Improving Garden Soil Fertility

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How do we define “Soil Fertility”

“Soil properties that promote healthy plant growth”

Adequate pH (crop dependent)

Adequate levels of Organic Matter (OM)

High nutrient content (calcium, potassium, phosphorus, nitrogen, etc)

Good water absorption and retention (texture)

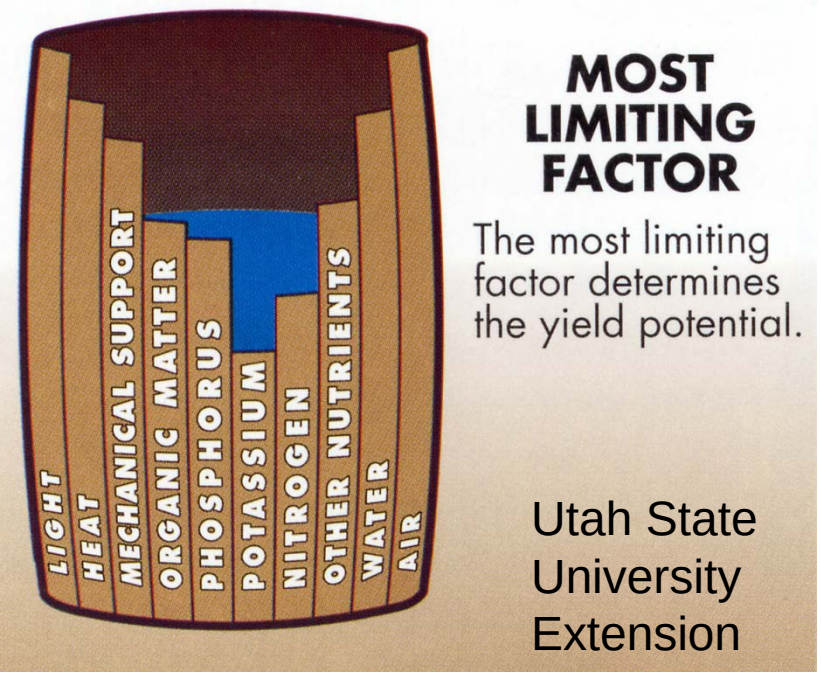
Adequate structure that enhances air and water movement and root growth

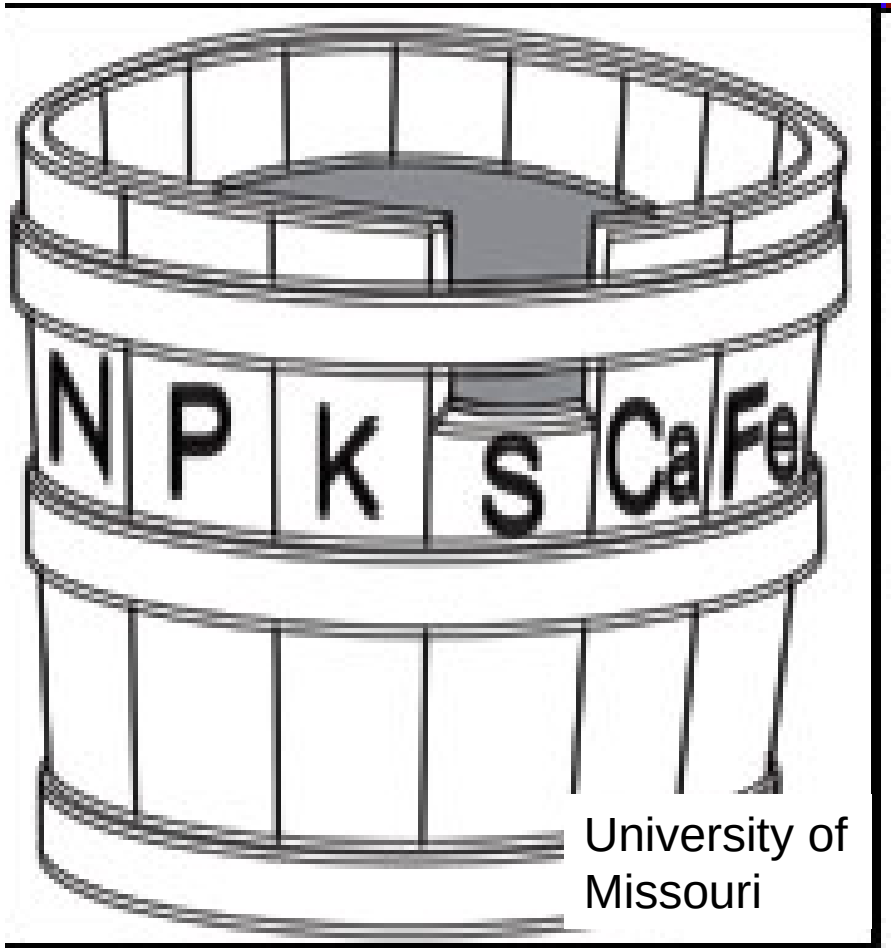
Free of pollutants that can harm the plants or other organisms feeding on them

