Humulus lupulus*) is a perennial herbaceous vine that is hardy and long lived. They develop a permanent perennial crown that can grow up to 30' in one year. For the first two years plants from rhizomes focus energy on developing extensive root systems and often only grow 6-12' and produce minimal cones. The plants' third year is typically considered full maturity for the perennial plant that can be productive for up to 15 years and live over 25 years. The plant is covered in small

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<sup>1</sup> <https://store.extension.iastate.edu/product/Hop-Production-Calendar>

<sup>2</sup> [http://thehopyard.com/wp-content/uploads/2012/06/COSState\\_Soil.pdf](http://thehopyard.com/wp-content/uploads/2012/06/COSState_Soil.pdf)

<sup>3</sup> <https://hort.psu.edu/newcrop/afcm/hop.html>

<sup>4</sup> <https://www.crannogales.com/products/small-scale-organic-hops-production-manual?variant=14857172422>

hairs which allow the bines to grab, climb and twine around available material. Hops are generally grown on large trellis systems from 12-18' tall.

Hops flowers are called cones which are the part of the plant which produces lupulin and is harvested for sale and use. Hops are either male or female, and only female hops plants produce cones. Hops produce vegetative growth until 1-3 weeks after the summer solstice. At this point, hops switch to flower production and primarily grow lateral branches where clusters of flowers are borne. The flowers contain lupulin glands which create lupulin and are the most important part of the plant to brewers. These tiny yellow lupulin glands produce resins (alpha and beta acids) and oils.

## Propagation and Varietal selection

Hops root systems consist of both roots and rhizomes. The rhizomes are the part which produces new shoots each year. Hops plants are generally propagated by division of rhizomes which produces a clone of variety from which the rhizome is cut. A 6-8" long section of rhizome with at least 2 buds can be used to plant each new crown. Rhizomes should be dug during dormancy and planted immediately, or stored in a cool, moist, well ventilated place for planting in early spring. In order to prevent spread of viruses, commercial hops rhizomes should be certified virus-free prior to purchase and planting.<sup>5</sup>

Many commercial varieties are available as certified virus-free. It is important to select varieties that are in demand by the desired market. Hops are sold nationally on a commodity market so pricing at this scale as well as local demand needs to be assessed. Many trademarked and patented varieties are unavailable for purchase as rhizomes.

Commonly used varieties in the US Craft Beer movement that have been trialed and identified as higher yielding in high desert climates include:

1. Cascade
2. Chinook
3. Nugget
4. Galena
5. Willamette
6. Crystal
7. Centennial

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<sup>5</sup> <https://www.usahops.org/growers/clean-plants.html>

An extensive supplier directory for both plants and hopyard supplies is available the the Hop Growers of America website: <https://www.usahops.org/growers/>

## Soils and fertility

Hops are vigorous plants and require high soil fertility, consistent water, and full sun. They prefer well drained soils, and deep sandy loams are best. Soils which are “poorly drained, strongly alkaline, or saline” are not recommended.<sup>6</sup> They prefer soils with a pH of 5.7-7.5 and 3-5% organic matter content.

Hops plants require large amounts of nutrients to produce high yields of cones annually. During first year establishment Nitrogen should be applied at 70-75 lbs/ac and increased to 150-250 lbs/ac in following years. Ideally Nitrogen is applied in two even applications: 1. in spring as shoots begin emerging , and 2. again 5 weeks later (mid-late May) to support rapid growth in June. Phosphorous and Potassium should also be applied annually to replace nutrients removed from the field as cones. Phosphorous should be applied at 20-30 lbs/ac and Potassium at 80-150 lbs/ac.<sup>7</sup> These rates should be adjusted based on annual soil test results collected in early spring of each year. Hops are sensitive to Zinc and Boron deficiencies and need levels >6ppm Zn an 1.5ppm B with application rates of 25lbs/ac and 6 lbs/ac respectively.<sup>8</sup>

High desert soils are often low in organic matter. Compost can be applied in order to increase organic matter content and to apply mineral fertility to soils. Compost can be applied at 6-10 tons/ac. Other methods such as cover cropping can be used to increase soil organic matter when sufficient water is available.

For improved fertility management, leaf tissue samples can be taken as petiole tests in the 1st week of june and used to inform fertility needs.

