Ask not what your soil can do for you, ask what you can do for your soil.

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What is soil anyway?

The Oxford English Dictionary offers several definitions, including:

- The earth or ground; the face or surface of the earth.
- The ground with respect to its composition, quality, etc., or as the source of vegetation.
- Fragmentary or unconsolidated material occurring naturally at or near the earth's surface, regardless of its suitability for plant life.
- Such material as will support the growth of plants, as contrasted with subsoil.

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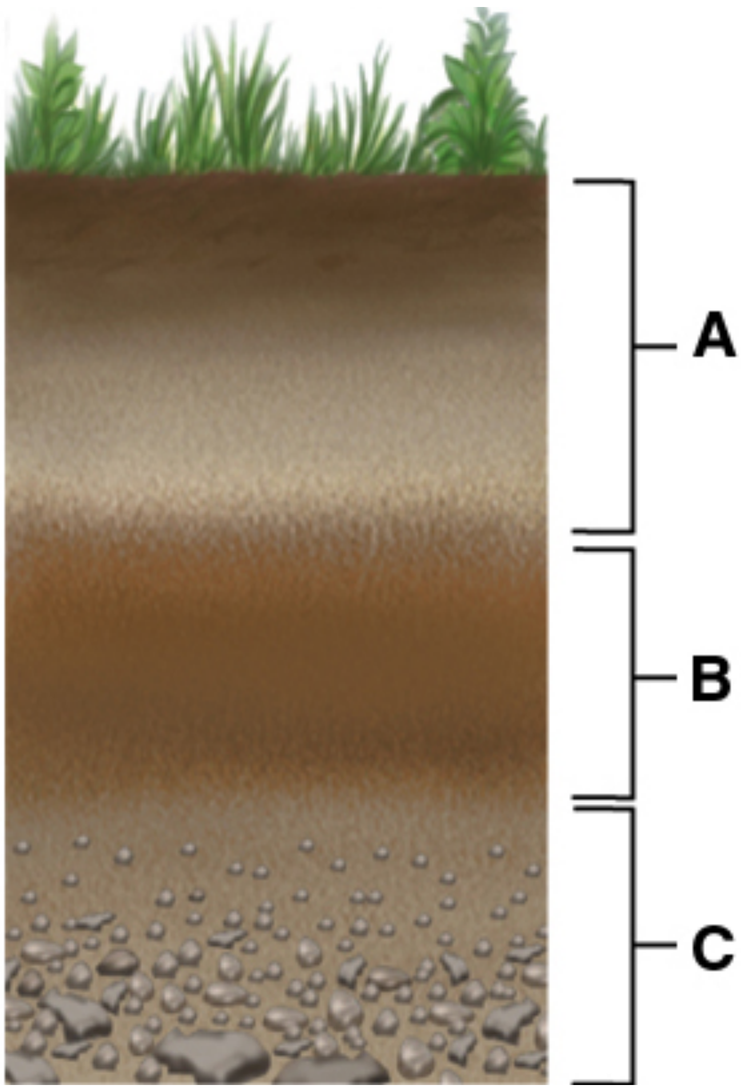
A general soil profile has three horizons.



- Fine-textured, loose organization
- Source of nutrients, water, and gas exchange for plants
- Zone with highest biological activity and organic matter
- Subject to leaching

- Compacted organization
- Much fewer roots and microorganisms
- Accumulates fine particles and leached salts

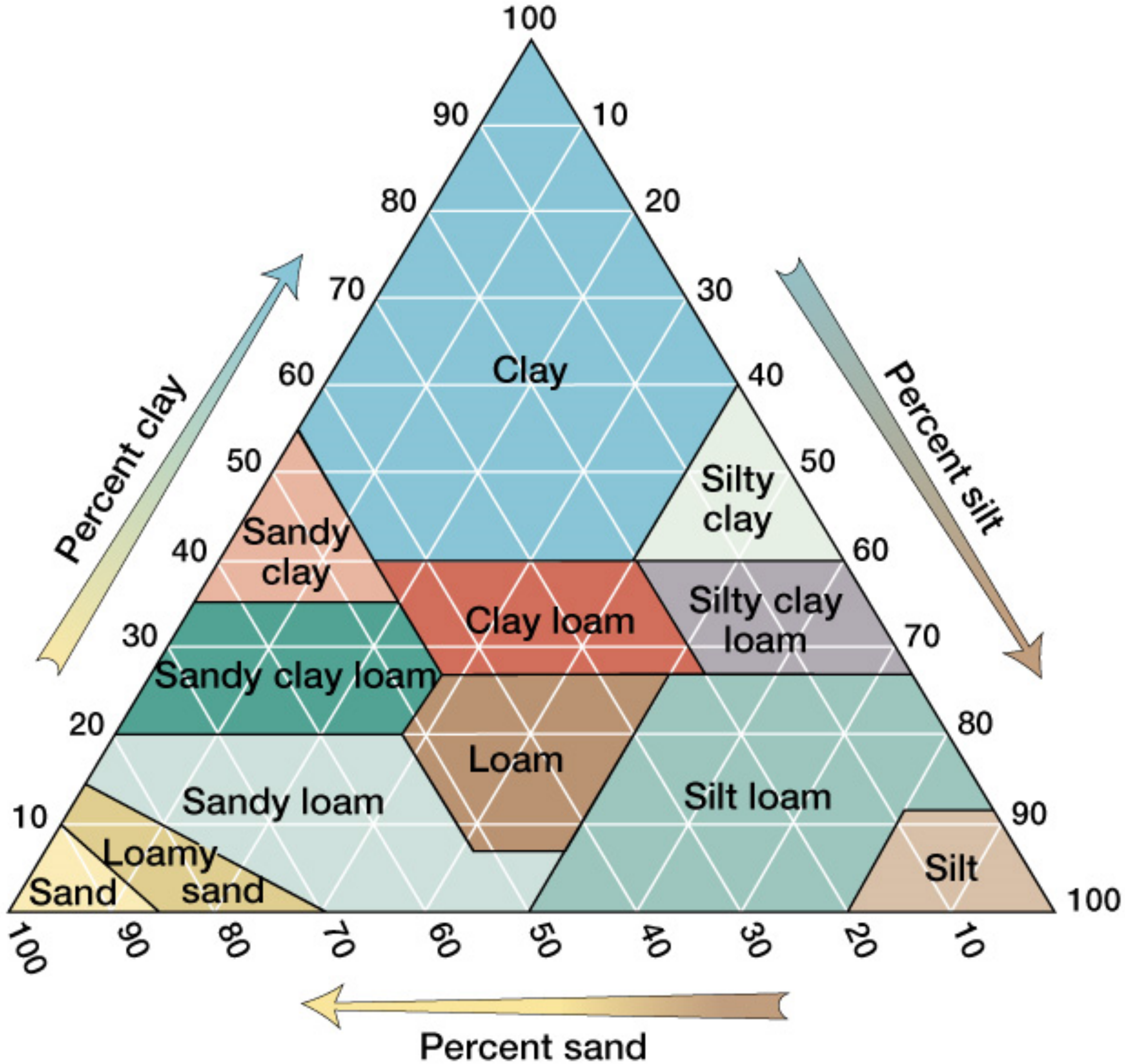
- Nearly solid rock
- Little or no biological activity

Soils are classified by texture.