Types of nutrients and concentrations

- Essential
  - Macro (potassium, phosphorus, nitrogen, calcium)
  - Oligo (magnesium, sulfur)
  - Micro (zinc, copper, manganese, iron, boron, etc)
- Non essential
  - Silicon, sodium
- The concept of a limiting nutrient is important
  - The first nutrient to induced limited growth or production (mostly nitrogen, phosphorus and potassium)
  - Like a barrel missing one piece

http://extension.usu.edu/smac/images/uploads/most_limiting_factor_nutrients.jpg





http://extension.missouri.edu/explore/images/mg0004art05.jpg

Soil Fertility Parameters – what we measure

- Routine Soil Analysis at SPAL
  - pH (called the master variable)
  - Nutrients (phosphorus and potassium)
  - Organic matter

- Other Analyses
  - Oligonutrients (Calcium, magnesium, sulfur)
  - Micronutrients (iron, zinc, boron)
  - Heavy metals (Lead, arsenic, cadmium, etc)
  - Texture

Determining if you need to sample

- Some questions related to this are:

- Is this a new area?
  - What do you want to grow?
  - How do you want to grow it?
  - Are you concerned about pollution?

- Is this an old area?
  - Are the plants growing poorly?
  - Are you changing the use?
  - Do you think you can do better?
  - When was the last sample taken?

