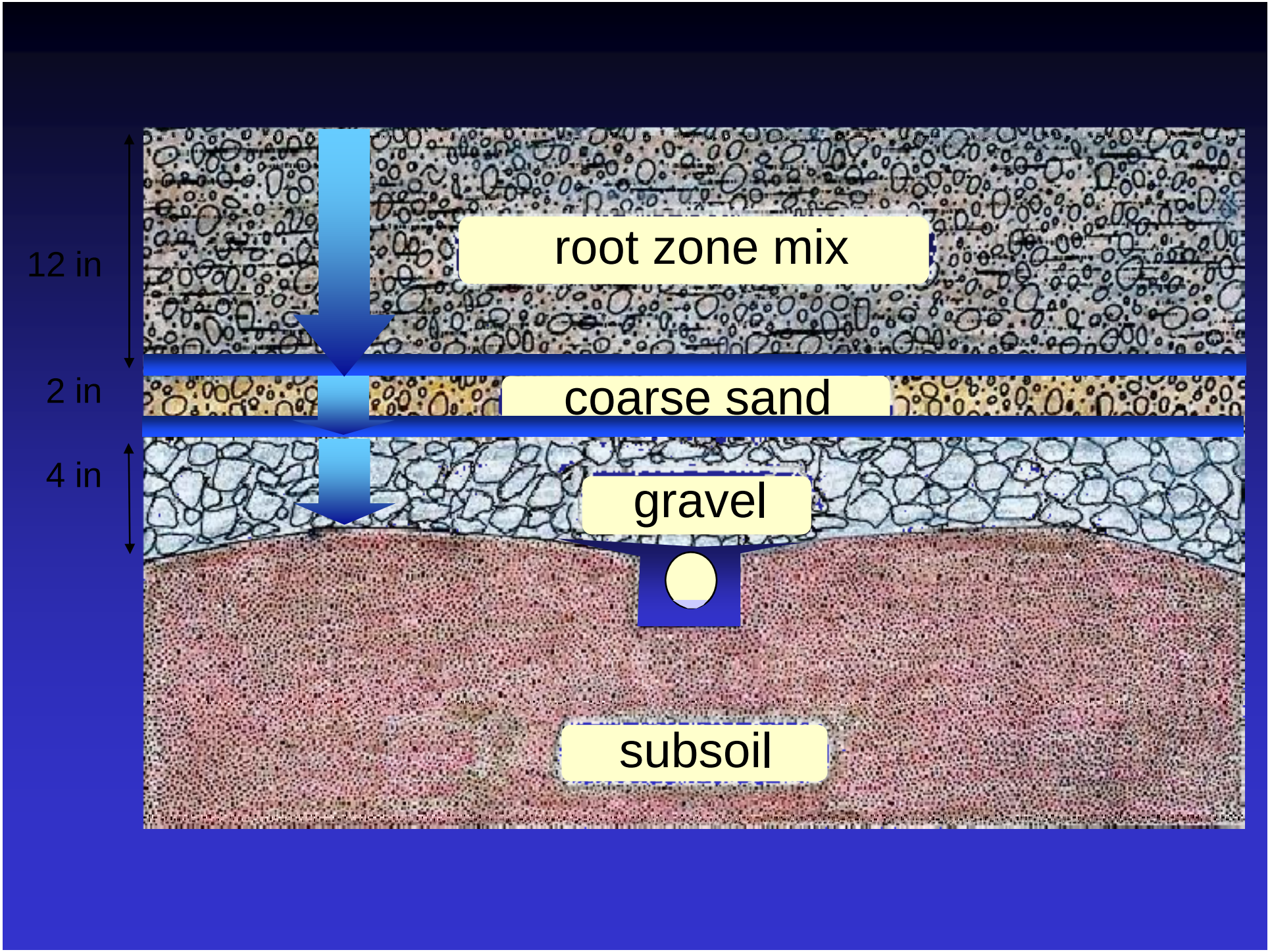
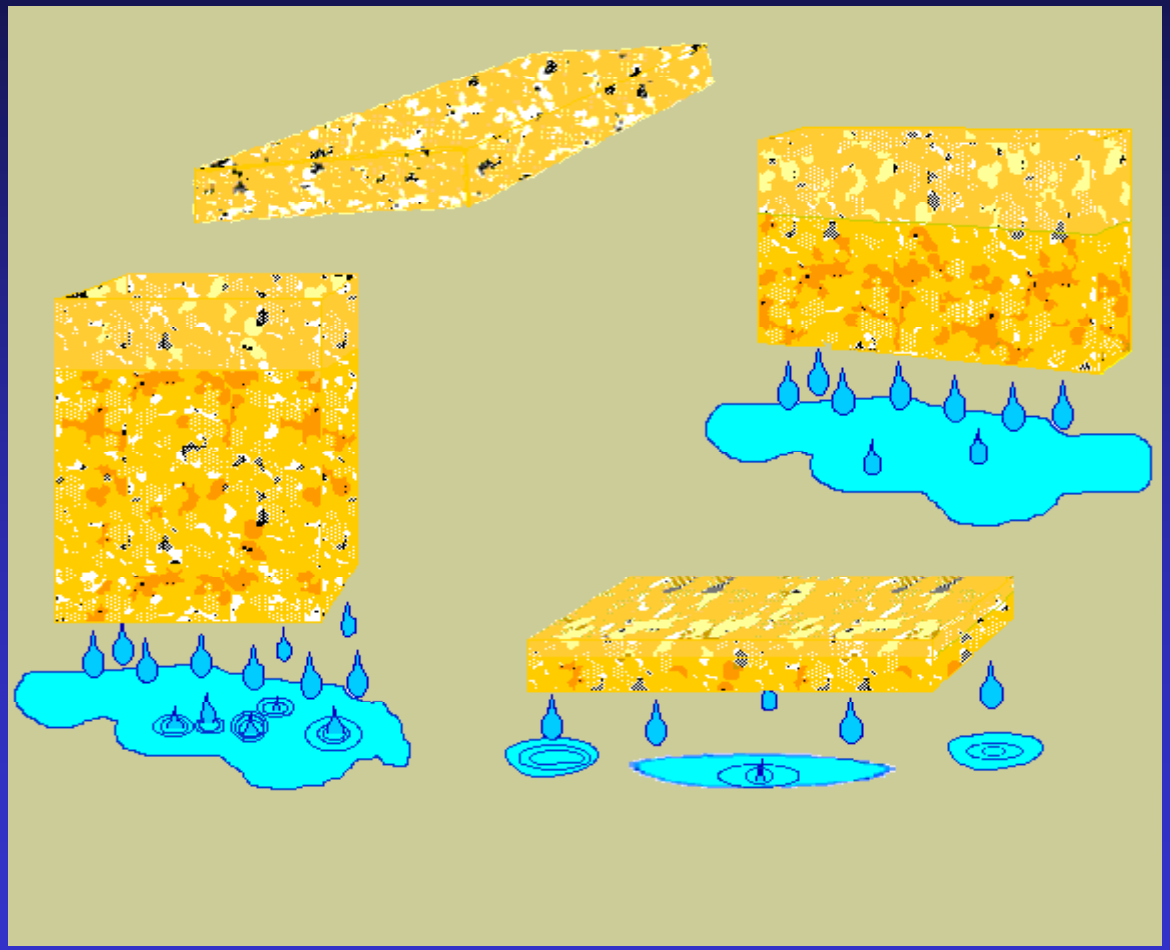
Greens Construction

