Hops Production in New England

Heather Darby[1], Chris Callahan[1], and Roger Rainville[2]
[1]University of Vermont Extension, Burlington, VT and [2] Borderview Farm, Alburg, VT

Hops were a major crop in the Northeast in the early 1800s, before disease pressure and the appeal of the Pacific Northwestern climate drew the hops industry to the other side of the county. Currently, New England is home to over 175 high quality microbreweries. Public interest in sourcing local foods is also extending into beverages, and the current demand for local and organic brewing ingredients is quickly increasing. The breweries in New England want locally grown hops to create niche brews for local markets. This demand has created a niche market potential for many farmers. However there is very little information on how to grow hops in our region. Hops are primarily grown in the Pacific Northwest a climate that is far different than ours. Since 2009, UVM Extension has been working to develop regionally relevant production and processing information on hops.

Construction of a Hopyard

Hops are grown on vertical trellis systems that are built to heights of 22 feet. A complete list of materials and videos on the construction of the UVM Extension hop yard can be found at www.uvm.edu/extension/cropsoil/hops. Low trellis systems are possible but require specific varieties that produce cones at lower growing heights. Hops require substantial quantities of water throughout the growing season and irrigation is a necessity to produce high yields. Drip irrigation is the most common system implemented in hopyards in the Northeast. Costs for implementing an irrigation system and a YouTube video on how to set up irrigation in your hopyard can be found at http://bit.ly/poHHoy.

Selecting Hop Varieties

Proper variety selection is essential to producing high yielding hops in the region. Publicly available varieties can be secured from a number sources located throughout the U.S. Hops can be purchased as rhizomes, rooted cuttings, or plants. Rhizomes are the cheapest source of hop material but may also be laden with diseases including downy mildew and various viruses and viroids. Purchasing plants or rooted cuttings that have been confirmed to be "disease-free" will get your hop operation off to a good start! Selecting varieties that have some disease and insect tolerance will also be important as pests can reduce hop yields significantly. Lastly understanding what types of hops brewers are interested in purchasing can further guide the varieties that you might select for production. UVM has conducted research to identify varieties that perform well in our region. After four years of research, the most successful varieties were clear. Several varieties did not survive pest pressure or lacked winter hardiness. Table 4 indicates varieties that performed well and those that did not.

Table 4. *High and low performing hop varieties after four years of evaluation.*

High Performance Cultivars	Low Performance Cultivars
Centennial	Liberty
Chinook	Crystal
Newport	Saaz

Cascade	Sterling
Nugget	Cluster

Fertility Management

Hop plants prefer to grow in a soil with a pH ranging from 6.0 to 6.5. For the lime to react quickly, it is best to mix it in with the soil. In some cases the ph maybe too high. A pH over 7.5 should be lowered, as certain nutrients are less available to plants above that range. Soil amendments such as sulfur fertilizers, pine needles and peat moss will lower the pH. Since it takes time for the soil pH to change, it is best to correct soil pH prior to establishment.

Nitrogen **-** A hop crop will require a substantial amount of nitrogen (N) to meet growth requirements. A high yielding hopyard can remove between 100 to 150 lbs of N per acre from the soil. Nitrogen application rates are often based on knowing your whole plant biomass yield. Higher yielding plants will obviously require more N per acre to promote plant growth and development. A whole plant biomass yield of 1000 lbs/acre will remove 80 to 90 lbs of N per acre from the soil. As the cone yield increases to 2000 lbs/acre the hop plant can remove 150 to 170 lbs/acre of N from the soil. Nitrogen rates should be based on yield but also soil organic matter level and/or soil type. Nitrogen should be applied about 30 to 45 day after emergence or mid May to mid June. The primary N uptake period for hops occurs during the vegetative stage (May through early to mid July). It is important to not apply N after flowering as this can lead to unwanted vegetative growth. Split applications of N are recommended on lighter textured (i.e. sandy) soils where leaching is an issue.