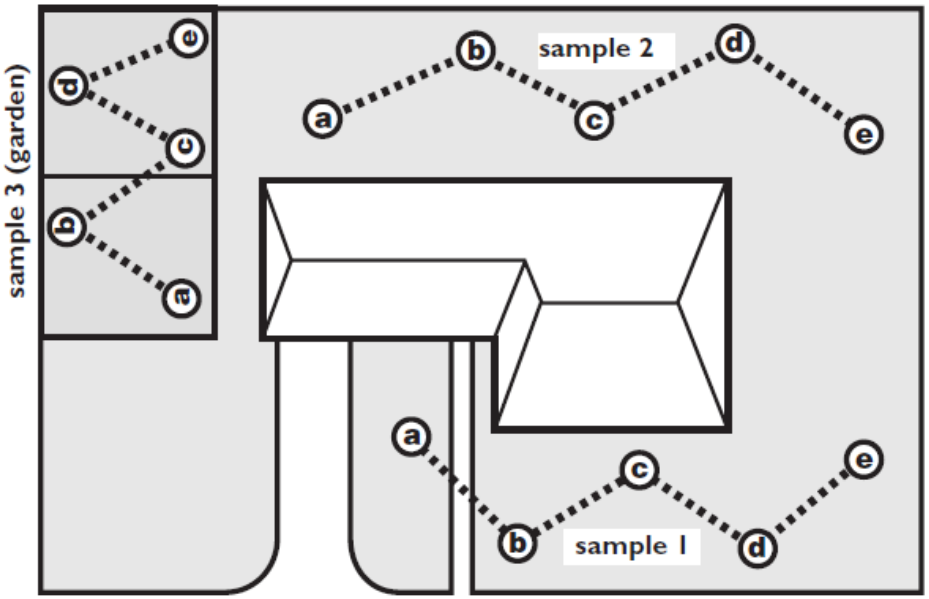
Sampling

Different areas should be sampled separately

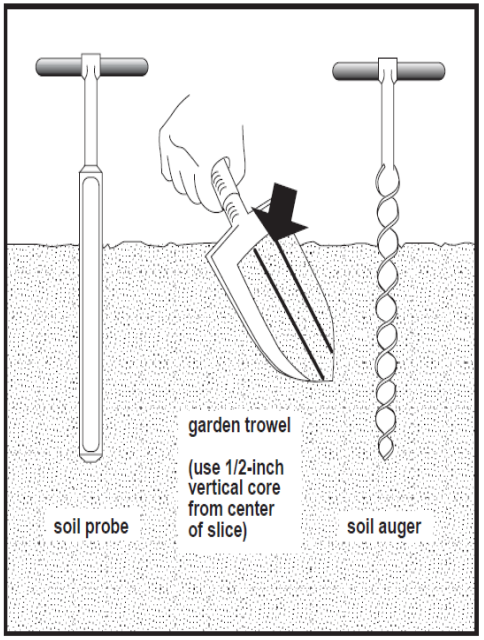
For very different uses in same area you can ask for two reports too

Sampling tools can vary

Make sure the sample is representative of the area and use



Make a composite sample by collecting small cores from at least five locations.



Appropriate sampling tools. A shovel or spade would also work, using the center core as witih the trowel.

Preparing the sample

Take 4 to 6 clumps of soil from 0 to 8 inches from various points

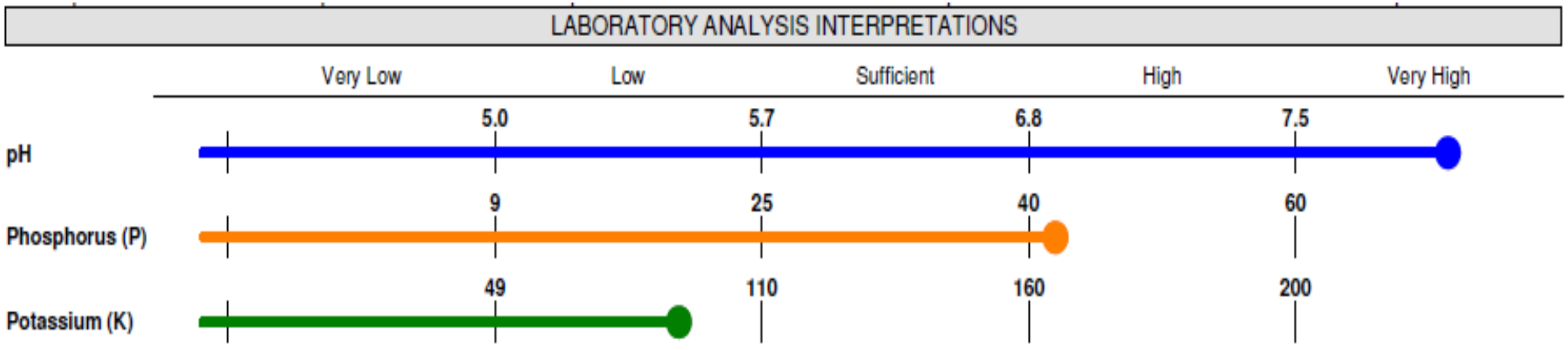
Mix thoroughly in a bucket or on a tarp

Put about ½ lb of soil in bag

Label properly

Fill out submission form making sure sample ID from bag is in the form
Name, address, contact info, and proper crop selection

Interpretation of garden soil analysis



LABORATORY ANALYSIS

Sample	pH	Phosphorus [P] (ppm)	Potassium [K] (ppm)	Organic Matter %
1	7.9	42	91	5.9