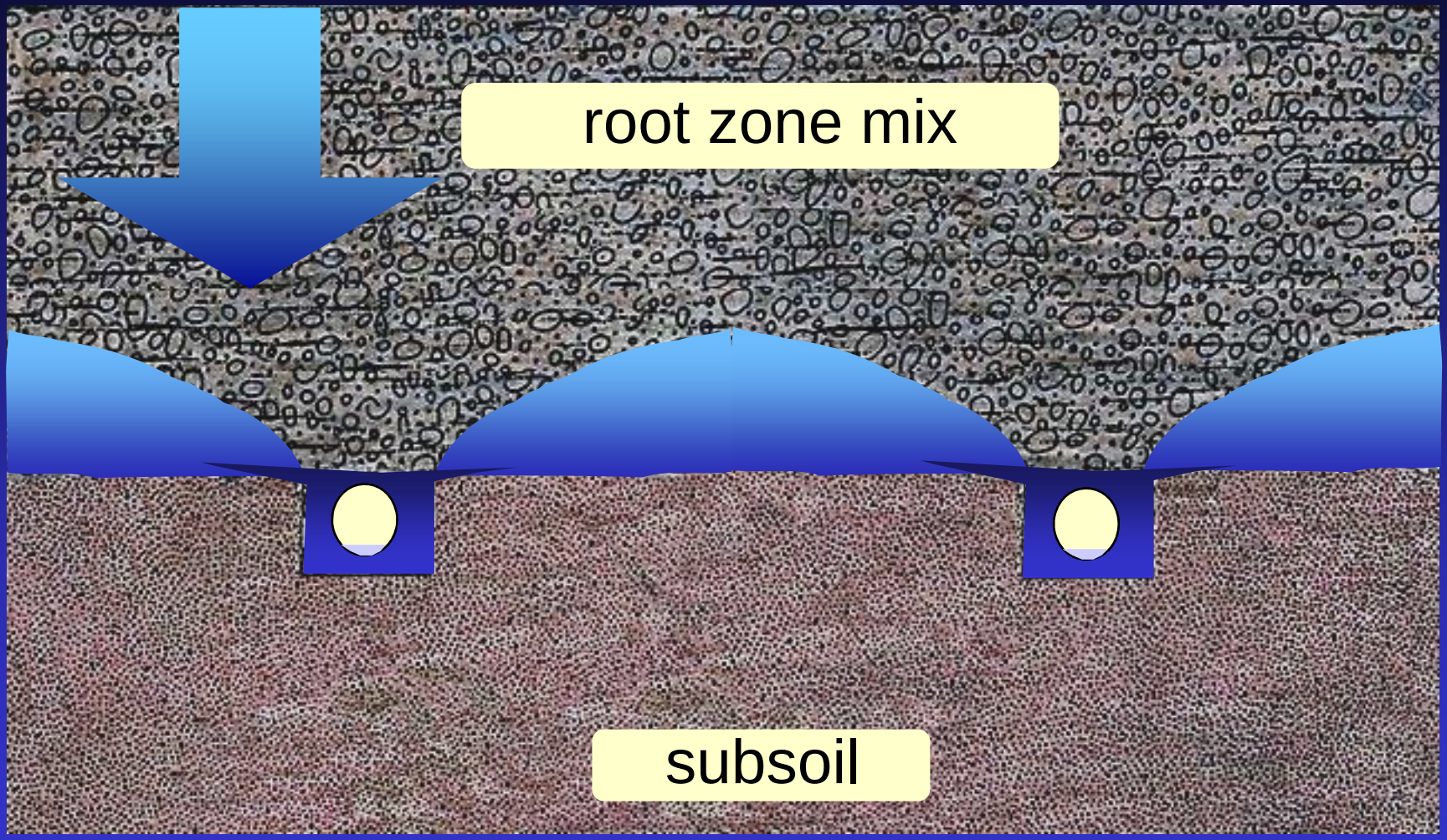
- USGA?
- Califoronia?


12 in
2 in
4 in
root zone mix
coarse sand
gravel
subsoil

Sponge Analogy



California Method



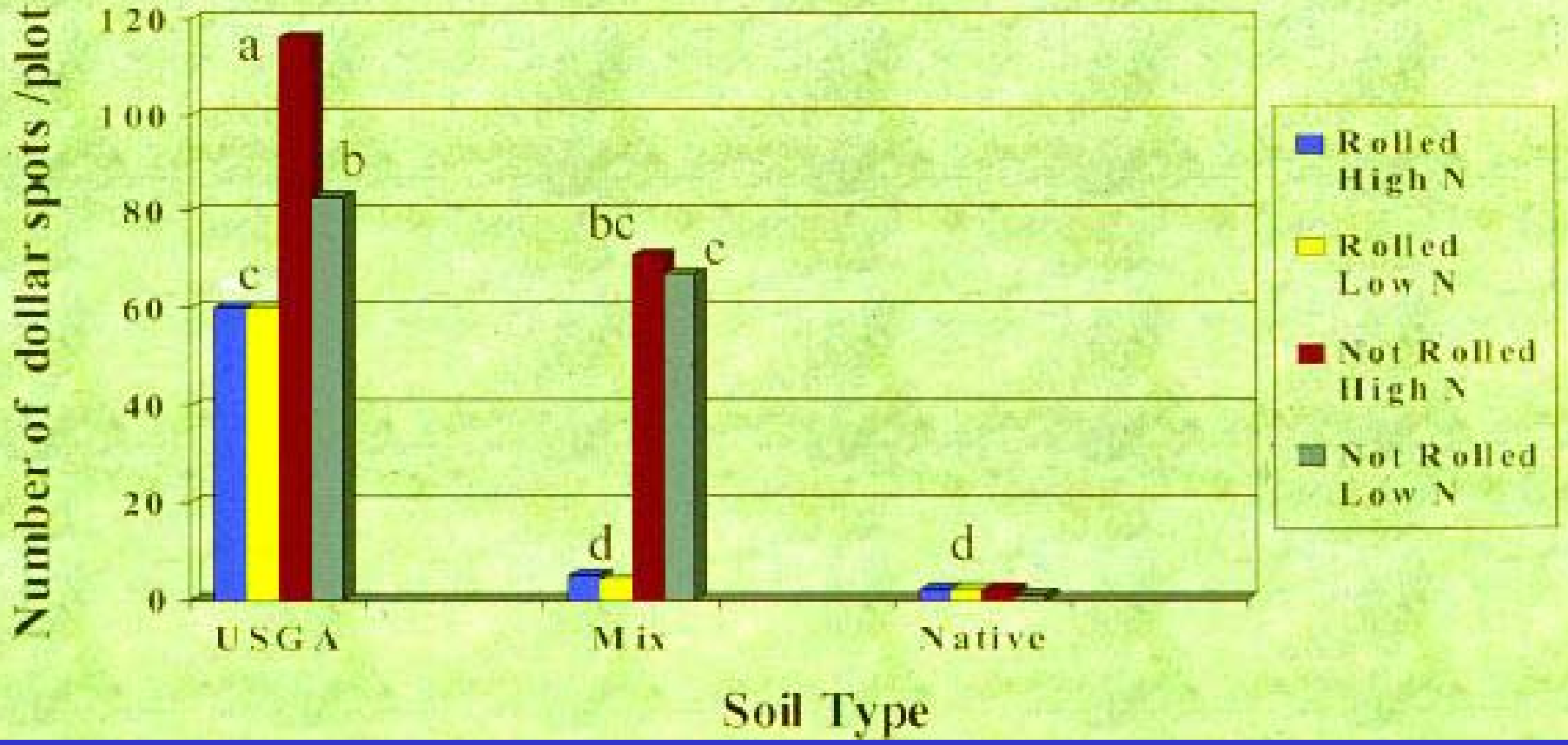
Greens mix

- What should it be?
  - Straight sand?
  - Sand-peat 80-20?
  - Sand-Soil-Peat 80-10-10
  - Sand-Soil 90-10?

