

Fertilizers and nutrient management for hops

Diane Brown, Michigan State University Extension



10-5-5 Guaranteed Analysis

Ammoniacal Nitrogen	4.5%
Nitric Nitrogen	0.5%
Organic Nitrogen (derived from urea)	5.0%
Total Nitrogen	10%
Phosphoric Acid (Available, derived from superphosphate)	5.0%
Potash (Water soluble from Potassium sulfate)	5.0%

Soils for hop production

- Loams that are well-drained, deep, and either sandy or gravelly.
- Poorly-drained soils promote root rots and should be avoided.
- Deep soils permit the hop plant's roots, which may reach a depth of 15 feet or more, to fully develop.
- Level and gently sloping fields are preferred to rolling land because irrigation systems and trellises are easier to construct and maintain on flat terrain.

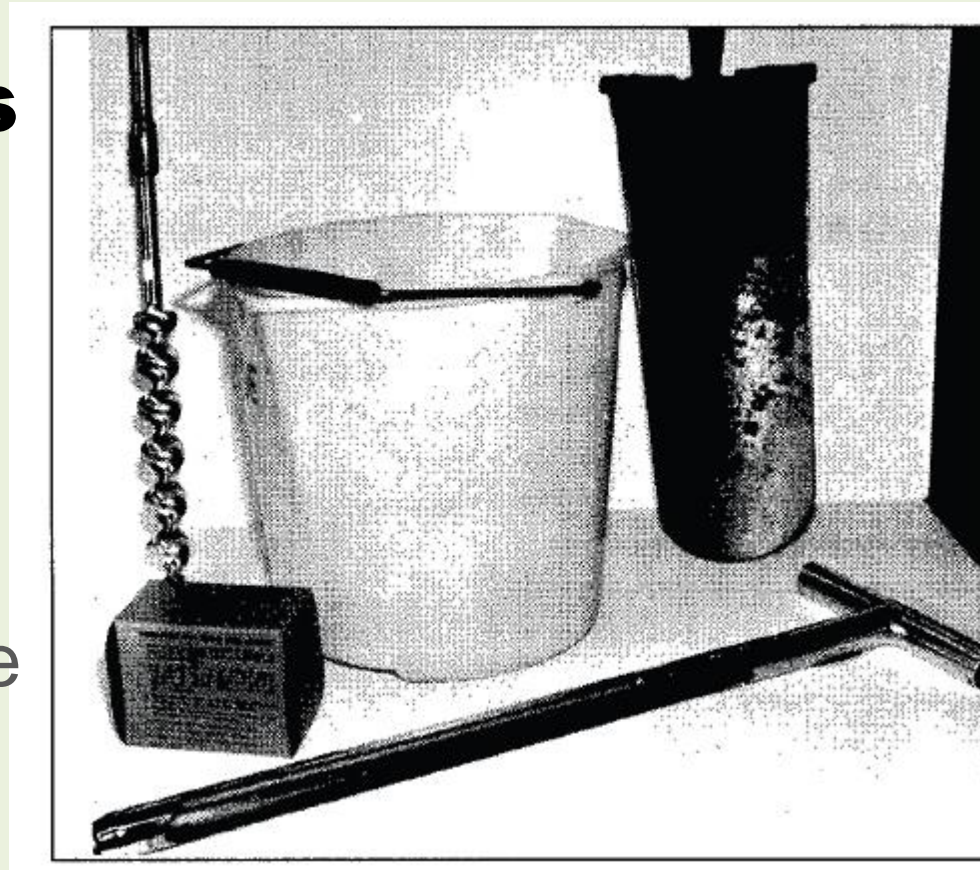
Pre-plant nutrient management for hops

- Soil test!
- Correct major issues before planting
- pH 6.0 to 6.5
- Lime- season before if necessary
- Make sure all nutrients in optimum range



Soil sampling tools

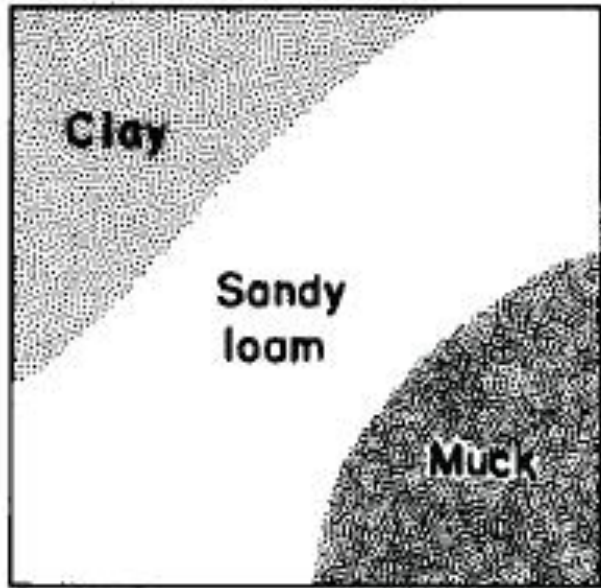
- Tools: a soil probe, spade, or trowel,
- clean plastic pail,
- sample bags and boxes, usually available from the soil laboratory;
- a pen or marker



