Fertility Guidelines for Hops in the Northeast
Dr. Heather Darby, University of Vermont Extension Agronomist

The increasing acreage of hops in the Northeast has prompted the need for fertility guidelines for this new and emerging crop. Unfortunately there has been no regional data generated to determine hop nutrient requirements for our soils and climate. Some basic fertility guidelines can be developed from research and information available from the Pacific Northwest (PNW). It is important to remember that these are just guidelines developed to help assist producers with maximizing hop yields until more local data can be generated for this crop.

Soil Testing

The first step to determine crop nutrient needs is to take a soil test. It is best to take annual soil tests in the fall after the crop has been harvested. Soil samples should be taken around the hill to a depth of 12 to 15 inches. A soil probe is the best tool for sampling and you may be able to borrow one from your local NRCS or Extension office. These offices will also have access to USDA soil maps that give the names and other pertinent information of the soils on your property. The name of your soil will help in the recommendations for soil amendments. The goal is take a representative sample from the hopyard. This may require pulling 10 to 20 samples for a one-acre yard. All soil cores should be put into a bucket and mixed thoroughly. Approximately a one-cup subsample should be taken and sent to a local soil-testing laboratory. It is important to always use the same soil lab so that you can monitor changes in soil nutrient levels. The test results will provide information about relative soil levels of phosphorus (P), potassium (K), calcium (Ca), magnesium (Mg), and micronutrients such as boron (B), zinc (Zn), manganese (Mn), and sulfur (S). Generally the pH and organic matter levels of the soil are provided on a soil test. We will use these relative levels to provide some guidelines for fertilizing hops in the Northeast.

pH and Liming

Hop plants prefer to grow in a soil with a pH ranging from 6.0 to 6.5. In the Northeast, the lime requirement is based on a combination of the soil pH and reactive aluminum soil test. The acidic nature of many soils in the Northeast may require lime to raise the pH to the optimum range. Liming with standard agricultural lime, also known as calcium carbonate, will be adequate unless other nutrients such as Mg are required. Wood ash is another soil amendment available that can be used to raise the soil pH. On average, wood ash has half the liming value or Calcium Carbonate Equivalent of agricultural lime. That means if the soil needs one ton of lime, then 2 tons of wood ash would need to be applied to have the same affect. There are other benefits to wood ash, including the addition of K and micronutrients such as B. The availability and nutrient content of wood ash will be dependent on your location. 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.

Keeping the soil pH between 6.0 and 6.5 will also aid in making other macronutrients and micronutrients available to the plant. Since it takes time for the soil pH to change, it is best to correct soil pH prior to planting and hopyard 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.

If you are dealing with low organic matter (OM) soils (1 to 2%) a rate of 150 to 200 lb /acre of N should be applied. If soil OM levels are between 2 and 5% than a rate of 100 to 150 lbs of N per acre should applied. For organic matter levels over 5% than 80 to 100 lbs of N per acre should be applied to the crop. First year hops (establishment year) should only receive 75 lbs N per acre.

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.

It is difficult to predict N from a standard soil test. Therefore other tests such as leaf petiole testing can be used to determine N requirements of hops during the growing season.

Leaf Petiole Testing

Monitoring N needs of a crop can be difficult in perennial crops. Petiole testing can help producers identify N deficiencies throughout the critical growth stages. In the PNW, petiole testing begins when the hop plants are halfway to the top of the trellis. At the time of sampling, select 30 to 50 petioles from the yard (or whatever area you are sampling). Mature petioles should be selected from 5 to 6 feet above the ground. It is best to use the paper sample bags provided by the lab for transporting the leaf petioles. Regular lunch bags are often treated with Borax and can throw off the results if Boron is a critical element as with hops. Plastic bags hold too much moisture and can result in molding of the sample. The samples should be put into a cooler with ice and

immediately dried or transported to the lab for analysis. Petiole sampling may occur weekly to biweekly depending on results. There are no University recommendations for interpreting petiole N or nitrate-N test results. The best way to use petiole test results are to be able to compare them to previous years' testing results and hop yields. There are guidelines that are implemented by growers in the PNW. The guidelines can be found below. Please remember the PNW presents very different growing conditions than the Northeast.