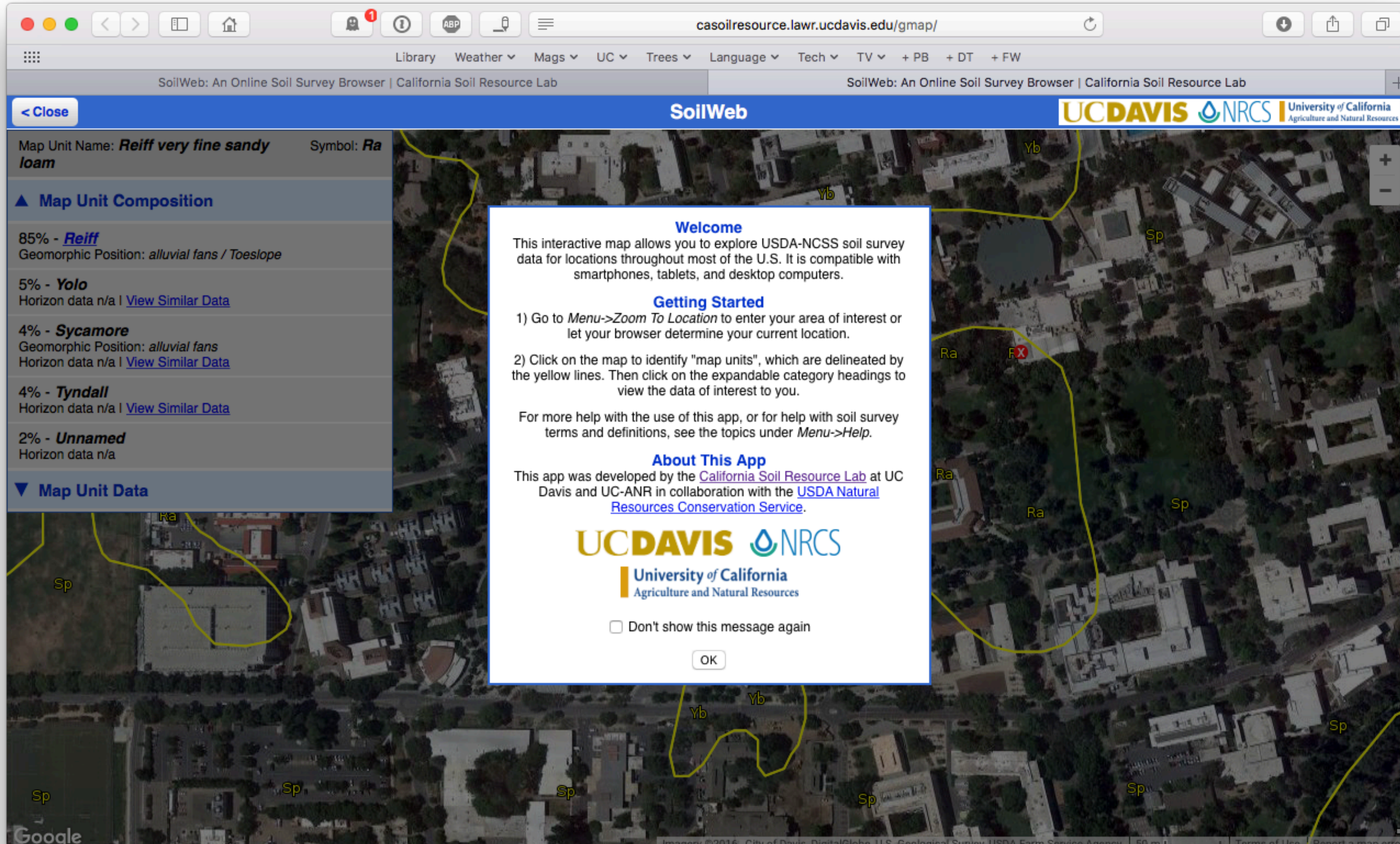
Particle type	Particle diameter (*mm*)	Surface area per g (*square inches*)
very coarse sand	2.0–1.0	1.7
coarse sand	1.0–0.5	3.5
medium sand	0.5–0.25	7.0
fine sand	0.25–0.10	14.1
very fine sand	0.10–0.05	35.2
silt	0.05-0.002	70.4
clay	< 0.002	1240002.5

That's over 8600 sq ft!

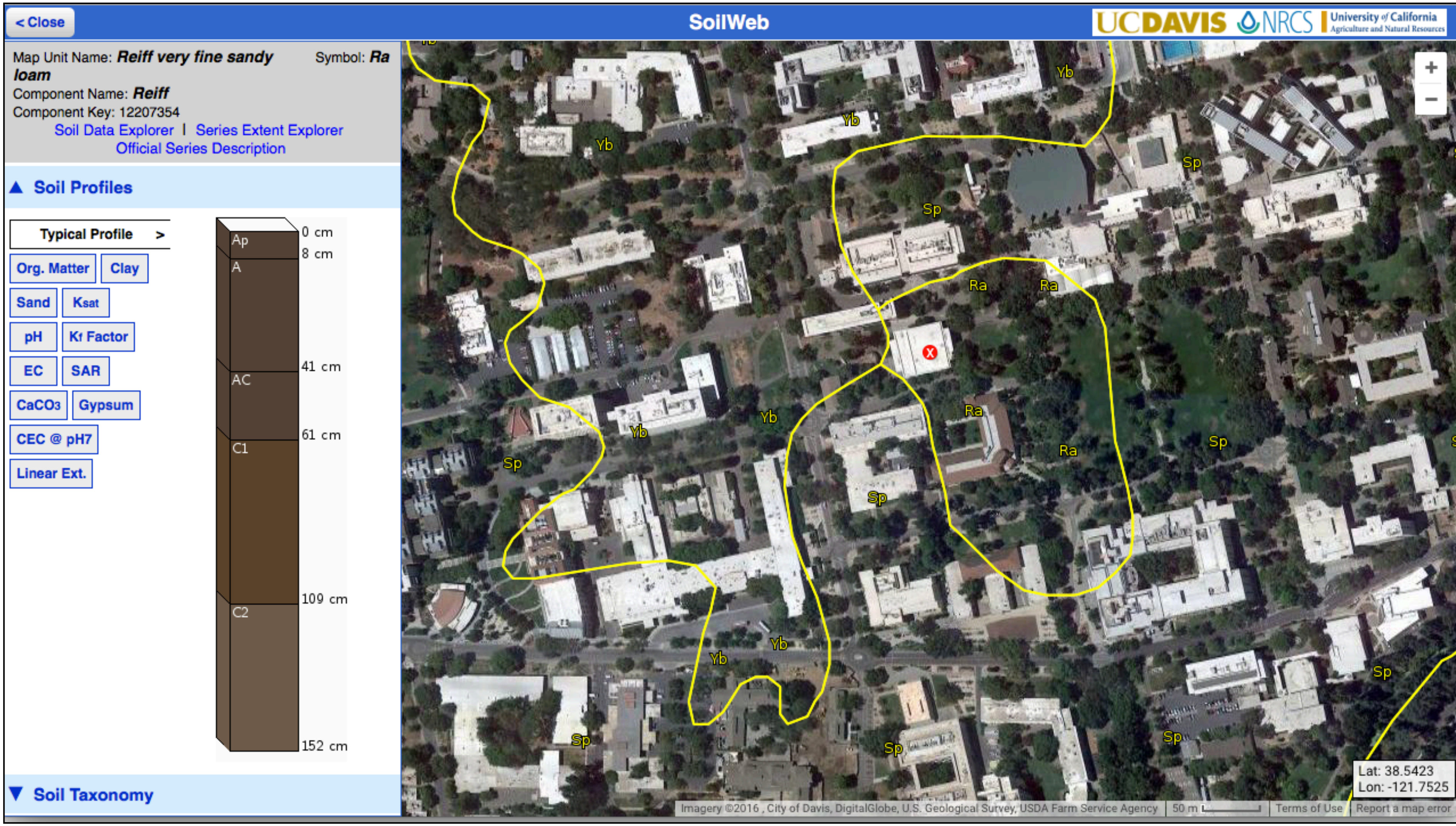
I’m sure you knew I’d show a soil texture triangle before the end of this talk.



You easily can look up your soil type!

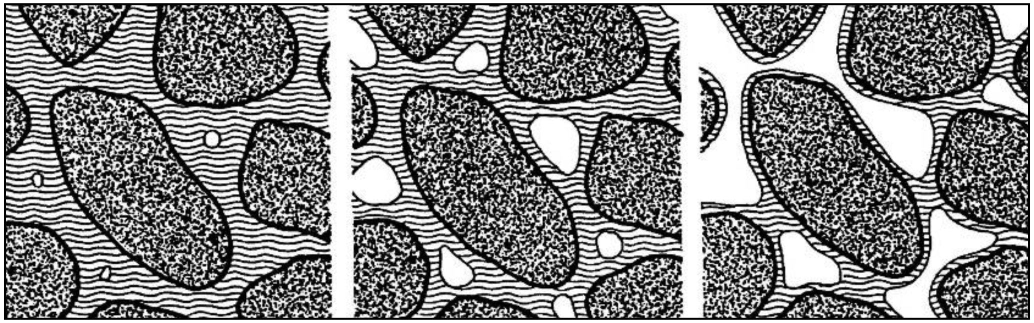


Wellman Hall covers a very fine sandy loam.



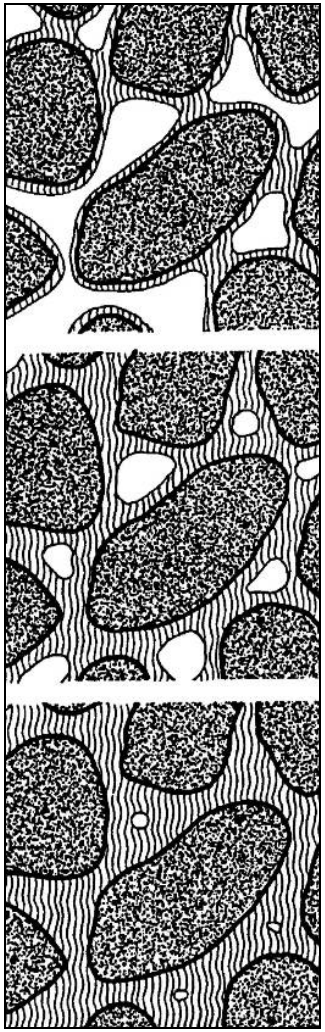
Clay particles aggregate to provide soil structure.