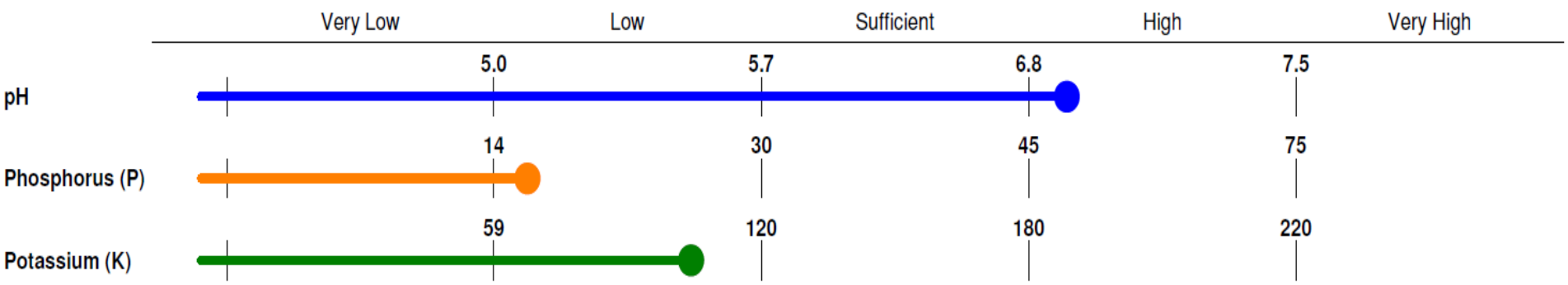
UW-SPAL LaG 1.1.2 CLIENT COPY page 1

It is common to see low pH in new areas while old gardens tend to be high

Most new gardens are low in P and K but old ones can be high or low

The ranges are different for different crops (this one is for garden vegetables)

LABORATORY ANALYSIS INTERPRETATIONS



LABORATORY ANALYSIS

Sample	pH	Phosphorus [P] (ppm)	Potassium [K] (ppm)	Organic Matter %
1	6.9	16	104	8.9

UW-SPAL LaG 1.1.2 CLIENT COPY page 1

The Organic Matter content is important for the nitrogen recommendations

Previous sample had 5.6%, this one has 8.9% (N recommendations follow)

1 ppm = 1 lb of nutrient in 1 million lbs of soil.

There are about 2 million lbs/ac at 8 inches deep

So, this soil has about 32 lbs of P and 208 lbs of K

The soil fertility report

RECOMMENDATIONS

Lime to Apply

No soil pH adjustment is recommended.

Fertilizer to Apply

The following summary specifies the actual amount of nutrients needed based on the results of your soil analysis. Most plants require at least an annual nitrogen application, but recommended potassium should be split over two years and soils retested in 2-3 years to determine if more is needed.

Actual Nutrient Need (lbs/100 ft^2)

Nitrogen (N)	Phosphate (P_2O_5)	Potassium (K_2O)
0.30	0.0	1.0

These nutrients can be applied using many different commercial fertilizers. The following suggestions are provided for your reference.

Nitrogen: Needed nitrogen will be supplied with the phosphate and/or potassium recommendations below.

Phosphate: No phosphate fertilizer needed.

Potassium: Apply 2.5 lbs of high potassium fertilizer per 100 sq-ft annually for 2 years to meet plant potassium needs.

Use of high potassium fertilizer will increase available potassium to a level optimum for plant growth and supply some needed nitrogen. For a description of fertilizer grades please see http://uwlab.soils.wisc.edu/pubs/grades.pdf

Recommendations are given in lbs/100 square feet

We convert from lbs of nutrient (colored numbers) to lbs of fertilizer (text below the table).

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Actual Nutrient Need (lbs/100 ft^2)

Nitrogen (N)	Phosphate (P_2O_5)	Potassium (K_2O)
0.15	0.75	0.75

These nutrients can be applied using many different commercial fertilizers. The following suggestions are provided for your reference.

Nitrogen: Needed nitrogen will be supplied with the phosphate and/or potassium recommendations below.

Phosphate: Apply 1.9 lbs of high phosphorus fertilizer per 100 sq-ft annually for 2 years to meet plant phosphate needs.

Potassium: Apply 1.9 lbs of high potassium fertilizer per 100 sq-ft annually for 2 years to meet plant potassium needs.

