THE UNIVERSITY OF ARIZONA
Cooperative Extension

az1819 April 2020

Hop Production in Northern Arizona: Opportunity and Challenges for Small-scale Growers?

Isaac K. Mpanga and Jeff Schalau

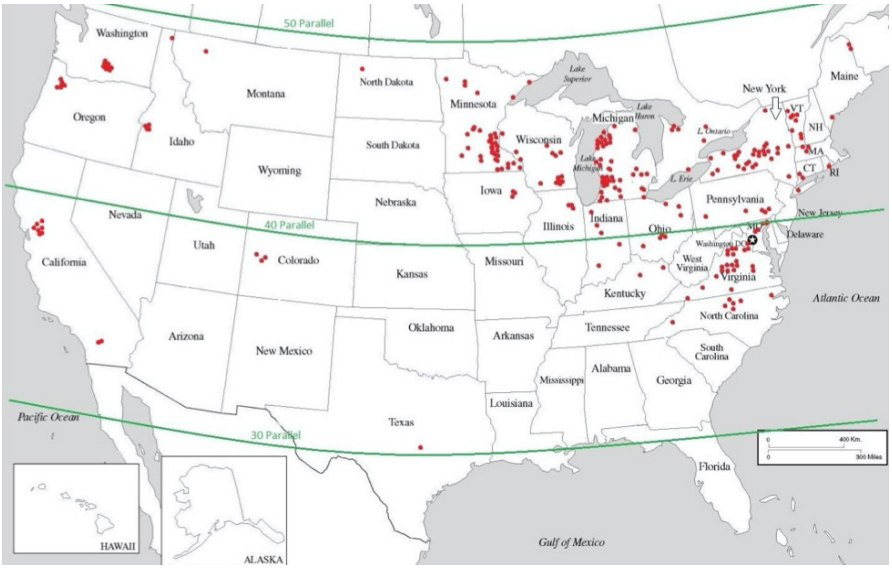

Figure 1: Hop growing region in the United States of America (Sara del Moro, 2015 © John I. Haas, Inc)

Introduction

Hops are an essential crop in the world for beer production and are mostly grown between latitudes 35° to 55° north (Dodds 2017). This includes northern Arizona (Figure 1). The U.S. leads world hop production (40%) and is closely followed by Germany (38%). In the U.S., Washington state is the highest producer (68%), followed by Idaho and Oregon in the second and third positions, respectively, with a total of about 28%. According to Dobis et al. (2019), craft breweries are driving local hop production expansion to most states in the USA with promising opportunities for small-scale, beginner farmers, and other related stakeholders. This could open a new frontier to the large population of small-scale growers in the region. This paper aims to provide growers and potential hop growers information about hop production in central and northern Arizona, and the possible challenges ahead.

Basic Physiology of Hop Plant

The hop plant (*Humulus lupulus L.*) is in the same family as the hemp plant (Cannabaceae) and is a native plant to Europe, western Asia, and North America. It is a herbaceous perennial plant that produces annual bines (long, flexible stem of climbing plant such as hop) (figure 2 a), which can grow up to 15-25 feet high. The rootstocks have both rhizomes (a modified subterranean plant stem that sends out roots and shoots from its nodes) and real roots (without buds) and could grow up to a depth of 15 feet or more in the soil. The rootstocks overwinter and grow rapidly from spring to early summer into bines. The bines grow fast with massive biomass and require substantial support such as poles on which they climb in a clockwise direction. In mid-summer, the plant stops vertical growth in response to shortening day length and produce side arms to bear the flowers. It

Figure 2: Hop plant (a), female hop flower (b), male hop flowers (c), and a vertically cut mature hop cone with Lupulin glands (d) (Pictures b and c by Dodds 2017 ©NSW Department of Primary Industries; Pictures a and d by Stephen Ausmus, © USDA).

is important to know that hop is a dioecious plant, which means seeds could germinate into a female or male plant and will produce a female (Figure 2b) or male (Figure 2c) flowers, respectively. The male flower is a pollinator while the female produces the cone-shape (hop) (Figure 2 d) with the economic value. Though the male serves as a pollinator, the female can still produce the hop cones without the male (Conway and Snyder 2008).