Foliar fertilizer applications can be used through the first week of July to improve yields. Dr. Ron Godin recommends using 25-100 gallons of water per acre to apply a mix of:

- 1-2 lbs N/ac (8 gal fish @ 2.5% = 2 lbs N)
- 1-15 lbs Zn/ac (4.5 lbs ZnSO<sub>4</sub> @ 32% = 1.5 lbs Zn)
- ¼ lb B/ac (1.25 lbs Solubor @ 20.5% B = ¼ lb B)

Additional soil fertility details can be found in the Hops Fertilizer Guide from the Oregon State University Extension Service.<sup>9</sup>

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<sup>6</sup> <https://hort.purdue.edu/newcrop/afcm/hop.html>

<sup>7</sup> <https://store.extension.iastate.edu/Product/14564>

<sup>8</sup> [http://thehopyard.com/wp-content/uploads/2012/06/COSState\\_Soil.pdf](http://thehopyard.com/wp-content/uploads/2012/06/COSState_Soil.pdf)

<sup>9</sup> <https://catalog.extension.oregonstate.edu/fg79>

## **Water**

Hops require 24-36" of water per year, and in areas with dry summers this is supplied via irrigation. In high desert situations, drip irrigation is the preferred irrigation to minimize water use.

Generally water should be applied at 1"/wk through Late May, 2"/wk in June, 2.5"/wk in July-mid-Aug, 1"/wk late Aug-early Oct. and shut off in October.<sup>10</sup>

## **Pest and disease management**

Hops suffer from several common agricultural pests and diseases. Pests include weeds and arthropods, particularly aphids and spider mites. Diseases include Downy mildew, powdery mildew, verticillium wilt, and several viruses.

Treatment of weeds begins with good site preparation (as described in that section) to create a weed free planting bed. Continued weed management can include tillage, cover cropping, herbicide application, hand picking, mowing, and/or mulch. Each has its advantages and disadvantages and should be evaluated on a case by case basis.

Weeds can also be managed through integration of livestock, particularly sheep, into the hopyard prior to Mid-May when ropes are installed and bine training begins.

All pests and diseases should be monitored for on a weekly basis during the growing season and treatment should occur immediately upon detection to prevent spread throughout the entire crop.

Aphids, particularly the hop aphid (*Phorodon humuli*), should be treated if found in the cropping area. Integrated Pest Management (IPM) for aphids includes creating habitat for predatory arthropods such as ladybird beetles and lacewings. If aphids are found, they can be treated with high pressure water, soap and water, or sprays such as insecticidal soaps or other insecticides.

Spider mites are a common pest, particularly the red spider mite (*Tetranychus urticae*). Spider mites are encouraged by dry, dusty conditions. Preventative treatment for spider mites includes maintaining ground cover (cover crop, ground cover plants, or mulch) to minimize dust and removing leaves from the bottom 4' of each bine because spider mites climb up from the ground. If spider mites are

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<sup>10</sup> [http://thehopyard.com/wp-content/uploads/2012/06/COSState\\_Soil.pdf](http://thehopyard.com/wp-content/uploads/2012/06/COSState_Soil.pdf)

detected, treatment options include pyrethrum sprays, insecticides, and bio-controls such as Grandevo.<sup>11</sup>

Powdery mildew (*Podosphaera macularis*) is best managed through prevention by maintaining good sunlight and airflow through the hopyard and by spreading out nitrogen fertilization into two or more applications. Dry conditions prevalent through the Intermountain West decrease incidence of powdery mildew. If spotted remove and burn all plant materials affected immediately. Sulfur based fungicides or biocontrols such as Regalia<sup>12</sup> can be applied if needed

Downy mildew (*Pseudoperonospora humuli*) is also best managed through prevention and removal. Remove and burn any infected plant materials immediately. Sometimes entire crowns must be removed. Maintain good sunlight and ventilation.

## Hopyard design and trellising

Hopyards need to be designed with both sun access, plant height, and equipment based management and harvest in mind. Plants can be spaced at ~4' between crowns within rows and 12-14' between rows (adjust based on equipment size). Generally this allows enough light to support vigorous growth and high yields.

Trellising often consists of 18-24' long, 6" diameter poles buried 4-5' deep to create a trellis 13-20' tall. Commercial trellises are often 18' and much of the equipment is designed for this size.

Poles can be a non-rotting wood like black locust, redwood, or cedar, can be pressure treated, or untreated. Regardless of treatment, plan on replacing poles every 5-10 years.

Pole spacing is often 32-42' apart with outside perimeter poles being angled slightly to improve load bearing. ¼" Cable is strung between poles, staples to the tops and secured to the ground via guy lines, 5' ground anchor pins, turnbuckles and clamps. Additional 5/16" cable is used in between posts and attached to the ¼" cables using clamps. Enough 5/16" cables should be attached to support V-shaped trellising for every row. Generally a post is placed every 3 rows, so an additional 3-6 5/16" cables should be added between each post row.

