Soil Fertility for Wine Grapes

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University of Minnesota

Michigan Wine Grape Vineyard Establishment Conference
January 22, 2014

UNIVERSITY OF MINNESOTA
EXTENSION

General topics

- Soil testing and basic nutrient management for vineyards **before** planting
  - Taking a representative soil sample
  - Soil pH
  - Organic matter management
  - Macronutrients
  - Micronutrients

- Suggested amendments before planting

Essential Plant Nutrients

14 nutrients derived from the soil and/or fertilizer

<u>Macronutrients</u>

Primary

- N - Nitrogen
- P – Phosphorus
- K – Potassium

Secondary

- S – Sulfur
- Mg – Magnesium
- Ca – Calcium

<u>Micronutrients</u>

- Zn – Zinc
- B – Boron
- Fe – Iron
- Mn – Manganese
- Cu – Copper
- Mo – Molybdenum
- Ni – Nickel
- Cl – Chlorine

Determining Nutrient Needs

- Vine vigor
- Visual symptoms
  - Yield and quality already affected
- Soil testing
- Petiole analysis

Grapes are a Perennial Crop

- Making proper decisions based on soil testing prior to planting is essential

- Once planted, only surface applications are possible
- For some amendments surface applications are inefficient or ineffective

Availability of Essential Mineral Nutrients

- Composition of the soil parent material
- Soil pH
- Soil Texture
  - Soil weathering / leaching
  - Internal drainage characteristics of the soil
- Soil organic matter content
- Competition between nutrients for uptake by the plant
- Previous fertilizer history

Soil Testing

- Soil test before planting
- Test every 4 to 5 years after planting...
  - or when a problem is suspected
- Supplements petiole testing in established vineyards

Soil Testing

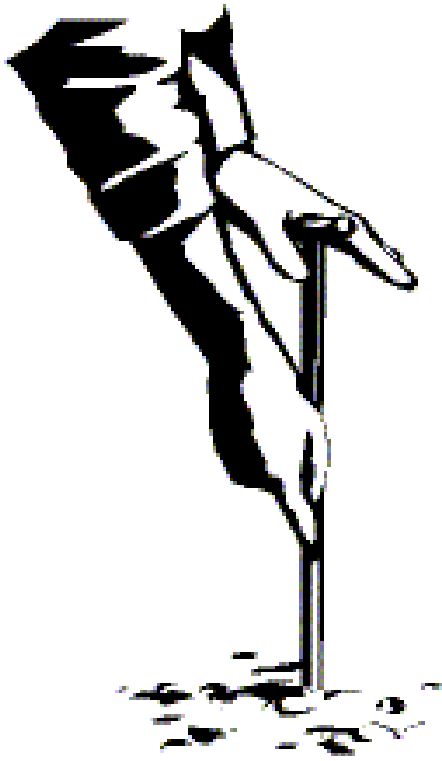
- pH, P, and K
  - Soil tests very well calibrated for adjusting these properties
- Ca, Mg, S, Zn, B
  - Soil tests also useful for detecting deficiencies (or excesses) of these nutrients
- Organic Matter
  - Used to adjust N rates

Soil Sampling

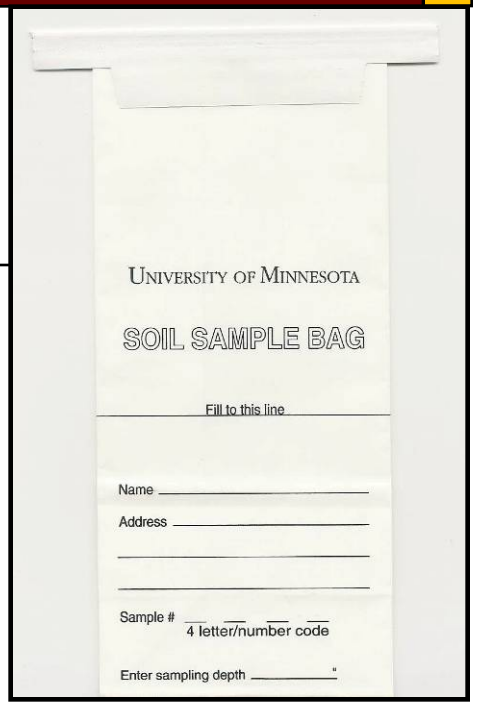
- Collect representative samples
  - Soil tests are only as accurate as the samples you submit
  - Sampling is often the weakest link in a soil testing program

Sampling Guidelines

- Divide fields into uniform areas
  - Soil type, slope, crop history, previous lime, fertilizer, manure applications
  - < 20 acres for a single sample
  - < 2-3 acres on uneven land
- Collect 15-20 soil cores per sample
  - Random, zig-zag pattern across the field



Soil Sampling



- Sample to a depth of 0 to 8”
- A second sample, 8 to 16” can also be submitted
- Thoroughly mix sub-samples in a clean, plastic container
  - Submit about a pint of composite sample to testing lab
- If soil is wet
  - Air dry
  - Oven dry at <97° F

UNIVERSITY OF MINNESOTA
Soil Testing Laboratory

FARM/FIELD CROPS and COMMERCIAL HORTICULTURAL CROPS

Report No.

