Understanding Garden Soils: What Lebron James, Jack Nicklaus & Julia Child Have in Common

April , 2023

11th Annual Living in the Garden Symposium

Bryce Lane
brycehortlane@me.com

“The Good the Bad, and the Ugly”
I have gardened in the same quarter acre spot for 39 years

Using plant science as a foundation for gardening

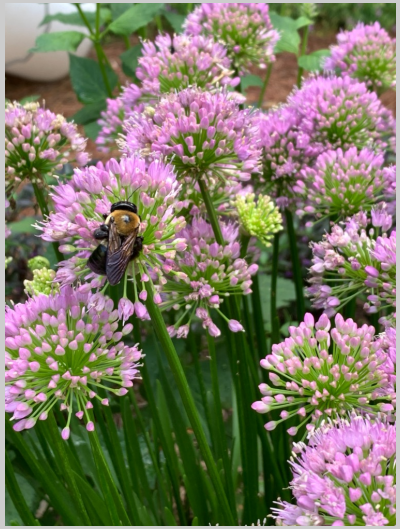
Why do plants die?

Poor understanding of how light influences plant growth

Poor understanding of how soil influences plant growth

Plant dry weight from sun vs. soil?

96% from photosynthesis, 4% from soil… however



Nutrition is just as important as light, but,

You can’t fertilize a plant into a healthy specimen
If the environment (Light & Soil) doesn’t support growth

Let’s talk about soil!

Welcome to dirt school!

What is Soil?

Soil Science Academy of America (in 2016) defined as:

"Soil is the top layer of the Earth's surface that generally consists of loose rock, and mineral particles mixed with dead organic matter"

SSC 200: Soil = Stuff + space

Mineral material derived from rock

Dead organic material (from living things)

Living organic material: Organisms & Roots

Space: Water & Air

Soil Properties

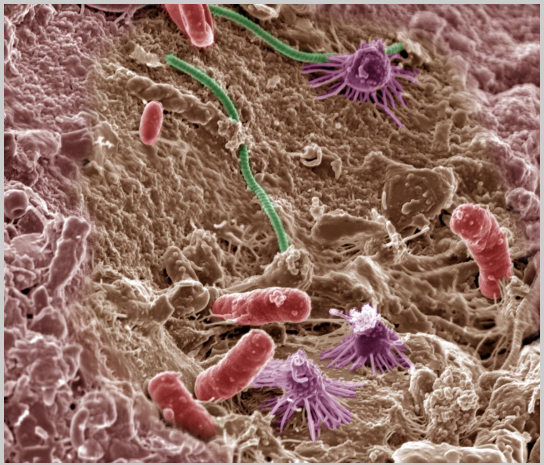
Physical: color, particle size, porosity, water relations

Chemical: nutrient holding ability, soil acidity (pH)

Biological: Soil microflora, macrofauna, partnerships

Up to 1 billion Bacteria!

Soil Fungi



What should good soil do?

Provide:
Anchorage
Water
Nutrients
Oxygen

Excellent garden soils also:

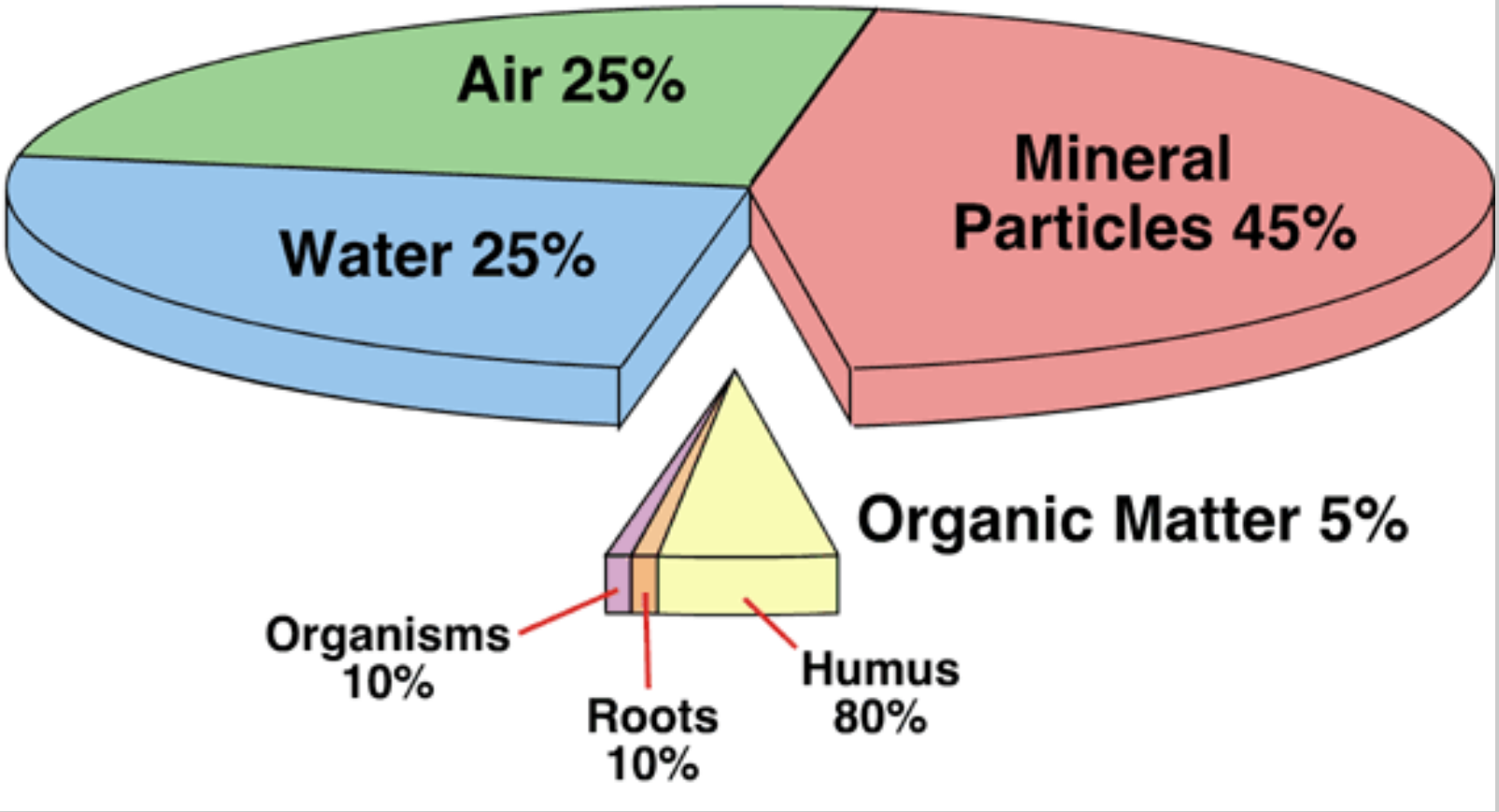
Improve water infiltration by up to 20%
Reduce and slows runoff (sedimentation)
Purifiy water
Decompose pollutants
Bacteria… *Micobacterium vaccae*


VARSITY DEPT.
28
AH-64A

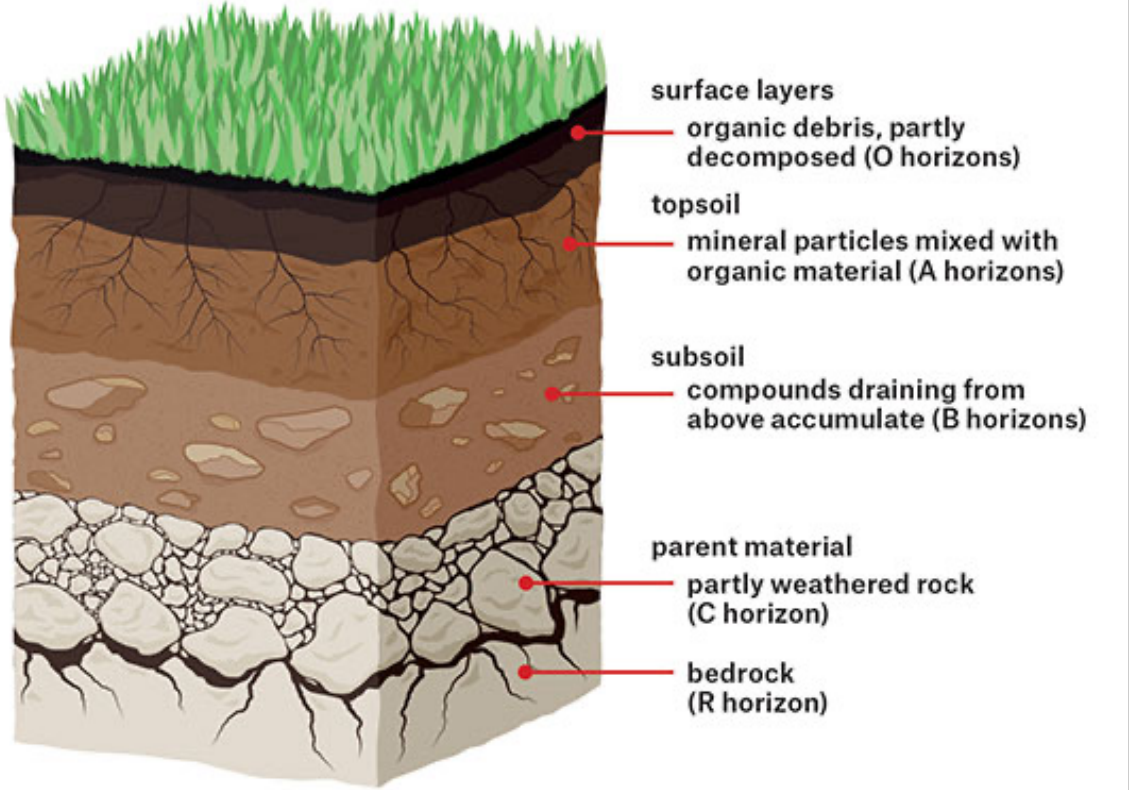
Wait, there is more!