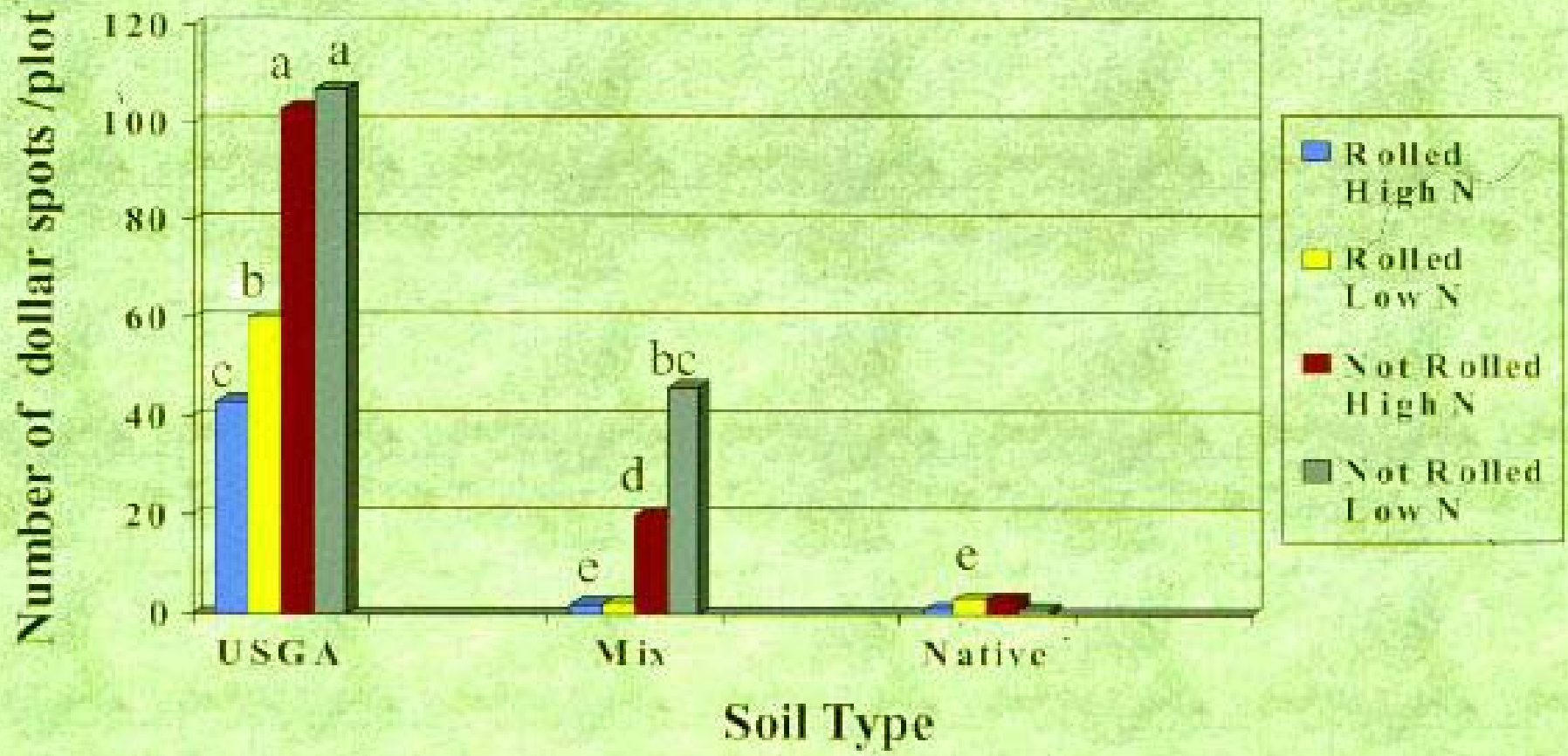
Root Zones

- Three root zone mixes were constructed in 1992 and seeded with Penncross creeping bentgrass
  - USGA 85% sand, 15% peat (v/v)
  - 80% sand, 10% peat, 10% soil (v/v)
  - Sandy clay loam 58% sand, 42% silt and clay

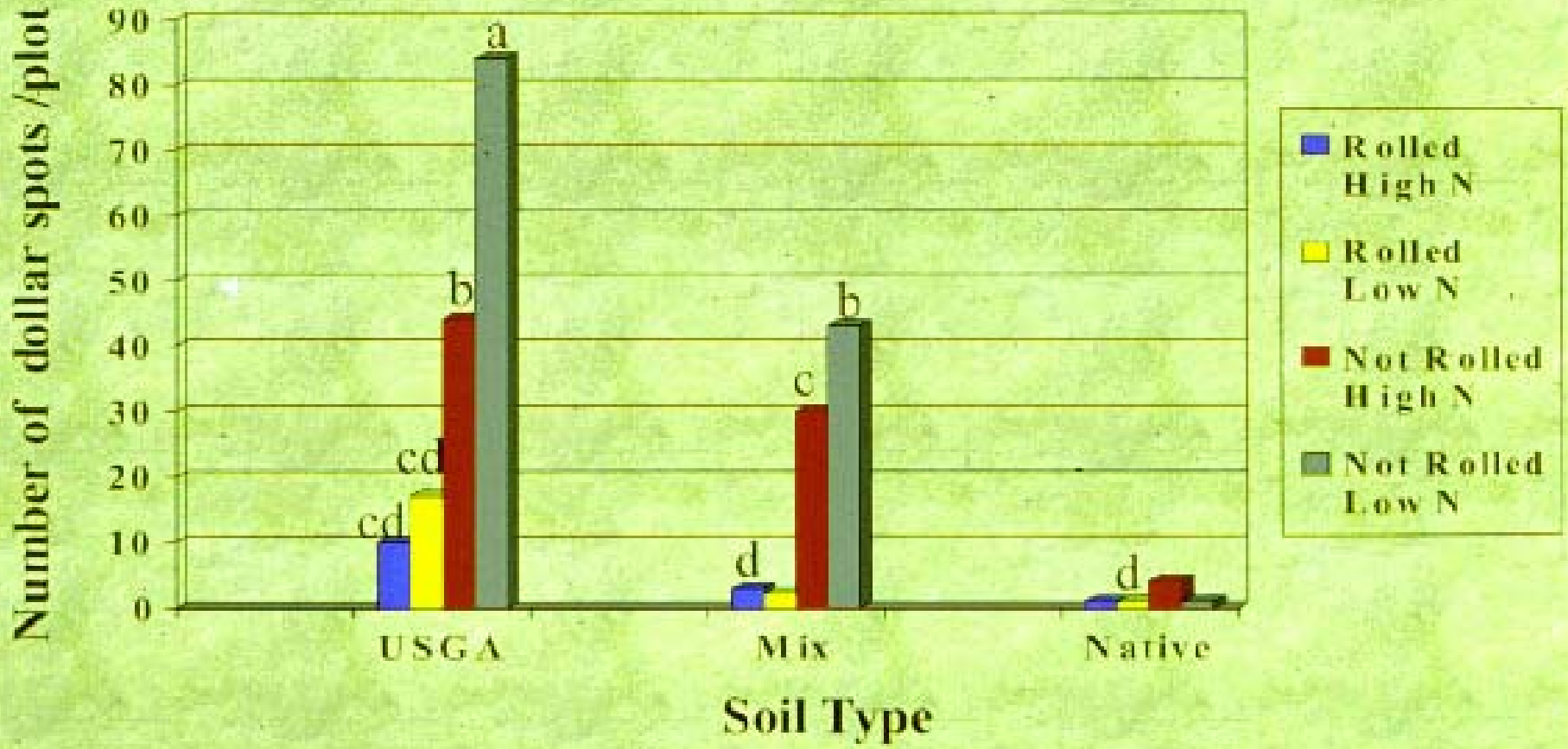
Root zone, rolling, and nitrogen rate interaction on dollar spot activity August 20 1997.

