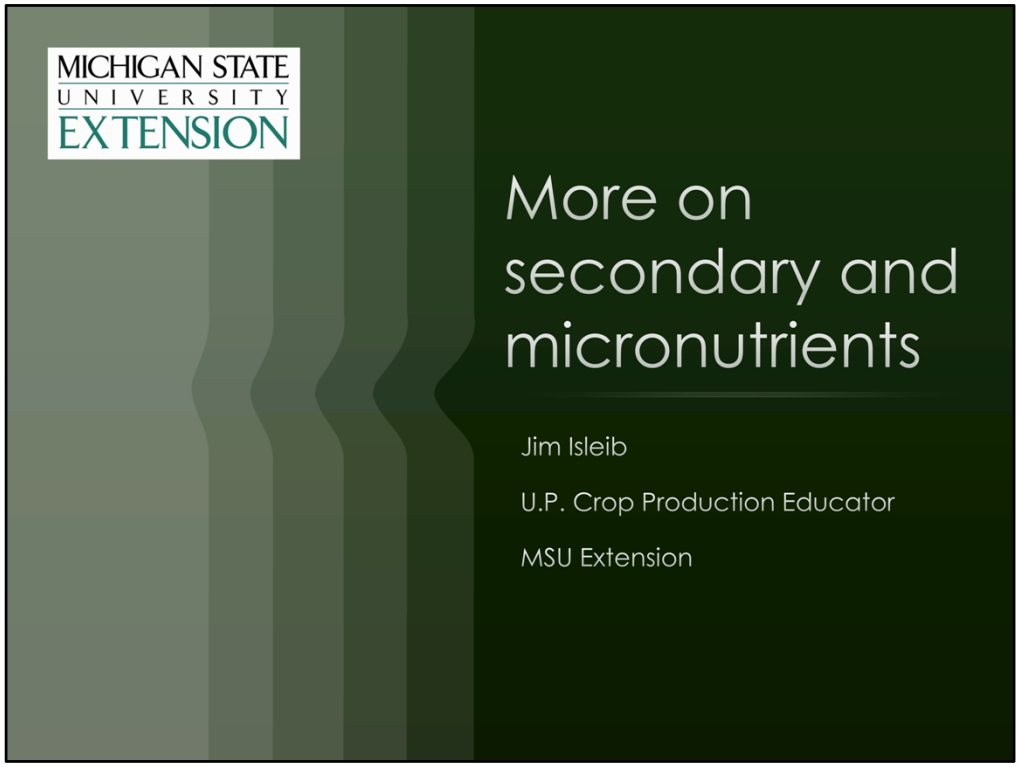
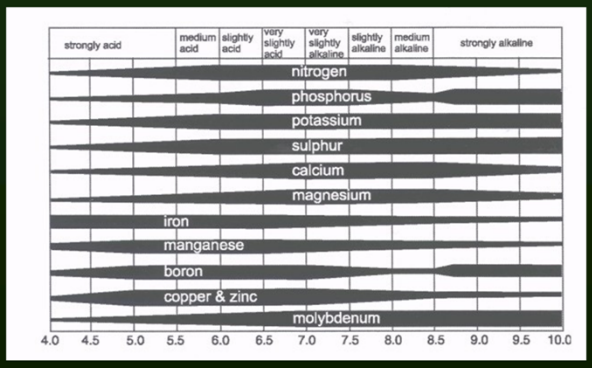


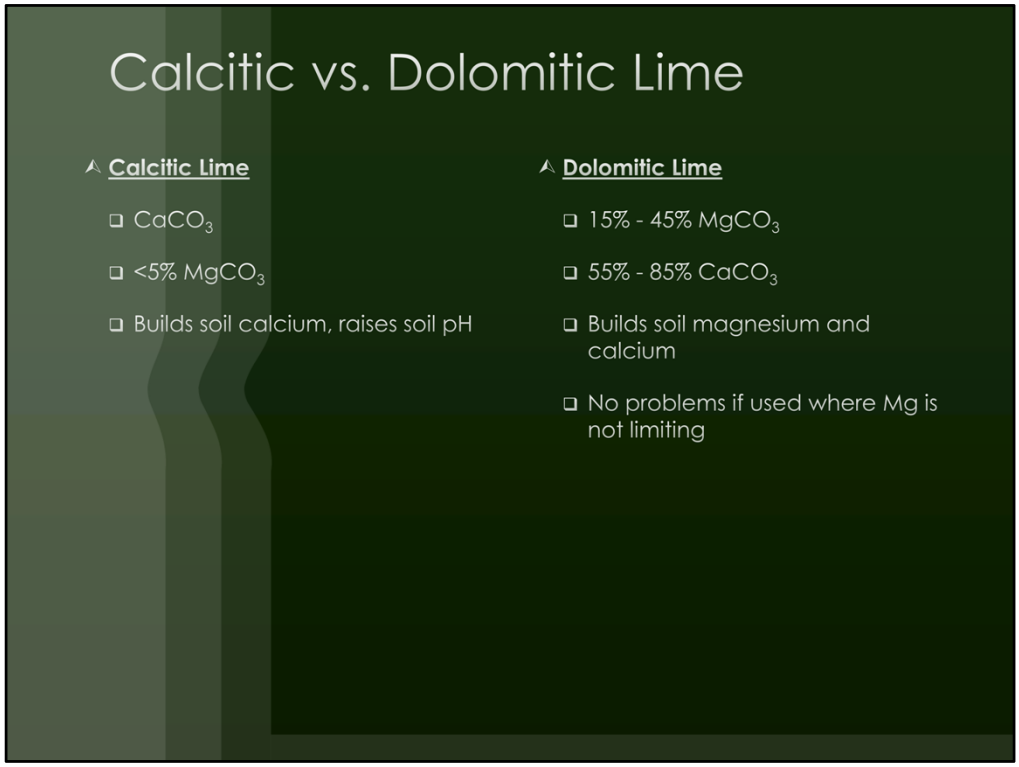
This presentation covers micronutrient needs of U.P. crops that are NOT forage grass or legume species.