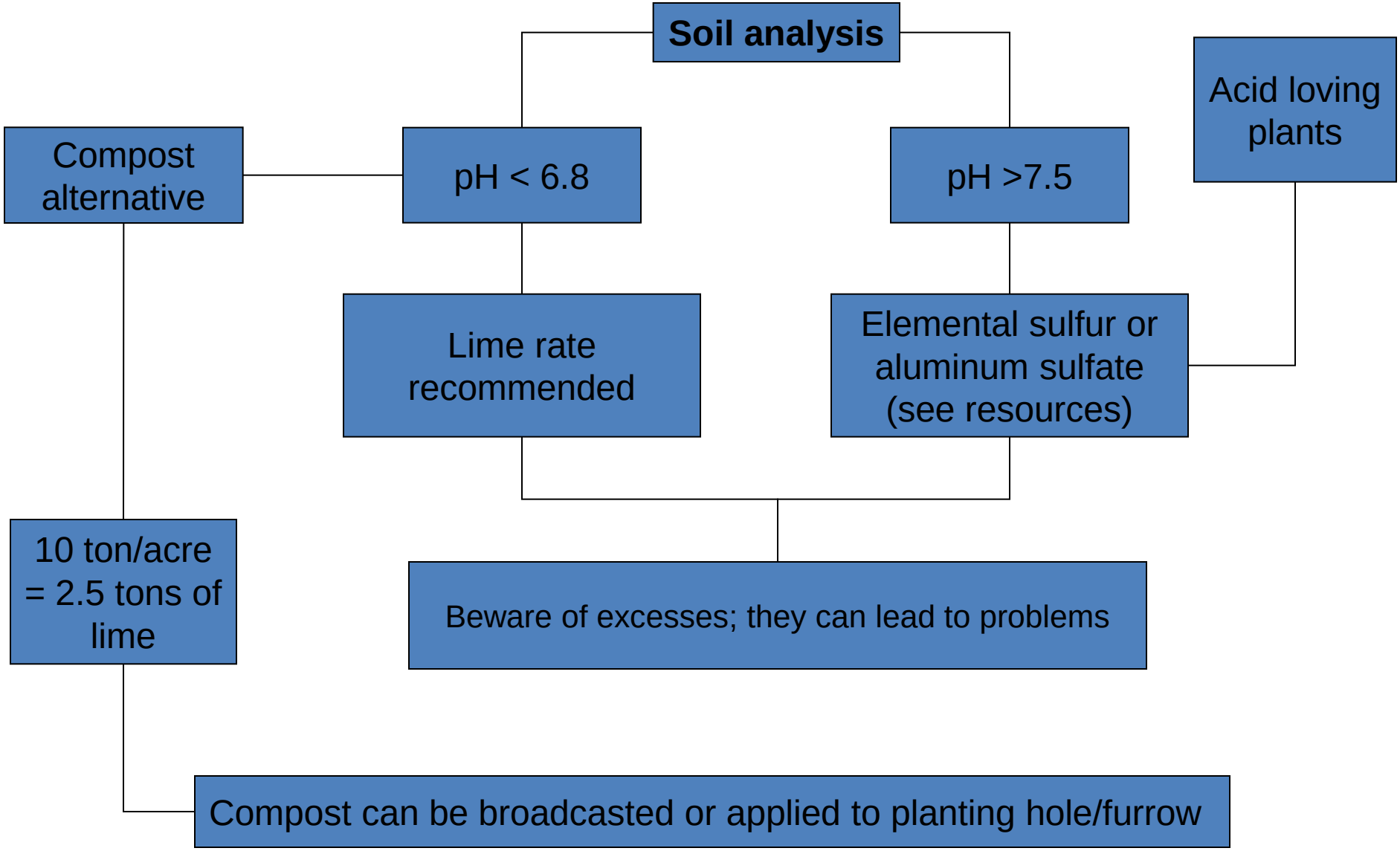
Use of high phosphorus and high potassium fertilizers will increase available phosphorus and potassium to levels optimum for plant growth and supply some needed nitrogen. Recommended high phosphorus fertilizer should be applied in the spring and high potassium fertilizer should be applied in the fall. For a description of fertilizer grades please see http://uwlab.soils.wisc.edu/pubs/grades.pdf

In this case, Nitrogen, Phosphorus and Potassium are all needed

The calculation from 0.75 lb of phosphorus to 1.9 lbs of fertilizer is important

At this point you need to know how fertilizers work but first lets look at liming!

First things first, pH



How does UW calculate lime rates?