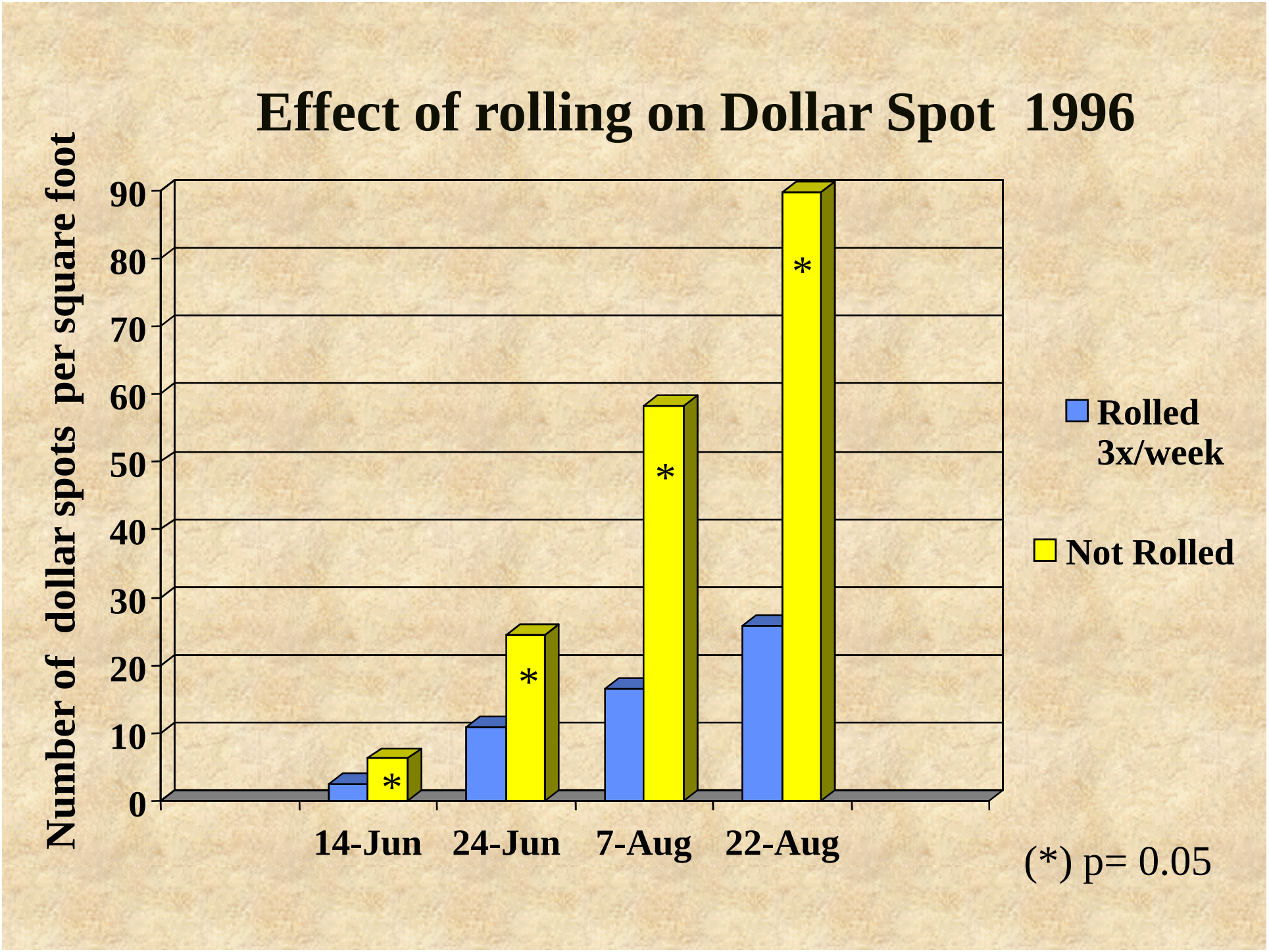


The effects of root zone, nitrogen rate , and rolling on dollar spot June 16, 1998.



The effects of root zone, nitrogen rate , and rolling on dollar spot June 10, 1999.




Effect of rolling on Dollar Spot 1996
Number of dollar spots per square foot
90
80
70
60
50
40
30
20
10
0
14-Jun
24-Jun
7-Aug
22-Aug
*
*
*
*
Rolled 3x/week
Not Rolled
(*) p= 0.05


80-10-10 Mix
Non-rolled
Rolled

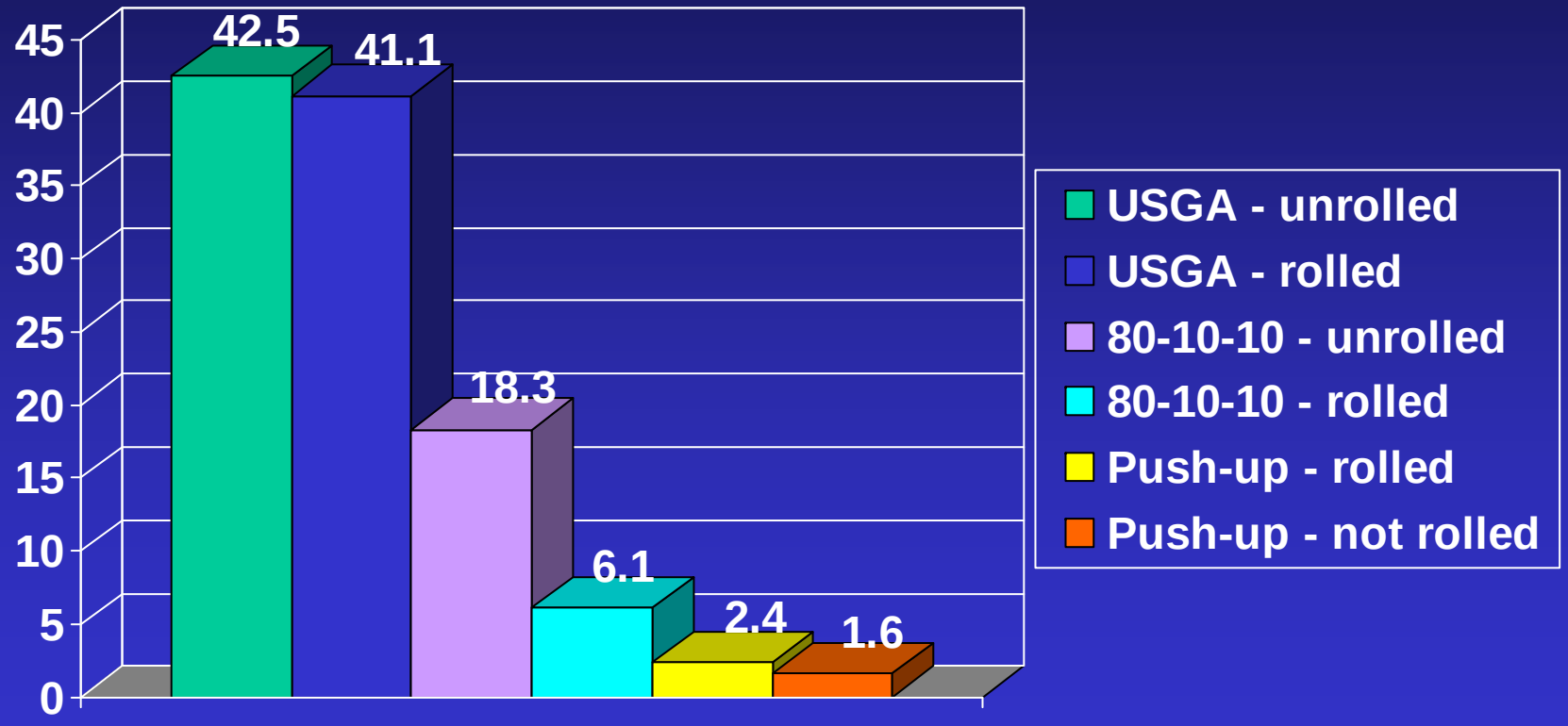
Disease: Microdochium patch

- Causes: Microdochium nivale
- Months: Sept - June
- Grasses:
  - Annual bluegrass
  - Creeping bentgrass
  - Perennial ryegrass
  - Fine leaf fescue
  - Colonial bentgrass

2001 Disease rating

Treatment	Mean % disease	P=0.05
USGA	42.5	A
USGA, rolled	41.1	A
80-10-10	18.3	AB
80-10-10, rolled	6.1	B
Native, rolled	2.4	B
Native	1.6	B

Microdochium Patch 2001




USGA
85% sand
15% peat


80-10-10
mix


Native
push-up

Greens mix

- What should it be?
  - Straight sand?
  - Sand-peat 80-20?
  - Sand-Soil-Peat 80-10-10?
  - Sand-Soil 90-10?