Instructions for filling out this form are given on the back side

SOIL SAMPLE INFORMATION SHEET

LOCATION REFERENCE

Name Pine Hill Vineyard

Address 123 Needle Lane

City, State, Zip Big Lake, MN 55309

Phone ______

Soil location: County Sherburne

Township ______

Check for $ 48 enclosed

Customer Number ______
(pre-arranged accounts only)

MAIL REPORT TO:

Name ______

Address ______

City, State, Zip ______

Phone ______

Sample Identification: Laboratory Number (Lab Use Only)	Field or Sample No. or Letter	Check if Irrigated	1 Crop History: Crop Grown Before Last – Crop Code No.	If Alfalfa check plants per sq ft	Last Crop Grown – Crop Code No.	If Alfalfa check plants per sq ft	2 Proposed Crops: Option 1 Crop Code No.	Expected Yield	Option 2 Crop Code No.	Expected Yield	Option 3 Crop Code No.	Expected Yield	3 Check Tests Requested (plow layer sample): * Regular Series P, K, pH, %OM $9	Sulfur ** $4	Zinc $4	Zinc, Copper, Iron, Manganese $10	Boron $6	Calcium and Magnesium $6	Nutrient Management P $5	Soluble Salts $5	Nitrate (Before selecting this test please read section on nitrate on the BACK SIDE. Sampling to 24" is required for this test.)
	1			☐ 4+ ☐ 2-3 ☐ 0-1	57	☐ 4+ ☐ 2-3 ☐ 0-1	57						X		X			X			Nitrate ☐ 0-6"/6-24" sample $5.00 ☐ 0-24" sample $5.00
	2			☐ 4+ ☐ 2-3 ☐ 0-1	25	☐ 4+ ☐ 2-3 ☐ 0-1	57						X	X	X		X	X			Nitrate ☐ 0-6"/6-24" sample $5.00 ☐ 0-24" sample $5.00
				☐ 4+ ☐ 2-3 ☐ 0-1		☐ 4+ ☐ 2-3 ☐ 0-1															Nitrate ☐ 0-6"/6-24" sample $5.00 ☐ 0-24" sample $5.00
				☐ 4+ ☐ 2-3 ☐ 0-1		☐ 4+ ☐ 2-3 ☐ 0-1															Nitrate ☐ 0-6"/6-24" sample $5.00 ☐ 0-24" sample $5.00
				☐ 4+ ☐ 2-3 ☐ 0-1		☐ 4+ ☐ 2-3 ☐ 0-1															Nitrate ☐ 0-6"/6-24" sample $5.00 ☐ 0-24" sample $5.00
				☐ 4+ ☐ 2-3 ☐ 0-1		☐ 4+ ☐ 2-3 ☐ 0-1															Nitrate ☐ 0-6"/6-24" sample $5.00 ☐ 0-24" sample $5.00