- Silt and sand particles may appear as inclusions in clay aggregates.
- Cations like calcium help to keep clay particles together.
- Organic polymers provide cement to stabilize structure.
- Each soil aggregate functions as a unit.
- Together, aggregates affect water and air movement, fertility, density, and root growth.



Structure affects water-holding capacity and available water.

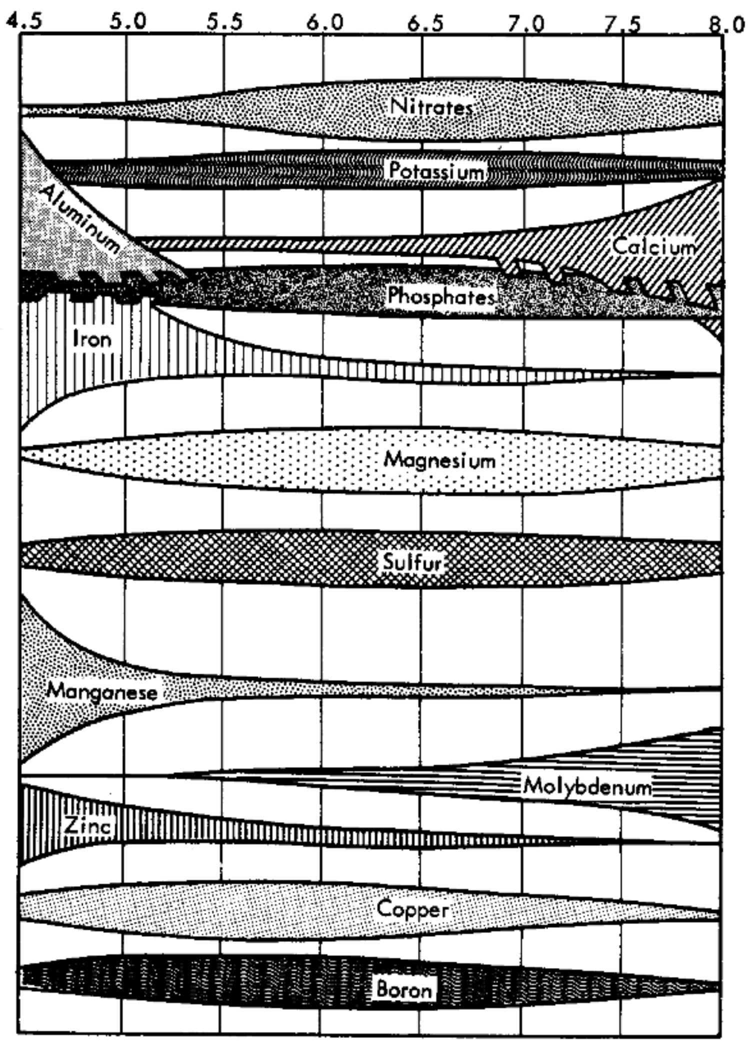
Texture	Available water (inches per foot)	Gallons of water per cu. ft. of soil
sand	0.5–1.0	0.3–0.7
sandy loam	1.0–1.5	0.7–1.0
clay loam	1.5–2.0	1.0–1.3
clay	1.5–2.5	1.0–1.7



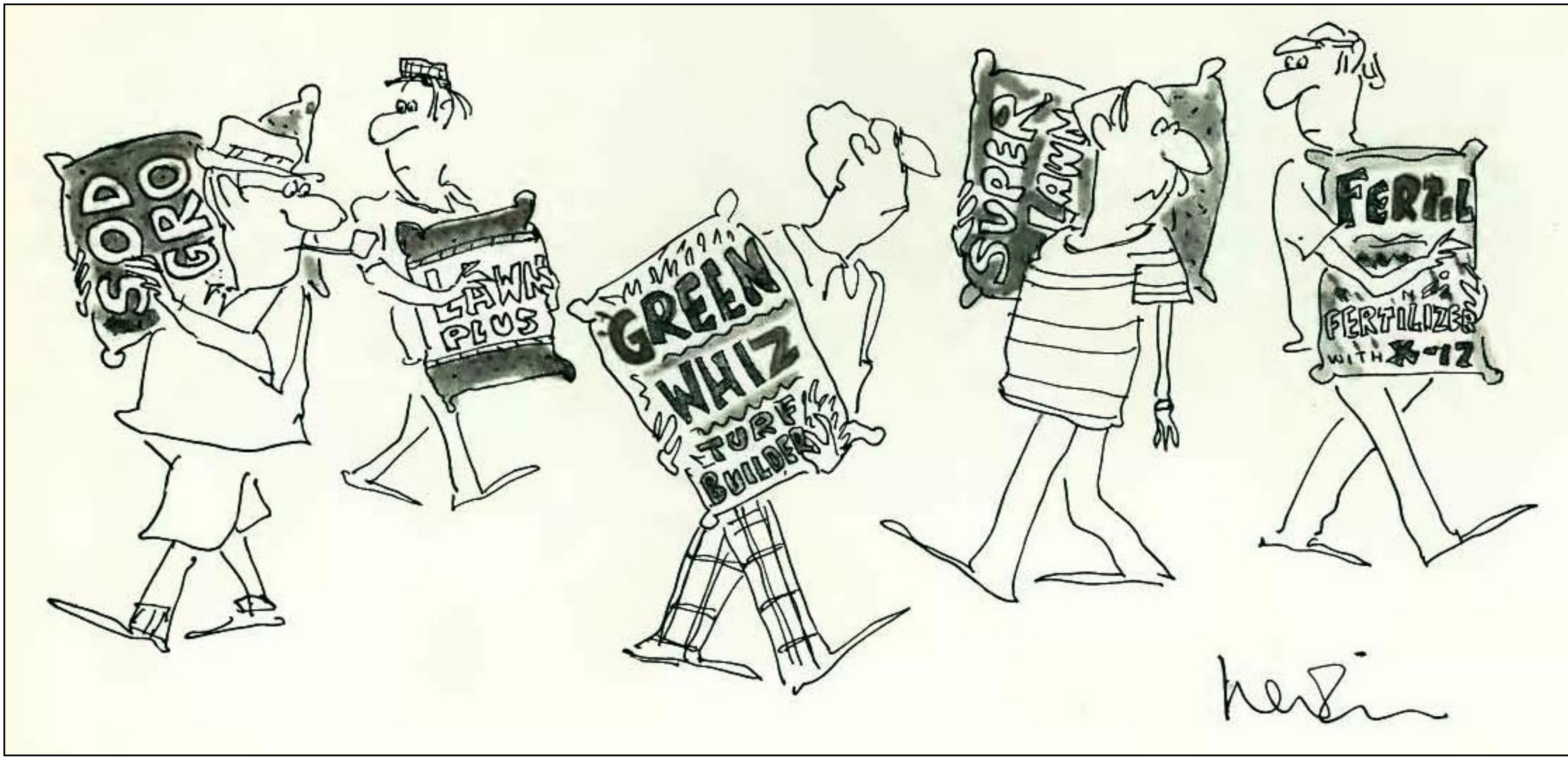
Most essential plant nutrients come from soil.

Element	Symbol	Nutrient type	Uptake	Leaf content (% dry wt)
Carbon	C	Non-fertilizer		
Hydrogen	H	Non-fertilizer		89.0
Oxygen	O	Non-fertilizer		
Nitrogen	N	Macronutrient	NO_3^-, NH_4^+ in soil solution	4.0
Potassium	K	Macronutrient	K^+ in soil solution	4.0
Calcium	Ca	Macronutrient	Ca^{2+} in soil solution	1.0
Phosphorus	P	Macronutrient	Phosphates in soil solution	0.5
Magnesium	Mg	Macronutrient	Mg^{2+} in soil solution	0.5
Sulfur	S	Macronutrient	SO_4^{2-} in soil solution	0.5
Chlorine	Cl	Micronutrient	Cl^- in soil solution	0.1
Sodium	Na	Micronutrient	Na^+ in soil solution	0.03
Iron	Fe	Micronutrient	Ion or chelate in soil solution	0.02
Manganese	Mn	Micronutrient	Ion in soil solution	0.02
Boron	B	Micronutrient	Boric acid or borate ion	0.006
Zinc	Zn	Micronutrient	Ion or chelate in soil solution	0.003
Copper	Cu	Micronutrient	Ion or chelate in soil solution	0.001
Molybdenum	Mo	Micronutrient	Ion or chelate in soil solution	0.0002

Soil pH affects nutrient availability and chemical toxicity.