Trellising should be oriented to allow wind to flow along the rows rather than against them. Ideally rows are oriented N-S to allow maximum solar access.

It is ideal for each plant to be trained up 2 ropes in a V-shape.

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<sup>11</sup> <https://marronebioinnovations.com/ag-products/brand/grandevo/>

<sup>12</sup> <https://marronebioinnovations.com/ag-products/brand/regalia/>

Several guides for trellis construction are available online and we recommend reading these before deciding on a final trellis design.

- Hop Farm Management and Trellis Construction  
[http://msue.anr.msu.edu/uploads/234/78941/Hop Intro - 2 Hopyard Pre plant Preparation and Setup - Dan Wiesen.pdf](http://msue.anr.msu.edu/uploads/234/78941/Hop%20Intro%20-%202%20Hopyard%20Pre%20plant%20Preparation%20and%20Setup%20-%20Dan%20Wiesen.pdf)
- Great Lakes Hops: Selecting the Right Trellis Design to Grow Great Hops  
<https://www.greatlakeshops.com/hops-blog/selecting-the-right-trellis-design-to-grow-great-hops>
- Virginia State University Requirements and Estimates for Building a ½ acre Hop Yard  
<http://www.agriculture.vsu.edu/files/docs/agricultural-research/trellis-construction.pdf>
- UVM SSchmidt Hop Yard Trellis Design v5  
<http://www.uvm.edu/extension/cropsoil/wp-content/uploads/SSchmidt-Hop-Yard-Trellis-DesignV5.pdf>
- Hop Production 101: Commercial Hop Yard Trellis Design  
<https://store.extension.iastate.edu/product/Hop-Production-101-Commercial-Hop-Yard-Trellis-Design>

## Site preparation

The trellis poles are generally setup outside the hopyard perimeter with enough space to allow equipment based maintenance and management of the hop yard. Prior to planting, a weed free site should be established. This can be done through tillage, herbicide application, or solarization. Often a cover crop is grown prior to planting to smother weeds and tilled in to supply fertility.

## Stringing, training, and pruning

Training of hops plants up trellis ropes needs to begin in mid-May. Ideally all ropes should be in place by May 21st to allow shoot selection and training. Use classic commercial hops ropes made from coconut coir. Soak ropes 2-12 hours prior to hanging them in the hopyard. Ropes should be attached to the trellis cables using a clove hitch. To safely tie ropes to the cables, equipment should be used. This can be specialize hopyard equipment or machines such as a scissor lift or boom lift can be rented.

Hops plants should be cut back to initiate new shoot growth one to two weeks prior to installing the ropes at each hops plant crown. Only train the most vigorous upright shoots onto the trellis ropes. Each plant should get 2 ropes and 2-3 bines should be trained up each rope. All other bines should be pruned to the ground at this point. Bines can be allowed to grow again in early August to help plants develop root reserves for over-wintering

## Seasonal instructions

From about **mid-November through February** the plants are in dormancy and not much care is needed for the plants themselves. This time can be used to do any major repairs necessary on the trellising structure or irrigation system. This time should also be used for planning, particularly scheduling supplies orders and site management activities as well as any direct marketing and sales that can be done during the dormant season.

Around **March 1<sup>st</sup>**, the plants will begin coming out of winter dormancy. This is a good time to slowly introduce irrigation to the rhizome if ground moisture from winter is dwindling and when temperatures are guaranteed to not be below 20°F at night and daytime temperatures are up in the 60's.

Around **March 20<sup>th</sup>**, plants will likely be starting to emerge. This is the time to **prune the rhizomes**. Pruning the rhizomes consists of cutting back the vigorous underground growth of the rhizome to 2-4' from the crown. Rhizome pruning can be done by mechanical means such as tillage or subsoiling. If rhizomes harvest for propagation or sale is desired, rhizomes can be dug by hand with a fork or shovel and removed from the hopyard for sale.

Following rhizome pruning apply compost and mulch if you are using these fertility and weed management strategies.

This is also the time to start **trimming** the first shoots as they emerge. Trimming consists of cutting back all the first round of growth.

April is the month to begin inspecting for any pests and diseases. Continue to manage weeds and irrigation. Increase irrigation if precipitation is low.

**May 1<sup>st</sup>** will be the time to till the cover crop into the ground in between the rows of hops. Continue inspections for disease and pests. Increase irrigation to 1" every week and prune crowns to 4-6 vigorous, vertically growing bines. Apply first round of fertilizer if not applied prior to mulching.

Complete any final machine based management near the hops crowns by mid-May so ropes can be installed by **May 15<sup>th</sup>**. Once trellis ropes are installed, begin training bines up ropes. Two ropes should be installed per crown with 2-3 bines per rope. Bines need to be twined around ropes in a **clockwise** manner.