Recommendations available for these crops

** See comment on back side

* THE REGULAR SERIES NOW INCLUDES PERCENT ORGANIC MATTER

Crop Code	Name	Yield Unit
	LEGUMES	
01.	Alfalfa, New Seed	tons/acre
02.	Alfalfa, Established	tons/acre
03.	Birdsfoot Trefoil	tons/acre
04.	Legume/Grass Hay	tons/acre
05.	Legume/Grass Pasture	-
06.	Red Clover	tons/acre
	CORN	
07.	Corn, Grain	bu./acre
08.	Corn, Silage	tons/acre
09.	Sweet Corn	tons/acre
	SMALL GRAINS	
10.	Barley	bu./acre
11.	Oats	bu./acre
12.	Rye/Triticale	bu./acre
13.	Wheat	bu./acre
	MISCELLANEOUS	
14.	Buckwheat	lb./acre
15.	Edible Beans	lb./acre
16.	Fallow	-
17.	Flax	bu./acre
18.	Grass Hay	tons/acre
19.	Grass Seed Prod.	lb./acre
20.	Grass Pasture	-
21.	Millet	lb./acre
22.	Native Grasses	tons/acre
23.	Potatoes	cwt/acre
	MISCELLANEOUS (continued)	
24.	Rape/Mustard/Canola	cwt/acre
25.	Sorghum Sudan	-
26.	Soybeans	bu./acre
27.	Sugarbeets	tons/acre
28.	Sunflowers	lb./acre
29.	Wild Rice	-
	VEGETABLES	
30.	Asparagus, New Planting	
31.	Asparagus, Establ. Planting	
32.	Beans, Snap	
33.	Beets, Table	
34.	Broccoli	
35.	Brussels Sprouts	
36.	Cabbage	
37.	Cauliflower	
38.	Carrots	
	VEGETABLES (continued)	
39.	Celery	
40.	Cucumbers	
41.	Lettuce	
42.	Melons	
43.	Onions, Dry	
44.	Onions, Green	
45.	Parsnips	
46.	Peas	
47.	Peppers	
48.	Pumpkins/Squash	
49.	Radishes	
50.	Turnips	
51.	Rhubarb	
52.	Rutabagas	
53.	Spinach	
54.	Tomatoes	
	FRUITS	
55.	Apples	
56.	Blueberries	
57.	Grapes	
58.	Raspberries/Brambles	
59.	Strawberries	
	TURF	
60.	Cultured Sod	
	NURSERY – FIELD STOCK TREES/SHRUBS	
61.	Suggested tests: Regular, Soluble Salts, Nitrate. For sampling instructions, please see Nursery Form MI-3658-GO.	
62.	Other ______	

REV 3/03

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Soil Testing Laboratory

SOIL TEST REPORT

Farm and Field

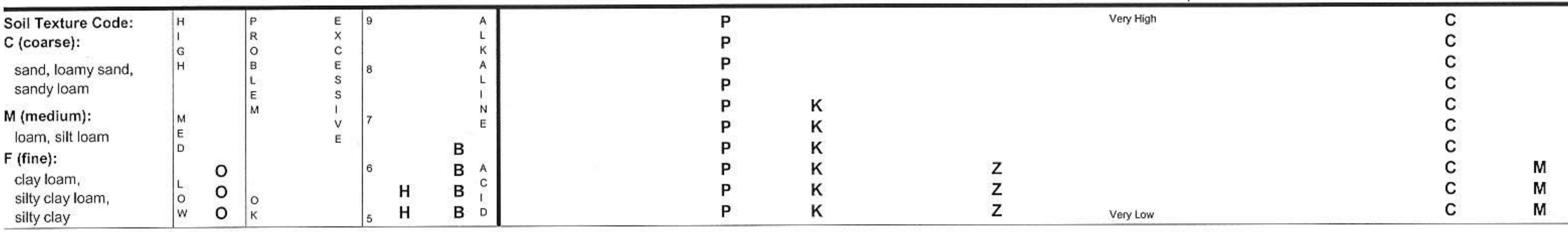
Client Copy

Department of Soil, Water, and Climate
Minnesota Extension Service
Agricultural Experiment Station

FARMER DOE
ROUTE 1
ANYWHERE MN 55000

Page	1
Report No.	9
Laboratory No.	146999
Date Received	03/08/2005
Date Reported	03/20/2005

INTERPRETATION OF SOIL TEST RESULTS



SOIL TEST RESULTS

Sample/ Field Number	Estimated Soil Texture	Organic Matter %	Soluble Salts mmhos/cm	pH	Buffer Index	Nitrate NO3-N ppm	Olsen Phosphorus ppm P	Bray 1 Phosphorus ppm P	Potassium ppm K	Sulfur SO4 -S ppm	Zinc ppm	Iron ppm	Manganese ppm	Copper ppm	Boron ppm	Calcium ppm	Magnesium ppm
	Medium	**3.0**		**5.5**	**6.5**			**30**	**85**		**0.5**					**1500**	**70**

RECOMMENDATIONS **Crop Before Last: Grapes; Last Crop: Grapes**

Crop and Yield Goal	Method	Lime #ENP/A	N lb/A	P2O5 lb/A	K2O lb/A	S lb/A	Zn lb/A	Fe lb/A	Mn lb/A	Cu lb/A	B lb/A	Ca lb/A	Mg lb/A
Grapes	Broadcast	**2500**	**30**	**50**	**100**		**10**					**0**	**50**
	Row/Drill						**2**						**10**