Soil pH impact on nutrient availability

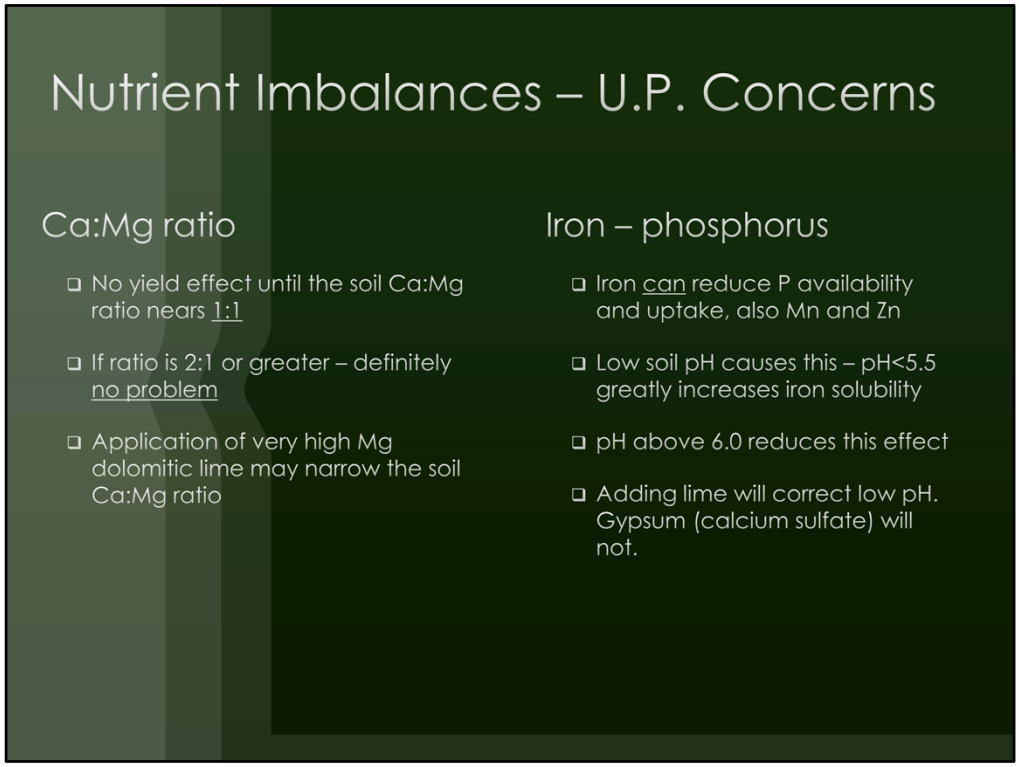
- **Low** soil pH has major impact on availability of:
  - Phosphorus
  - Calcium
  - Magnesium
  - Molybdenum
- **High** soil pH has major impact on availability of :
  - Phosphorus
  - Iron
  - Manganese
  - Boron
  - Copper
  - Zinc



Crop nutrient uptake is directly affected by soil pH. Large areas of the U.P. contain low pH soils. In combination with low nutrient levels, these soils can be very nutrient deficient. High soil pH is generally not an issue in upper Michigan, although several areas in Delta and Menominee counties have soil pH of 7.0 and above naturally.

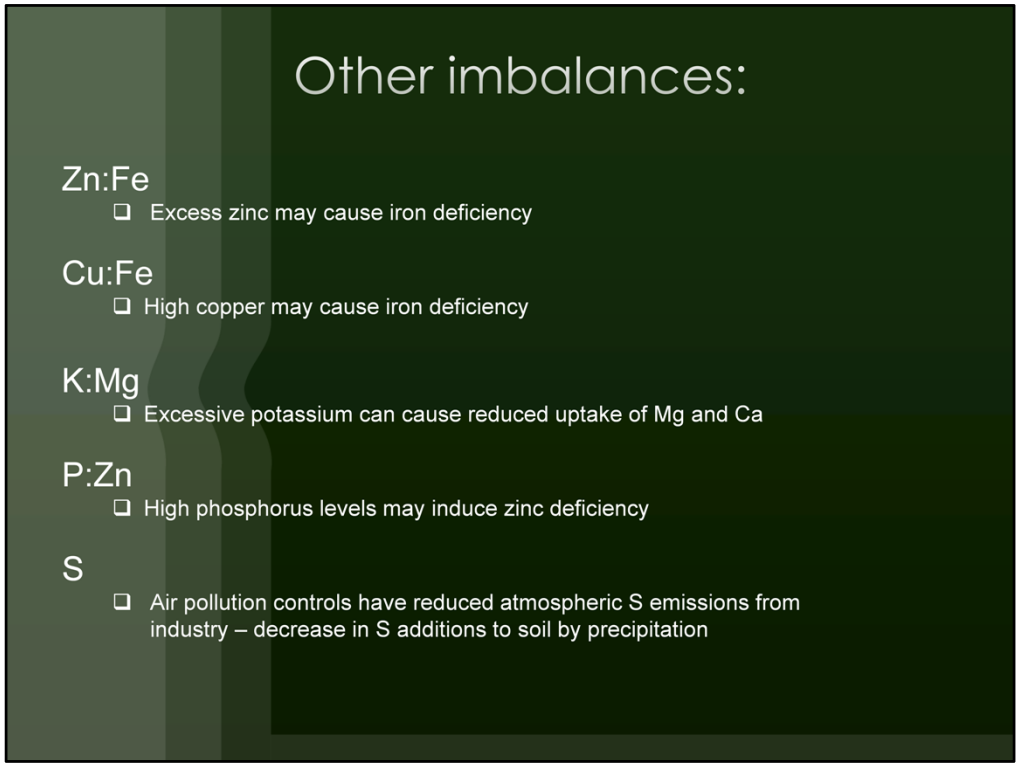


Calcitic and dolomitic limestone deposits are both found in the U.P. Commercial ag lime from these deposits can be purchased. Some U.P. soils are deficient in magnesium. If these soils also need lime to increase soil pH, then dolomitic lime is preferred.

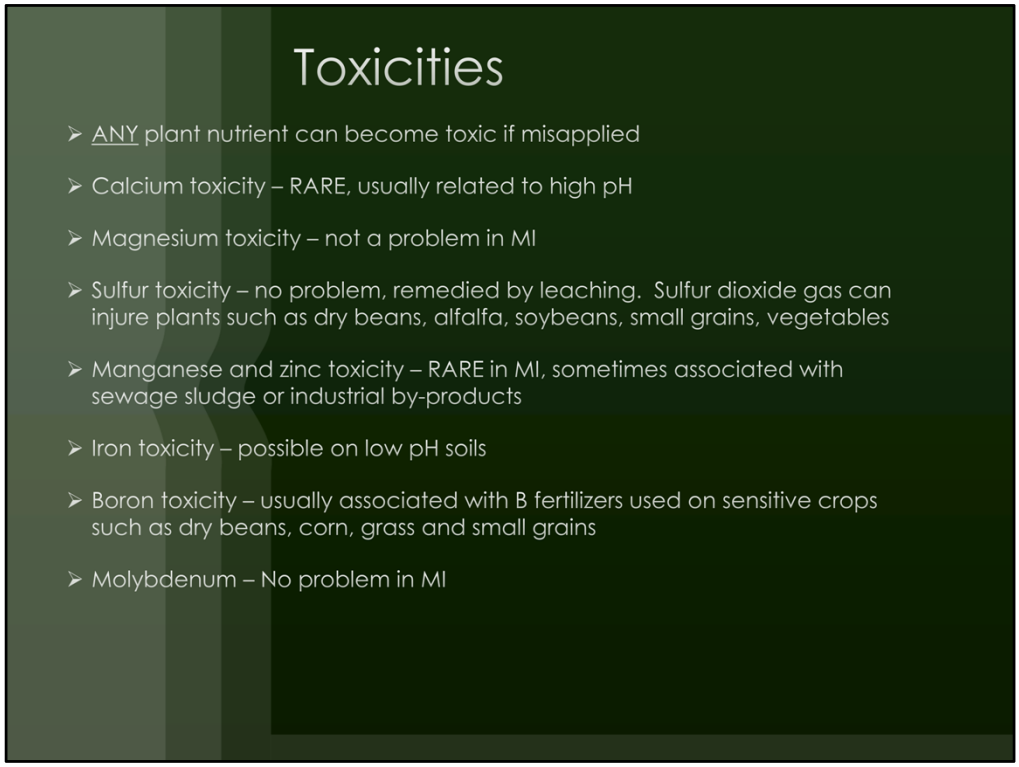


In some areas of low soil pH, where dolomitic lime for agricultural application is readily available, farmers have seen a narrowing of the ratio betweem calcium and magnesium concentrations. The ratio has not come close to being a problem yet. If the ratio reaches 1:1, then plant uptake of calcium could be inhibited.