- Organic soil
  - Target pH is 5.6

  51 – (5.4 * pH in buffer) – (2.67 * pH in water)

- Mineral soil
  - Target pH is 6.0

  72.2 – (7.59 * pH in buffer) – (3.78 * pH in water)

- Follow recommended rate in report

Liming

- **Apply limestone only if a need is indicated by the results of soil testing and the requirements of the plants being grown.**

- Overliming can reduce nutrient availability, especially of micronutrients such as iron, manganese, and zinc. Iron deficiency (chlorosis) of pin oak, for example, is common when soil pH is greater than 7.0.

- Source: UW Extension on liming and adjusting pH
  - http://www.extension.org/pages/Raising_Soil_pH_and_Soil_Acidification

- Follow the recommendations given by the analysis report

- Apply early in the spring or late in the fall so it has time to act

Typical iron deficiency

Mississippi State University Extension

http://msucares.com/crops/comhort/tomatodisease/

How to acidify the soil if the pH is too high

Table 1. Elemental sulfur application rates to lower soil pH by one unit

Soil texture	Amount of elemental sulfur (S) to apply* Area basis		Volume basis
	lb./100 sq. ft.	lb./1000 sq. ft.	lb./cubic yard
sand, loamy sand, sandy loam	0.8	8.0	1.0
loam, silt loam	2.4	24.0	3.0

*Multiply by 44 to convert the rates in lb./1000 sq. ft. to lb./acre.

University of Minnesota Extension

- If pH is >7.5 acidifying can prevent micronutrient deficiencies
- Can be an uphill battle in calcareous soils
- Can be combined with compost, to cancel liming effect of compost