That’s what soil can do for you. What can you do for your soil?



That's what soil can do for you. What can you do for your soil?

- You can lower the soil pH, if desired, by about 1 unit by adding soil sulfur at a rate of 20–40 lb. per 100 sq. ft.
- You can treat sodic soils (high in sodium) by adding gypsum (calcium sulfate) at a rate of about 20 lb. per 100 sq. ft. and watering thoroughly.
- Nitrogen (and maybe phosphorus) are the only plant nutrients that normally need to be supplied in fertilizer.

Your dog can pitch in.

- There are about 83 million dogs in the U.S.
- A dog produces 185 g (dry weight) of poop each day
- The dog poop fertilizer analysis is 0.75 - 0.25 – 0.02
- Therefore dogs poop about 1.4 g of N each day

$$\frac{1.4\ \text{g N/dog}}{\text{day}} \times \frac{1\ \text{lb}}{454\ \text{g}} \times \frac{365\ \text{days}}{\text{year}} \times 83{,}000{,}000\ \text{dogs} = 93{,}420{,}705\ \text{lb N per year}$$

$$\frac{93{,}420{,}705\ \text{lb N}}{\frac{175\ \text{lb N}}{\text{acre}}} = 533{,}833\ \text{acres} = 834\ \text{sq. miles of turf}$$

One dog can fertilize a 280 square foot lawn.
That's 3.6 dogs per 1000 square feet.
You might need a fan to get even coverage.

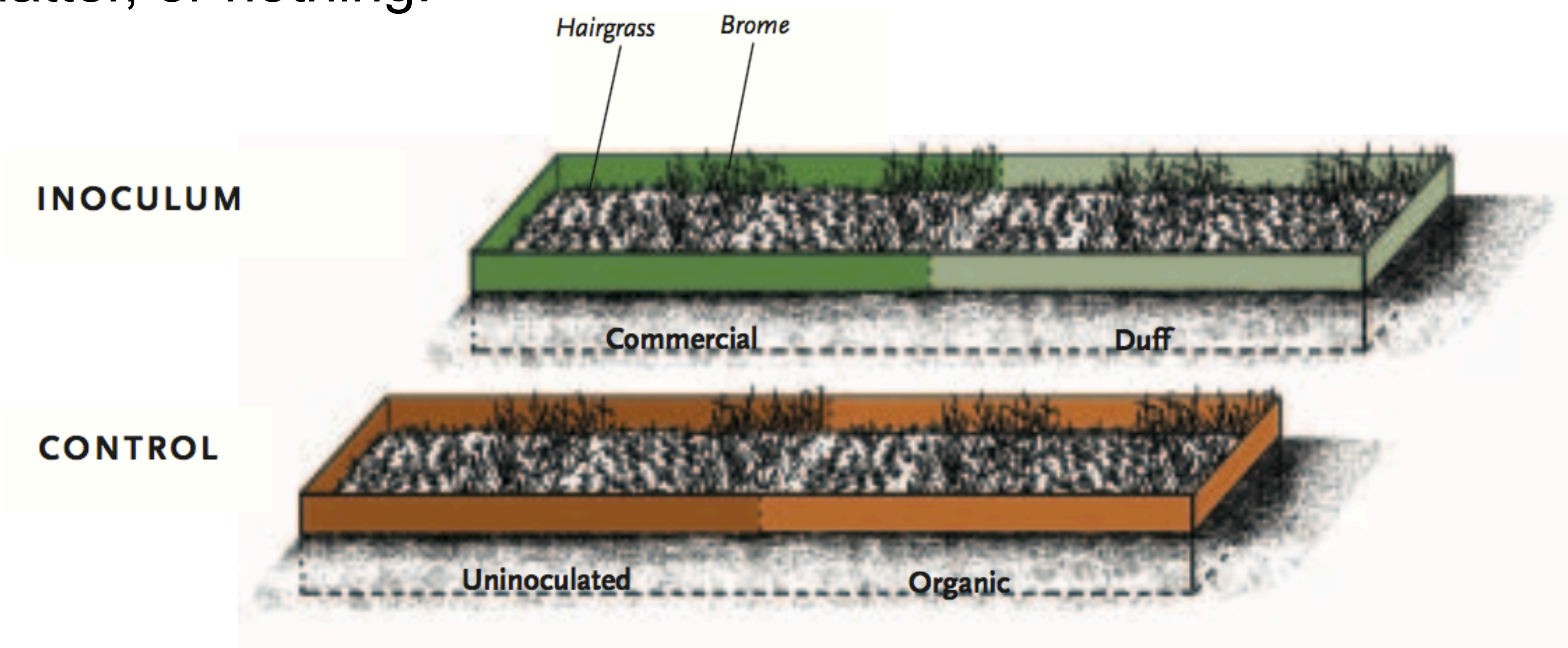
You can add organic matter to maintain or improve soil structure.

- You have to add at least 30% by volume to improve soil physical properties.

% Amendment	Amount needed (cu yd/1000 sq ft) to amend soil to specified depth	
	6 inches	9 inches
30	5.6	8.3
40	7.4	11.1
50	9.3	13.9

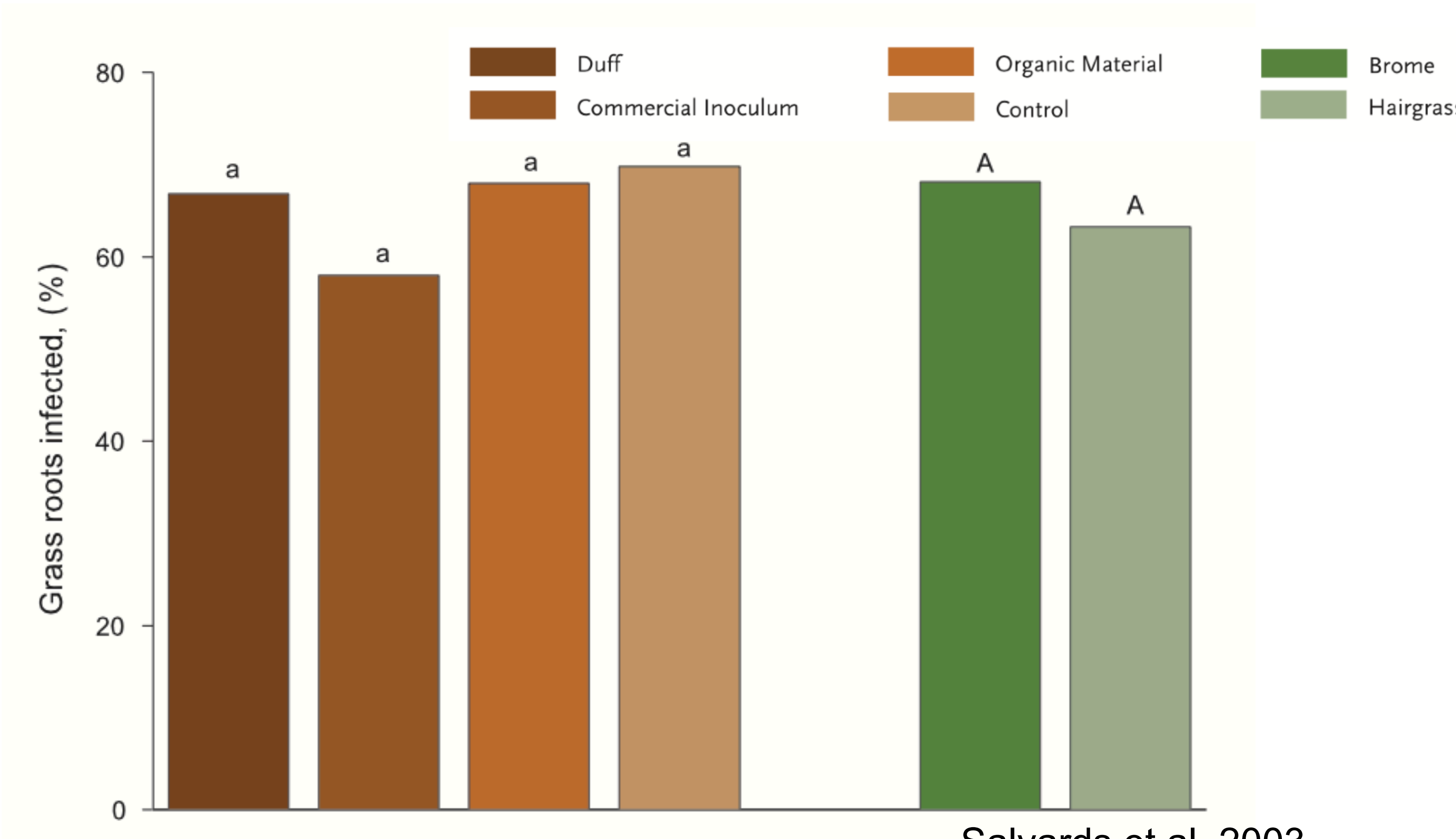
What about messing around with the soil microorganisms?