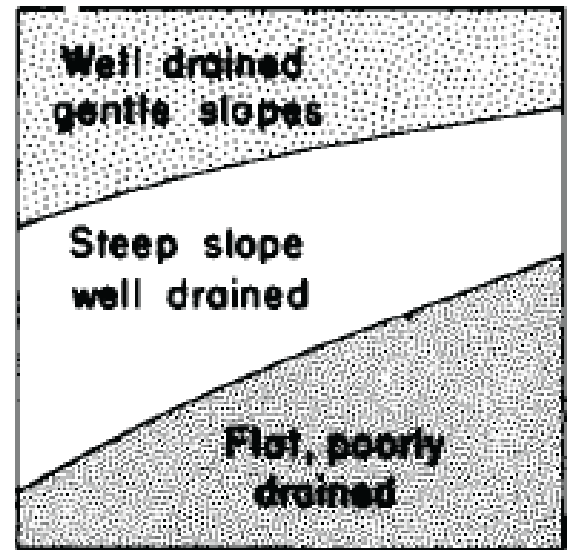
How to take soil samples

- Each sample should have relatively the same soil texture, topography, organic matter and cropping history
- Sample depth: 12-15 inches

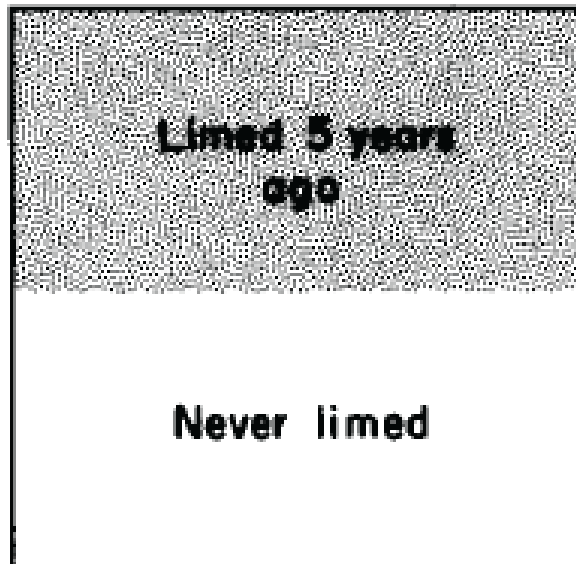




① 3 Composite samples



⑤ 3 Composite samples



② 2 Composite samples

How to take soil samples

- Sample in a zigzag fashion, no more than 10 A/sample
- Need 15-20 subsamples
- Combine all samples into the plastic pail and mix thoroughly.
- Fill a soil sample box with the sample, or package about a pint of soil
- Fill out an information form and send it in with the soil sample to the soil testing lab

Soil sampling



- Test at the same time of year
- Soil pH tends to be higher in spring than fall
- Extractable nutrients tend to be lower in fall after harvest
- Preplant, first couple of years, then every 3 years
- Tissue testing every 1-2 years
- Nutrient levels and pH tend to be more stable in soils with higher CEC
- CEC less than 6me/100g- K, Ca and Mg may change more rapidly

Established hops

- Don't need to sample soils every year
- Monitor changes in pH and organic matter over multiple years-
- These impact nutrient availability in the soil



What to test

- Soil pH
- Phosphorus
- Potassium
- Calcium
- Magnesium
- Zinc
- Boron
- Manganese
- Organic matter
- C.E.C.



Kinsey Agricultural Services, Inc.

297 County Highway 357 - Charleston, MO 63834
 Phone 573-683-3880 Fax 573-683-6227 e-mail psal@kinseyag.com

Client: MICHIGAN STATE UNIVERSITY EXTENS

City: SUTTONS BAY, MI

Date : 12-Sep-12

Location			HORT STATION		Previous Analyses & Applications								
Crop			HOPS / HOPS										
Field / Sample			N										
Lab No.			B0103										
Total Exchange Capacity (M.E.)			7.58										
Desired Ca - Mg, Percent			66 : 14										
pH of Soil Sample			7.0										
Humus Content, Percent			1.9										
BASE SATURATION PERCENT					%		%		%				
Calcium (60 to 70%)			76.15										
Magnesium (10 to 20%)			15.67										
Potassium (2 to 5%)			2.88										
Sodium (.5 to 3%)			0.92										
Other Bases (Variable)			4.38										
EXCHANGEABLE HYDROGEN (10 to 15%)			0.00										
					FOR ORGANIC		FOR CONVENTIONAL						
					RECOMMENDATIONS								
					Amendment		Lbs/Acre		Lbs/Acre				
S N O I N I N G	NITROGEN		58	FEATHER MEAL 13-0-0 (a)		450		UREA 46-0-0 (c)		40			
	Lbs/Acre	ENR Value		FEATHER MEAL 13-0-0 (b)		375		AMSULF 21-0-0-24 (d)		125			
				COMPOST		(See Note Below)		CAN 17 N (e)		50			
								LIQUID N 32% (f)		125			
S U L F A T E	SULFATE - S		16	SULFUR 90-92% (g)		75		SULFUR 90-92% (g)		75			
	p.p.m.	Value Found											
P H O S P H A T E S	PHOSPHATES		750										
	Desired Value	Olsen Value											
	as (P2O5)	Value Found		636									
	Lbs/Acre	Deficit/Surplus		-114									
C A L C I U M	CALCIUM		2062	NONE				Amend		added			
	Lbs/Acre	Value Found											
				+247									
M A G N E S I U M	MAGNESIUM		250	NONE									
	Lbs/Acre	Value Found											
				+35									
P O T A S S I U M	POTASSIUM		443	POT SULFATE 0-0-50 (h)		250		POT SULFATE 0-0-50 (h)		250			
	Lbs/Acre	Value Found											
				-273									
S O D I U M	SODIUM		35										
	Lbs/Acre	Value Found											
				-3									
T R A C E S	Boron		0.88	BORAX 11%		20		BORON 14.3%		15			
	p.p.m.												
				411									
				83		MANG SULF 28%		50		MANG SULF 28%		50	
				1.40		CU SULFATE 23%		20		ZINC SULFATE 36%		35	
		8.50		ZINC SULFATE 36%		35		(Or 5 lbs/acre per year for 4 years.)					
N O T E	(a) Apply 1 week or so before spring growth begins.												
	(b) Apply 1 week or so before bloom.												
	(c) Work into soil immediately or water in with a minimum of 1/2 inch of water.												
	(d) Apply in early spring.												
	(e) Apply at bloom.												
	(f) Apply at bloom.												
(g) Sulfur applications including the sulfate form of 50 lbs/acre or more need to be applied at least 6 months prior to next soil sampling.													
(h) Apply an additional 250 lbs/acre of Potassium Sulfate (0-0-50) during the growing season.													
NOTE: Could use compost here if Ca & Mg levels in the compost are not too high. Should not be applied though without an analysis first to determine the effects this would have on soil nutrient content.													