Comments: 3,18,24,50,53,64

Pre-Plant Soil Testing Sufficiency Ranges

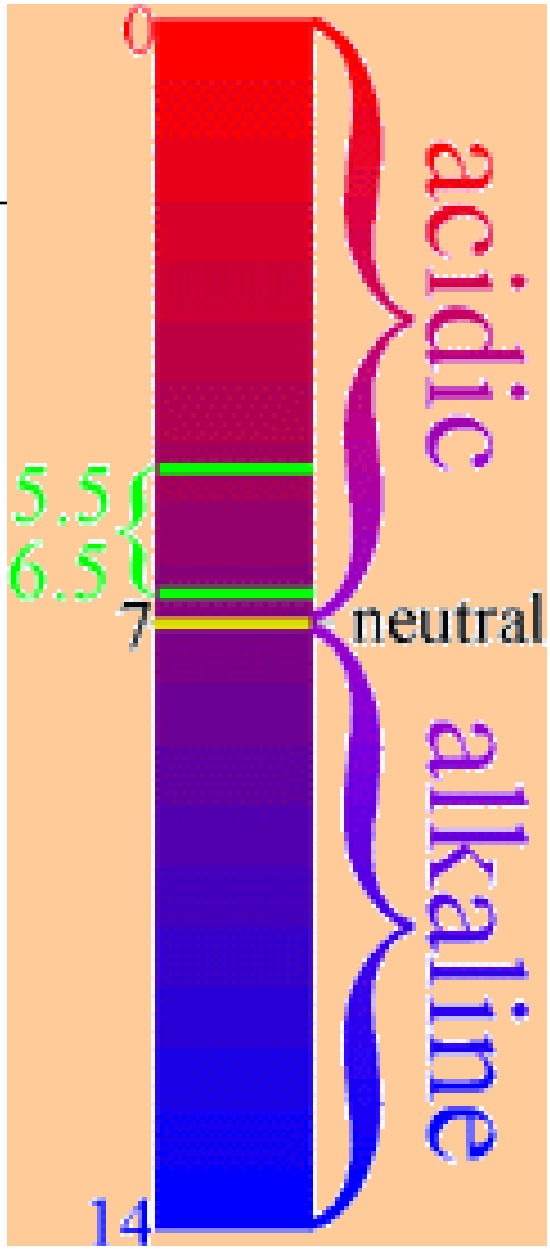
Test	OSU*	ISU	U of MN	NRAES-145**
Soil pH	**5.5 - 6.5**	**6.0 - 6.5**	**6.0 to 7.0**	**
Phosphorus (P)	**20 - 50 ppm**	**> 30 ppm**	**> 25 ppm**	**20 - 50 ppm**
Potassium (K)	**125 - 150 ppm**	**> 150 ppm**	**> 160 ppm**	**75 - 100 ppm**
Magnesium (Mg)	**100 - 125 ppm**	**100 - 125 ppm**	**~ 100 ppm**	**100 - 250 ppm**
Zinc (Zn)	**4 - 5 ppm**	**3 - 4 ppm**	**> 1 ppm**	**2 ppm**
Organic matter	**2 - 3 %**	**2 - 3** (4) **%**	**- -**	**3 - 5 %**
Calcium (Ca)	- -	- -	> 600 ppm	500 - 2000 ppm
Boron (B)	.75 - 1.0 ppm	- -	> 1 ppm	0.2 - 2.0 ppm
Manganese (Mn)	- -	- -	> 6 ppm	20 ppm
Copper (Cu)	- -	- -	>0.2 ppm	0.5 ppm
Iron (Fe)	- -	- -	--	20 ppm
Sulfur (S)	- -	> 7 ppm	> 7 ppm	- -

* **Midwest Small Fruit Pest Management Handbook** (OSU Ext. Bull. 861)
& **Midwest Grape Production Guide** (OSU Ext Bull. 919)