Jim Salyards sterilized a sandy loam soil, then treated with a commercial mycorrhizal inoculum, forest duff, organic matter, or nothing.



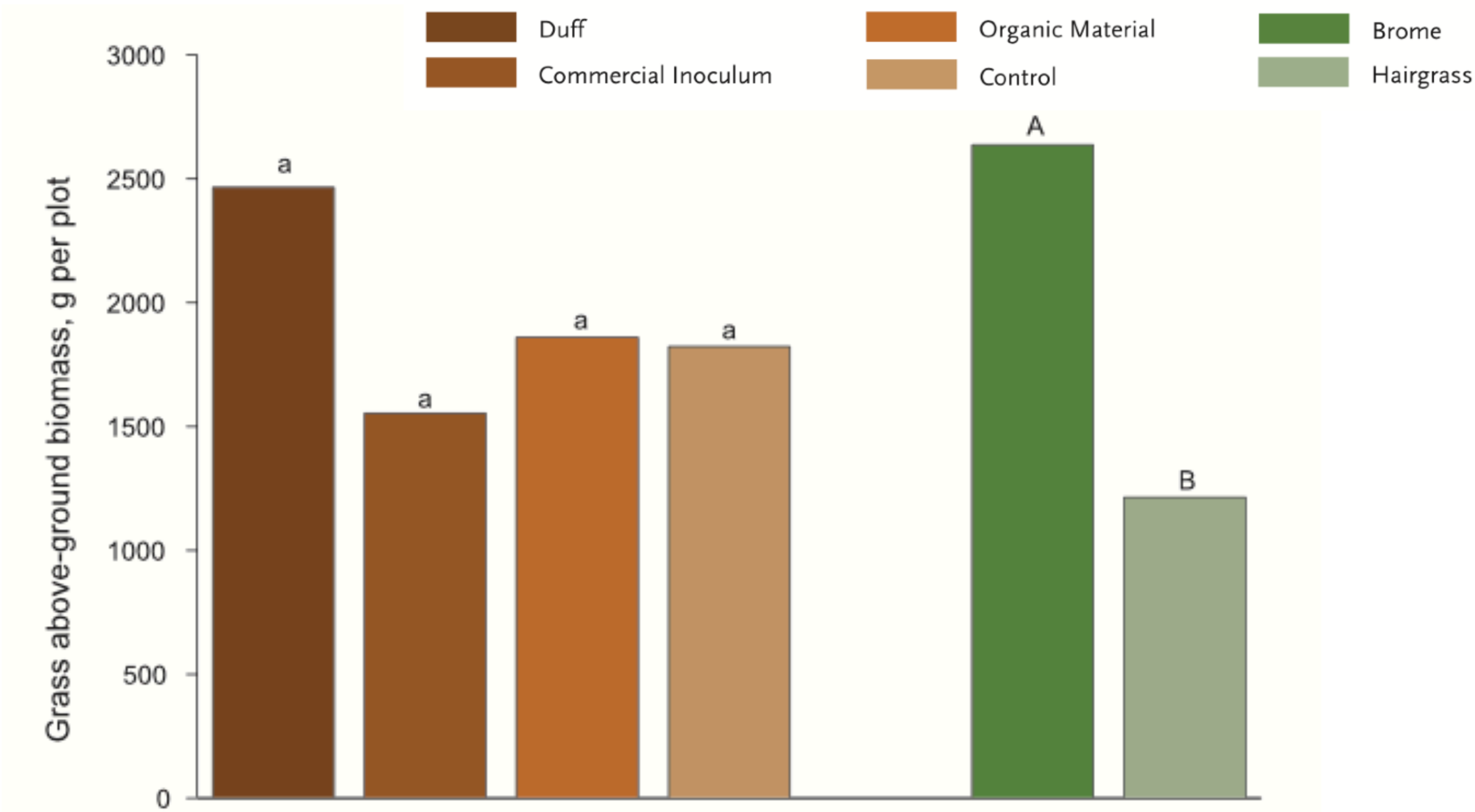
Salyards et al. 2003

After 68 weeks, there were no significant treatment effects on percentage of mycorrhizal grass roots.



Salyards et al. 2003

After 95 weeks there were no significant effects on biomass of the grasses.



Salyards et al. 2003

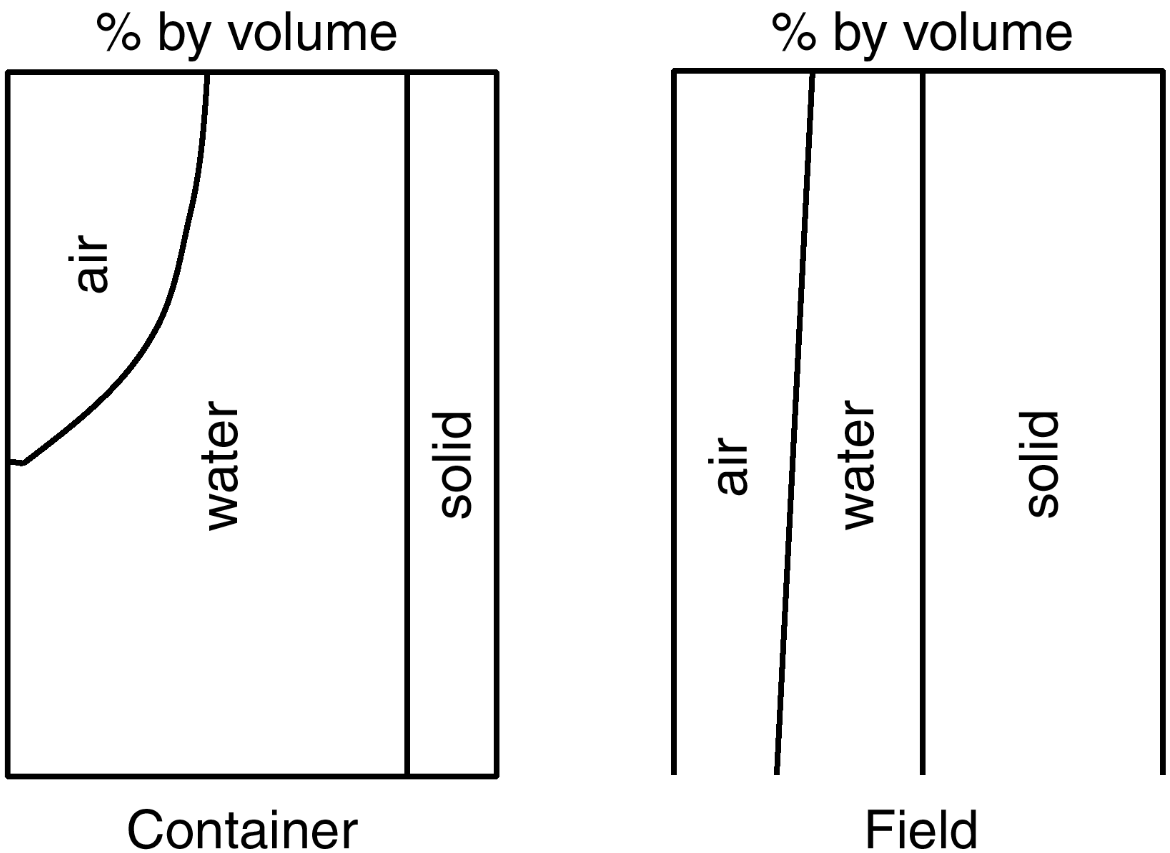
Summary

- **Let your soil do its thing.**
  - Till only when necessary.
  - Avoid soil compaction.
  - Promote good soil structure by adding organic matter and allowing soil wetting–drying cycles.
- **Help your soil when necessary.**
  - Add nitrogen (and phosphorus) if you remove a lot of plant material.
  - Keep soil pH below about 7.6.
  - Maintain soil organic matter.

What's so special about container media?