What about testing compost and manure?

- Saturated media test- compost used as a growth medium
- Compost analysis- compost used as fertilizer
- Maturity test for compost (Solvita test)
- Manure testing list of accredited labs:
- <http://www2.mda.state.mn.us/webapp/lis/manurelabs.jsp>



Why do foliar analysis?

- More reliable than soil test for judging nutrient status of the plant
- Check for nutrient deficiency
- Petiole analysis check levels of:
 - Nitrogen (N)
 - Phosphorus (P)
 - Potassium (K)
 - Zinc (Zn)
 - Boron (B)

Foliar analysis

- Sample 1st-2nd week in June
- Most recently developed leaf
- 30- 60 leaf petioles
- 5-6' height



When to do petiole analysis?

- When there are symptoms of nutrient deficiency
- collect petiole samples from vines showing leaf symptoms and from vines without symptoms (healthy or normal).
- The two samples are sent and analyzed separately for comparison purposes. This will allow you to diagnose whether or not the problem is related to nutrient status.

How to take samples for petiole analysis

- Be as consistent as possible with respect to growth stage when collecting tissue samples for nutrient analysis.
- Collect samples at the same growth stage each year.
- Monitor the same areas within specific hopyards or blocks. To do this, designate and flag specific rows within a block that are revisited yearly.

Petiole sampling

- Detach each petiole from the leaf blade immediately.
- Place petioles in a paper bag
- Label each sample and keep your own record of the following: varieties sampled, block where the samples are collected, sampling date, and conditions of hopyard.
- Prior to shipping, allow samples to dry for a day in a warm, dry, well-ventilated place

Petiole testing

- A general basis for nitrate levels from petiole testing:
- 0-6,000 ppm = low
- 6,000-10,000 ppm = normal
- 10,000+ ppm = plenty
- Conversion factor- 0.1000% =1000 ppm

Petiole testing

- P: Values over 10 ppm are likely sufficient
- Soil pH can effect availability of P
- Without the return of vines or other amendments, expect a drop of 2 ppm P per year
- K: 190 ppm is the critical value for K
- Less than this you will likely want to add anywhere from 100-200 lbs K
- Without the return of vines or other amendments, expect a drop of 40 ppm K per year.