** **Wine Grape Production Guide for Eastern North America.**

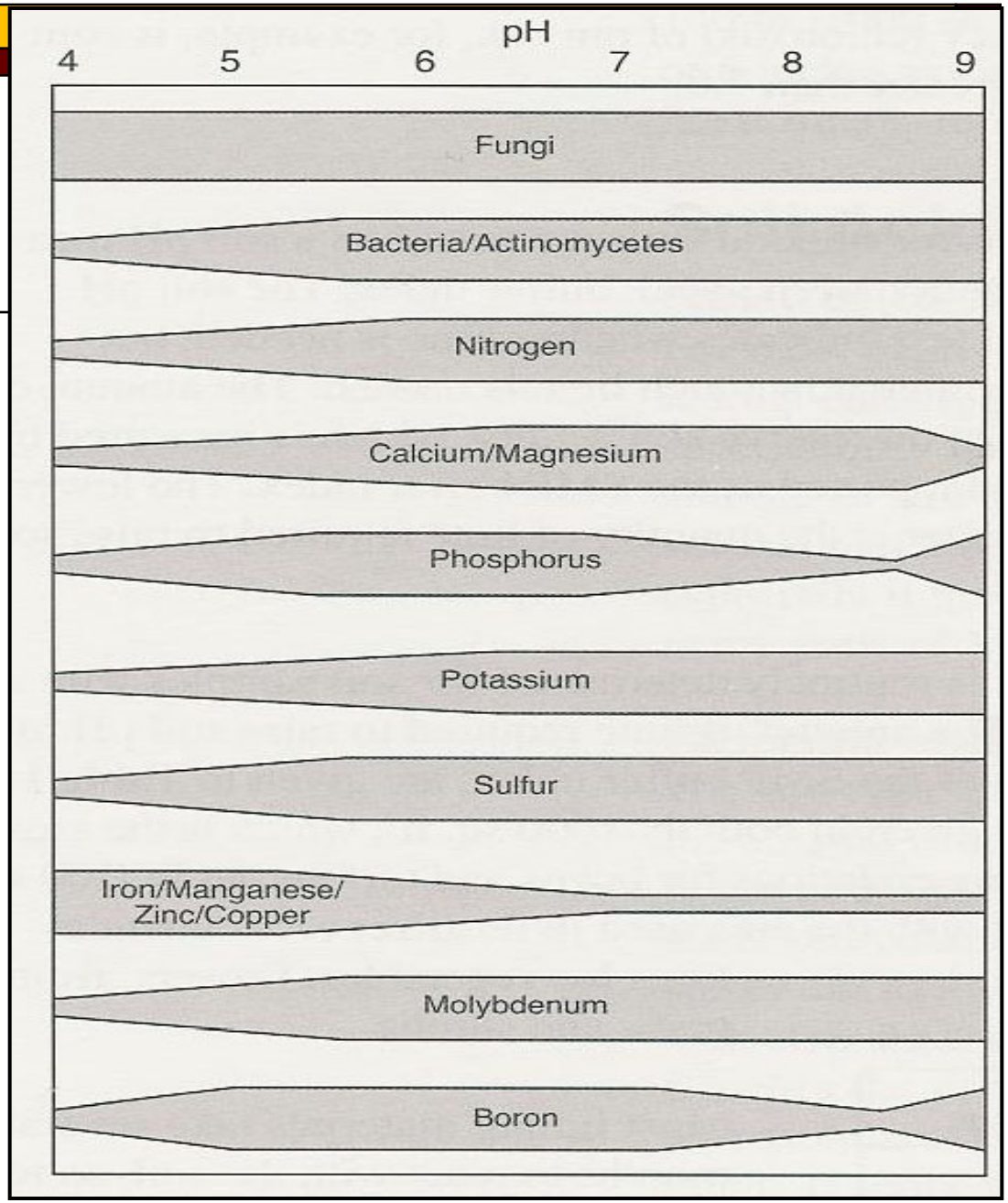
Soil pH

- Ideal pH range for grapes: 6.0 to 7.0
- Low pH easily modified before planting; high pH is often a problem – particularly with high carbonates
- Difficult to change after planting



Soil pH

- Microbial activity
- Nutrient availability



Mineral soils

Modifying Soil pH

- Raising pH
  - Lime recommended if pH <6.0
    - Rate based on buffer pH
    - Buffer pH depends on amount of clay and organic matter
  - Lime also adds Ca and Mg
    - Dolomitic lime contains Mg & Ca; Calcitic lime – mostly Ca
  - Incorporate lime 8 to 10 inches
    - Apply one year before planting

Modifying Soil pH

- Lowering pH is more of challenge
  - Acidification of high pH soils is difficult and expensive
  - Elemental sulfur used to lower pH
- Most high pH problems are on soils derived from limestone
- High pH soil can cause severe iron deficiency