Problems unique to sand greens

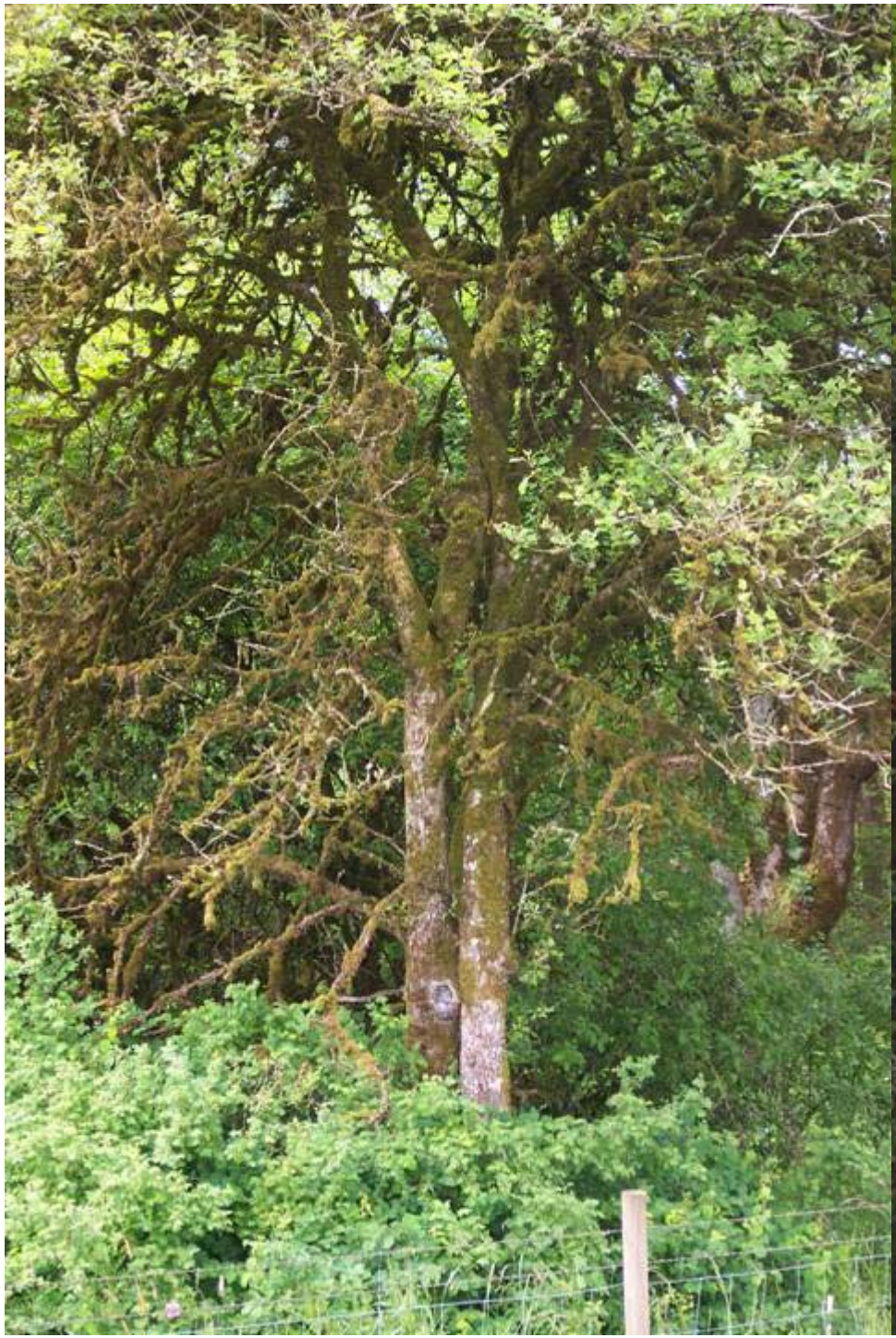
- Moss
- Localize dry spots

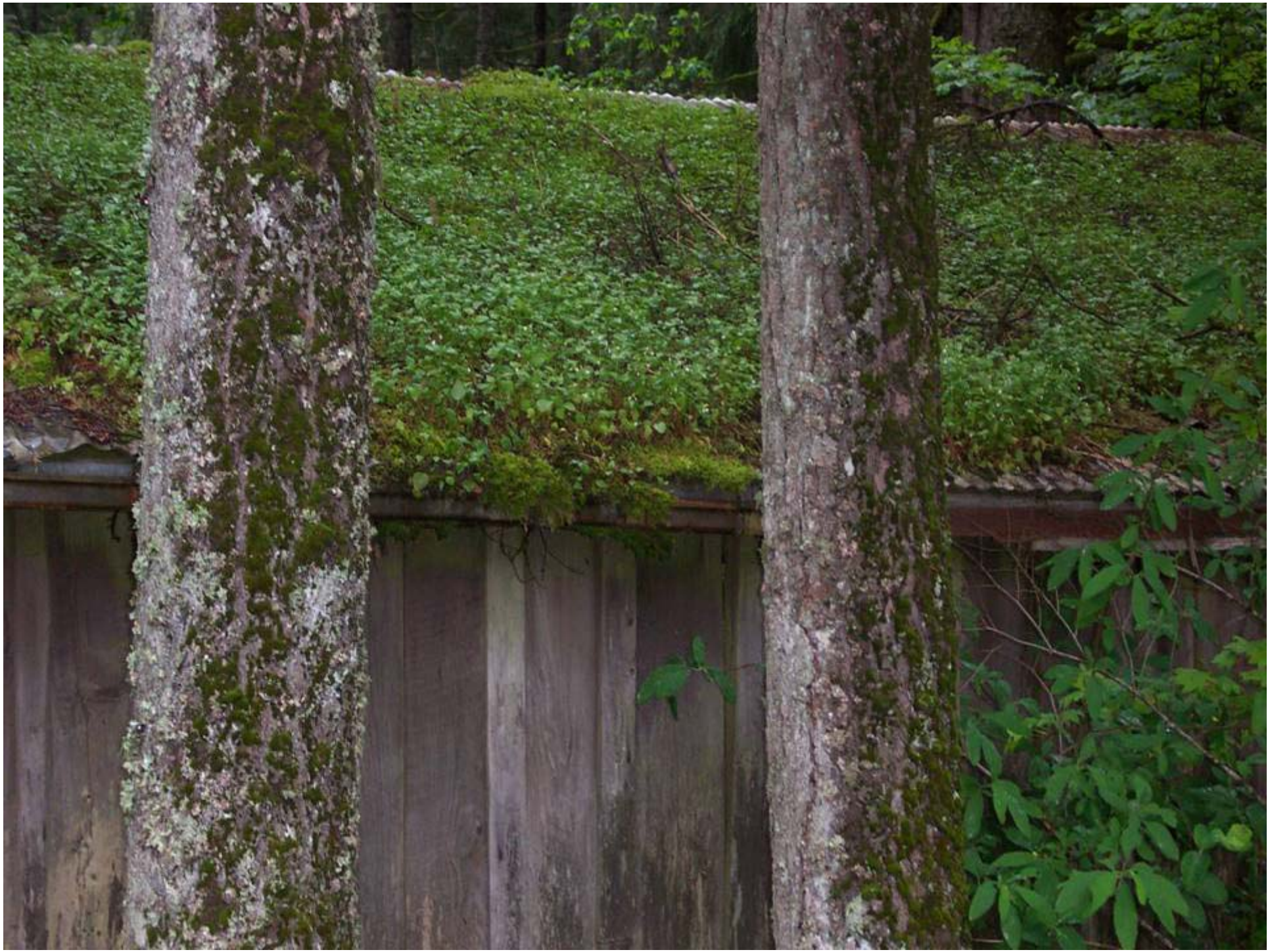
Why is moss becoming a problem?

