The Dirt on Soil Science

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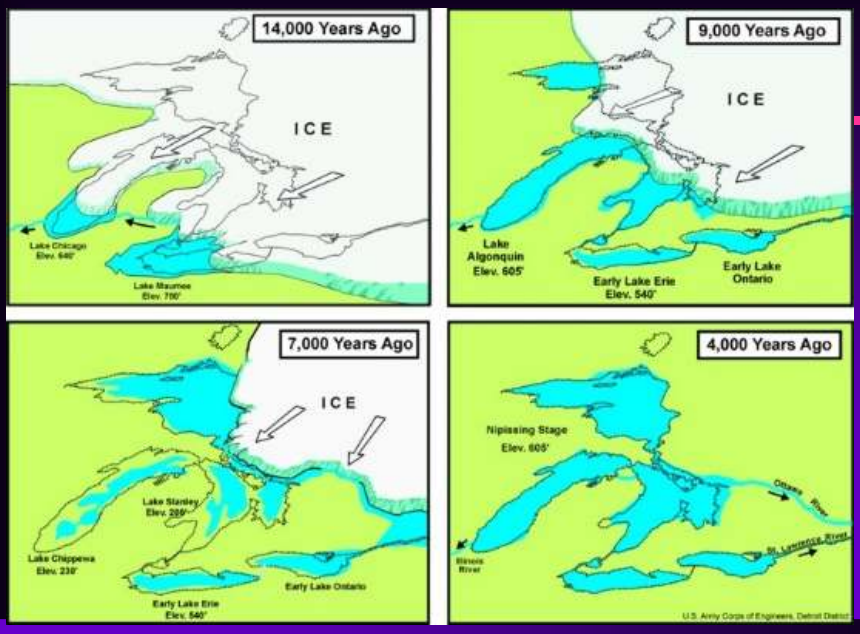
Rough Outline

- Basic Michigan soil history
- Soil Basics
  - What is soil
  - Soil texture/particles
- pH
- Plant nutrients
- Organic Matter

Michigan Soil History

- Glaciated several times
- Great Lakes were bigger in past
- Vast swaths of flat swamps
- Relatively low elevation

www.britannica.com



Michigan Soil History

- Fertile clay and loam in S
- Dry sand in N

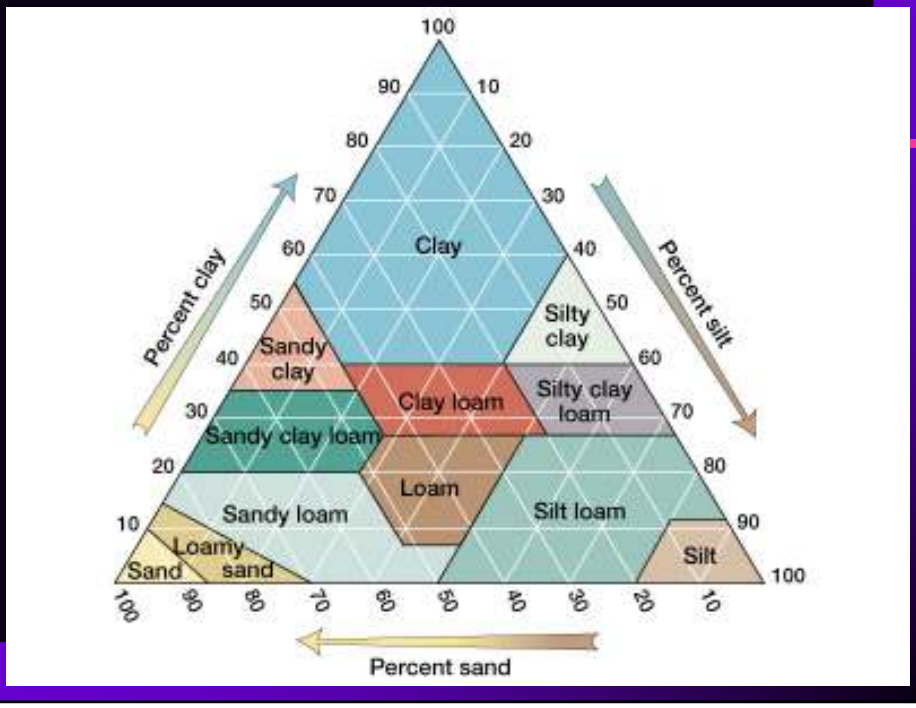
MSU Extension Bulletin E1550

What is Soil?

- Loose surface material in which plants grow – Webster's Dictionary
- Unconsolidated, thin, variable layer of mineral and organic material, usually biologically active that covers most of the Earth's land surface – M. Singer in Soils: an Introduction
- Soil is both part of the ecosystem and an ecosystem unto itself!