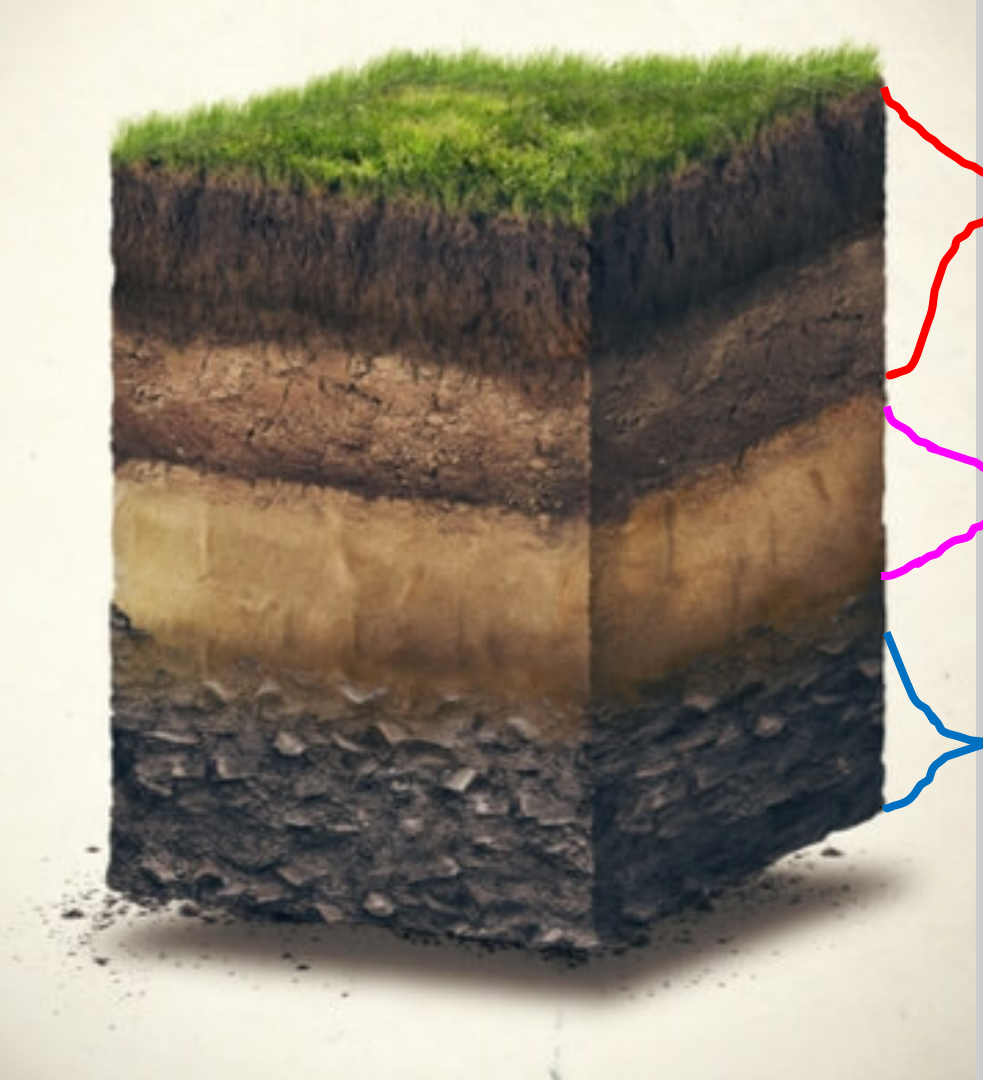
Reduces irrigation frequency
Reduces fertilizing frequency
Increases plant longevity

Ideal soil Make Up:



Soil profile: “Horizonation”





O + A = Topsoil

B = Subsoil

C = Loose parent material

Taking a soil profile

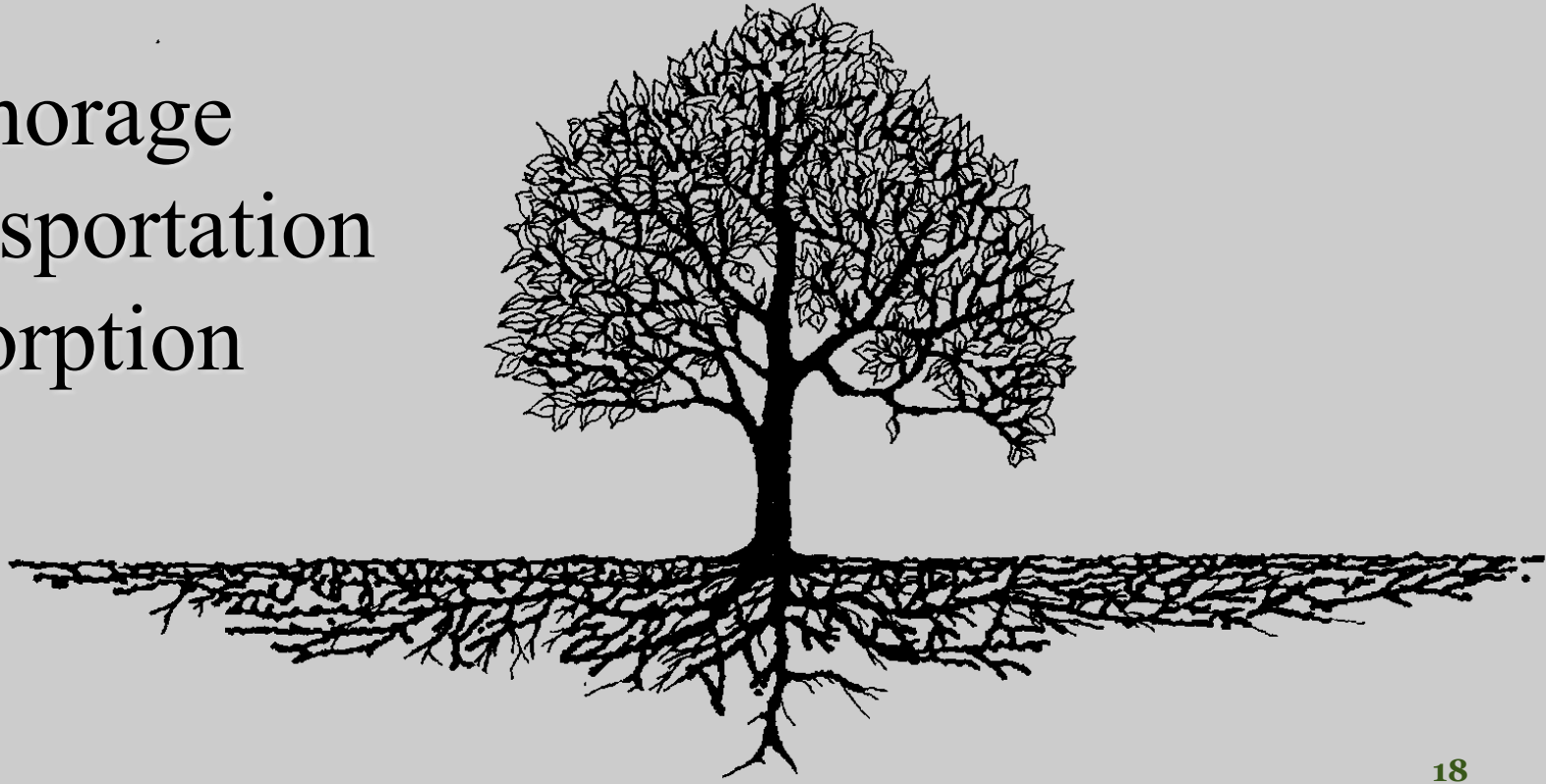




Roots

Roots grow where there is water & oxygen
Tree's absorbing roots are located in the top 12" of the soil

Anchorage
Transportation
Absorption



Pinus longaeva, Bristlecone pine,

We Have Soil Compaction Issues!