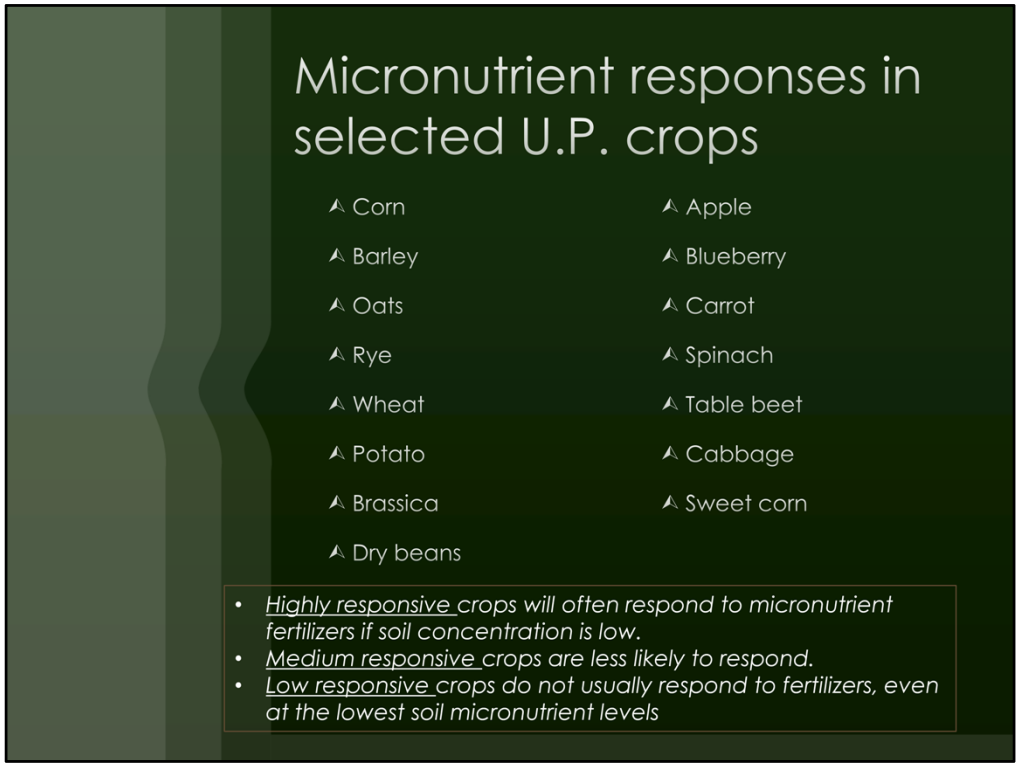
When soil pH is low (<5.5), plants on soils with high iron content may develop phosphorus deficiency. Manganese and zinc uptake can also be inhibited by high soil iron content, especially in acidic soils. This problem is reduced when soil pH is over 6.0.



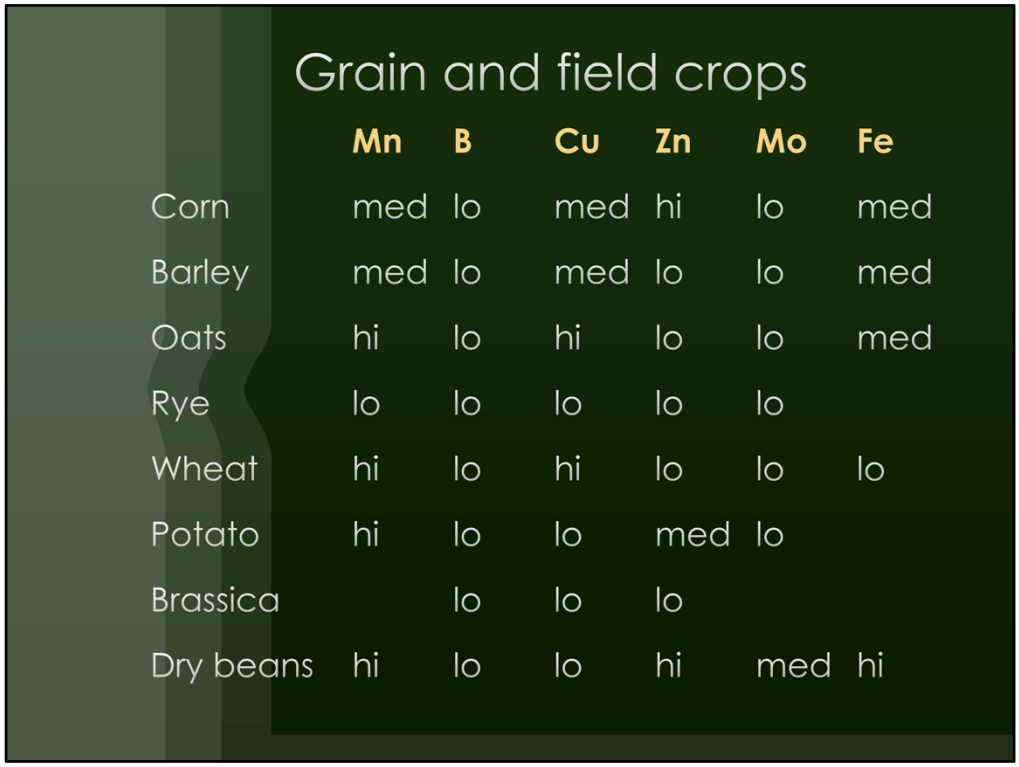
Other potential nutrient imbalances are listed.



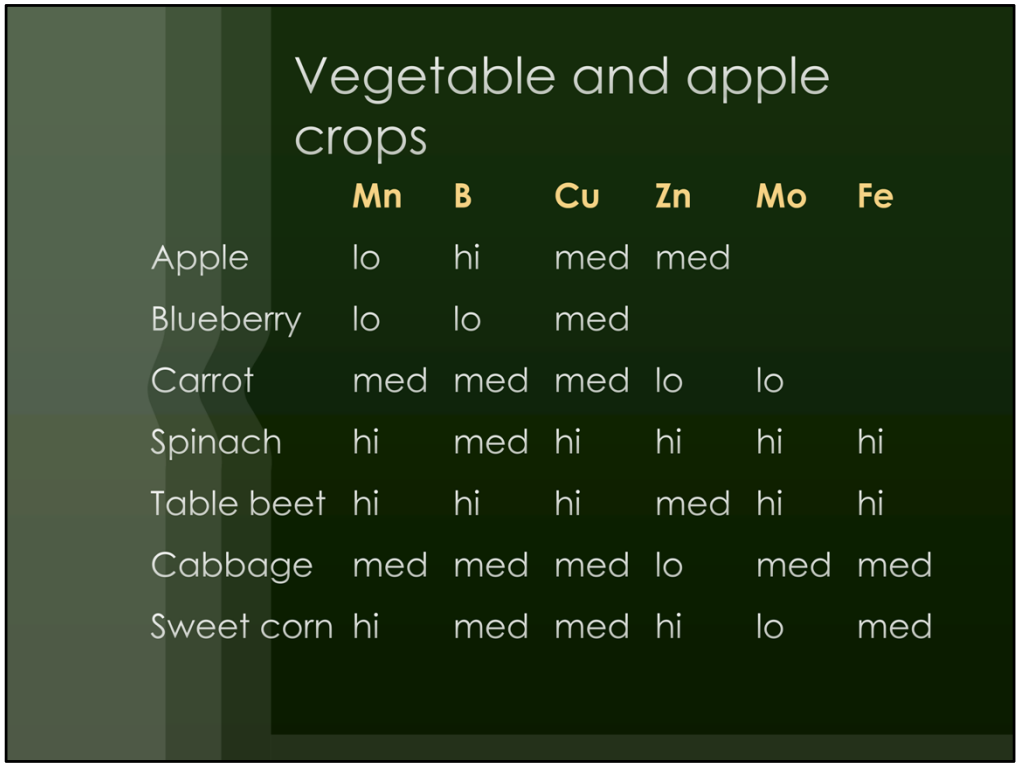
Secondary and micronutrient toxicities are listed. The only ones of real concern in upper Michgan are iron toxicity (on acidic soils) and boron toxicity if boron fertilizers are used.