Factors to consider in selecting your hop

1. Know the climate requirements of hops and the possible varieties that could adapt well in your local area.
2. Hop varieties should be selected based on your growing objectives. Hop can be grown for bitterness, aroma, and beauty of foliage as ornamentals. The bittering hop has high specific acids for bitterness while the aromatic hop has low acids but high essential oils for enhanced aroma.
3. Always select varieties that are hardy to pest and diseases. Some disease resistant varieties are Brewer's Gold, Cascade, Chinook, Columbia, Fuggle, Magnum, Newport, Perle, and Willamette, etc.

Climate Considerations

Climatic factors such as photoperiod (day light length), latitude, and heat (temperature) must be considered carefully for hop production. Though, a native to the temperate region, hops are grown widely between 35th and 55th latitudes, which includes northern Arizona. The ideal temperature for hop production is 50-66°F and hops needs 120 frost-free days with daylengths of 15 hours or more for flower initiation and cone maturity. A growing season with rainfall between 2.5 and 22.4 inches is required for hop production and must be supplemented with irrigation in dry regions (Conway and Snyder 2008).

Soil and Plant Nutrition

A well-drained sandy loam soil with a deep profile and pH of 6 to 7.0 would be suitable for hop production. Avoid soils such as poorly drained and strong alkaline (pH above 8) and saline (2-4 dS/m in the saturation extract) soils (Knee 2001). Spring Fertilizer application of nitrogen, phosphorus, and potassium may be required depending on soil test levels of these nutrients. Nitrogen is the most limiting nutrient for hop growth with a recommended rate of approximately 150 lbs per acre for mature plants (46-0-0) or (16-16-16) in split applications of 2 or 3 times between spring and mid-July (Getty et al. 2015). Organic fertilizers can also be used. However, cool soil temperatures in the early spring may limit N availability until soils warm and the microbial organisms become active.

Propagation and Planting

Hops are mostly propagated from fresh stem cuttings (Figure 3b) and rootstocks with rhizome (Figure 3a). Seeds are not used because they could germinate into male or female plants and produce hybrids of unknown quality. Other advantages of using the cuttings are vigor, disease resistance, and cone quality (acids, oils, aroma, yield, and quality). To ensure good material for propagation, use healthy plants free from disease and pests as your propagating materials. Before planting, make sure the soil is well-tilled and weed-free. Start planting once the danger of a late spring frost is past. The cuttings can also be established in pots in the greenhouse before transplanting, especially if the area is prone to late frost as common in northern Arizona. Plant two rhizomes per container to ensure successful establishment. In the field, plant rhizomes about 2 inches deep and at least 3 feet apart for the same varieties and 5 feet apart for mixed varieties.

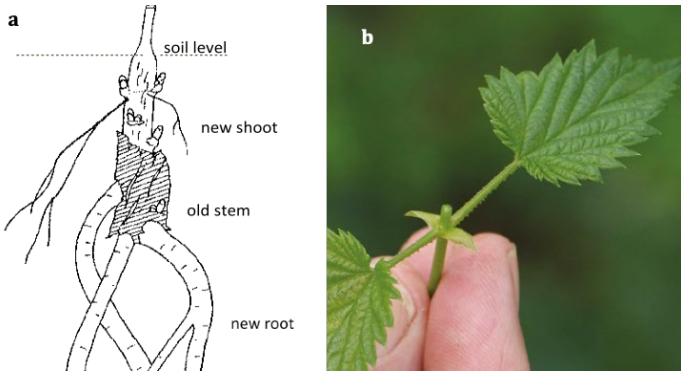

Figure 3: A young hop rhizome (over-winter as a dormant rhizome) (Williams, Roberts, and Coley-Smith 1961) (a) and Fresh stem cutting (Dodds 2017 ©NSW Department of Primary Industries) (b).