Green	% Moss
80-15	23
80-10-10	0
Soil	0

Moss

- Reportedly thousands of species
- Have existed for 350 million years
- Well-adapted for many different environments
  - Is considered “cosmopolitan”
  - Arctic, antarctic
  - Forests, plains
  - Wetlands





Conditions for growing moss

- Poor fertility
- Sun or shade
- Needs moisture (less than turf?)
- Acidic soils?
- Proliferates readily, so can fill in voids quickly
- Survives long periods of desiccation
- Does not grow in the presence of metal-contaminated soils

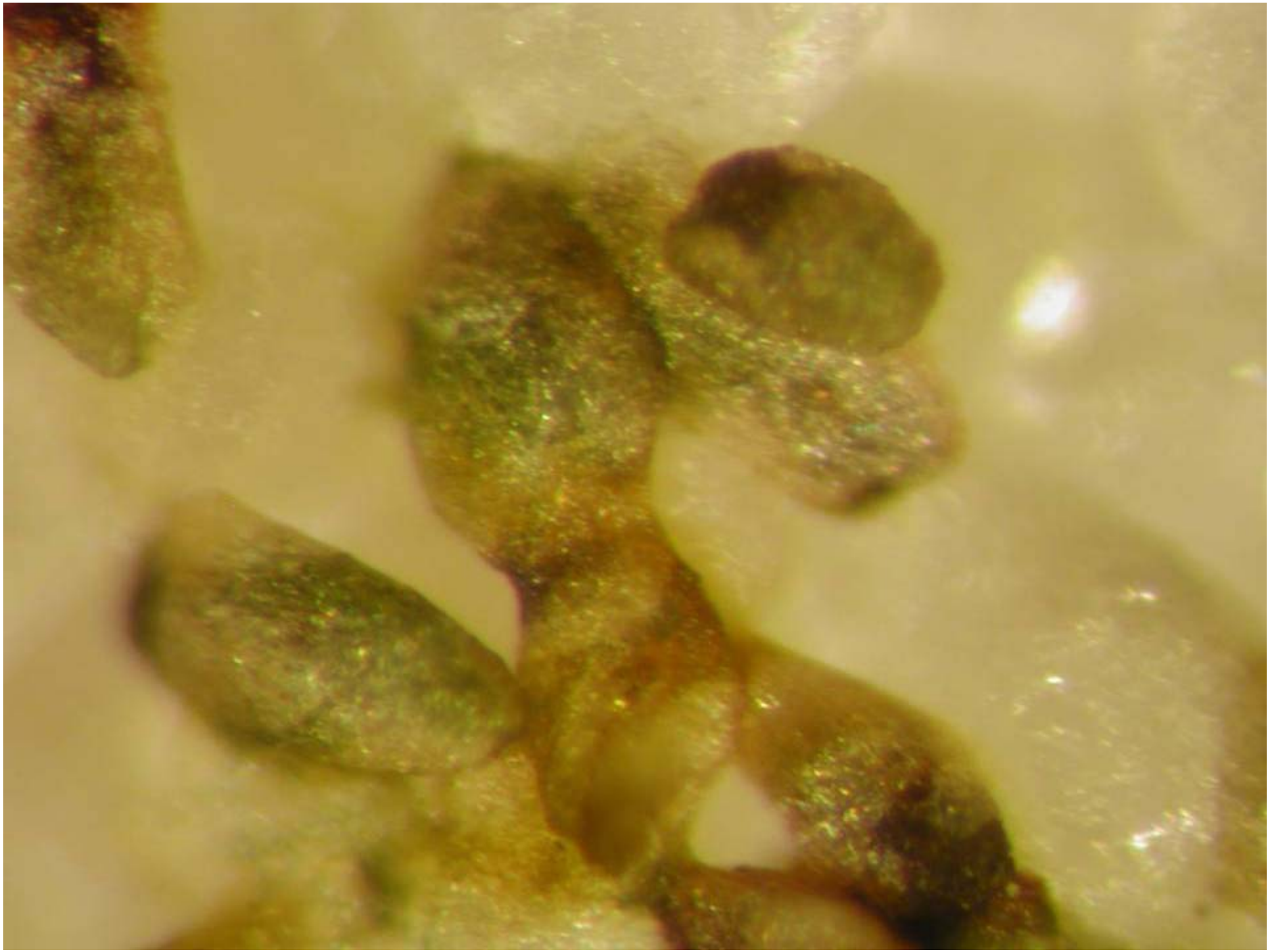
Moss in putting greens

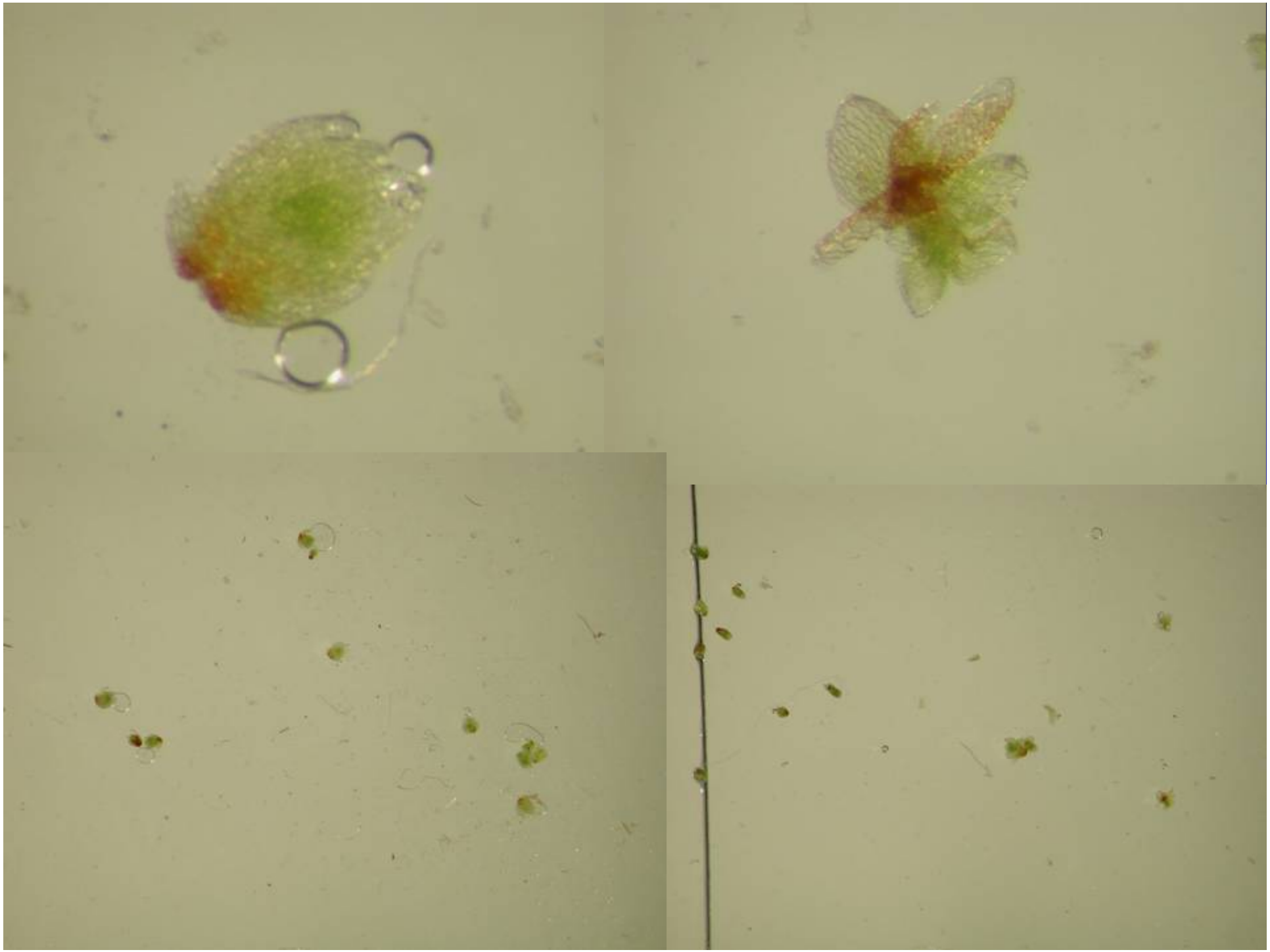
- Most common is *Byrum argenteum*, or silvery thread moss
- Has a characteristic morphology (shiny in sunlight)
  - Is ectohydric (can absorb water all over its surface area)
- Very small so can tolerate low mowing heights (even better than turf can!)