Stress	Container	Time	Field	Time
Water	Saturation to wilt	1-3 days	Field capacity to wilt	1-3 weeks
Aeration	Low to high	1 day	Adequate to high	Season
Nutrition	High to low	1 week or less	High to low	Season
pH	±1-2 units	1-3 weeks	Fairly constant	Season
Salinity	Chronic low to high	3-4 weeks	Low to high	Season
Temperature	40-50° change	1 day	Fairly constant	Season
Root disease	More susceptible		Less susceptible	

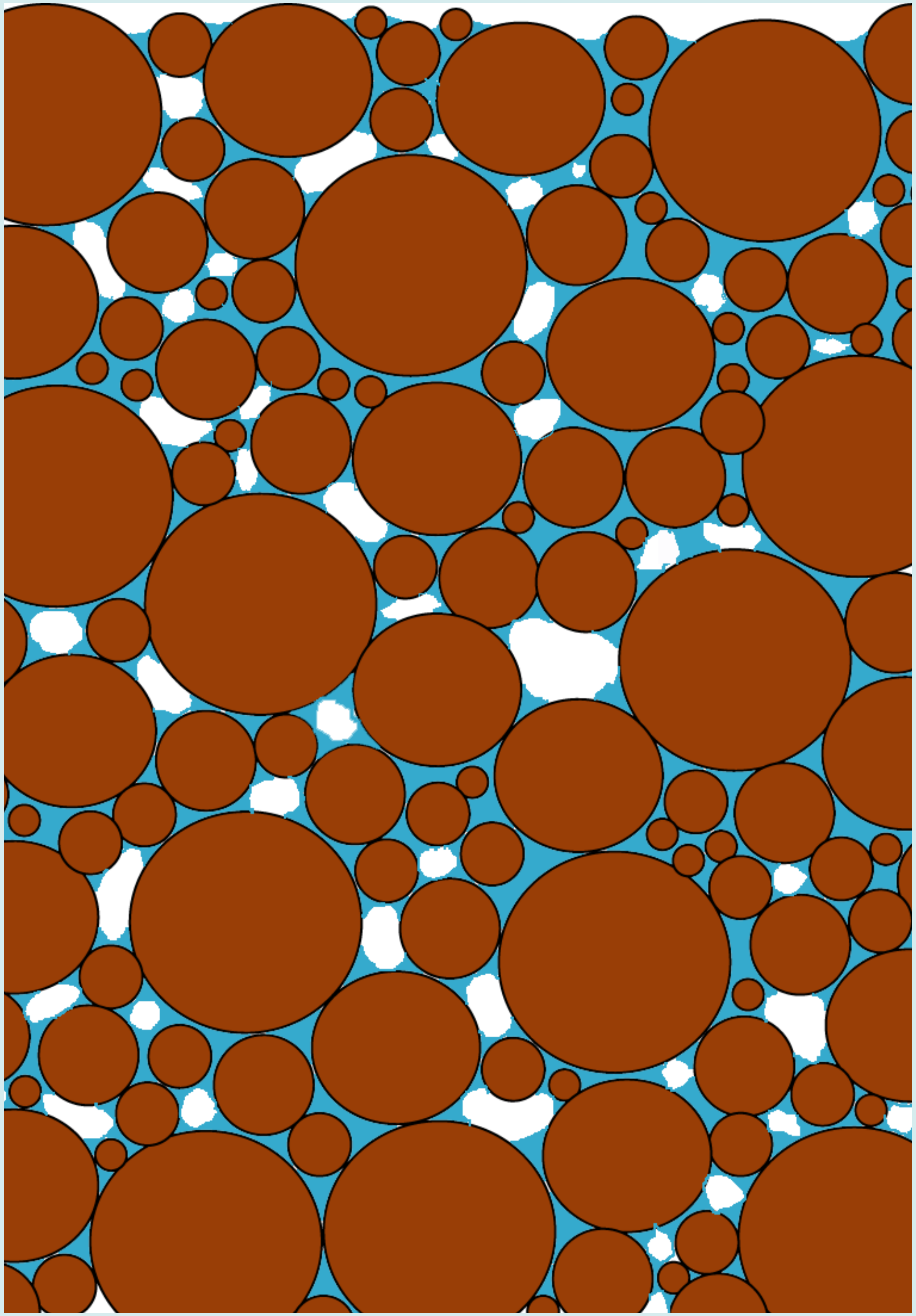
Soil and potting mixes have different distributions of air, water, and solids.



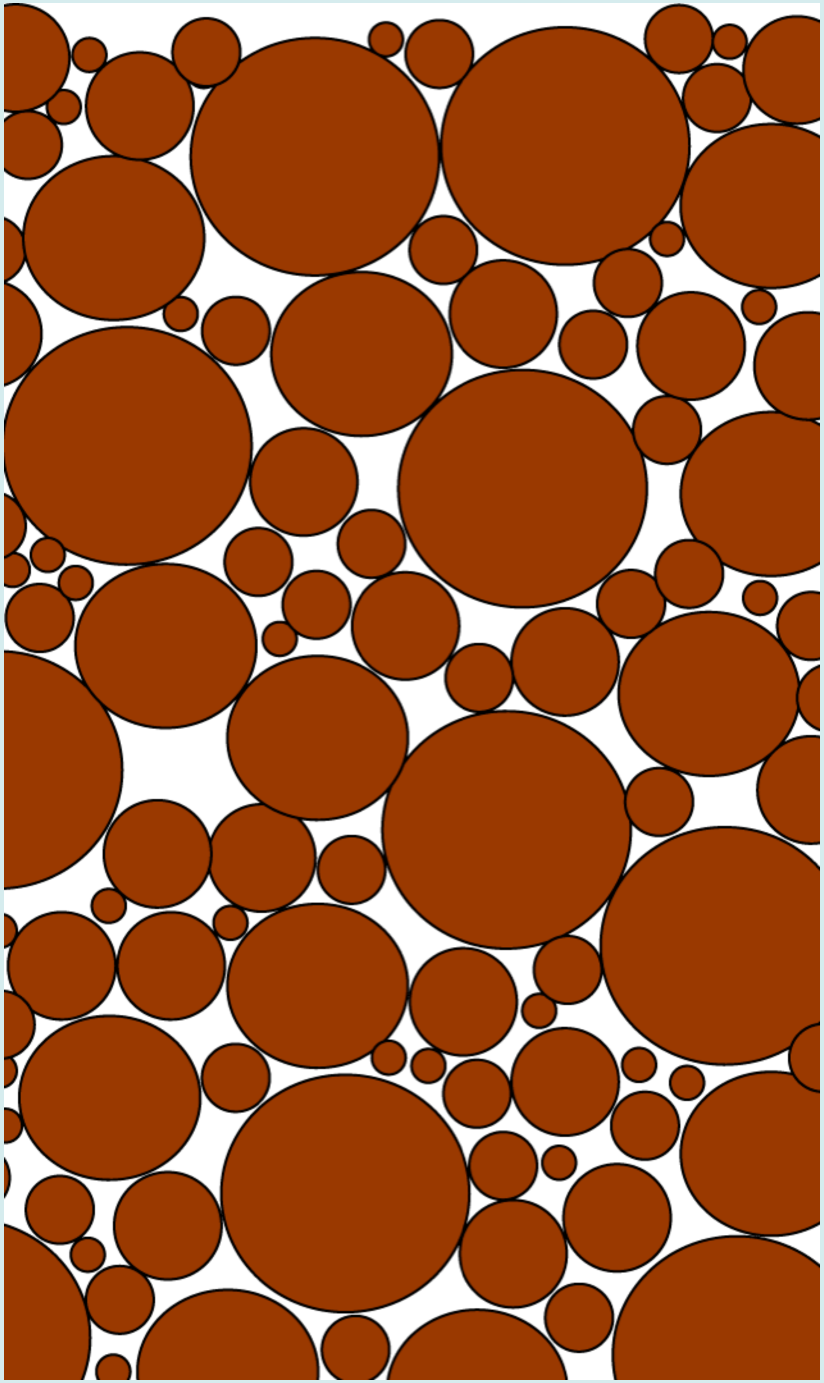
Drainage in a field:

Water is pulled downward into drier soil by capillary action.

Large pores fill with air throughout the profile.

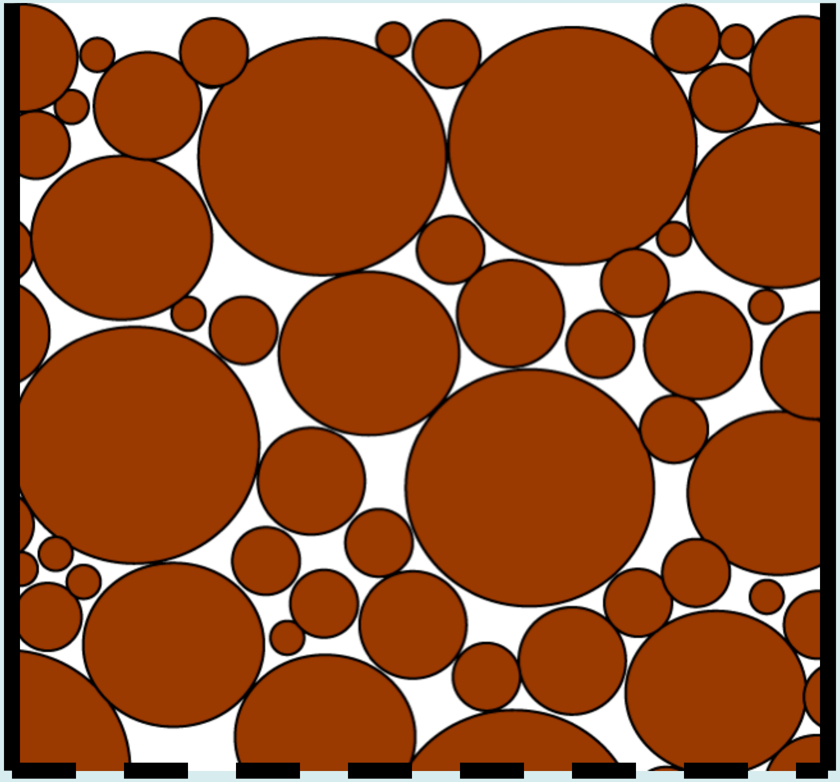


Drainage is different in a container.