Soil Texture

Distribution of different sizes of **mineral** particles in the soil

Organic matter not included

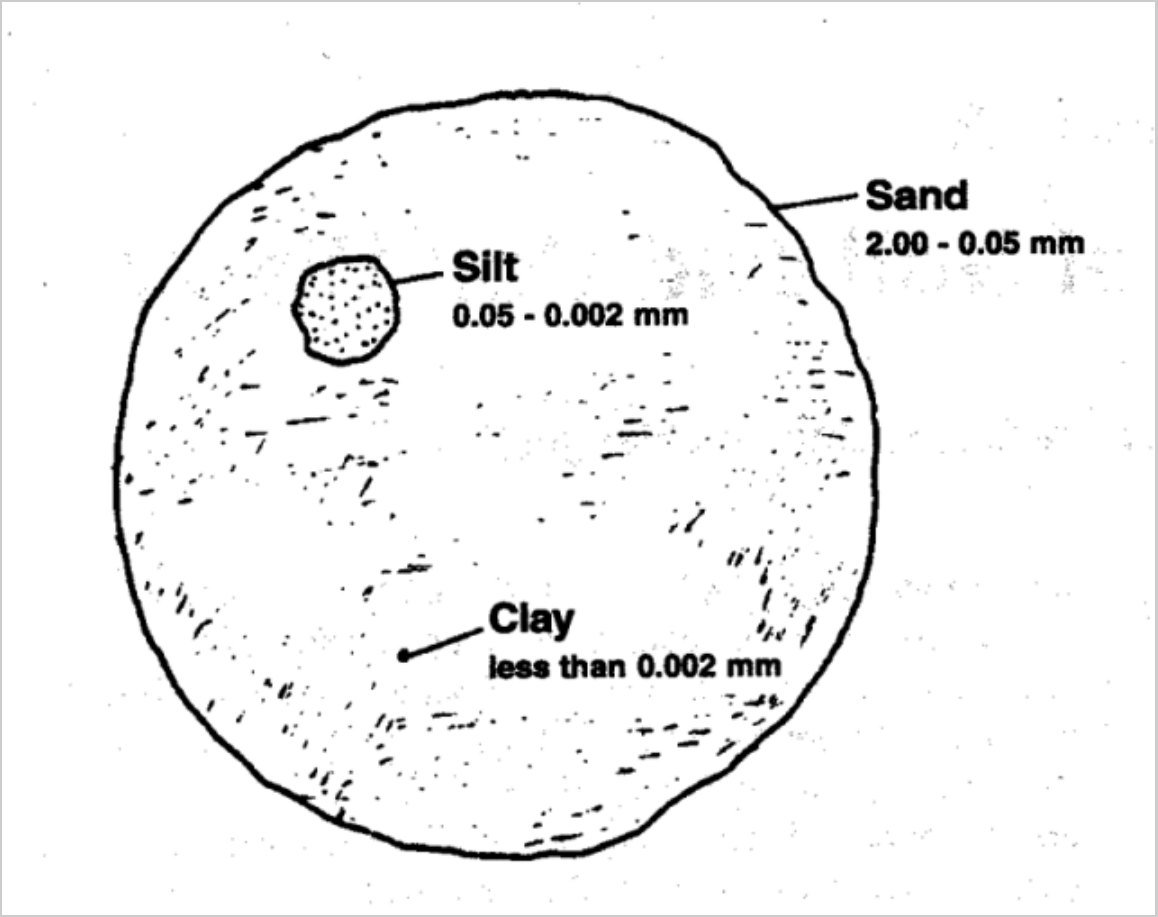
"Soil separate" :