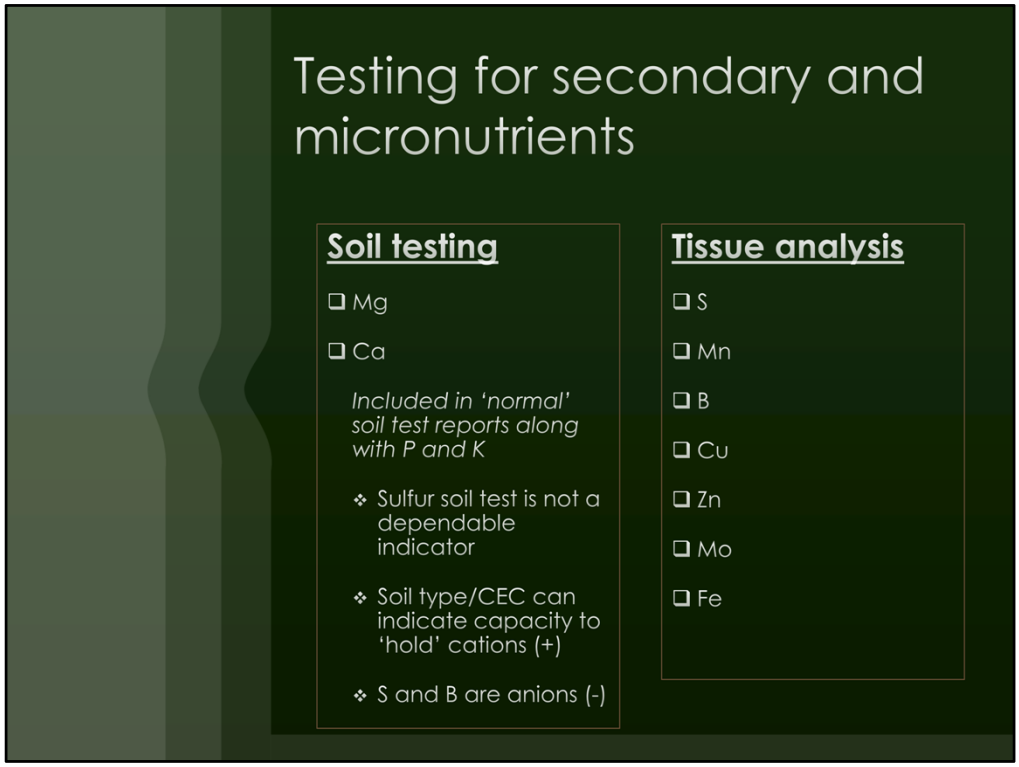
This short list of agronomic and horticultural crops are grown around the U.P. The following slides rate them in terms of responsiveness to micronutrient fertilizers.



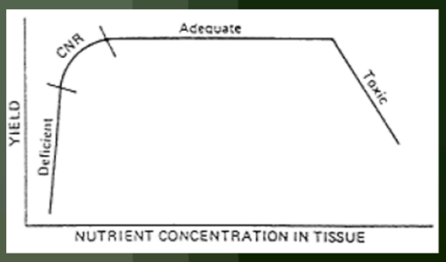
Responsiveness to listed micronutrient fertilizers



Horticultural crop responsiveness to micronutrient fertilizers

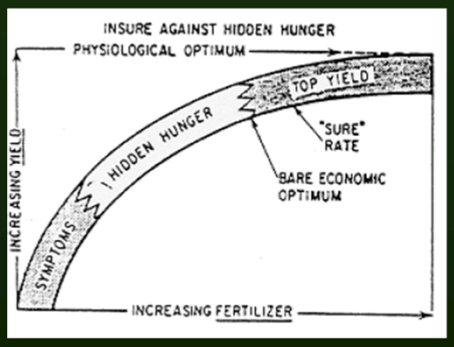


Soil testing is a good indicator of deficiencies in magnesium and calcium. However, soil testing is NOT a good way to determine if sulfur or micronutrient fertilizers including manganese, boron, copper, zinc, molybdenum and iron are needed. Tissue analysis is the best way to determine these deficiencies. A good knowledge of nutrient deficiency symptoms will help.



Relationship between nutrient concentrations in plant tissue and top yield, showing proposed critical nutrient range (CNR)

Source: Dow and Roberts, 1982



"Hidden Hunger" is the term used to describe a plant that shows no obvious symptoms, yet the nutrient content is not sufficient to give the top profitable yield.

Source: Tisdale et al., 1985

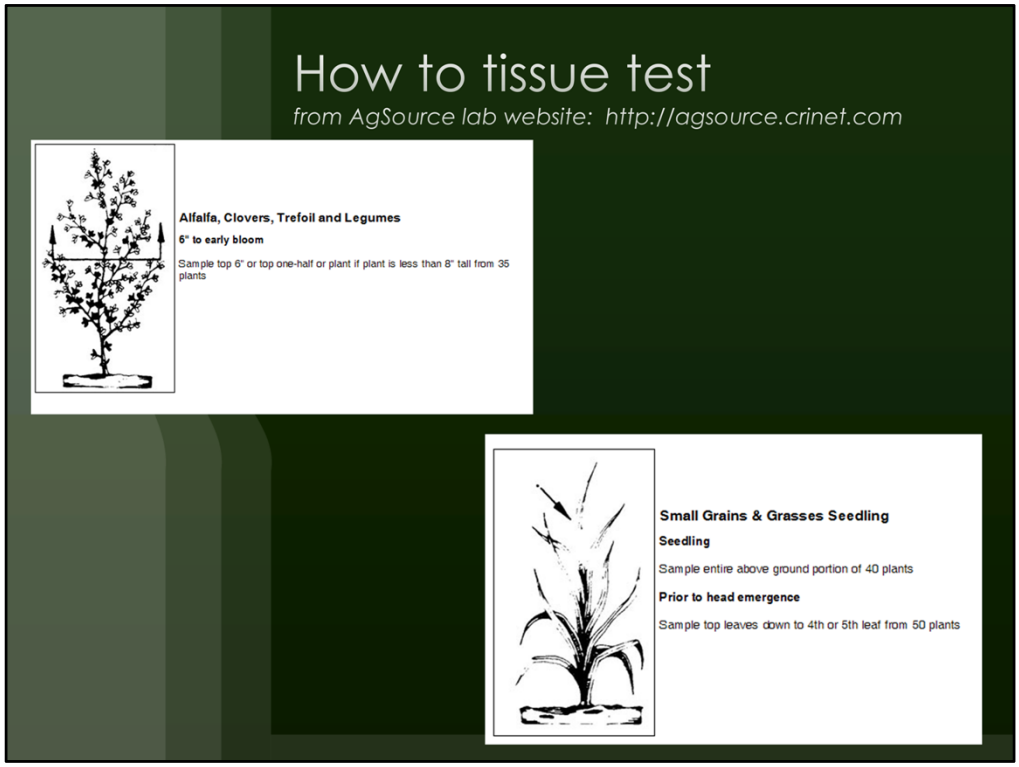
There is a range of nutrient deficiency between the adequate nutrient concentration in tissue, and the deficiency concentration range called the "Critical Nutrient Range" by Dow and Roberts, or the "Hidden Hunger" range by Tisdale et al. In this range of concentration, symptoms are not obvious, but yields begin to be depressed.