Soil Texture/Particles

- Texture – refers to the size of the particles
  - Sand, loam, clay
- Structure – arrangement of the particles



Estimating Texture

- Gather soil in a jar
- Shake well
- Let sit for 24 hours
- Guess the percentages

- Moisten soil
- Roll into a ribbon

Guidelines

- Sand to loamy sand
  - Grains easily seen, crumbles easily
- Sandy loam
  - Cast can be gently handled
- Silty loam
  - Floury when dry, will not ribbon when moist
- Clay loam
  - Ribbon barely sustains weight, cast can be easily handled
- Clay
  - Sticky and plastic when wet, forms strong ribbon

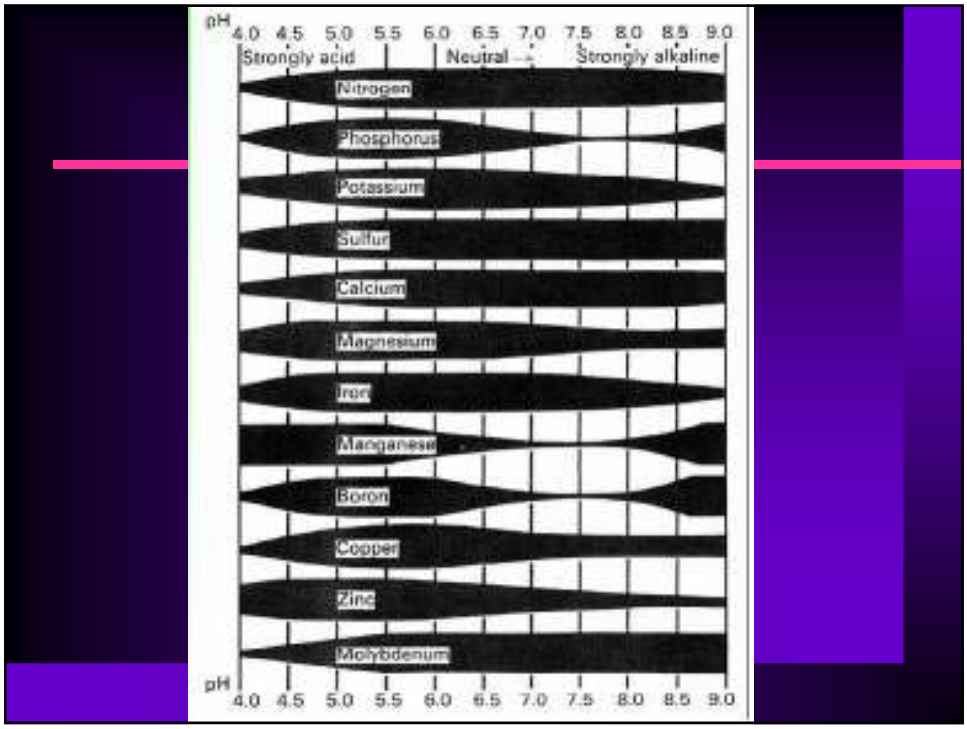
-USDA Handbook of Soil Survey Investigations

pH

- Measure of acidity/alkalinity
  - # of Hydrogen ions in soil

pH

- Ideal range?
  - 5.5-6.5 for most plants
  - Slightly acidic
- WHY?
  - Better nutrient availability



pH

- Many "problems" are really problems due to pH issues!

Factors affecting pH

- Subsoil
  - Limestone, sandstone
- Rainfall
  - Leaches calcium and magnesium
  - Areas with lots of rain have more acidic soils

Factors affecting pH

- Amount of organic matter
  - Increased levels of decomposition increase acidity
- Type of organic matter
  - Oak leaves are more acidic
  - Maple leaves are more alkaline

Raising the pH

- Lime
  - Limestone – also contains calcium
  - Dolomitic limestone – calcium and magnesium
- Wood ashes
  - Also contain Phosphorus, Potassium and Boron (very small quantities)
  - Don't allow contact with plants (can burn)

Raising the pH

- Apply in fall or winter
- Gives time to work
- Smaller granules increase effectiveness

Lowering pH

- Aluminum sulfate
  - Works faster
  - Aluminum is acidic on contact with water
  - Doesn't last as long
- Sulfur
  - Slower – bacteria convert to sulfuric acid
  - Lasts longer
- Gypsum (ONLY in sodic soils!!!!!!!)

Lowering pH

- No contact with plants
- Water in after application
- Use fine particles

- WILL need to reapply, especially in clay soils
  - Buffering capacity is high

POUNDS of Aluminum Sulfate (pounds per 10 square feet)

D pH / C pH	6.5	6.0	5.5	5.0	4.5
8.0	2.7	3.6	5.0	6.3	10.4
7.5	1.8	3.2	4.0	5.4	6.3
7.0	0.9	1.8	3.2	4.5	5.4
6.5	-	0.9	2.0	3.6	4.0
5.5	-	-	0.9	2.0	3.2

POUNDS of Sulfur (pounds per 10 square feet)

D pH / C pH	6.5	6.0	5.5	5.0	4.5
8.0	0.45	0.6	0.75	0.9	1.0
7.5	0.2	0.45	0.6	0.75	0.9
7.0	0.15	0.2	0.45	0.6	0.75
6.5	-	0.15	0.2	0.45	0.6
5.5	-	-	0.15	0.2	0.45

Plant Nutrients

- 17 basic nutrients
- 2 or 3 classifications
  - Primary (macro-nutrients)
  - Secondary (sometimes not used)
  - Micro-nutrients
- ALL are important
  - Varies by AMOUNT required!!!