- Sand
- Silt
- Clay


Wilson
Wilson

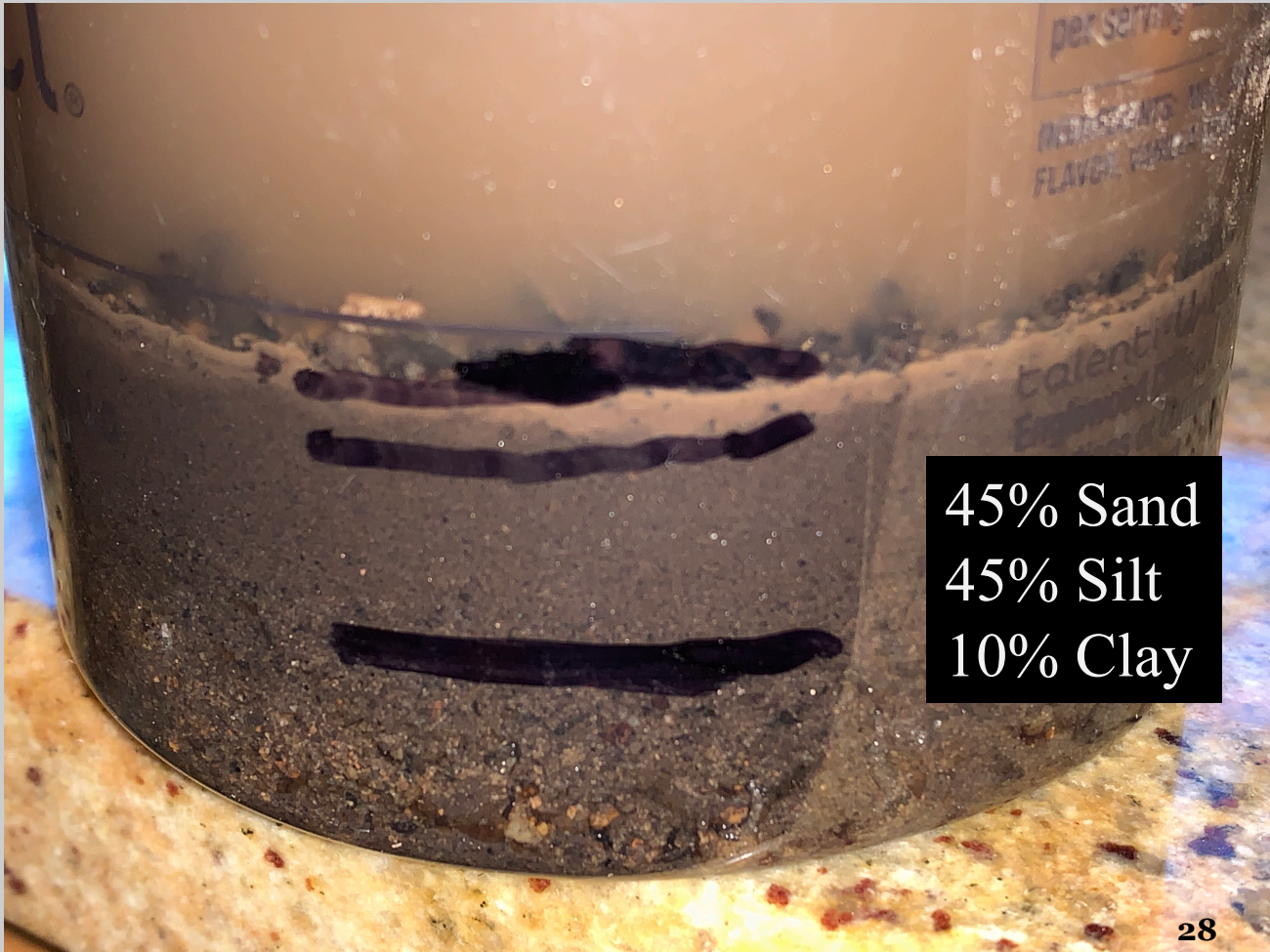

Wilson
LAKERS
6

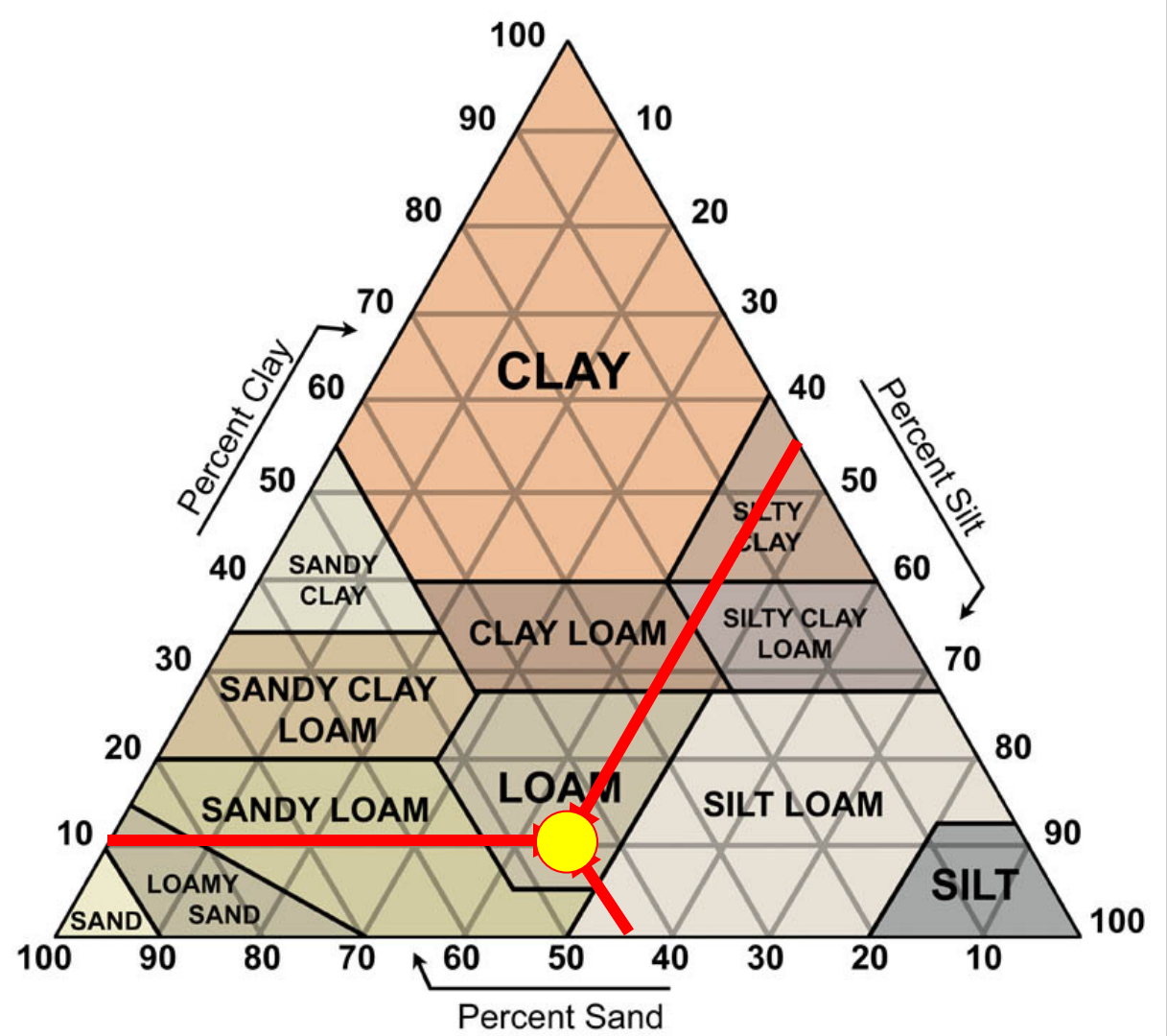
Soil Texture



Home soil texture test


Nutrition
Facts
3 servings
Serv. size
2/3 cup (
Calories
per serving 270


45% Sand
45% Silt
10% Clay



45% Sand
45% Silt
10% Clay

In general…

Sandy soils:

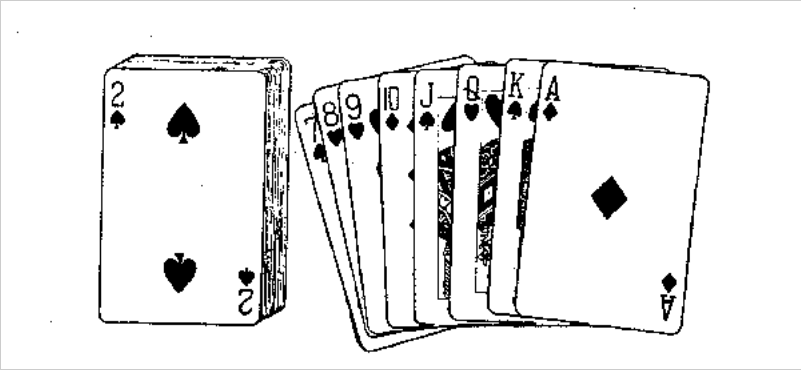
Faster water movement
Excellent aeration
Decreased water holding capacity
Decreased nutrient holding capacity

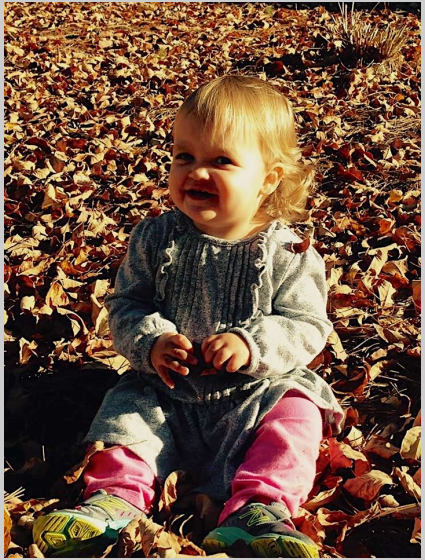
Clay soils:

Slower water movement
Poorly aerated
Increased water holding
Increased nutrient holding

Soil texture contributes to:

Chemistry of soil
Surface area
Ability to hold nutrients
Clay:1000 times more surface area than coarse sand
Clay plays a major role in soil chemistry
Fertility: Clay vs. Sand





Cation Exchange Capacity

The ability of soil to hold nutrients against the forces of leaching

Ion is a charged particle: + or -

K^{+} H^{+} Ca^{+2} NH_4^{+} NO_3^{-} Mg^{+2} HPO_4^{-2}

Cation is positive, Anion is negative

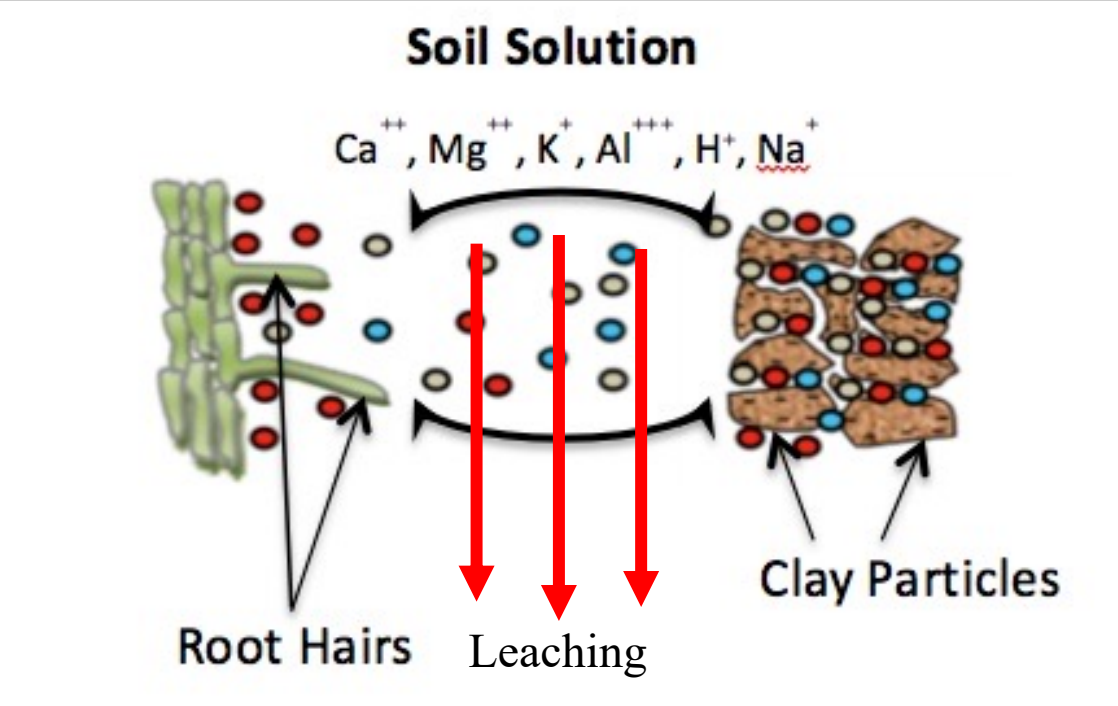
The binding sites on soil particles are negatively charged

"CEC"

"Binding Sites"

Cation Exchange Capacity
"CEC"

Nutrients are primarily available to the plant in the soil solution!