Tissue analysis is the best diagnostic tool to determine if special fertilizers are needed, since symptoms will not be evident to give clues.

TABLE 1.
Nutrient sufficiency ranges for corn, soybeans, alfalfa, wheat, sugar beets, potatoes and vegetables.

ELEMENT	CORN Ear leaf sample of initial silk	SOYBEANS Upper fully developed leaf sampled prior to initial flowering	ALFALFA Top 6 inches sampled prior to initial flowering	WHEAT Upper leaves sampled prior to initial bloom	SUGAR BEETS Center fully developed leaf sampled in midseason	VEGETABLES Top fully developed leaves	POTATOES Petioles from most recently matured leaf sampled in midseason
Percent (%)							
Nitrogen	2.76-3.50	4.26-5.50	3.76-5.50	2.59-3.00	3.01-4.50	2.50-4.00	2.50-4.00
Phosphorus	0.25-0.50	0.26-0.50	0.26-0.70	0.21-0.50	0.26-0.50	0.25-0.80	0.18-0.22
Potassium	1.71-2.50	1.71-2.50	2.01-3.50	1.51-3.00	2.01-6.00	2.00-9.00	6.00-9.00
Calcium	0.21-1.00	0.36-2.00	1.76-3.00	0.21-1.00	0.36-1.20	0.35-2.00	0.36-0.50
Magnesium	0.16-0.60	0.26-1.00	0.31-1.00	0.16-1.00	0.36-1.00	0.25-1.00	0.17-0.22
Sulfur	0.16-0.50	0.21-0.40	0.31-0.50	0.20-0.40	0.21-0.50	0.16-0.50	0.21-0.50
Parts per million (ppm)							
Manganese	20-150	21-100	31-100	16-200	21-150	30-200	30-200
Iron	21-250	51-350	31-250	11-300	51-200	50-250	30-300
Boron	4-25	21-55	31-80	6-40	26-80	30-60	15-40
Copper	6-20	10-30	11-30	6-50	11-40	8-20	7-30
Zinc	20-70	21-50	21-70	21-70	19-60	30-100	30-100
Molybdenum	0.1-2.0	1.0-5.0	1.0-5.0	0.03-5.0	.15-5.0	0.5-5.0	0.5-4.0

This table from MSU Extension publication E-486 “Secondary and Micronutrients for Vegetables and Field Crops” shows nutrient concentrations needed for several Michigan crops.



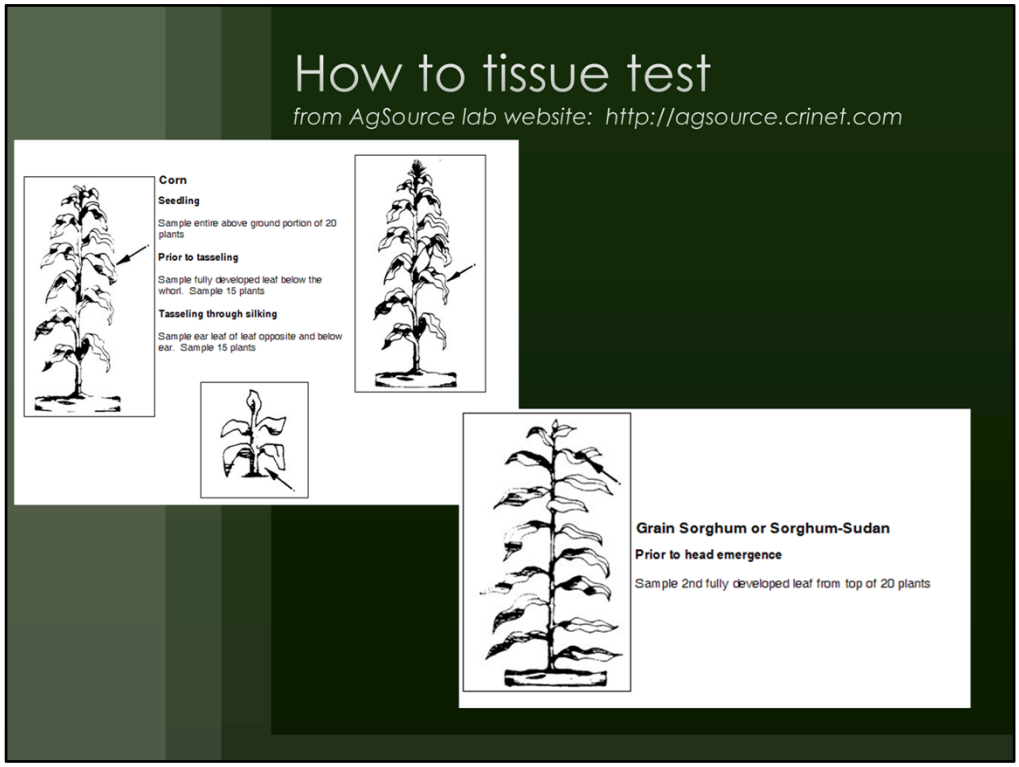
Proper sample collection and handling for tissue analysis is important.

Keep in mind that plant tissue samples are dried and subsequently ground, leaving only a fraction of the originally submitted sample available for analysis, so the results will only be as good as the sample submitted. Submit clean undamaged leaf tissue in a paper bag.
Submit at least a half a lunch bag full of tissue.
Label bag and make sure submittal form matches with sample.
To prevent contamination and assure a representative sample, proper sample instructions must be followed.

A good sample of instructions for sending in tissue samples from AgSource Lab:

Do not sample dust or soil contaminated tissues. If all the tissue available is dusty, wash gently in flowing clean water.
Do not sample diseased, insect or mechanically damaged plant tissue.
Place the plant tissue sample into a brown paper bag. Do not use plastic or polyethylene bags as containers. If the plant tissue is wet or succulent, leave out in the air one day and then mail to the laboratory.
When sampling suspected nutrient element deficient plants, take two samples if possible, one from the normal plants, the other from the abnormal. This comparison testing assured the most valid interpretation of the results.