**June 1<sup>st</sup>** is the time to continue pruning any additional shoots and training 2-3 bines per rope. Increase irrigation to 2"/wk. Apply second round of fertilizer. Send

petioles off for leaf tissue analysis and use this analysis to specify any additional fertilizer needed.

**July 1st** increase irrigation to 2.5"/wk. Continue to prune crowns and inspect for pests and disease.

Starting **August 7th**, it's time to inspect cones to determine ripeness.

**How to tell when hops are ripe:**

- To the touch, cones will be dry, papery, and flakey.
- Rubbing a cone between fingers will obviously leave yellow oily residue from the lupulin gland.
- When bending a cone in half, the stem in the middle should snap, not bend.
- The aroma from a cone should smell bitter, not grassy/earthy.

Sending hops for analysis to determine ripeness is recommended. If this is not possible, purchase of a moisture meter and getting trained in assessing ripeness by an experienced professional is recommended.

Many labs are available.

- AAR labs is an example. <https://www.aarlab.com/>

After ripeness is determined, harvest the hops. This is done by cutting the ropes off the trellis and into a truck for transport to the hop biner and drying facility.

Remove hops from the bines using a mechanical biner if possible. If not possible, hand separation can be done but it is very labor intensive and is likely to make hops production cost prohibitive.

Once harvested, the cones need to be **dried** immediately. A homemade Oast or a pre-fabricated drier. Hops cones should be dried to 8% moisture content for storage.

Once the cones are dried, they need to be **processed into pellets** to be acceptable to brewers. A commercial hops pelletizer is necessary and brewers are unlikely to purchase non-pelletized hops unless they have agreed to use fresh hops. Once processed, use a vacuum sealer to preserve the hops for storage.

Once processed, hops need to be analyzed again for moisture content and Alpha and Beta acid content, then clearly labeled with this data for sale.

Once all the plants have been harvested, decrease watering to 1"/wk and allow bines to grow until frost. Upon first frost, turn off irrigation water.

After harvest, cover crops can be planted if irrigation water is available.

Clean up and winterize hopyard in **October** and begin planning for the next year.

## Resources

- Hop Growers of America <https://www.usahops.org/>
  - Supplier Directory <https://www.usahops.org/growers/>
- Hops production calendar. 2017. Iowa State University Extension and Outreach.  
<https://store.extension.iastate.edu/product/Hop-Production-Calendar>
- Calendar of Hops Field Work. Dr. Ron Godin. Colorado State University Extension.  
[http://thehopyard.com/wp-content/uploads/2012/06/COSState\\_Soil.pdf](http://thehopyard.com/wp-content/uploads/2012/06/COSState_Soil.pdf)
- Alternative Field Crops Manual. University of Wisconsin-Extension, Cooperative Extension. University of Minnesota: Center for Alternative Plant & Animal Products and the Minnesota Extension Service  
<https://hort.purdue.edu/newcrop/afcm/hop.html>
- Small Scale & Organic Hops Production. Rebecca Kneen. Left Fields.  
<https://www.crannogales.com/products/small-scale-organic-hops-product-on-manual?variant=14857172422>
- Hops Production 101: A Guide to Growing Healthy Hops.  
<https://www.extension.iastate.edu/news/hop-production-101-guide-growing-healthy-hops>
- Field Guide for Integrated Pest Management in Hops.  
<https://www.usahops.org/resources/field-guide.html>
- The Science of Hops.  
<https://www.fortlewis.edu/Portals/178/Science%20of%20Hops%2014.pdf>
- Hop Farm Management and Trellis Construction  
<http://msue.anr.msu.edu/uploads/234/78941/Hop Intro - 2 Hopyard Pre plant Preparation and Setup - Dan Wiesen.pdf>
- Great Lakes Hops: Selecting the Right Trellis Design to Grow Great Hops  
<https://www.greatlakeshops.com/hops-blog/selecting-the-right-trellis-design-to-grow-great-hops>
- Virginia State University Requirements and Estimates for Building a ½ acre Hop Yard  
<http://www.agriculture.vsu.edu/files/docs/agricultural-research/trellis-construction.pdf>
- UVM SSchmidt Hop Yard Trellis Design v5  
<http://www.uvm.edu/extension/cropsoil/wp-content/uploads/SSchmidt-Hop-Yard-Trellis-DesignV5.pdf>
- Hop Production 101: Commercial Hop Yard Trellis Design  
<https://store.extension.iastate.edu/product/Hop-Production-101-Commercial-Hop-Yard-Trellis-Design>
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