Cation Exchange Capacity

Material	CEC (meq/100g)
Clays	
Kaolinite	3-15
Illite	15-40
Montmorillonite	80-100
Soil Texture	
Sand	1-5
Loamy Sand to Sandy Loam	5-10
Loam	5-15
Clay Loam	15-30
Clay	>30

Organic Matter (“Compost”)

Plant or animal Residue decomposed beyond the point of recognition
That is different than mulch
Very important ingredient in soil
Is “DYNAMIC”
Contains varying degrees of nutrition
Holds significant amounts of nutrition
Humus: the most stable form of “OM”

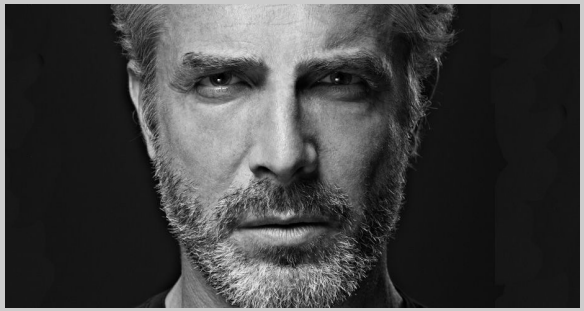

TIMBERLINE
SOIL
PEAT HUMUS
humus de la turba
Oldcastle Lawn & Garden, Inc.
P.O Box 581418
Atlanta, GA 31150-1418
www.myoldcastle.com
40 LB / 18.14 Kg
PEAT HUMUS
PEAT HUMUS


TIMBERLINE
SOIL
COW MANURE
and COMPOST
.05 - .05 - .05
Estiércol de vaca
Oldcastle Lawn & Garden, Inc.
P.O Box 4685367
Atlanta, GA 31146
www.myoldcastle.com
.75 Cu.Ft.
COW MANURE and COMPOST
COW MANURE and COMPOST

Organic Matter

Residue (organic material or “pre-organic matter)

“Organic Matter”



Humus

Gone!

Organic Matter

Improves soil structure (aggregation)
Increases water holding capacity
Improves water relations (percolation & movement)
Improves pore space
Provides a small amount of nutrition
Increases nutrient holding capacity…
Cation Exchange Capacity! CEC

Cation Exchange Capacity

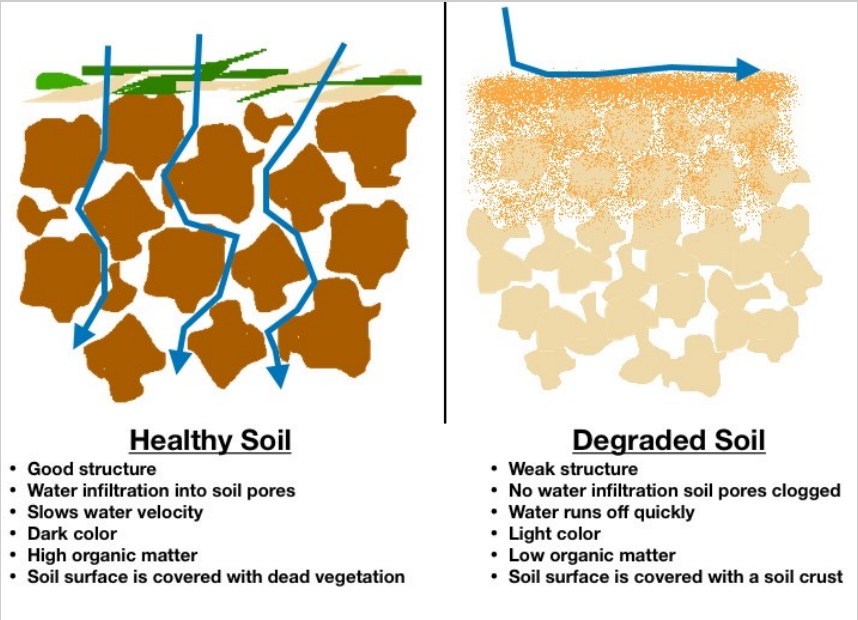
Material	CEC (meq/100g)
Clays	
Kaolinite	3-15
Illite	15-40
Montmorillonite	80-100
Organic Matter	200-400
Soil Texture	
Sand	1-5
Loamy Sand to Sandy Loam	5-10
Loam	5-15
Clay Loam	15-30
Clay	>30

Soil Structure

Ability of soil to form clumps
Aggregates: (brown sugar)

"A soil without aggregation can be a big aggravation"

Improved by adding humus
Microbes, fungi, & small insects secrete binding agents

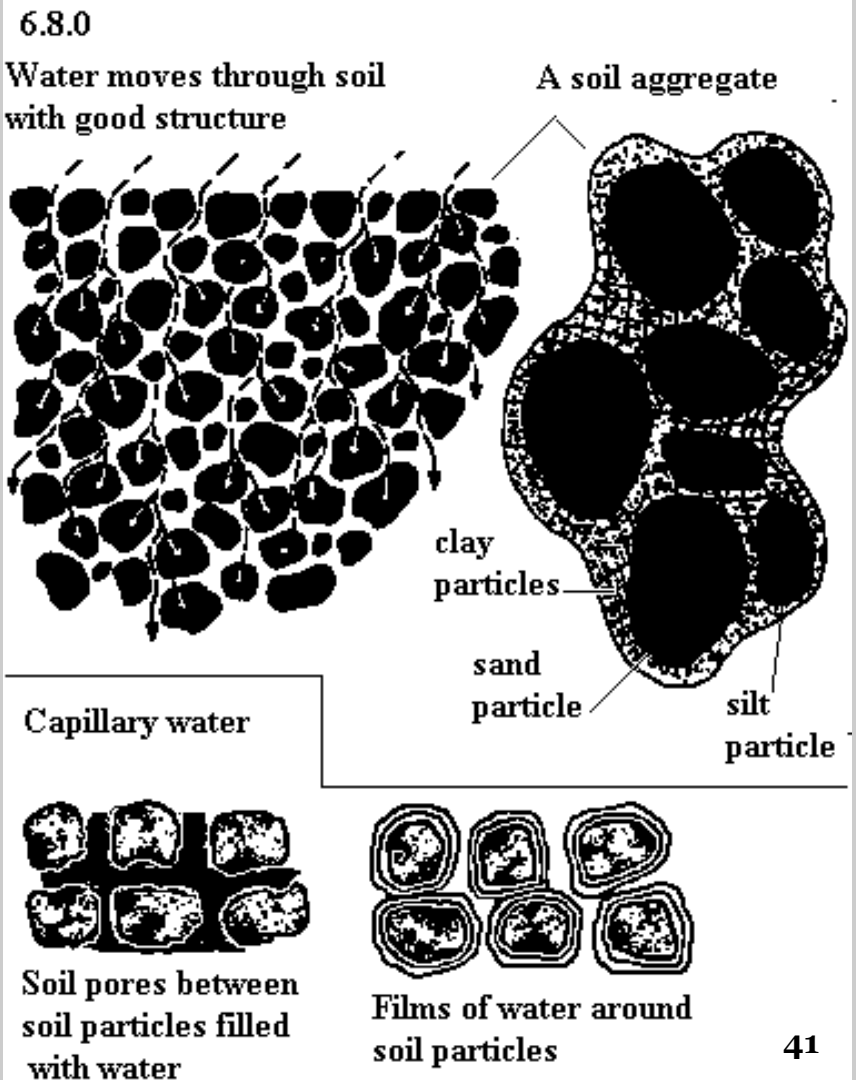


Healthy Soil

- Good structure
- Water infiltration into soil pores
- Slows water velocity
- Dark color
- High organic matter
- Soil surface is covered with dead vegetation

Degraded Soil

- Weak structure
- No water infiltration soil pores clogged
- Water runs off quickly
- Light color
- Low organic matter
- Soil surface is covered with a soil crust



Organic matter improves “Soil Structure”

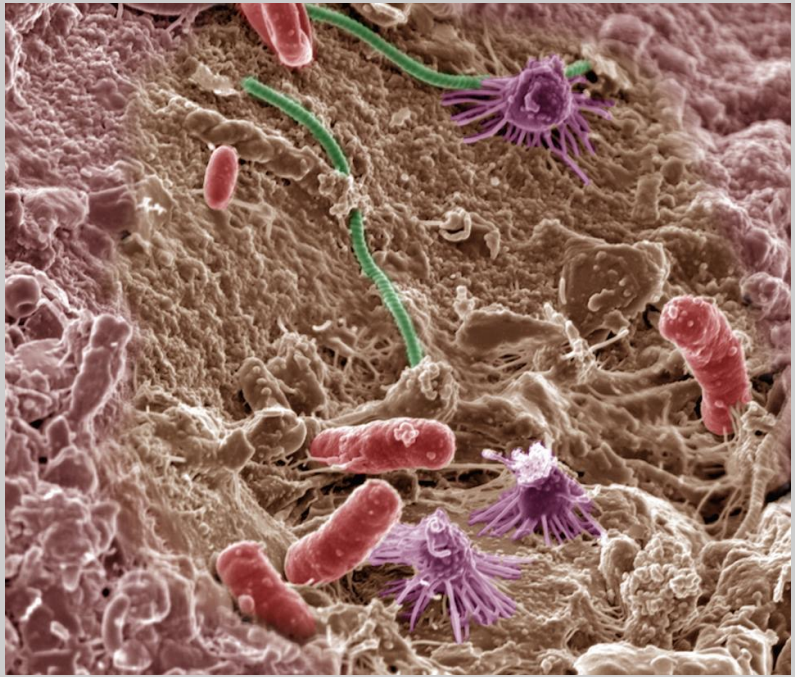
Add OM to soil on a yearly basis
What should be added?
Soil conditioners, compost, manures etc.