When sampling, both the TIME and PLANT PART collected are important. Be sure to collect the proper plant part at the recommended time. If specific sampling instructions are not given for the crop you wish analyzed, a good rule of thumb is to sample mature leaves which are representative of the current season's growth during the mid-period of the growth cycle or just prior to seed set.
It is recommended that a concurrent soil sample be taken near the roots where the plant sample was taken and sent in for a complete analysis of nutrients.



See notes on slide 13

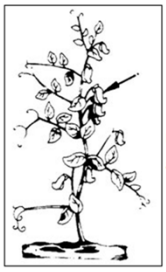
How to tissue test

from AgSource lab website: http://agsource.crinet.com

Potatoes

Prior to and during early flowering

Sample petiole and leaf blades of the 4th leaf from the growing tip of 40 plants



Soybeans, Field Beans and Peas

Prior to or during initial flowering

Sample first fully developed trifoliate and petiole from the top of 25 plants

See notes on slide 13

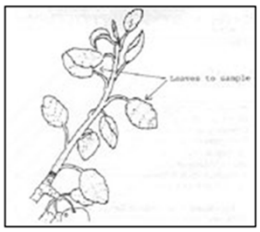
How to tissue test

from AgSource lab website: http://agsource.crinet.com

Beets, Radishes and Celery

Anytime during growing season

Sample petioles of recently fully expanded mature leaves from 20 plants

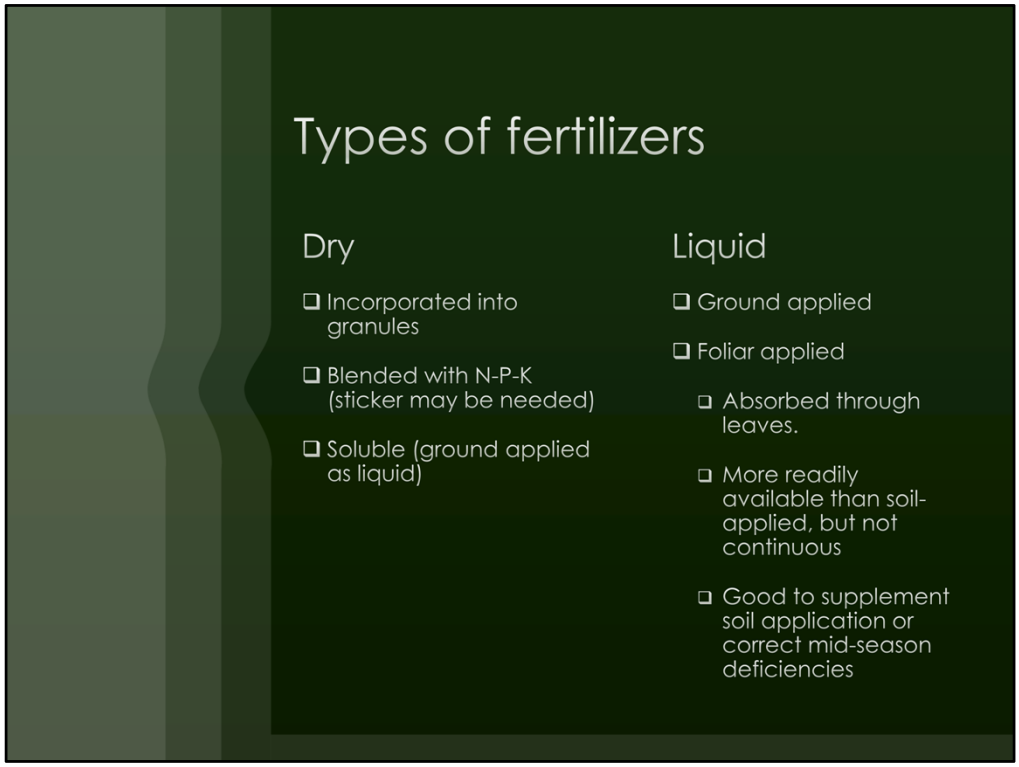


Fruit Trees

Mid-July through August

Include only one cultivar or strain in a sample and select most recently developed leaves from new growth

See notes on slide 13



Secondary and micronutrient fertilizers can be ground applied as either dry or liquid formulations. They can also be foliar applied. Only a small volume of micronutrient per acre is typically foliar applied, with the intent of correcting mid-season deficiency or supplementing soil application. Foliar-applied nutrients are readily available to the plants, but don't last long.

If a know nutrient deficiency exists, soil application is a better choice in most cases.

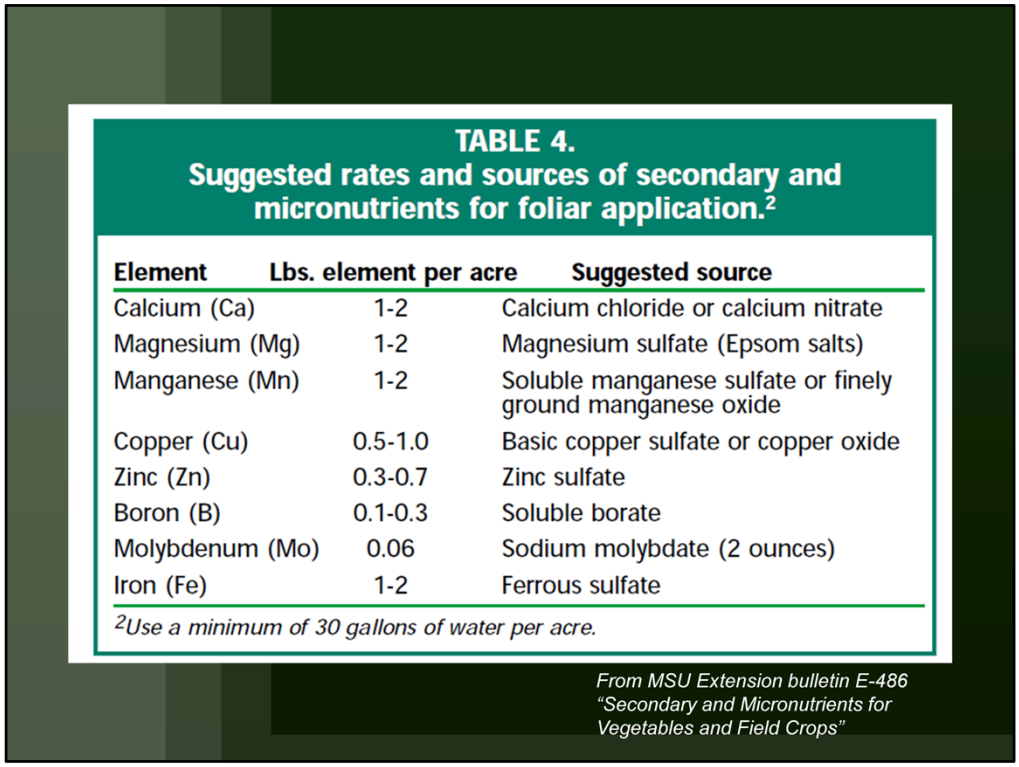


TABLE 4.
Suggested rates and sources of secondary and micronutrients for foliar application.[2]

Element	Lbs. element per acre	Suggested source
Calcium (Ca)	1-2	Calcium chloride or calcium nitrate
Magnesium (Mg)	1-2	Magnesium sulfate (Epsom salts)
Manganese (Mn)	1-2	Soluble manganese sulfate or finely ground manganese oxide
Copper (Cu)	0.5-1.0	Basic copper sulfate or copper oxide
Zinc (Zn)	0.3-0.7	Zinc sulfate
Boron (B)	0.1-0.3	Soluble borate
Molybdenum (Mo)	0.06	Sodium molybdate (2 ounces)
Iron (Fe)	1-2	Ferrous sulfate

[2]Use a minimum of 30 gallons of water per acre.