Soil testing and tissue testing

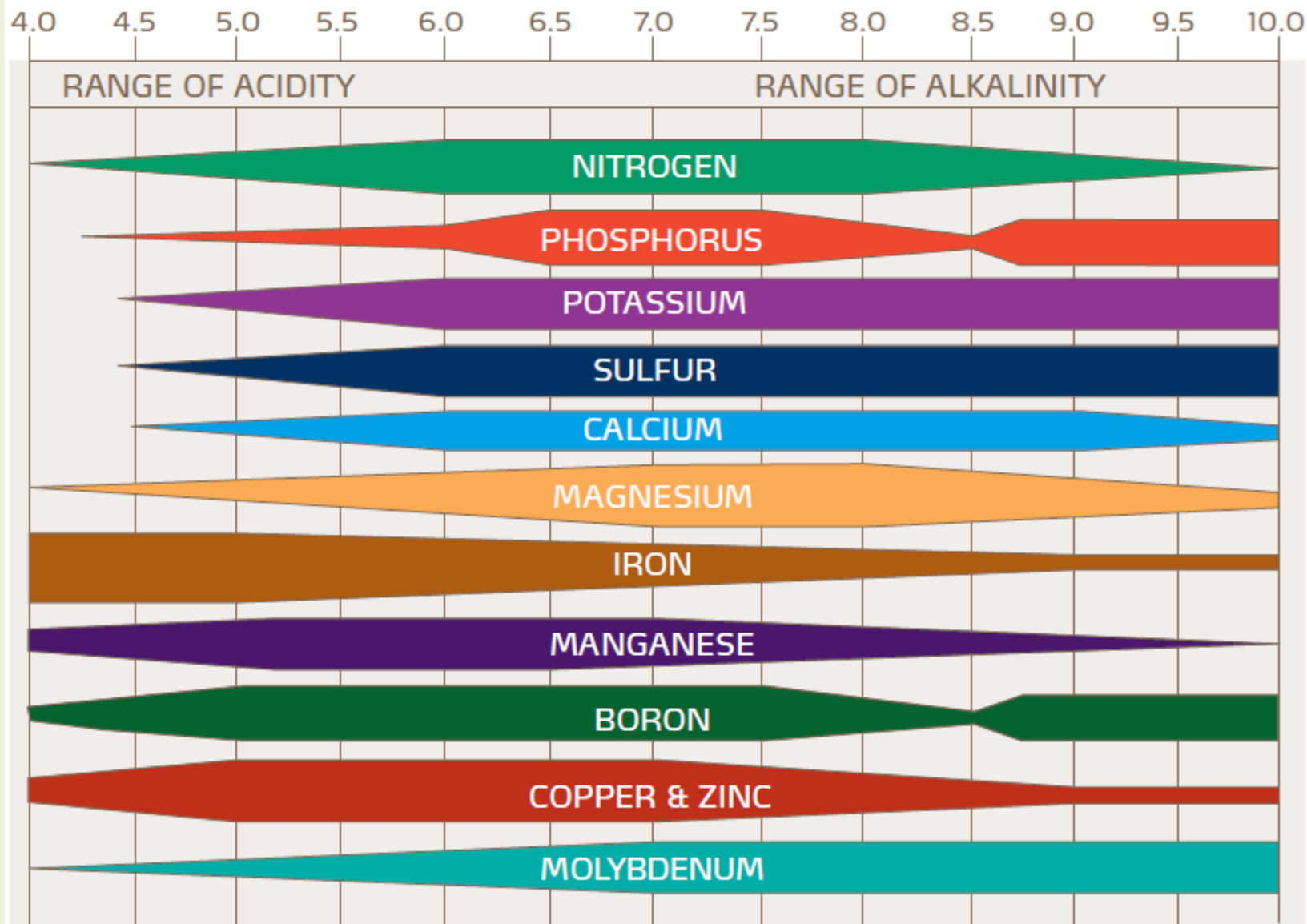
- **A & L Great Lakes Lab, Inc.**, 3505 Conestoga Drive Fort Wayne, IN 46808. (219) 483-4759
- **Michigan State University, Soil & Plant Nutrient Lab**, Plant & Soil Sciences ,1066 Bogue St. Room A81 East Lansing, Mi 48824-1325, Phone: 517-355-0218, Fax: 517-355-1732 Website: <http://www.spnl.msu.edu>
- **Kinsey Agricultural Services, Inc.** 297 County Highway 357 - Charleston, Missouri 63834 Telephone (573) 683-3880 Fax (573) 683-6227 www.kinseyag.com (soil only)
- There are many others- these are just a few.

Soil pH and Nutrient Availability

Table 1. Soil pH and Interpretation

5.0	5.5	6.0	6.5	7.0	7.5	8.0
Strongly Acid	Medium Acid	Slightly Acid	Slightly Acid	Neutral	Mildly Alkaline	Moderately Alkaline
			6.0-6.5 best pH range for hops			

The Influence of Soil pH on Nutrient Availability



Why pH matters

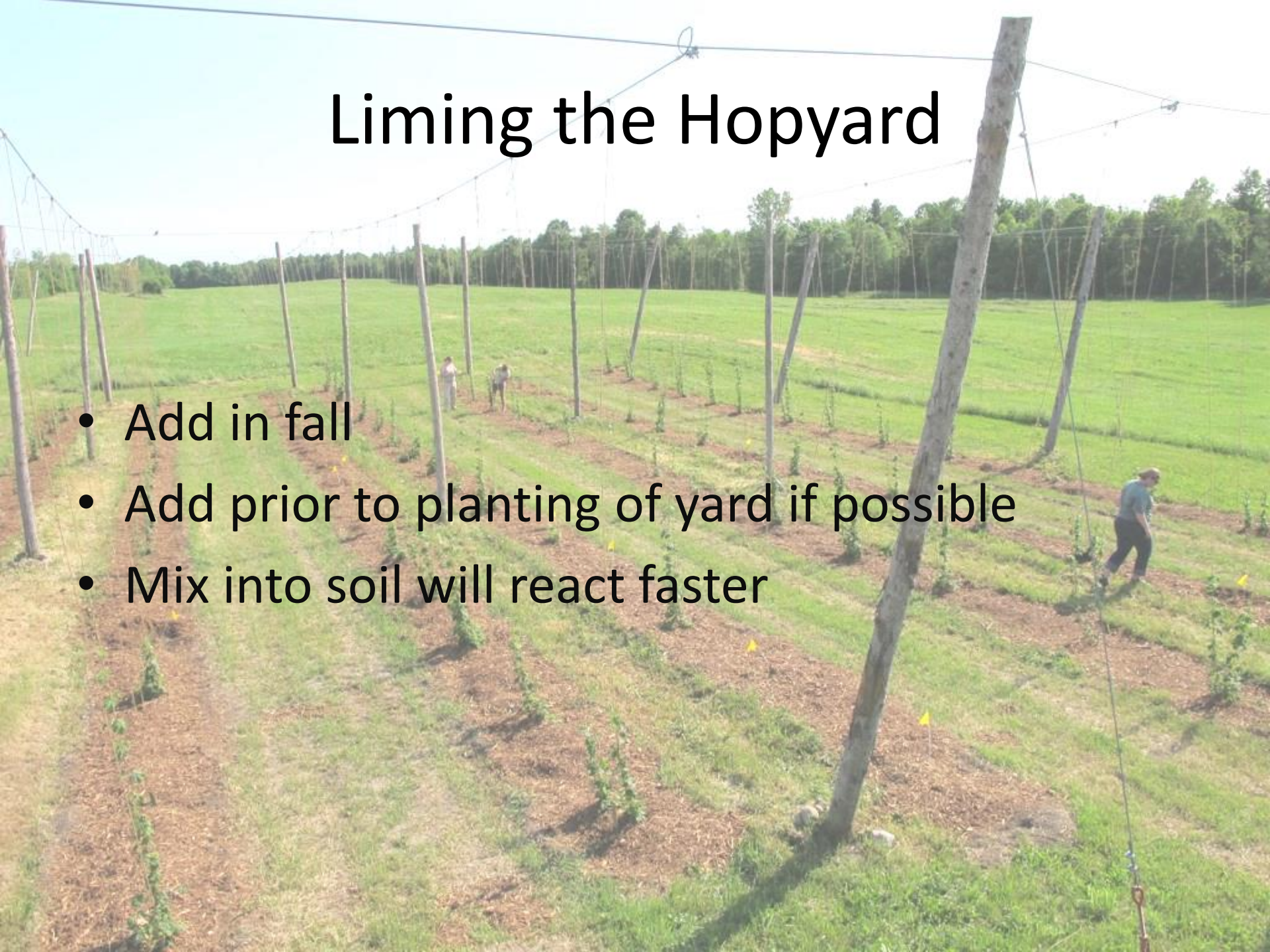
- soil pH affects the abundance of microorganisms.
- Bacteria are generally more prevalent in alkaline soils and fungi dominate in acidic soils.
- Microbes are responsible for the cycling of nutrients.
- The most diverse and numerous populations are found in near-neutral soils.