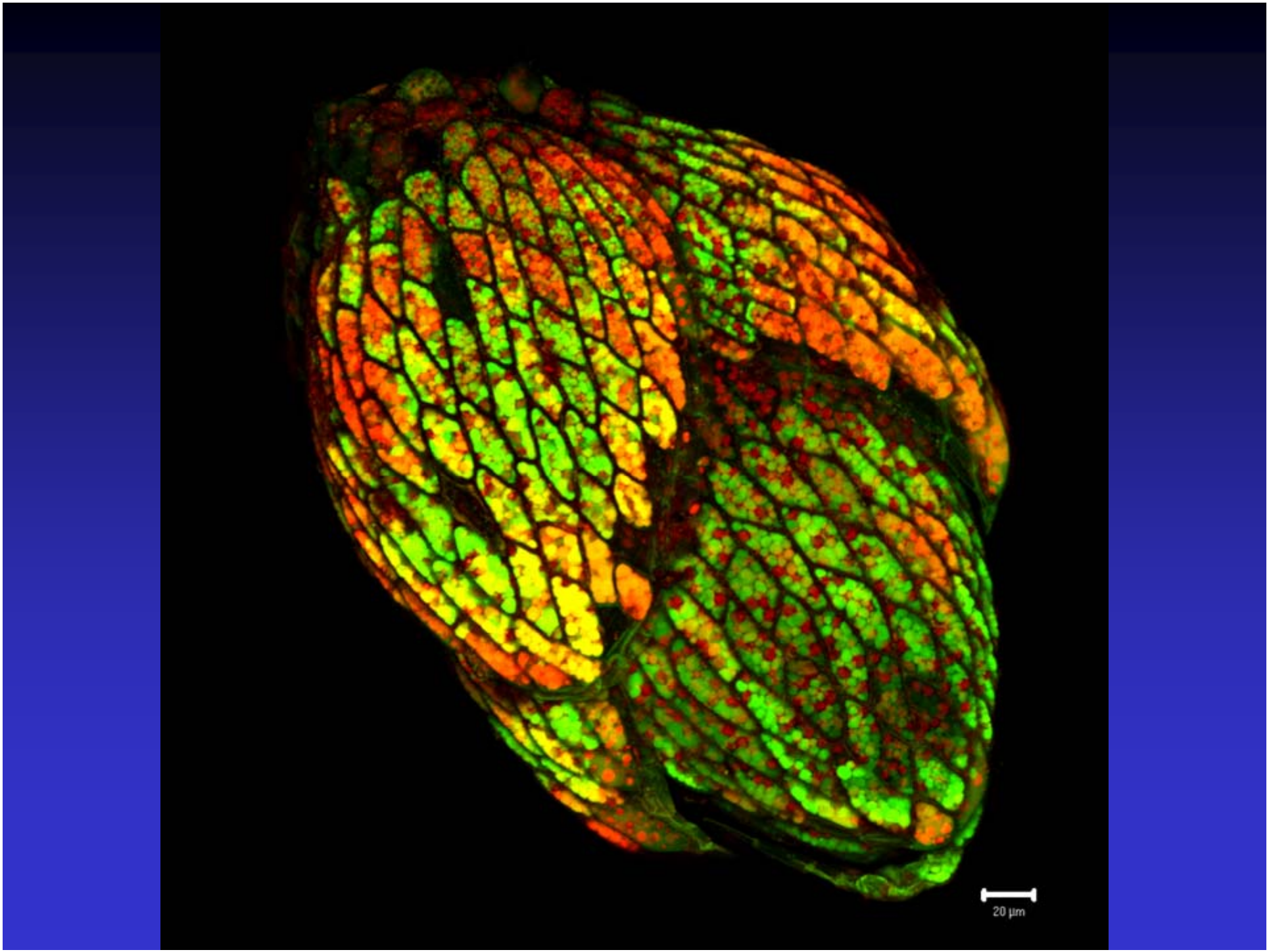
How does moss spread?

- Moss reproduces both vegetatively and by spores
  - 1. Vegetatively
    - Can be generated from plant fragments carried by equipment, golf spikes, etc.


Water dispersed
vegetative propagules






20 µm

How does moss spread?

- Moss reproduces both vegetatively and by spores
  - 2. Spores
    - Spores are tiny and are translocated mostly by air
    - Are dessication-resistant

Problems unique to sand greens

- Moss
- Localize dry spots

Wetting Agents

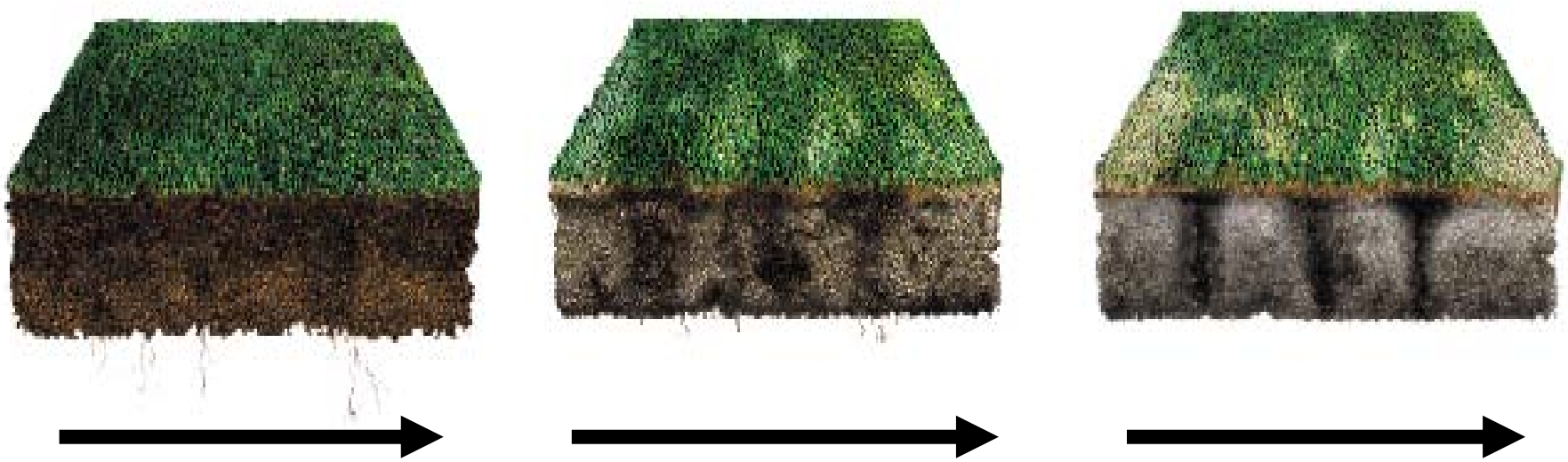
- Short-term
  - Surf-Side 37A
  - Primer
  - Rely
  - Rewet
- Long-term
  - Cascade
  - Brilliance
  - Lesco Flow