Improves drainage
Moisture holding
Root zone
Soil biology
Builds soil

Soil Biology

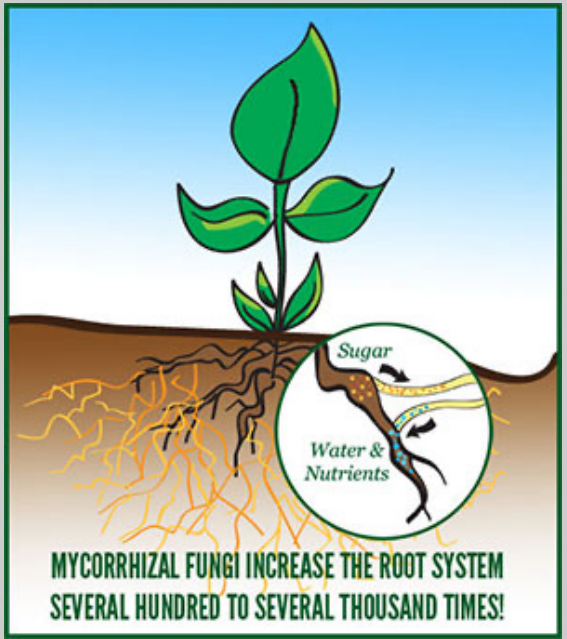
- Bacteria
- Fungi
- Soil Algae
- Nematodes, Worms, & soil insects

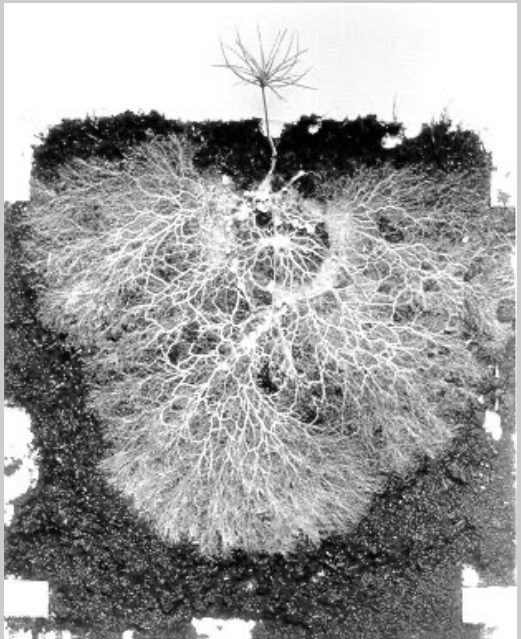
“If you build it, he (they) will come”



Mycorrhizae

Symbiotic relationship between fungi and plant roots
Fungi assists absorption of water and nutrition, fights infection
Roots provide sugar (glucose)e to the fungus





pH = Soil Acidity

pH = -Log of the Hydrogen ion concentration in the soil solution

SCALE: 1-7-14

<7…Acidic

7…Neutral, $H^+ = OH^-$

>7...Basic

pH of 5 is 10 times more acidic than pH of 6, & 100 times more acidic than pH of 7!

pH influences a soil's ability to be fertile

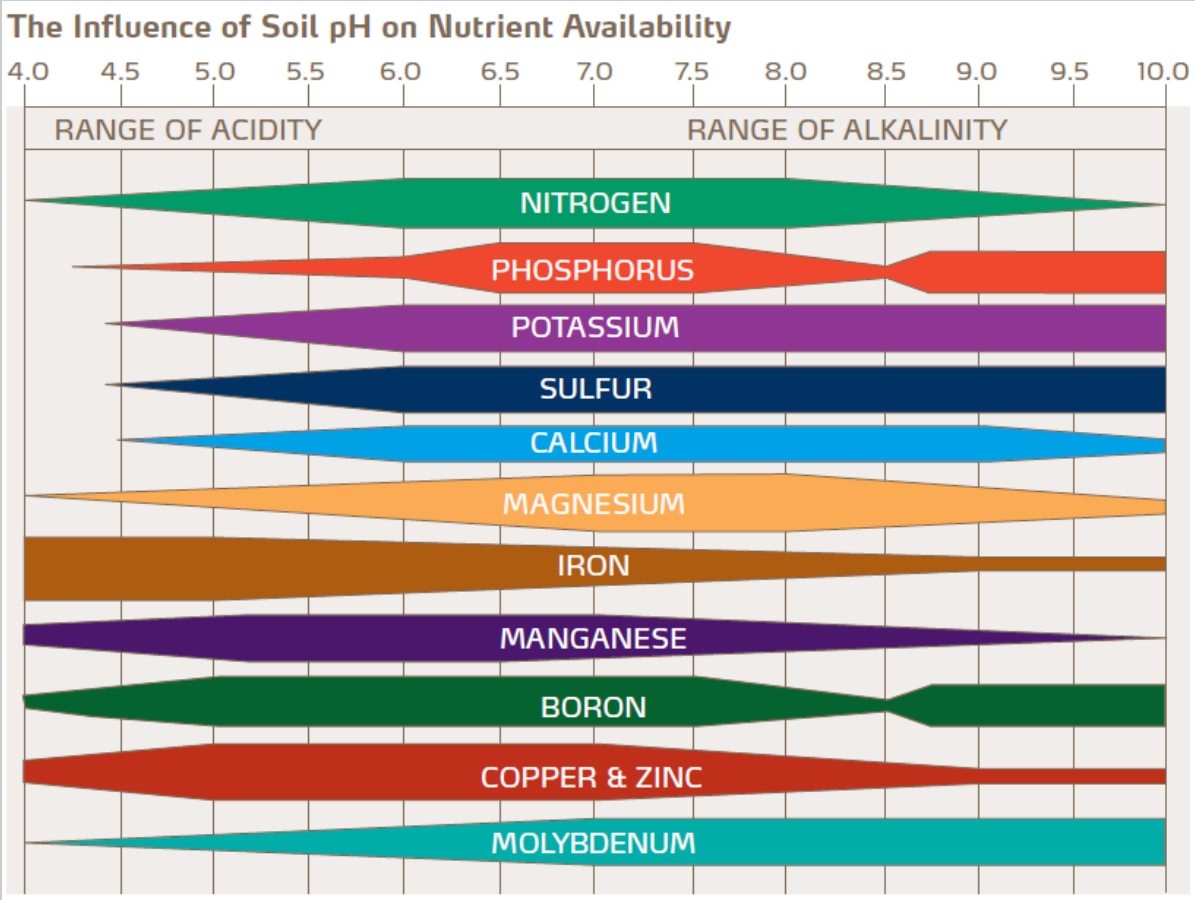
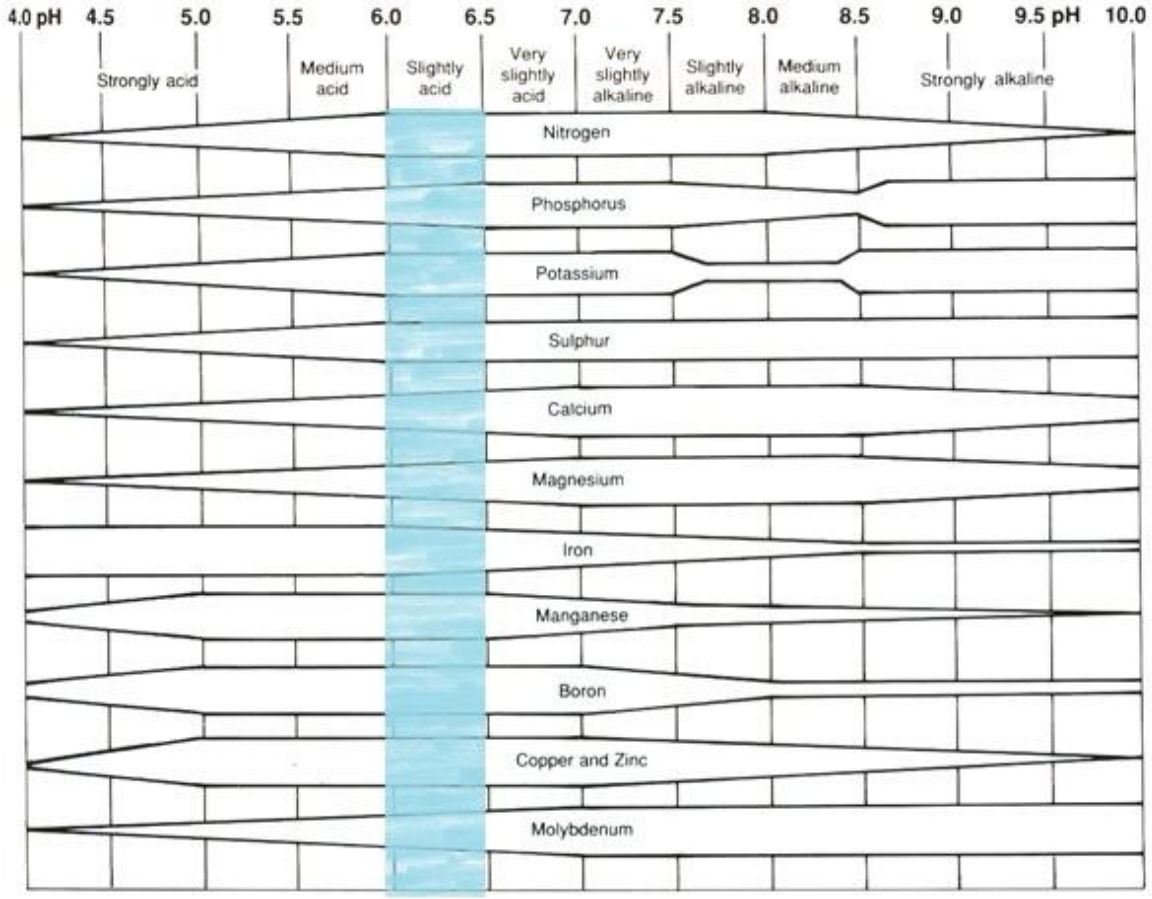
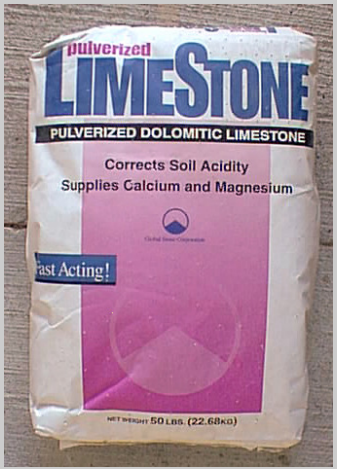