Iron Chlorosis

Photographed by Elf Bergmeier

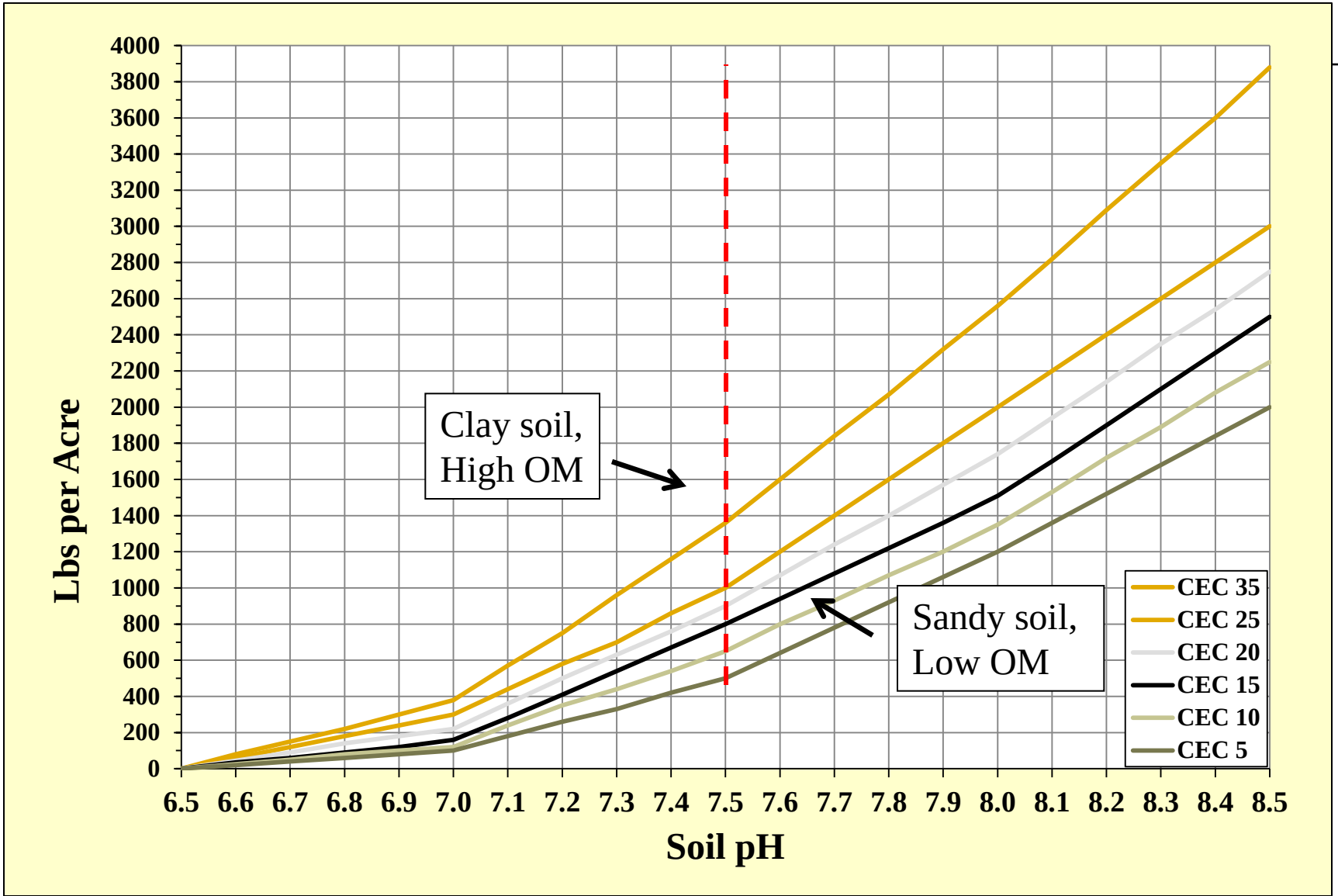
Guidelines for Lowering Soil pH

- Soil pH between 6.5 to 7.0
  - No amendments needed
- Soil pH 7.0 to 7.5
  - Apply elemental sulfur to lower the pH to 6.5 or 6.0
- Soil pH above 7.5
  - Apply sulfur to lower the pH to 6.5 or 6.0 if free of carbonates
  - If carbonates present - Not recommended due to cost
    - Use soil applied iron chelates if chlorosis is a problem