http://www.extension.org/pages/Raising_Soil_pH_and_Soil_Acidification

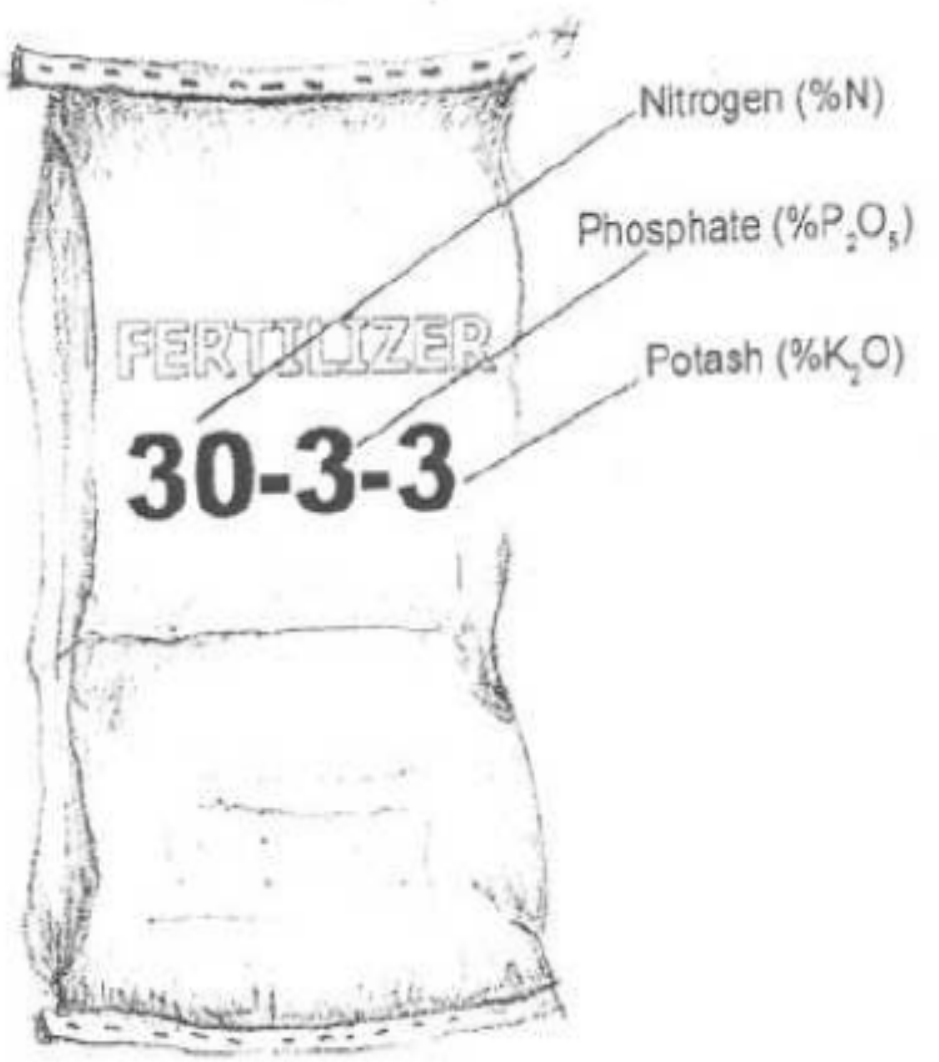
More on soil acidification

Table 2. Elemental sulfur application rates to lower soil pH to 4.5

Initial pH	Soil texture	
	sand, loamy sand, sandy loam	loam, silt loam
	Amount of elemental sulfur (S) to apply lb./100 sq.ft.	
7.0	1.9	5.8
6.5	1.5	4.6
6.0	1.2	3.5
5.5	0.8	2.4
5.0	0.4	1.2

- Can be costly and needs to be repeated every few years
- It is mainly for acid loving plants (blueberries, cranberries, etc)
- Apply late in the fall; however, early in the spring can do just fine

Fertilizers



Common formulas

- High nitrogen
  - 24 – 0 – 0 (Ammonium Sulfate)
  - 45 – 0 – 0 (urea)
- High phosphorus
  - 10 – 20 – 10
  - 7 – 22 – 8
- High potassium
  - 9 – 23 – 30
  - 10 – 20 – 30
-
- Organic fertilizers
  - 13 – 2.3 – 2.4 Blood meal
  - 4 – 12 – 0 Bone meal
  - 1 – 0.25 – 0.6 Compost

Application rates of fertilizers

Fertilizing Your Home Vegetable Garden

Recommendation	Fertilizers(s) recommended	At planting[1] Cups per 100 sq. ft.	3-4 weeks after planting[2] Cups per 10 feet of row
Nitrogen only	Ammonium sulfate 21-0-0	4	¼
Nitrogen and Phosphorus	10-20-10, 7-22-8	8	½
	Organic fertilizer[4]	15	1
Nitrogen and Potassium	9-23-30, 10-20-30	6	½
Compost	*1 – 0.25 – 0.6*	*60*	*4*

Note the large difference in doses for organic fertilizers and compost

Compost

- Best source of organic matter there is
- Excellent source of phosphorus, potassium, calcium, magnesium and micronutrients
- Improves structure, aeration, water infiltration, and water retention
- Increases the efficiency of nitrogen fertilizers (including organic fertilizers such as bone and feather meal)
- Improves microbial and biological activity and has potential to decrease diseases and pests (nematodes)
- Relatively cheap and even cheaper if you can make it yourself

Cover Crops and Green Manures

- **Rye grass, oats, winter wheat, clover, etc**
  - Biomass that can be put incorporated
  - Biomass for compost
  - Fix atmospheric nitrogen (legumes mostly)
  - Retain nitrogen in organic material
  - Improve soil structure
  - Control weeds
  - Control diseases and pests (break cycles)
  - Reduce erosion by improving water infiltration

Beyond soil fertility – Soil Health

- If you do all those things right, you are not only improving soil fertility, you are improving soil health:
- Better infiltration
- Better water retention
- Higher nutrient content
- Improved aeration and root respiration
- Improved nutrient cycling and retention
- More balanced biology which limits disease and pests
-

Thank You!

I'll be happy to answer any questions ☺

Various Resources

- http://uwex.edu/ (general resource)
- http://dane.uwex.edu/ (general resource)
- http://learningstore.uwex.edu/Assets/pdfs/A2166.pdf (soil sampling)
- http://www.mccc.msu.edu/ (cover crops at University of Minnesota)
- http://uwlab.soils.wisc.edu/ (soil analysis at UW Madison)
- http://compostingcouncil.org/ (compost)
- http://www.extension.org/pages/Raising_Soil_pH_and_Soil_Acidification
- http://fyi.uwex.edu/cwas/files/2010/10/Soils-Genrich.pdf (Soils handbook!!)