This table from MSU Extension publication E-486 "Secondary and Micronutrients for Vegetables and Field Crops" lists various secondary and micronutrients, suggested foliar application rates, and nutrient sources.

Micronutrient chelates are generally no more effective than water-soluble inorganic sources when foliar applied. Chelates, however, are more compatible when mixed with other spray materials. For a preventative spray program, spray the crop 4 weeks after emergence or transplanting. Because many micronutrients are not readily translocated within the plant, a second spray will be needed two weeks later to cover the new foliage.

When a known nutrient deficiency develops, spray the crop with the appropriate nutrient at the recommended rate every 10 days until the deficiency is corrected.

TABLE 5.
Pounds of secondary or micronutrient carrier needed to obtain the desired amount of the element per acre.[3]

Analysis of secondary or micronutrient carrier (%)	Pounds of element desired per acre							
	.1	.2	.3	.4	.5	1.0	1.5	2.0
1	10.0	20.0	30.0	40.0	50.0	100.0	150.0	200.0
2	5.0	10.0	15.0	20.0	25.0	50.0	75.0	100.0
4	2.5	5.0	7.5	10.0	12.5	25.0	37.5	50.0
6	1.7	3.4	5.0	6.0	8.3	16.7	25.0	34.0
8	1.2	2.5	3.8	5.0	6.2	12.5	18.7	25.0
10	1.0	2.0	3.0	4.0	5.0	10.0	15.0	20.0
12	.8	1.7	2.5	3.4	4.2	8.4	12.6	17.0
14	.7	1.4	2.1	2.9	3.6	7.2	10.8	14.0
16	.6	1.3	1.9	2.5	3.2	6.3	9.5	13.0
18	.5	1.1	1.7	2.3	2.8	5.6	8.4	11.0
20	.5	1.0	1.5	2.0	2.5	5.0	7.5	10.0
25	.4	.8	1.2	1.6	2.0	4.0	6.0	8.0
30	.3	.7	1.0	1.4	1.7	3.4	5.1	7.0
35	.2	.6	.9	1.2	1.5	2.9	4.4	6.0

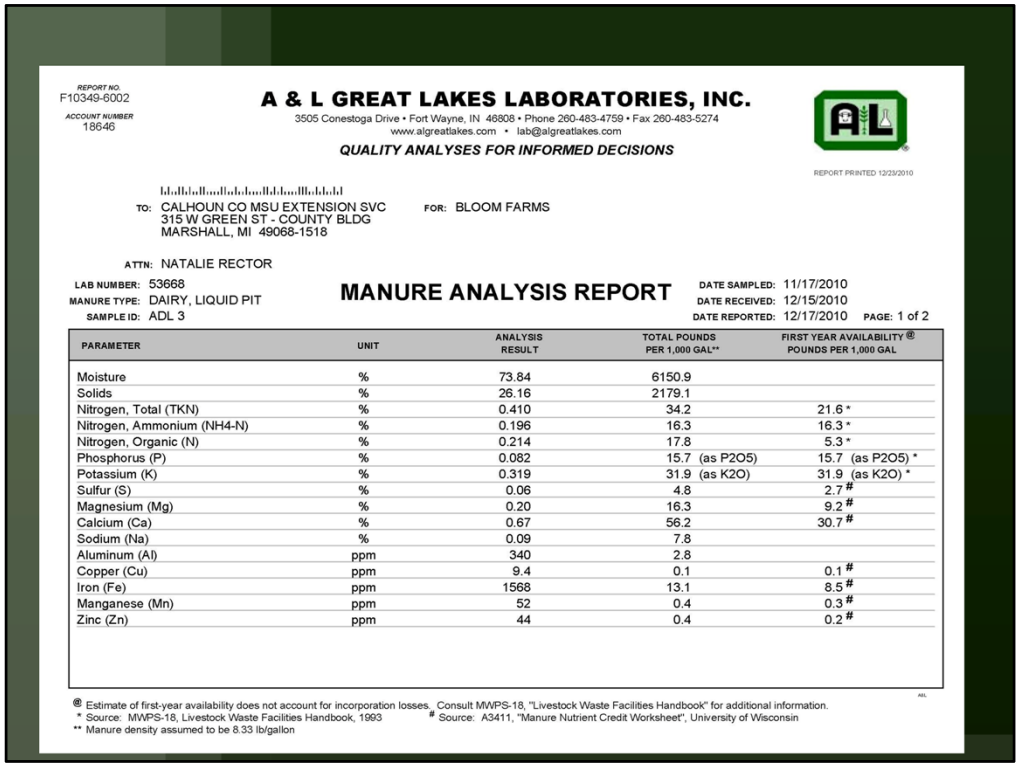
[3] To convert from dry to liquid: 1 pint equals about 1 pound.

From MSU Extension bulletin E-486 "Secondary and Micronutrients for Vegetables and Field Crops"

This table is also from MSU Extension publication E-486 "Secondary and Micronutrients for Vegetables and Field Crops".

Micronutrients may be mixed with most fungicides and insecticides. However, some combinations are incompatible and may injure crops. When in doubt, spray only a limited acreage until compatibility is established. Any injury will usually appear within 48 hours. This table provides a guide for obtaining the desired mixture of various secondary and micronutrient carriers.

Remember that some fungicides and insecticides contain copper, manganese or zinc. The amounts of micronutrients present in these materials may or may not be sufficient to correct a deficiency but should be considered when determining a spray program.



REPORT NO. F10349-6002
ACCOUNT NUMBER 18646

A & L GREAT LAKES LABORATORIES, INC.
3505 Conestoga Drive • Fort Wayne, IN 46808 • Phone 260-483-4759 • Fax 260-483-5274
www.algreatlakes.com • lab@algreatlakes.com
QUALITY ANALYSES FOR INFORMED DECISIONS