Plant Nutrients

C HOPKNS CaFe

Mg B Mn

CuZn NiMoCl

Plant Nutrients

- C HOPKNS CaFe Mg B Mn CuZn NiMoCl
- CHO → plants get from water and air
- N P K – primary or Macronutrients
- S Ca Mg – secondary nutrients
- Fe B Mn Cu Zn Ni Mo Cl - micronutrients

Nitrogen (N)

- Required in the largest amounts
- Most mobile in the soil
- Leaches readily – need regular applications
  - Don't apply too much!
- Many metabolic processes require
- ESSENTIAL for chlorophyll production

Phosphorus (P)

- Essential for many metabolic processes:
  - Seed germination
  - Flower bud set
- Bound tightly in soil (esp. clay soils)

Potassium (K)

- Essential to water regulation
- Usually not a problem
- Sodic soils!

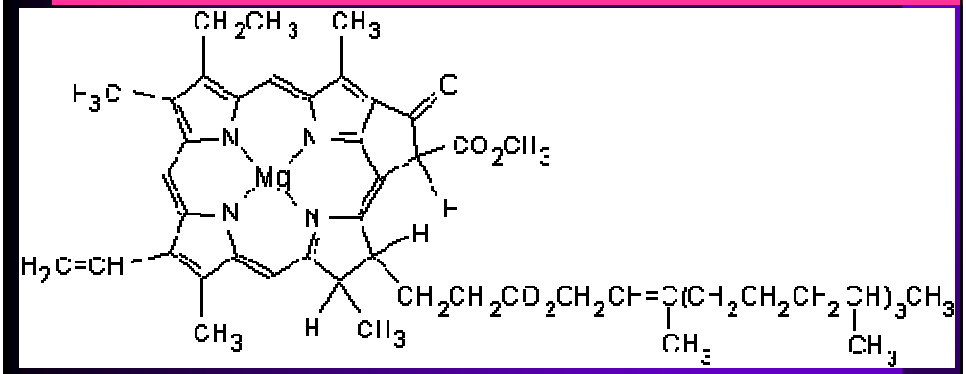
Calcium (Ca)

- Cell walls
- In both shoot and root growing tips

- Almost immobile in the plant
- Most soils contain ample Ca

- Gypsum ($CaSo_4$) can help

Magnesium (Mg)



Dolomitic lime applications will generally correct pH problems are usually to blame!

Boron (B)

- Critical for cell differentiation!
- Plants need very little
- Small range
  - 0.15 – 0.5ppm is ideal
  - 1.0ppm is toxic
- Tied up quickly in high pH soils

Boron (B)

- Borax (11% B)
- Solubor (20% B)
- 0.5 – 1.0 OUNCES per 1000 SQUARE FEET!!!!!!
- Correct soil pH!

Organic Matter

- Many soils 1-5% organic matter naturally
- Ideally: 30% organic matter!
- Incorporate as deep as possible
  - **Rototiller (be careful)**
  - Double digging
  - Top dress 1" per year

Organic Matter

- Grass clippings
  - No pesticide treated clippings
  - Good source of N
  - Decompose quickly
  - Weed seeds
  - Excellent in compost pile
- Manure
  - Be sure to compost
  - Cow, llama, horse, poultry
  - Small amounts of fertilizer

Organic Matter benefits

- Improves aeration in clay soils
- Improves water retention in sandy soils
- Small amounts of nutrients
- Increases microbial activity
- Improves soil physical and chemical properties
- Reduces soil borne pathogens

Organic Matter problems

Other Amendments

- Sand
  - BE CAREFUL!!!
- Gravel
- Gypsum
- Lime

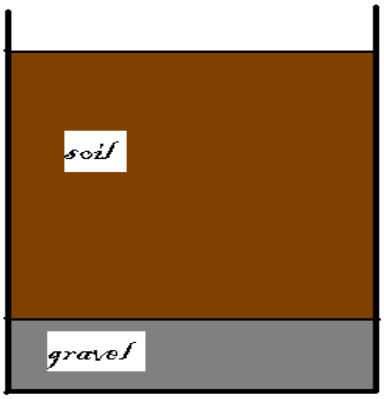
Other Amendments

- Mushroom Compost
  - Expensive
  - Excellent
  - 2-1-1, pH 6.8
  - Pasteurized

Other Amendments

- Cocoa mulch
  - Toxic to pets
  - Safe for plants
  - Excellent source of phosphorus
  - Can mold
  - Can be expensive

- DON'T create drastic soil texture changes!!



- Two biggest issues?
  - pH
  - Drainage
- Organic amendments can help with both