A general basis for nitrate-N levels from petiole testing in the PNW:
0-6,000 ppm = low
6,000-10,000 ppm = normal
10,000+ ppm = plenty

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 an application of 40 to 60 lbs of P per acre. Remember that over application of P to soils can lead to increased environmental pollution.

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. Soil test ranges for K include low, medium, optimum, high and excessive. If your soil test K falls in the high or excessive range, K does not need to be added to the soil. About 40 to 60 lbs of K per acre could be applied to soils testing in the optimum K. 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. Split applications of K should be used in light textured soils that are prone to leaching.

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.

Other micronutrients such as manganese (Mn) have been shown to be higher in hops grown in low pH soils. Levels could reach levels that are toxic to the plants. Maintaining the soil pH in the optimum range will keep Mn levels in check. Sulfur deficiency has been noted in the PNW. Some growers choose to apply 30 to 40 lbs of sulfur per acre on an annual basis. Sulfur deficiency is not common in the Northeast.

Micronutrients are essential, but are only required in small quantities. Micronutrients will need to be blended with other fertilizers to act as a carrier, or applied through irrigation lines.

Finding the Right Soil Amendment

Once you determine the nutrient needs of the crop, it is time to decide what type of fertilizers or nutrient sources will be used to supply the hops with their required nutrients. Commercial synthetic fertilizers are generally considered 100% available to the plants. These fertilizers can be blended to include a variety of nutrients or just one nutrient. For example, a fertilizer analysis may read 10-10-10. This analysis indicates that 10% of the fertilizer contents is N, 10% P, and 10% K. So if you are applying 100 lbs per acre of the fertilizer blend you will be adding 10 lbs each of N, P, and K. Given the perennial nature of this crop, it may be best to apply N sources that are slow to volatilize from the soil's surface. This would include products such as ammonium sulfate.

Many farmers may choose to apply compost or other organic amendments to the yard to meet the nutrient demands of the hops. Remember that these materials should be tested to determine their nutrient value. Composts will contain many nutrients including N, P, and K. In addition, cover crops or other plowed down amendments will provide nutrients such as N to the following hops crop. If a clover field is plowed and a hopyard planted in its spot, the N from the terminated clover will become available to the hops. Cover crop and rotational crop N credits can be found in various University Extension publications. If you are adding compost or manure, it is important to remember that not all the N will be available to the crop during the first growing season. Depending on the scenario, compost can have between 1% and 15% of its N available in the first year. If 4000 lbs of compost were applied and it had 2% N, there would be 80 lbs of N in the compost. At 15% N availability, the crop would only receive 12 lbs of N per acre. The more **you** know about the compost product, the better you are able to predict nutrient mineralization rates.

Remember that you can also return hop leaves and stems to the hopyard as a nutrient source. In order to determine its fertilizer value the material should be tested for nutrient content.

If you are a certified organic producer, you will need to apply only fertilizer materials that are approved for organic use. You will need to check with your organic certifier to verify what sources are available in your area. Generally organic certified sources of nutrients are slowly available.

When establishing a hopyard, it is important to make major soil adjustments prior to planting. Nutrients are more readily available to the crop when they are incorporated into the soil. Once the hops are established, it may be difficult to change soil nutrient test levels in a timely fashion.

Putting the Pieces Together

This publication is meant to provide general hop fertility management guidelines to producers in the Northeast. There currently is not any local fertility data available to tailor the recommendations to our region. One of the best means to better understand your crop needs will be through routine soil and leaf petiole testing. In addition, recording whole crop yields and nutrient content will assist in the development of more reliable recommendations for your farm. Good record keeping will be a must to track nutrient dynamics on the farm. If you need further assistance with fertility recommendations please feel free to contact Dr. Heather Darby, University of Vermont Extension at 802-524-6501 or heather.darby[at]uvm.edu or visit the program website: http://www.uvm.edu/extension/cropsoil/hops.