REPORT PRINTED 12/23/2010

TO: CALHOUN CO MSU EXTENSION SVC
315 W GREEN ST - COUNTY BLDG
MARSHALL, MI 49068-1518

FOR: BLOOM FARMS

ATTN: NATALIE RECTOR

LAB NUMBER: 53668
MANURE TYPE: DAIRY, LIQUID PIT
SAMPLE ID: ADL 3

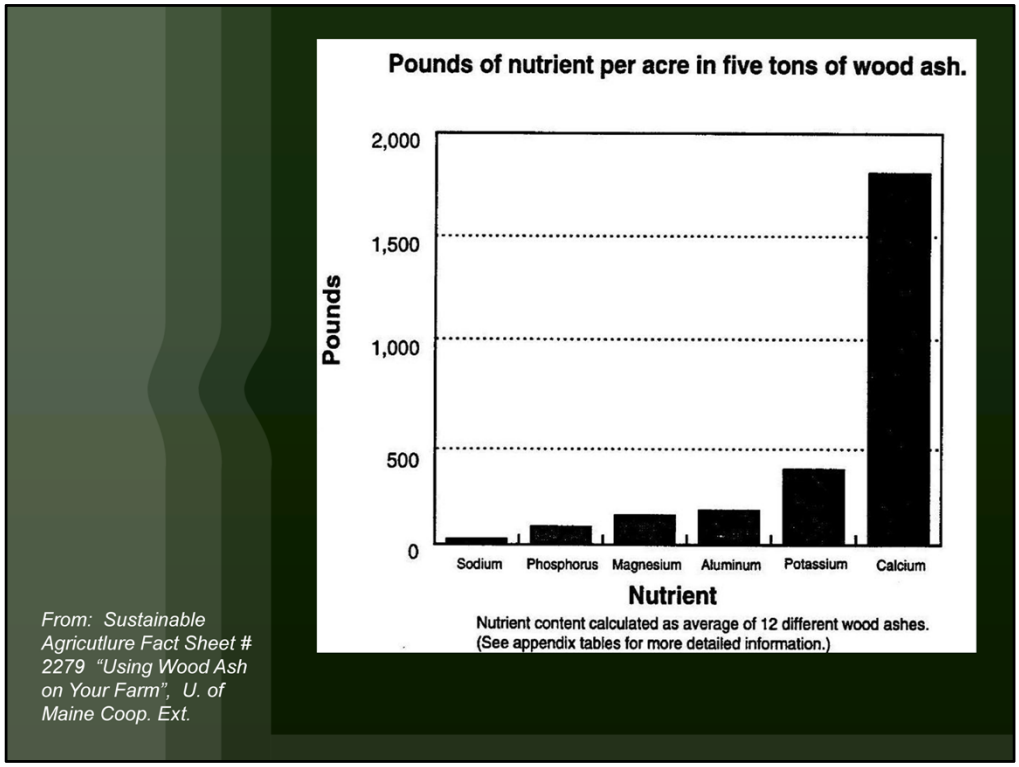
MANURE ANALYSIS REPORT

DATE SAMPLED: 11/17/2010
DATE RECEIVED: 12/15/2010
DATE REPORTED: 12/17/2010 PAGE: 1 of 2

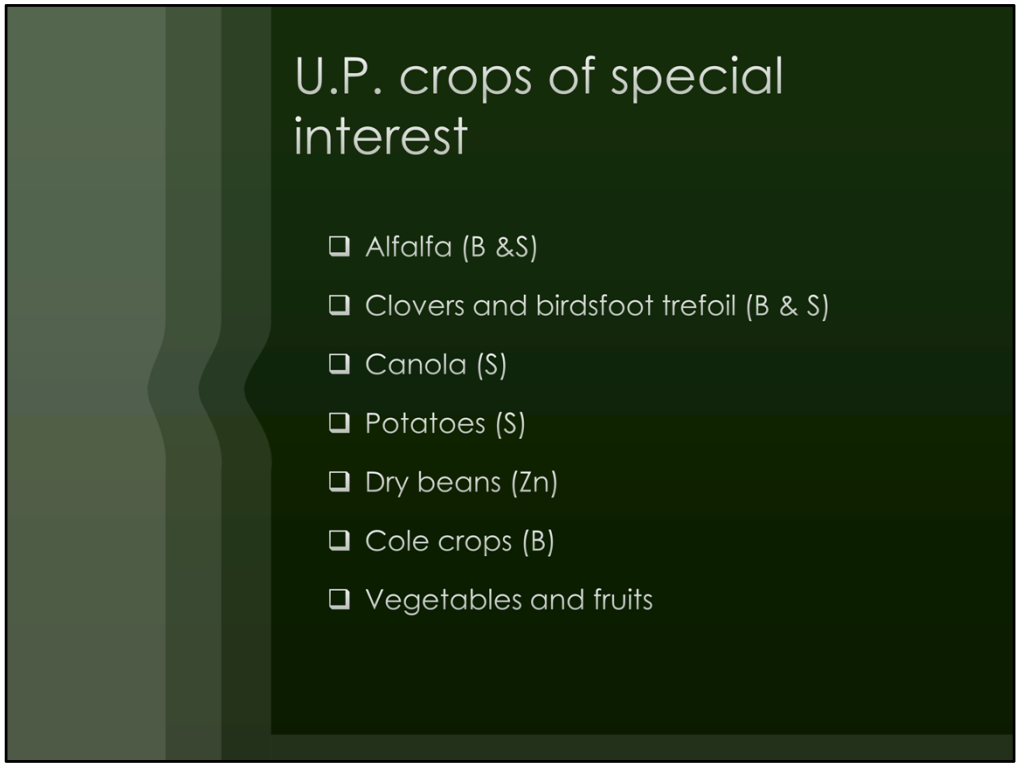
PARAMETER	UNIT	ANALYSIS RESULT	TOTAL POUNDS PER 1,000 GAL**	FIRST YEAR AVAILABILITY @ POUNDS PER 1,000 GAL
Moisture	%	73.84	6150.9	
Solids	%	26.16	2179.1	
Nitrogen, Total (TKN)	%	0.410	34.2	21.6 *
Nitrogen, Ammonium (NH4-N)	%	0.196	16.3	16.3 *
Nitrogen, Organic (N)	%	0.214	17.8	5.3 *
Phosphorus (P)	%	0.082	15.7 (as P2O5)	15.7 (as P2O5) *
Potassium (K)	%	0.319	31.9 (as K2O)	31.9 (as K2O) *
Sulfur (S)	%	0.06	4.8	2.7 #
Magnesium (Mg)	%	0.20	16.3	9.2 #
Calcium (Ca)	%	0.67	56.2	30.7 #
Sodium (Na)	%	0.09	7.8	
Aluminum (Al)	ppm	340	2.8	
Copper (Cu)	ppm	9.4	0.1	0.1 #
Iron (Fe)	ppm	1568	13.1	8.5 #
Manganese (Mn)	ppm	52	0.4	0.3 #
Zinc (Zn)	ppm	44	0.4	0.2 #

@ Estimate of first-year availability does not account for incorporation losses. Consult MWPS-18, "Livestock Waste Facilities Handbook" for additional information.
* Source: MWPS-18, Livestock Waste Facilities Handbook, 1993
# Source: A3411, "Manure Nutrient Credit Worksheet", University of Wisconsin
** Manure density assumed to be 8.33 lb/gallon

Animal manure will provide significant amounts of secondary and micronutrients, depending upon the rate and method of application. This is a typical analysis for liquid pit dairy manure listing nutrient concentrations.



Wood ash contains relatively large amounts of calcium and potassium. It is an excellent liming agent. Soils generally require about twice as much of a good quality wood ash compared to the ag lime recommendation. Wood ash also contains significant phosphorus and can contain small amounts of boron, copper, molybdenum, selenium, sulfur and zinc, along with other heavy metals.



Several U.P. crops deserve attentiveness to secondary and micronutrient needs, especially on sandier soils that are never, or infrequently, manured.

These crops are followed by the most likely secondary or micronutrient problem to be encountered (in parentesis).

These resources will help you further develop your knowledge of secondary and micronutrients in Michigan crops.