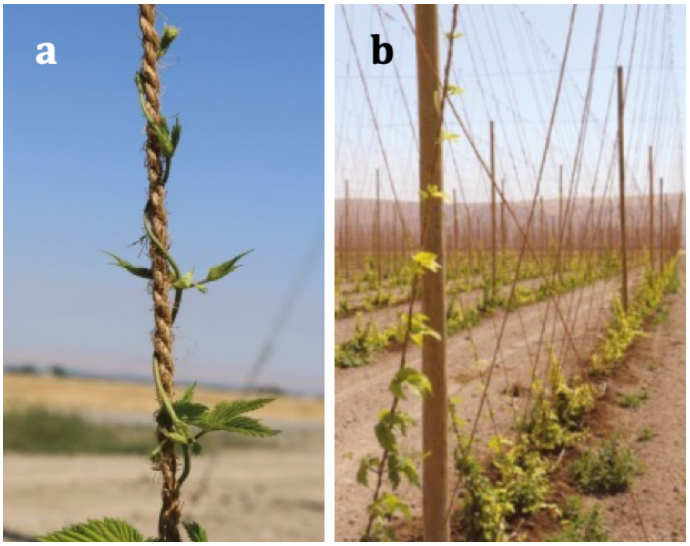

Figure 4: Bine stringing and training (Dodds 2017 ©NSW Department of Primary Industries)

Irrigation and water requirements for hop

Irrigation water demands for hop depends on climate, type of soil, time and stage of the growing season, and planting distance. Irrigations demands are generally low in May, peaks in June-August and decline in September with approximately 1.5" of water per week. Preferably use drip irrigation systems to avoid wetting foliar from sprinklers, which may induce diseases outbreak (Bamka, 2002). Do not overwater, so irrigate lightly but frequent (Getty et al. 2015). Also, ensure water sources for your irrigation is free from debris and mineral salts for efficient delivery of required water.

Bine pruning, stringing, and training

At the beginning of each growing season, select the three to six healthy bines from the hill of each plant and remove all others. Train the remaining healthy bines to climb clockwise (because they like to follow the sun) on a rope or stick tacked to the hill (Figure 4a) (Figure 4b). Avoid damaging the growing plant and make sure the side arms, which bear flowers, do not tangle. To ensure proper aeration and reduce disease occurrence, stripping is required. Stripping is the removal of the lowest foliage and lateral branches (about four feet above the ground) and must be done with care to avoid damaging the main bines.

Figure 5: A matured hop cone with golden-yellow colored lupulin inside. (Picture by Stephen Ausmus, © USDA)

Hop Cone maturity, harvesting and storage

Hops are usually harvested between August and September, depending on the variety and season. Mature cones can be identified by opening several cones from top of plants across the field. A cone which is ready to harvest should have a dry, papery feel with a golden-yellow colored lupulin (gland of a hop plant with acids and the essential oils) inside of the cone (Figure 5).

Harvesting can be done by picking cones from the plant, which may take 45 minutes to 1 hour per plant. The bines could also be cut at 3-4 feet above the soil level to have the whole plant on the ground for easy picking. During harvesting, take extra precaution by wearing long sleeves

and gloves, especially for pregnant women who may react to the high estrogens in the hop plant.

The harvested cone could be used fresh, stored fresh, or dried before storage in refrigerators or freezers in the dark for later use. Factors such as moisture, sunlight, oxygen, and heat affect hop quality. The heat for drying cones should not exceed 140°F due to loss of the essential oil component under high heat. For cone quality, the recommended drying temperature is 125°F or less. Store the dry cones in sealed plastic bags with as little air as possible to minimize chemical degradation. Ideally, the cones should be in a freezer to further reduce chemical degradation and preserve their brewing value.

Challenges associated with growing hops

1. Infrastructure and the initial cost of installing hop farm: The initial cost for harvesting machines, storage and cooling facilities, poles, and installation may be too costly for small-scale growers, especially the beginner farmers.
2. Disease pressure: Diseases such as downy mildew, Verticillium wilt, abiotic wilt, and viral infections may present a challenge in growing hops.
3. Insect pressure: Insects such as aphids, spider mites, and cutworms commonly attack hop plants.
4. Late frost and over-bearing heat in the summer could be another challenge to consider. Northern Arizona is cooler in the summer compared to low elevation regions in the southern part of the state, making the north a preferable location for hop production in Arizona.
5. Irrigation water demands may exceed availability in some areas.
6. Uneven terrain could also increase the cost of installing training and staking materials.
7. High soil pH conditions in Arizona could be a challenge and must be considered critically with management options at the planning stages of the project.