Phosphorus **-** Hops do not require high levels of phosphorus for acceptable yields. It has been shown that a 2000 lb/acre crop of whole plant biomass removes an average of 30 lb/acre of P from the soil. Most of the P in hops is found in the cones and the rest in the remaining plant parts. If leaves and vines are returned to the soil, there is actually very little P exportation from the soil. If soils have optimum levels of P, approximately 20 lb/acre of P should be applied to the soil. Low levels of soil P would warrant an application rate of between 60 and 100 lbs of P per acre. Soil test P levels in the Medium range would require 40 to 60 lbs of P per acre.

Potassium **-** Hops will remove 80 to 150 lbs of K per acre. Interestingly, most of the K taken up by the hop plant is retained in the leaves and stems with very little in the cone. Returning hop leaves and stems to the yard would be a means to replenish soil K levels. If your soil test K falls in the high range, K does not need to be added to the soil. A medium soil test K result might require the application of 80 to 100 lbs of K per acre. However, if soil test K levels are in the low range, 150 to 100 lbs/acre of K fertilizer should be amended to the soil.

Micronutrients **–** Boron deficiency has historically been a problem in the Northeast, especially in crops such as alfalfa and clover. Boron deficiency in hops has been reported in the Pacific Northwest. As a basic guideline, 1 to 2 lb/acre of B should be added annually to the hopyard. Zinc deficiency can also be an issue in hop production. Similarly, Zn deficient corn has been observed in the Northeast. Soils that have an especially high pH, low organic matter, and a light texture can be prone to low zinc levels. Based on PNW information, an application of 2-4 lbs/acre of Zn should be amended if soil test levels are lower than 1 ppm.

Pests and Management

Seven hop yards in Vermont were scouted for arthropod pests and natural enemies every other week June-August for three years (2012-2014). The goal was to identify the major arthropod pests. The major arthropod pests in NE hop yards were two-spotted spider mite, hop aphid, and potato leafhopper. Higher populations of hop aphid were observed in cooler, moister seasons while higher numbers of two-spotted spider mite were observed in seasons of dry heat. Secondary outbreaks of spider mite were observed following broad-spectrum pesticide sprays targeted at potato leafhopper. Proper identification and scouting (pests and beneficials) is important especially before insecticides are to be applied. More information on hop arthropod pests and management can be found at www.uvm.edu/extension/cropsoil/hops.

Downy mildew (Pseudoperonospora humuli, Miyabe and Takah,Wilson) is the primary disease issue of hops in the Northeast. Downy mildew can cause the complete loss of marketable hop yield, and even hill death in sensitive varieties. It is a very serious hindrance to successful hops production, but diligent integrated pest management (IPM) can help reduce disease infection, and/or help control downy mildew once the disease has reached your hopyard. A combination of scouting, mechanical control of early season disease combined with appropriate fungicide applications has been successful in controlling this disease in our region. Identification and control options can be found at http://www.uvm.edu/extension/cropsoil/wp-content/uploads/DownyMildew.pdf.

Harvesting and Processing Hops

The reintroduction of hops through-out the US requires scale-appropriate harvest and processing equipment. In 2011, there were no feasible mechanized harvest options for a 1-2 acre hop producer. Handpicking was the most wide-spread practice which is labor intense and time consuming leading to expense and quality impact due to delayed harvest. Mechanized harvesting can increase harvest rate by a factor of 100. Mechanized harvesters were available but were capitally-intense and required import and modification for use in our country. Early re-adopters of hops in the northeast are eager to have an option for mechanical harvesting of the crop to reduce production costs and improve overall quality. The presentation will summarize advancements in mechanized harvest options. A mobile, trailer-based mechanized hop-harvester was developed and documented as an open-source design for others to replicate at UVM. The design was the result of a collaborative design effort involving growers, brewers, agronomists, fabricators and engineers. Additionally, several hundred people have downloaded the plans for the machine and there have been 8 replicates partially informed by this work. Commercially produced, scale-appropriate harvesters are now available for the smaller scale producer. Some have been based on the open-source design work. Designs and videos of the UVM Harvester can be found at http://www.uvm.edu/extension/cropsoil/hops.

In addition to harvesting improvement, growers require systems for post-harvest management of the crop including drying, baling, pelletizing and storing. Small scale models of balers and driers have been designed through UVM as well as many farmers in the region. We will cover current best practices in this area as well.