Adjusting Soil pH

- Easiest pre-plant
- Soils will progressively acidify with normal farming practices
- Low pH- use lime
- dolomitic lime also adds Ca and Mg
- Low pH- aluminum toxicity and P deficiency

Liming the Hopyard

- Add in fall
- Add prior to planting of yard if possible
- Mix into soil will react faster



CEC- Cation exchange capacity

- indicates of the nutrient holding capability of a soil.
- the greater the clay and organic matter contents, the higher the CEC of a soil.
- CEC is calculated by adding together the amount of soil test values of potassium, calcium, magnesium, and hydrogen held on the soil particles.

CEC- Cation exchange capacity

- Loamy sands and sands usually have a CEC less than 8.
- The CEC of sandy loams frequently falls between 8 and 12.
- Loams, clay loams and clays usually have a CEC greater than 12.
- As the soil pH changes, the CEC value will also vary somewhat. The higher the CEC, the greater the capacity of the soil to hold nutrients

Soil Organic Matter

- Release of N from organic matter.
- 20 lb N / % OM / Ac / Yr

fertility

- around 100 pounds of nitrogen per acre (lb N/acre) are removed on average during hop harvest.
- typical first-year N rates are 75 lb N/ acre; in subsequent years, 100 to 150 lb N/acre.
- Low phosphorus requirements- 20-30 lb P/A
- Potassium- 80-150 lb/A

Effect of fertilizers on soil pH

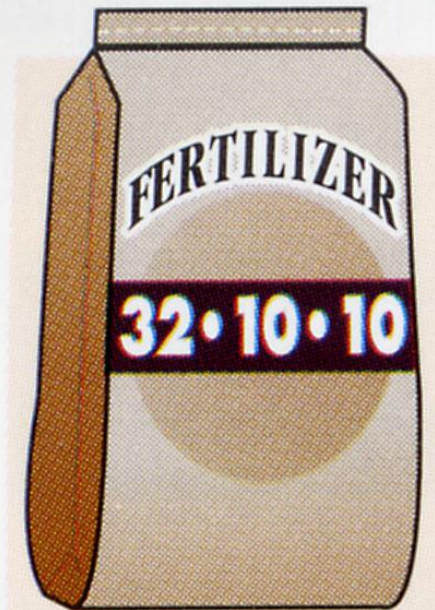
- Ammonium (NH_4^+) or ammonium forming fertilizers (ex. urea) will cause a decrease in soil pH over time.
- Nitrate (NO_3^-) sources carrying a basic cation should be less acid-forming than NH_4^+ fertilizers.
- The presence of Ca, Mg, K, and Na in the fertilizer will slightly increase or cause no change in soil pH.
- Elemental sulfur, ammonium sulfate, and compounds such as iron can reduce the soil pH

Nutrient Sources

- Bines and leaves returned to field-*use caution*
- Composts/cover crops
- Animal manure
- Organic Bagged Fertilizers
- Synthetic Fertilizers

Reading a fertilizer label- what's in a bag?

- Product or brand name
- N-P-K grade %(by weight) of the three major nutrients in a fertilizer.
- Guarantees for Total Nitrogen (N), Available Phosphate (P₂O₅) and Soluble Potash (K₂O)
Example: 12-15-24 means 12% nitrogen, 15% available phosphate, and 24% soluble potash
- Net weight
- Guaranteed analysis



Guaranteed analysis

Element	Agricultural Fertilizers (percent)	Specialty Fertilizers (percent)
Calcium (Ca)	1.00	1.00
Magnesium (Mg)	1.00	0.50
Sulfur (S)	1.00	1.00
Boron (B)	0.125	0.02
Chlorine	-	0.10
Copper (Cu)	0.05 (chelate 0.10)	0.50
Iron (Fe)	0.10	0.10
Manganese (Mn)	1.00	1.00
Molybdenum (Mo)	0.04	0.04
Zinc (Zn)	0.50 (chelate 0.125)	0.50