NORTHERN GRAPES PROJECT

Sulfur Required to Lower the Soil pH to 6.5

For a Carbonate-free Soil

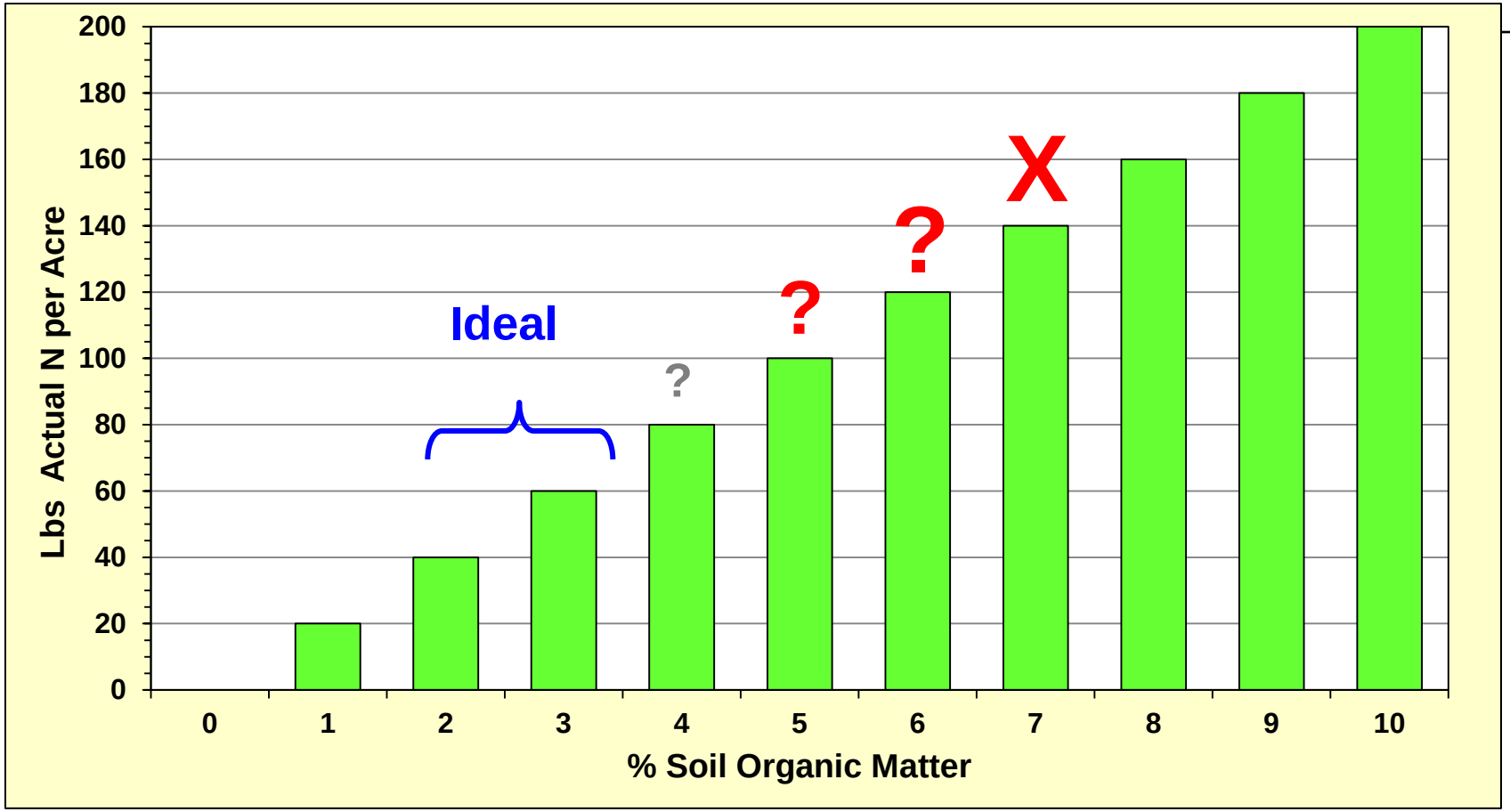


Nitrogen Fertilizer Recommendations

- Of all the essential elements nitrogen is often the most limiting
- Soil tests for nitrogen are not that reliable – most recommendations adjusted to soil organic matter level
- Nitrogen is mobile in the soil, so preplant N applications are generally not needed for grapes
- Grapes are very efficient N users – too much N will result in excessive vine growth

Soil Organic Matter Content:

Nitrogen Released from Organic Matter



Need to adjust N fertilization practices based on the organic matter content of the soil.

Nitrogen Fertilizer Recommendations

(Non-Bearing Vines – 1st or 2nd year)

- Apply inorganic N sources after planting
  - Split applications on sandy soils to reduce leaching
- Account for N from manure, compost, legume cover crops
- General N recommendations:
  - 30 lb N/ac – high OM soils (>4.6%)
  - 45 lb N/ac – medium OM soils (3.1-4.5%)
  - 60 lb N/ac – low OM soils (<3.1%)

Nitrogen Nutrition Effects on Grapes

- Deficient nitrogen
  - Poor vine growth; pale yellow leaves
  - Low sugar content
  - Low yeast assimilable nitrogen in grapes