Figure 1–28. Nutrient availability as affected by soil pH. The wider areas represent greater availability. The blue bar shows the optimum pH level for nutrient uptake by plants.



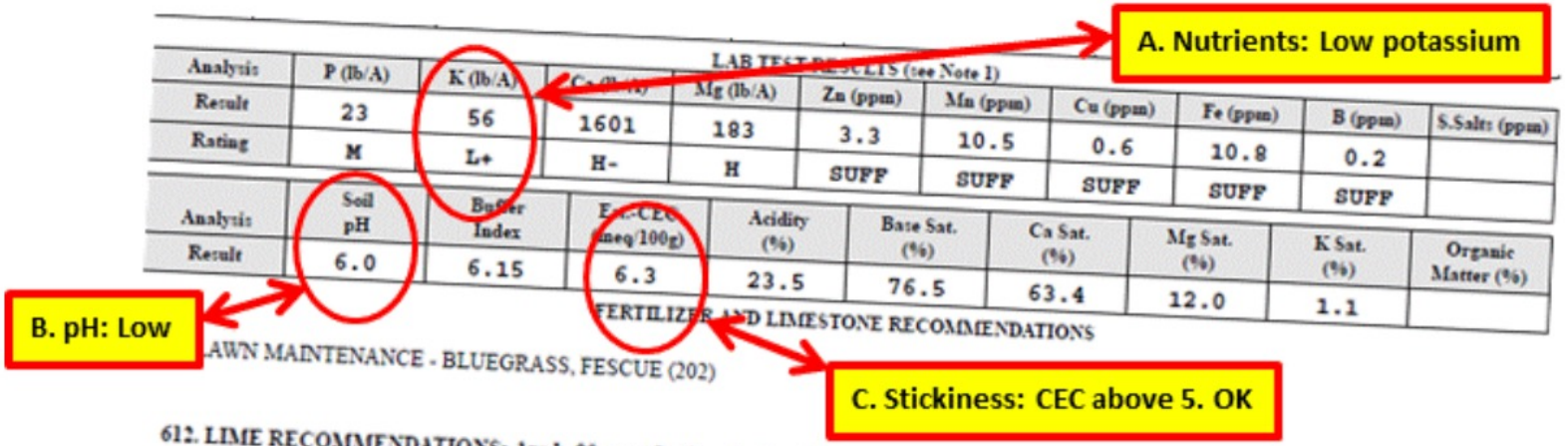
Raising the pH

Add limestone
Reacts with soil colloid, displaces H^+
Creating H_2O…Raising pH
5lbs/100 sq.ft. But… base on soil test!
Because of "buffer capacity" (reserve acidity)



Virginia Soil Testing

Report Sample 1



LAB TEST RESULTS (see Note 1)

Analysis	P (lb/A)	K (lb/A)	Ca (lb/A)	Mg (lb/A)	Zn (ppm)	Mn (ppm)	Cu (ppm)	Fe (ppm)	B (ppm)	S.Salt: (ppm)
Result	23	56	1601	183	3.3	10.5	0.6	10.8	0.2	
Rating	M	L+	H-	H	SUFF	SUFF	SUFF	SUFF	SUFF	

Analysis	Soil pH	Buffer Index	Est.-CEC (meq/100g)	Acidity (%)	Base Sat. (%)	Ca Sat. (%)	Mg Sat. (%)	K Sat. (%)	Organic Matter (%)
Result	6.0	6.15	6.3	23.5	76.5	63.4	12.0	1.1	

FERTILIZER AND LIMESTONE RECOMMENDATIONS

LAWN MAINTENANCE - BLUEGRASS, FESCUE (202)

612. LIME RECOMMENDATIONS: Apply 90 pounds of agricultural limestone (ground, pulverized or pelletized) per 1000 square feet in several small applications of up to 50 lbs each, at intervals of 1 to 6 months, until the full amount is applied.

990. We are trying to improve our service. PLEASE take a moment to complete our brief, anonymous customer survey at tinyurl.com/soiltestsurvey.

991. "Explanation of Soil Tests, Note 1" and other referenced notes are viewable at www.soiltest.vt.edu under Report Notes.

207. FERTILIZER RECOMMENDATIONS: Apply a 3-1-2 or 4-1-2 ratio fertilizer (examples of grades to use are 12-4-8, 16-4-8, 24-3-12, etc.) according to the instructions in the note on lawn fertilization. If you are unable to find this type of fertilizer, apply a 2-0-1 or 3-0-1 ratio fertilizer, such as 22-0-14, 32-0-10, 19-0-7 or a similar ratio product.

Proper Bed Preparation

Bed Preparation is key to good soil fertility

Roots grow where there is water and oxygen…
Soil Building is the key to success!
Cultivate
Incorporate
Invigorate
(mulch)

Benefits of Mulching

Existing beds that can't be disturbed

Research shows that after 3 years…

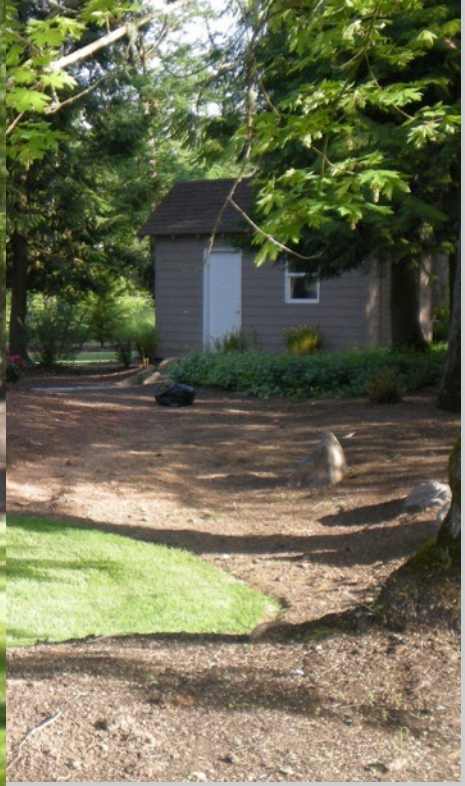
"Humates" influence subsoil

Bartlett Tree

90% more root growth in mulched beds than under turf!

Birthday present from my wife…

Prep entire bed before planting!
Stop thinking about the hole,
& start thinking about the whole!