Fertilizer and nutrients

- Organic or conventional?
- organic- can be difficult to supply nitrogen requirements
- USDA national organic program:
- <http://www.ams.usda.gov/AMSv1.0/nop>
- Template for organic USDA certification:
- <http://www.ams.usda.gov/AMSv1.0/getfile?dDocName=STELPRDC5091031>

Fertilizer and nutrients

- USDA national organic program:
- <http://www.ams.usda.gov/AMSV1.0/nop>
- OMRI approved fertilizers:
- <http://www.omri.org/simple-opl-search/results/fertilizer>

Organic Fertilizers

- Manures, composts, worm castings
- Often high in phosphorus
- Have them tested
- Commercially prepared bulk sources available



Organic Fertilizers- what's acceptable

- Naturally occurring fertilizers or amendments

Mined or Mineral Sources

Material

lime - carbonate, not hydrated or burnt

gypsum - calcium sulfate

rock phosphate - calcium phosphate

greensand - potassium (0-0-7)

potassium sulfate (0-0-50)

potassium magnesium sulfate (0-0-21)

basalt rock powder

granite rock powder (5-10% K₂O)

Organic Fertilizers- what's acceptable

- Naturally occurring fertilizers or amendments

Animal Derived Sources	
Material	Release time
bone meal (6-12-0)	1-4 mo.
blood meal (12-0-0)	1- 4 mo.
fish emulsion (5-2-2) adds micronutrients	1-4 mo.
fish meal (10-6-2)	1-4 mo.
feather meal varies- N content 7- 12%	4+ mo.
manure - many types	
3 to 5 ft³ per year	
worm castings	

Organic Fertilizers- what's acceptable

- Naturally occurring fertilizers or amendments

Plant Derived Sources

Material	Release time
alfalfa meal (3-0.5-3)	1- 4 mo.
soybean meal (6-1.4-2)	1-4 mo.
cotton seed meal (6-2-2)	1-4 mo.
kelp meal (negligible- for trace elements)	4+ mo.
Kelp powder (1-0-4)	immed. – 1 mo
wood ash (liming action) ~1/2 the liming value of ag lime	
composts (typ. 1.5-3.5% N, 0.5-1% P, 1-2% K) watch salts!	Very slow

Approximate nutrient content of manure

type		N	P	K
Dairy cattle	with bedding	0.5%	0.2%	0.5%
	without bedding	0.5%	0.2%	0.5%
Horse	with bedding	0.7%	0.2%	0.7%
Poultry	with litter	2.8%	2.3%	1.7%
	without litter	1.7%	2.4%	1.7%

Approximately 30-50% of N available in the first year

Non-composted manure- 120 day pre-harvest interval

http://msue.anr.msu.edu/news/fall_manure_application_tips

Want to make your own compost?

- **Compost production and use-** John Biernbaum and Andy Fogiel, Department of Horticulture, Michigan State University
- www.safs.msu.edu/soilecology/pdfs/Combine%20Compost05.doc

Synthetic Fertilizers

- Nitrogen sources
- Urea- 46-0-0- **converts to NH_4^+ in 2-3 d**
 - coated ureas- sulfur coated, CoRoN, Nutralene, N-Sure
- Ammonium nitrate 33-0-0
- Ammonium sulfate- 21-0-0 highly acidifying
- Calcium nitrate 16-0-0
- Potassium nitrate 13-0-44 low salt index

Synthetic Fertilizers

Common Phosphorus sources

- Triple superphosphate 0-46-0
- Diammonium phosphate 18-46-0
- Monoammonium phosphate 11-48-0

Synthetic Fertilizers

Common potassium sources

- potassium chloride 0-0-60 or 0-0-62 **not recommended**
- Potassium sulfate 0-0-50
- Potassium magnesium sulfate 0-0-22
Mg-11.2%, S-22.7%
- Potassium nitrate 13-0-44
- **! Excessive potassium can lead to Mg deficiency**

Hop Requirements

VARIES SLIGHTLY BY VARIETY

- 3% Nitrogen
- 2% Potassium
- 0.50% Phosphorus

- Other important nutrients
 - Boron
 - Zinc



Hops Nitrogen requirements

- 60 to 150 lbs of actual N per acre
- Apply in late May to mid June
- Base rate of application on yields
- Also consider soil type
 - Levels of organic matter-
 - 20 lb N / % OM / Ac / Yr

hop N requirement- (N from manure + returned bines,+ cover crops) = fertilizer N to apply

Nitrogen and OM

- 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.

First Year Hop Requirements

PRODUCE 1750 LBS DM/acre

- 3.0% Nitrogen = 55 Lbs
- 2.0% Potassium = 35 Lbs
- 0.50% Phosphorus = 9 lbs
- Check Zinc and Boron levels in soil