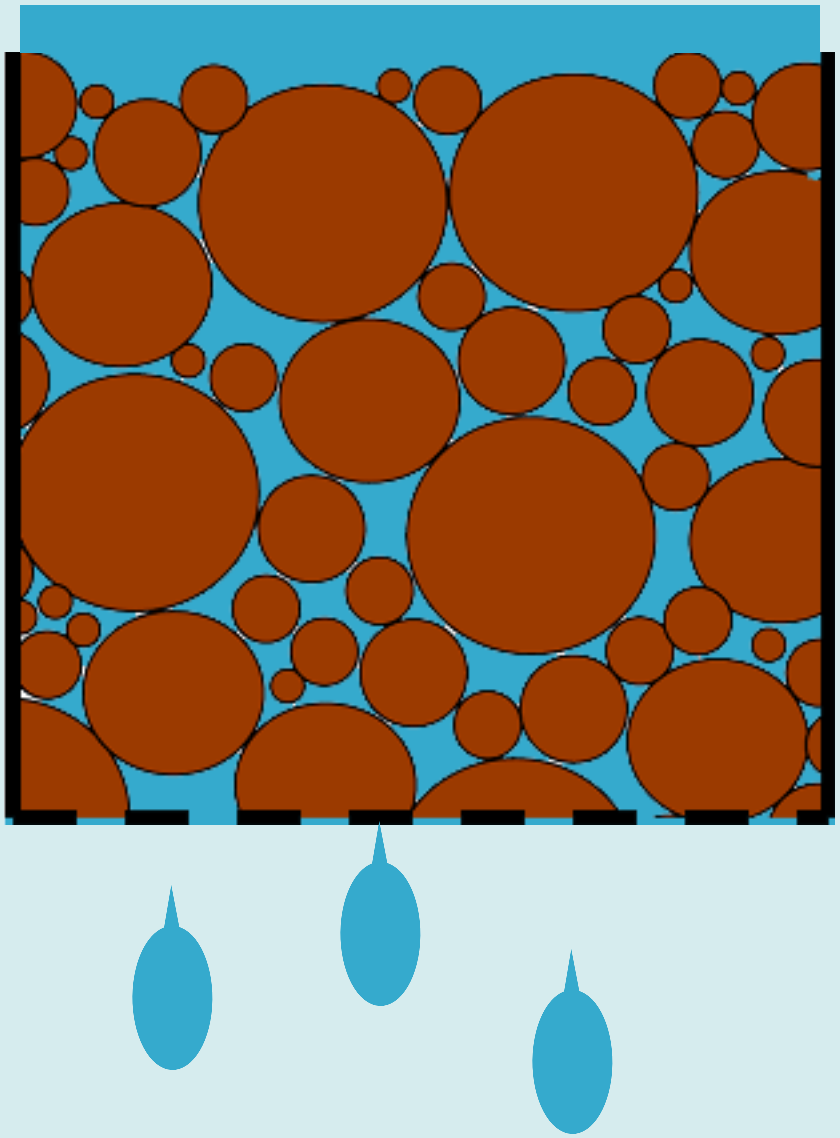


Drainage is different in a container.

There is no drier soil in contact with the bottom of the pot.

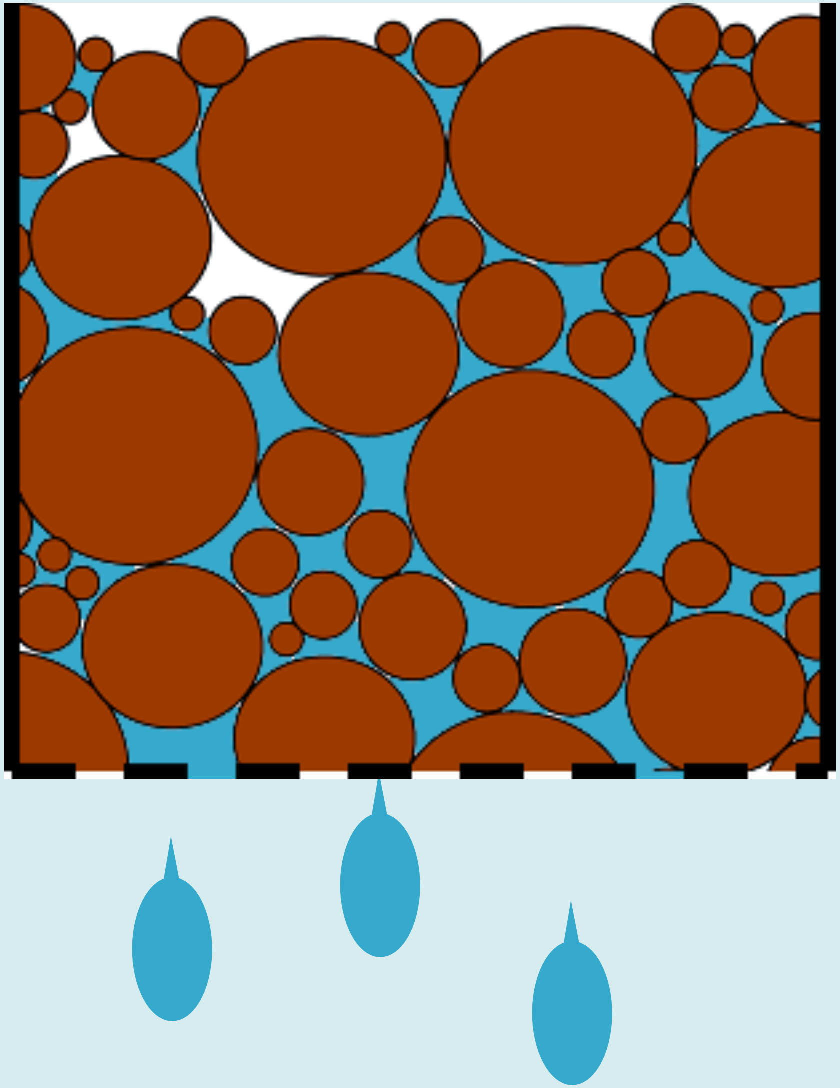


Water doesn't drain until the pot is saturated.

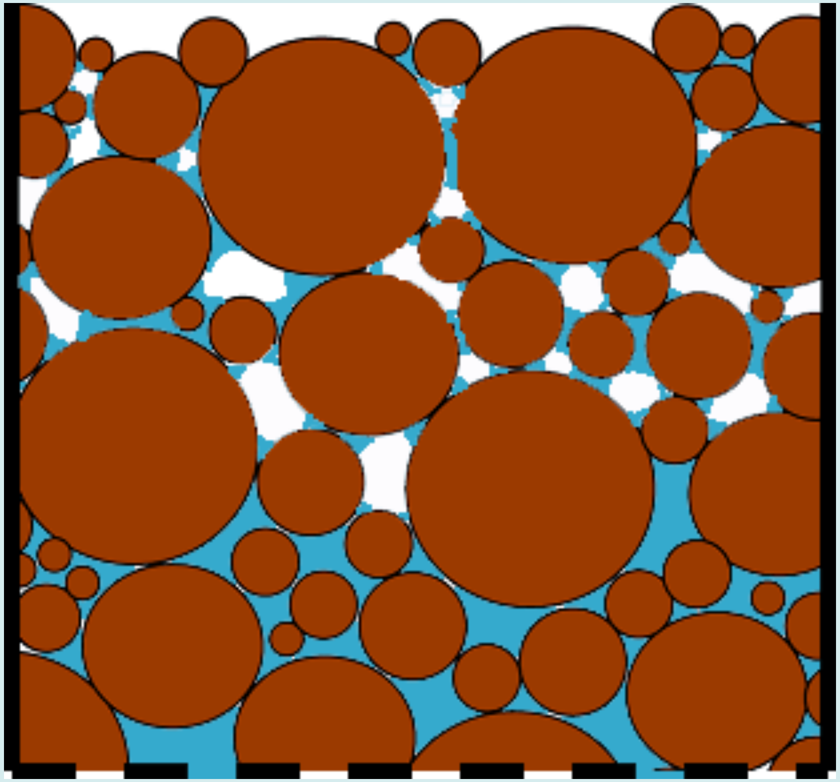


Drainage is due only to gravity acting **downward**.