Chemistry of Plant Nutrition

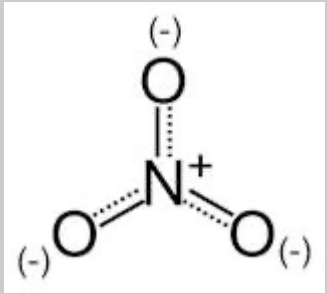
"Chemical"
Organic: from living things
Inorganic: from non living things
Synthetic: chemically synthesized
imitates a "natural product"
"Processed"

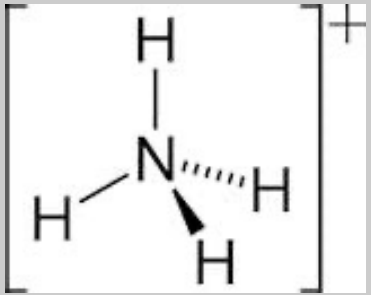
Chemistry of plant nutrition

Nitrate & ammonium from organic source
Nitrate & ammonium from synthetic source
Plants absorb nitrogen in two forms:

NH_4^+ & NO_3^-

Nitrate to Ammonium 2:1





Ammonium: NH_4^+ converts to $NO_3^- + H^+$

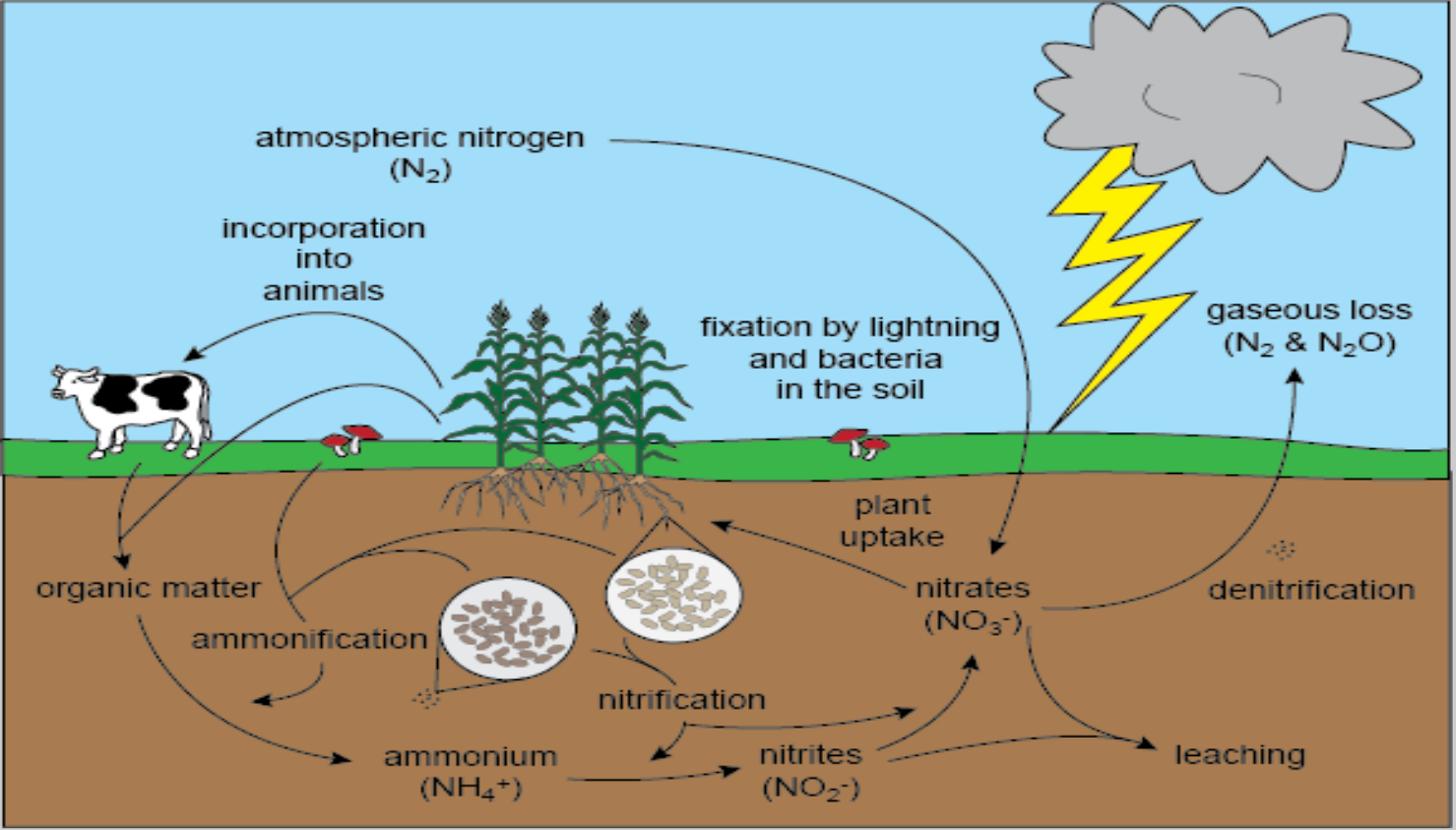
Mineralization (1) & Nitrification (2)

1. Organic compounds from OM are broken down leaving NH^{4+} (Ammonium)
2. Ammonia (NH^{3+}) and/or ammonium (NH^{4+}) is converted into nitrite (NO^{2-}) then nitrate (NO^{3-})

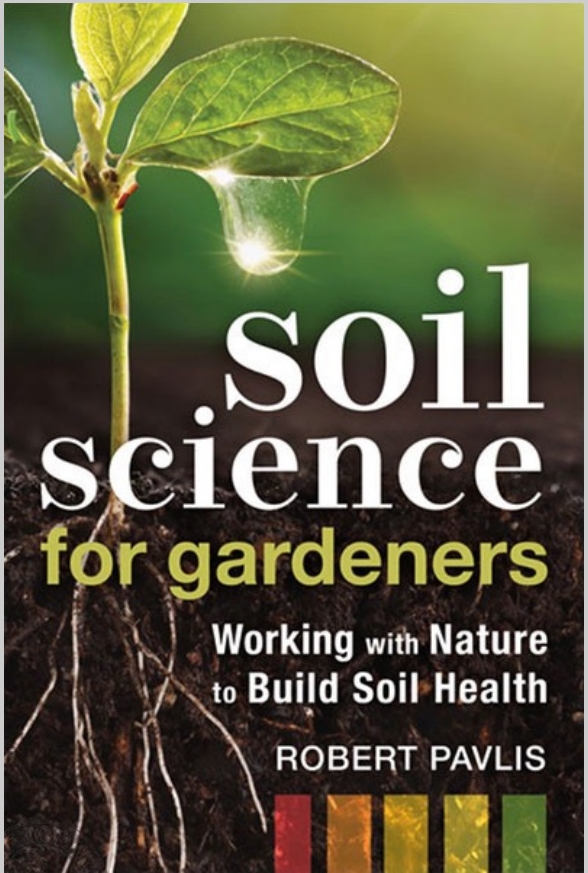
Occurs naturally in environment

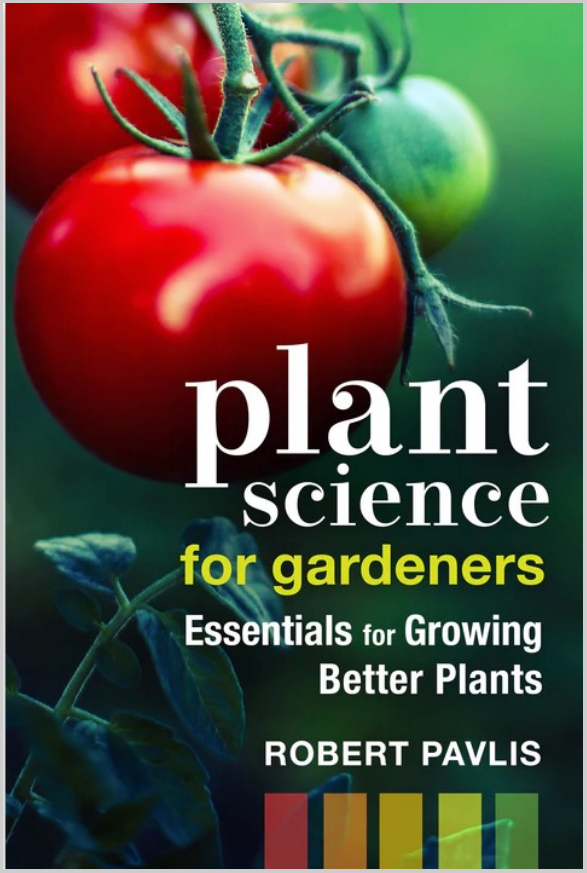
Various bacteria are responsible

Ammonium and/or ammonia is produced by the breakdown of Organic Matter – proteins - ammonium/ammonia


atmospheric nitrogen
(N_2)
incorporation
into
animals
fixation by lightning
and bacteria
in the soil
gaseous loss
(N_2 & N_2O)
plant
uptake
organic matter
ammonification
nitrates
(NO_3^-)
denitrification
nitrification
ammonium
(NH_4^+)
nitrites
(NO_2^-)
leaching

Recommended reading





brycehlane.com

Thanks for Your Attention!