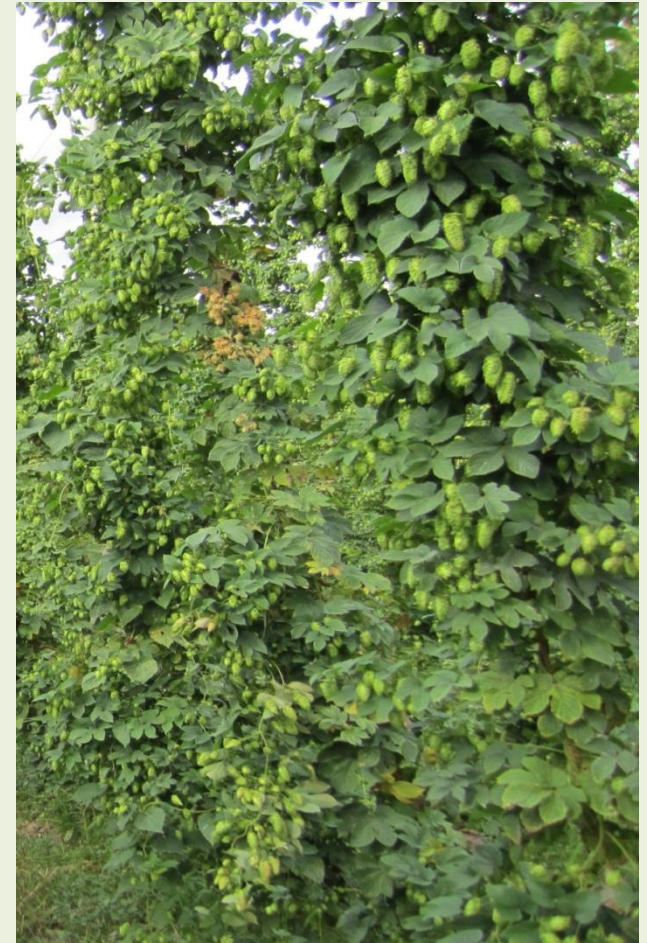
Hop Requirements

PRODUCE 5000 LBS DM/acre

- 3.0% Nitrogen = 150 Lbs
- 2.0% Potassium = 100 Lbs
- 0.50% Phosphorus = 25 lbs

CONES 1/3 to 1/2 of DM/acre

- 3.0% Nitrogen = 75 Lbs
- 2.0% Potassium = 50 Lbs
- 0.50% Phosphorus = 12.5 lbs



Yields?

You Should Know Cone Yields

1000 lbs dry cones per acre

30 to 50% of total weight

2000 to 3000 lbs total

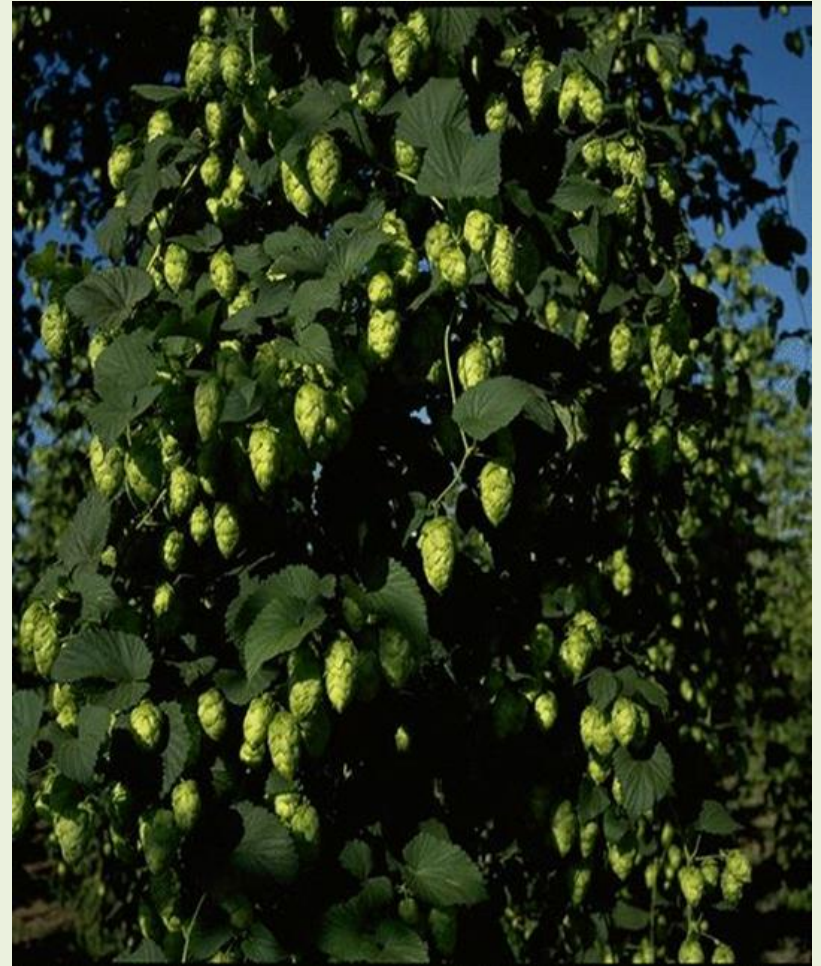
60 to 90 lbs of N removed



Phosphorus

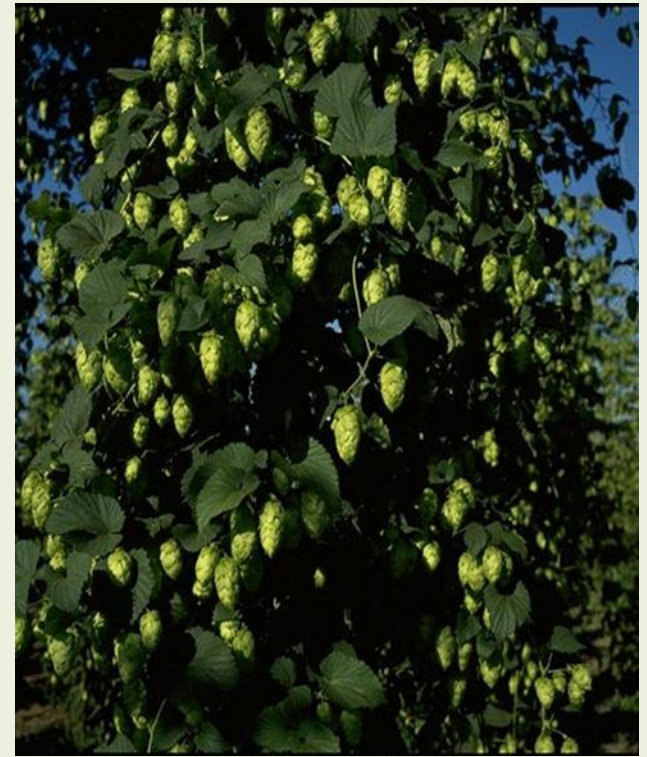
- Phosphorus (0 to 80 lbs/acre)
- Will depend on Al levels in soil and pH
- Will depend on soil test levels