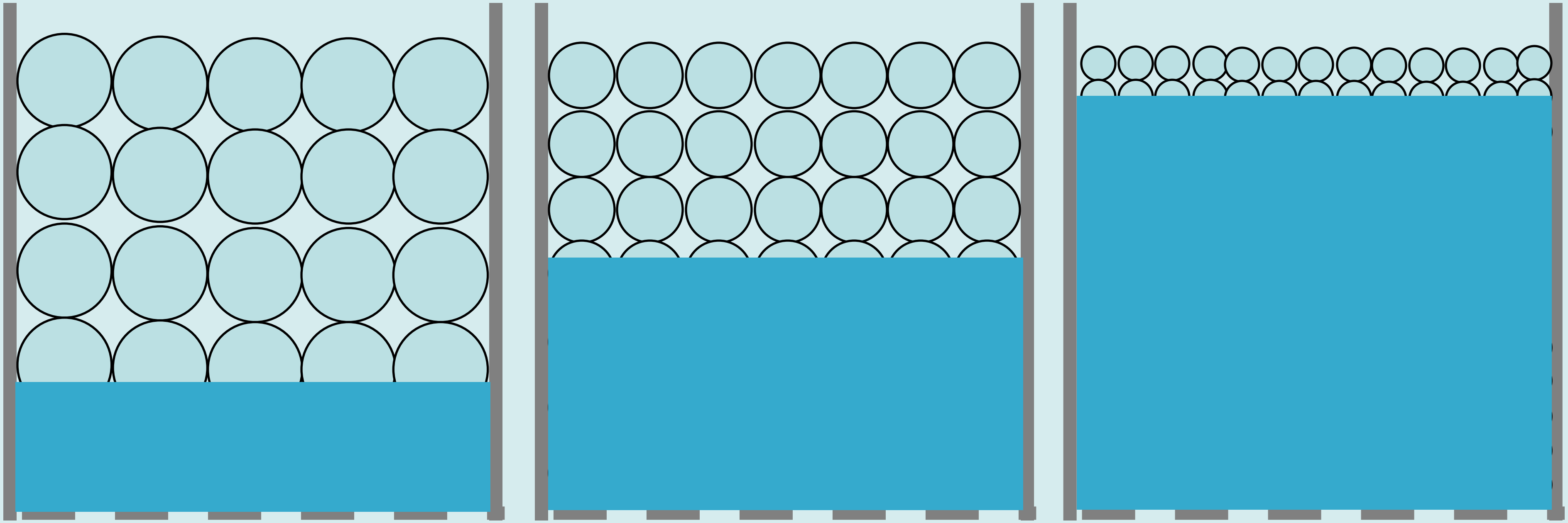
Some water is held against drainage by capillary rise acting **upward**.



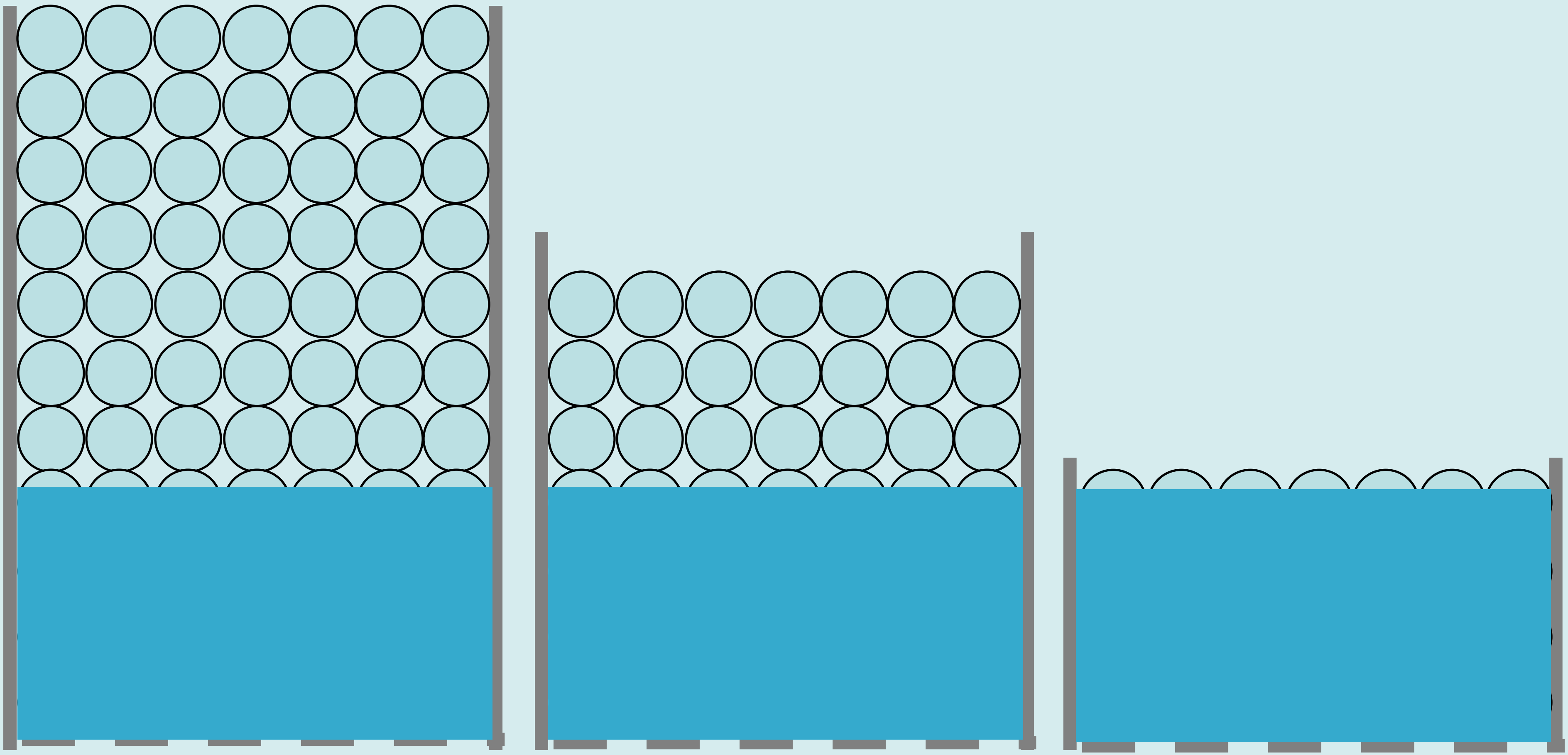
The upper part of the pot may be well aerated, but the bottom is **always saturated** immediately after drainage.



The height of the saturation zone depends on particle size.



The height of the saturation zone doesn't depend on container height.



Physical properties of some retail mixes

	Total Porosity %	Container Capacity %	Air-filled Porosity %	Bulk Density g/cm^3	Wet Weight lb/ft^3
Desired Minimum	50	40	10		
49'er Potting Soil	84	70	14	0.30	62
49'er Moisture Mix	86	79	7	0.25	65
Black Gold Bonsai Mix	84	64	20	0.34	61
Black Magic Potting Soil	88	67	21	0.22	56
Envee All Purpose	90	63	27	0.19	51
Nurseryman's Gardener's	84	53	31	0.29	51
GreenAll Orchid Mix	82	71	11	0.36	67
Master Nursery Potting	85	73	12	0.27	63
Rainbow Potting Soil	76	68	8	0.56	77
Schultz Potting Soil Plus	85	64	20	0.33	61
Sunshine Seedstart	95	72	23	0.09	50
Supersoil	88	70	18	0.21	57
Whitney Farms Seed	88	66	22	0.28	59
UC Mix	75	58	17	0.67	71

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Whitney Farms Seed	88	66	22	0.28	59
UC Mix	75	58	17	0.67	71

Sand

- High water-holding capacity
- High bulk density
- Usually chemically inert
- Inexpensive
- Best if particle size is 0.25 to 2 mm
- Avoid excessive fine particles

Bark and sawdust

- Softwoods are more stable than hardwoods
- Low bulk density
- Acidic
- Stable if composted
- Best if particle size is 0.5 to 2 mm

Here's a classic recipe for a 1 part sand + 2 part organic matter mix.

Fertilizer or amendment	Analysis	lb/cu yd
Potassium nitrate (KNO_3)	13-0-46	1
Single superphosphate	0-20-0	2
Dolomite		5
Ferrous sulfate ($FeSO_4 \times 7H_2O$)		1