Summary

Hop production is possible in Northern Arizona with already existing backyard growers and increasing interest for local production. Hop is another promising specialty crop for small-scale and beginner growers to increase their diversity of crops and income sources. There may be challenges such as the cost of initial installation, pest, diseases, and identifying adapted varieties. Interested growers are encouraged to research more about types that are adapted to the region and plan adequately. At this point, more collaborative trials and educational programs are required to help growers make informed decisions on growing and marketing hop in Arizona, especially among the small-scale operations.

References

1. Dobis, E., Reid, N., Schmidt, C., & Goetz, S. (2019). The Role of Craft Breweries in Expanding (Local) Hop Production. *Journal of Wine Economics*, 14 (4), 374-382. doi:10.1017/jwe.2019.17
2. Conway Sean and Snyder Reid (2008). *Humulus lupulus* – Hops. College Seminar 235 Food for Thought: The Science, Culture, & Politics of Food.
3. Dodds Kevin (2017). Hops - a guide for new growers (1st edition 2017). NSW 2720, TUMUT, Australia.
4. Getty, B., Townsend, S., and Detweiler, A. J. (2015). Growing Hops in the Home Garden. Oregon State University Extension Service. EM 9115.
5. Kneen, R. (2001). Small Scale and Organic Hops Production. Left Fields BC
6. Bamka W (2002). Growing Hops in the Backyard. New Jersey Agriculture Experiment Station FS992. https://www.canr.msu.edu/uploads/234/71501/fs992%20Growing%20Hops%20Rutgers%20University.pdf
7. Sara del Moro (2015). Basic Hop Physiology & Stages of Production. http://msue.anr.msu.edu/uploads/234/78934/2._Basic_Physiology__Stages_of_Production_Sarah_Del_Moro.pdf
8. Williams IH, Roberts JB & Coley-Smith JR (1961). Studies of the dormant phase of the hop (*Humulus lupulus L.*) Annual report for 1960. Department of Hop Research, Wye College England pp. 48–58.

Additional useful resources for further reading

- Dodds Kevin (2017). Hops - a guide for new growers (1st edition 2017). NSW 2720, TUMUT, Australia.
- Kuepper George (2005). Hops: Organic Production. https://attra.ncat.org/attra-pub/download.php?id=87
- USDA Named Hop Variety Descriptions http://www.freshops.com/hops/usda-named-hop-variety-descriptions

- Small Scale and Organic Hops Production. By Rebecca Kneen. http://www.crannogales.com/HopsManual.pdf Pest management
- Compendium of Hop Diseases and Pests. Edited by Walter Mahaffee, Sarah Pethybridge, and David Gent. https://my.apsnet.org/ItemDetail?iProductCode=43764
- Field Guide for Integrated Pest Management in Hops. By David Gent, James Barbour, Amy Dreves, David James, Robert Parker, and Douglas Walsh. https://www.ars.usda.gov/ARSUserFiles/37109/HopHandbook2010.pdf
- Hops Fertilizer Guide (FG 79) https://catalog.extension.oregonstate.edu/fg79
- Pacific Northwest Insect Management Handbook http://pnwhandbooks.org/insect/

THE UNIVERSITY OF ARIZONA
Cooperative Extension

The University of Arizona
College of Agriculture and Life Sciences
Tucson, Arizona 85721

AUTHORS

Isaac K. Mpanga
Area Associate Agent - Commercial Horticulture/Small Acreage

Jeff Schalau
Yavapai County Director

CONTACT
Isaac K. Mpanga
mpangai@email.arizona.edu

This information has been reviewed by University faculty.
extension.arizona.edu/pubs/az1819-2020.pdf

Other titles from Arizona Cooperative Extension can be found at:
extension.arizona.edu/pubs