Watch excessive P levels in soils-
ZN deficiency



Potassium

- Potassium (0 to 160 lbs/acre)
- Will depend on soil type
- Will depend on yield
- Also depends on soil levels



For potash

Category	Low	Medium	Optimum	High	V. High
K (ppm)	0–50	51–100	101–130	131–160	>160
K to apply	120-150	80–120	60-80	0	0

Boron

- Boron deficiency in hops
- Symptoms
 - Delayed emergence of shoots
 - Small, distorted, chlorotic leaves
 - Shortened internodes
 - Lots of buds on the crown at ground level



Boron

- Boron deficiency in hops-Based on soil test results
- < 1.5 ppm apply 1.0-1.5 lb/A
- > 1.5 ppm no need to apply
- Can be toxic if applied in excess!

Zinc

- Deficiency symptoms-
- Chlorotic leaves
- Long shoots with very small, cupped, with deeply cut lobes
- weak lateral and bine growth,
- Acid, sandy soils low in organic matter neutral to alkaline soils or high in P



Zinc

- Foliar application of zinc sulfate (0.15-0.18%).
- or If Zinc is low add 2 to 4 lbs per acre
- Will need to put through irrigation or blend with other fertilizer

Information sources:

Heather Darby, University of Vermont, Building a Hop Industry In New England, powerpoint presentation, August, 2013

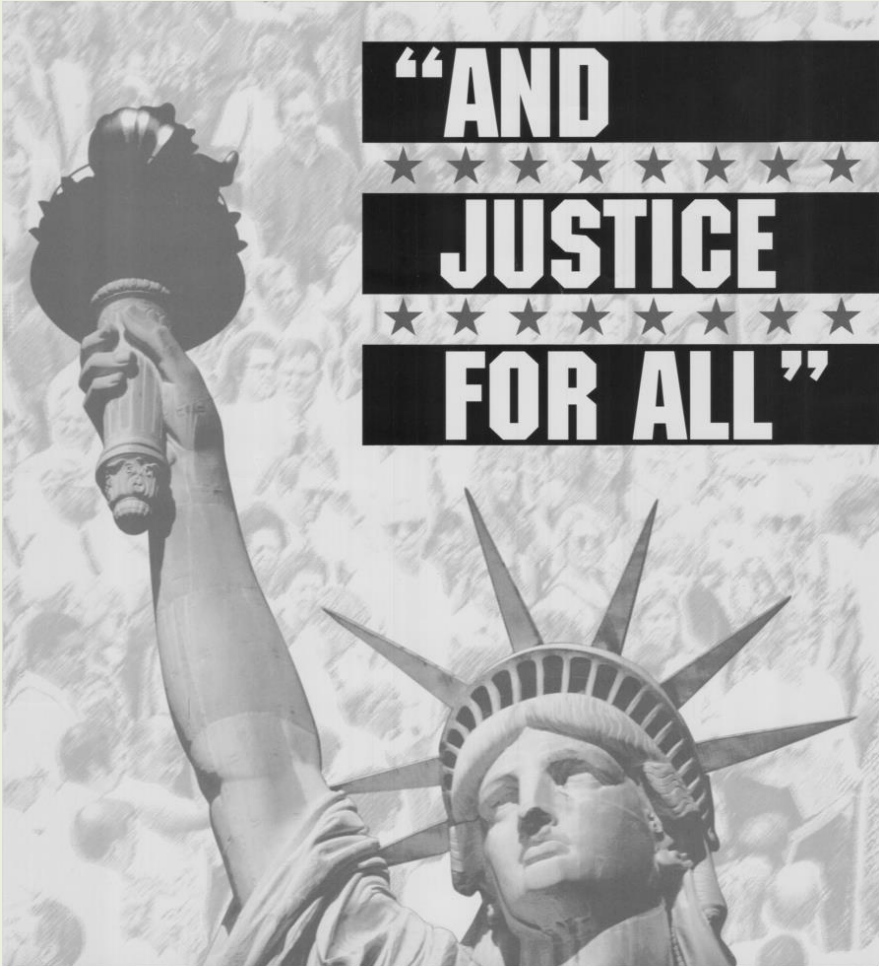
Fertility Guidelines for Hops in the Northeast- Dr. Heather Darby, University of Vermont Extension Agronomist

Organic Farming Principles and Practices, John A. Biernbaum,
Department of Horticulture, Michigan State University,
<http://www.safs.msu.edu/soilecology/pdfs/OrganicFarming.htm>

Using composts in the home garden, Colorado Master Gardener Note#243
<http://www.ext.colostate.edu/mg/gardennotes/243.html>

Organic fertilizers, Colorado Master Gardener Note #234
<http://www.ext.colostate.edu/mg/gardennotes/234.html>

Michigan State University Soil and Plant Nutrient Laboratory
<http://www.spnl.msu.edu/>



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