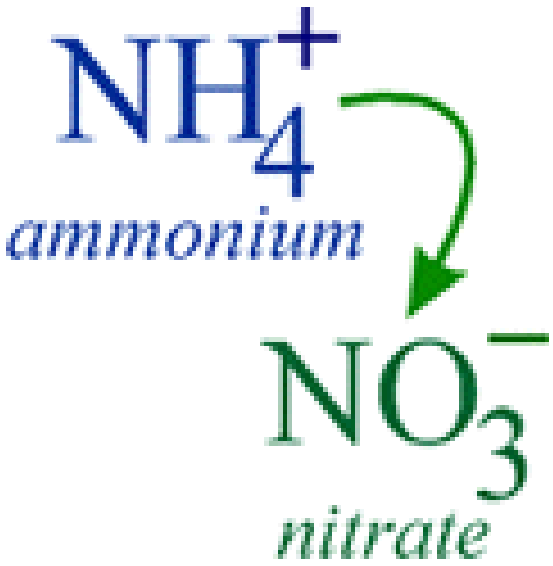
- Excess nitrogen
  - Excessive vine growth
  - Poor fruit color

Nitrogen Fertilizer Sources

- Organic
  - Manures, compost, legume cover crops
    - Apply manure/compost based on N content
- Conventional
  - Nitrate forms - Calcium nitrate :
    - Increases soil pH
    - Readily available to plants
    - Very subject to leaching
  - Urea - $CO(NH_2)_2$:
    - Taken up as urea, or converted to NH_4-N then to NO_3-N
    - Will volatilize with surface applications – esp. high pH soils

Nitrogen Fertilizer Sources (cont.)

- Ammonium forms – ammonium sulfate
  - Decreases soil pH
  - Converts to nitrate
  - Not prone to volatilization



Fertilizer Additions (Before Planting)

- Base P and K needs on a soil test
  - Also Mg, Zn, and B
- Very difficult to correct P and K deficiencies after vines are planted
- Broadcast and incorporate to a depth of 8 to 10 inches

Phosphorus Management

- Very immobile in the soil
  - Pre-plant soil analysis & amend before planting
- Generally not a problem for established grapes
  - Vines often do well on low P soils, but deficiencies can occur particularly on acid soils (pH < ~5.3)
    - Soil mycorrhizal organisms aid in making P available
- On low P testing soils
  - Apply manure or compost in the fall as an N source
  - Apply triple superphosphate (0-46-0) or mono ammonium phosphate (11-52-0)

Preplant Phosphorus Recommendations

Relative Soil Test P	Amount of Phosphate to Apply, lb P_2O_5/A
Very Low	150
Low	125
Medium	100
High	75
Very High	25

Potassium Management

- Generally immobile in the soil
  - Pre-plant soil analysis & amend before planting
- Grapes susceptible to K deficiency - esp. when fruiting
  - Low K results in low fruit sugars
  - high K can increase fruit pH
- Soil K applications:
  - Potassium chloride (0-0-62)
  - Potassium sulfate (0-0-50)
  - Potassium magnesium sulfate, (0-0-22 + 22% S, 11% Mg)

Preplant Potassium Recommendations

Relative Soil Test K	Amount of Potash to Apply, lb K_2O/A
Very Low	250
Low	200
Medium	150
High	100
Very High	0

Potassium Stratification

Soil Depth (inches)	K Level (ppm)
0-3	250
3-8	95

Magnesium Management

- Can be a problem on sandy soils, particularly when potassium has been over applied
- If the soil pH is low (acid), apply dolomitic lime to raise the pH to 6.0 or 6.5.
- Use Epsom salts (magnesium sulfate) or potassium- magnesium (sul-po-mag) if the soil pH is in the optimal range

Preplant Magnesium Recommendations

Relative Soil Test Mg	Amount of Magnesium to Apply, lb Mg/A
Low	100
Medium	50
High	0

Micronutrients

- Most micronutrients are present in sufficient amounts in soils to meet plant needs
- Deficiencies may occur on high pH or very sandy soils.
- Iron, zinc, manganese, and boron deficiencies may occur in grapevines
- Managing soil pH will help to reduce micronutrient problems

Micronutrients

- Use of compost or manure as a nutrient source will also provide micronutrients
- Once vines are established foliar fertilizer sources can be used
- Identify micronutrient needs with petiole analysis after the second or third year of growth

Summary

- Preparing soil before planting is especially important for a perennial crop like grapes

- Use soil tests to determine preplant amendments
  - pH, organic matter (OM), P, K, Mg, S, Zn, B
  - Adjust nitrogen needs based on OM

- Once vines are established and growing, supplement soil tests with petiole analysis