WATER REPELLENCY

Localized Dry Spot

The Cause and Treatment

LOCALIZED DRY SPOT

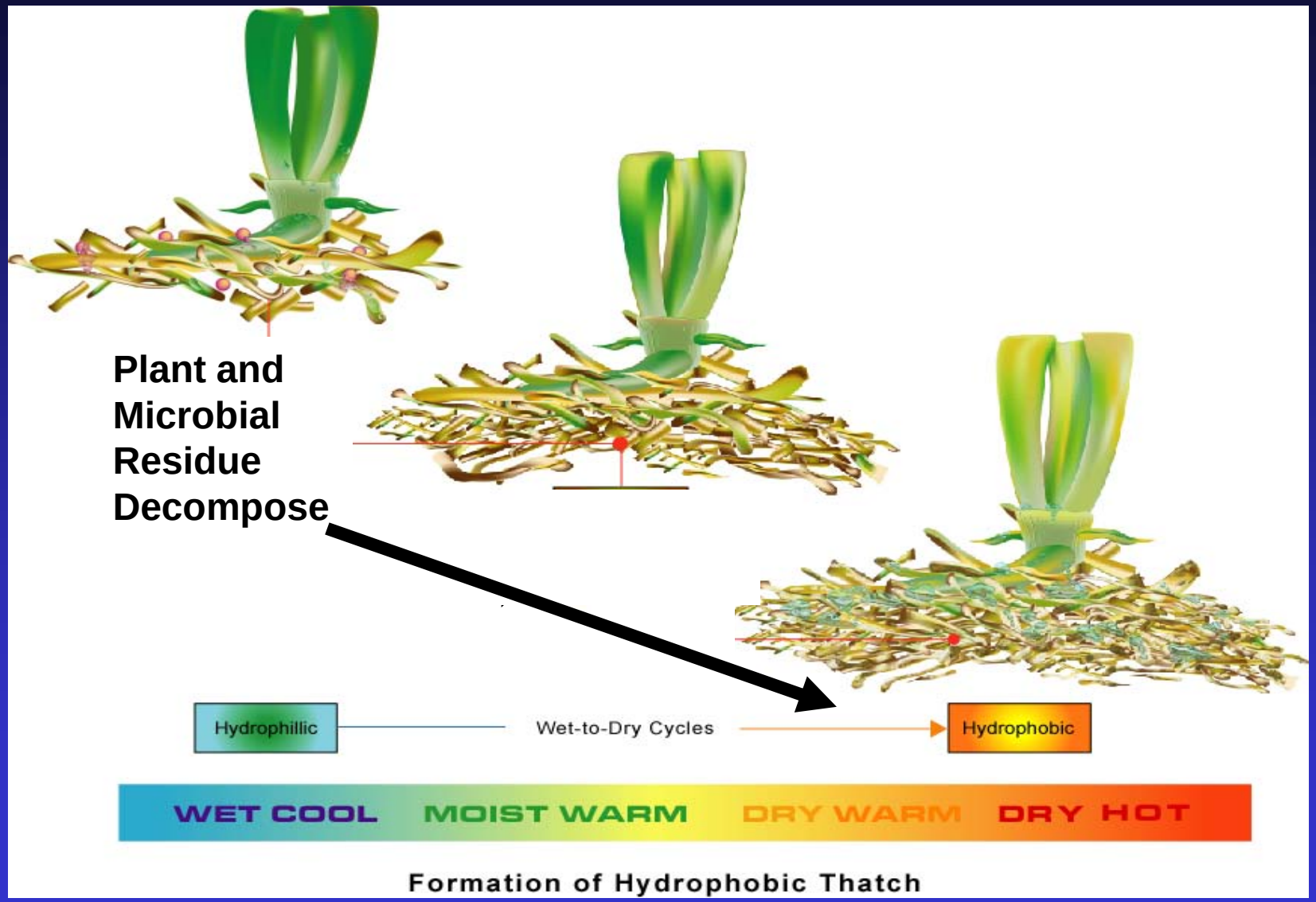


Cool / Moist

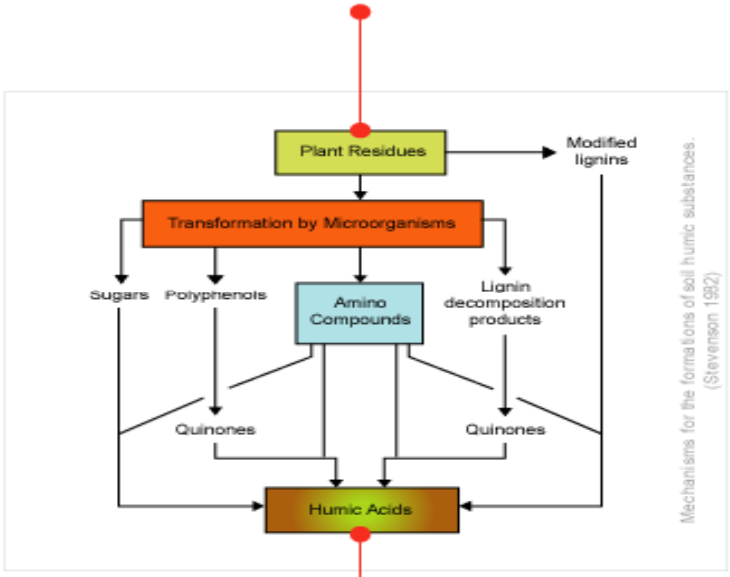
Hot / Dry

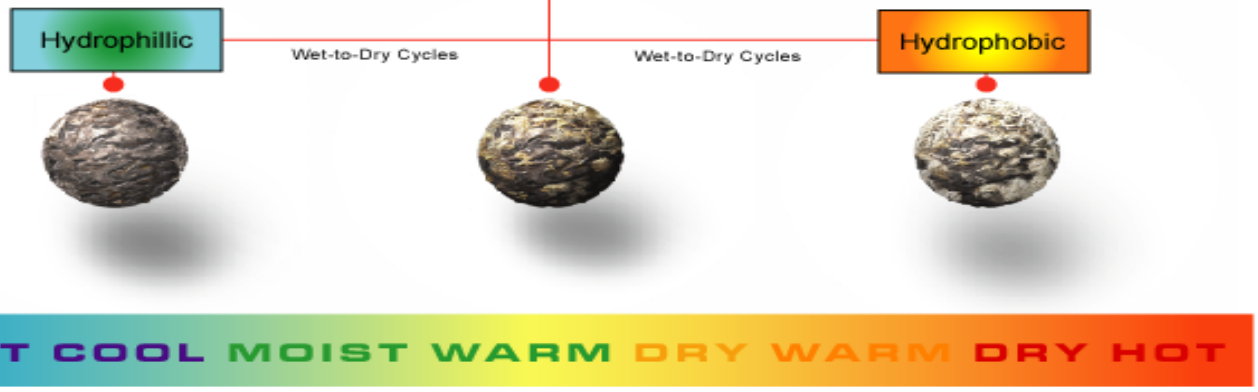
Localized
Dry Spot

WATER REPELLENCY STARTS HERE!

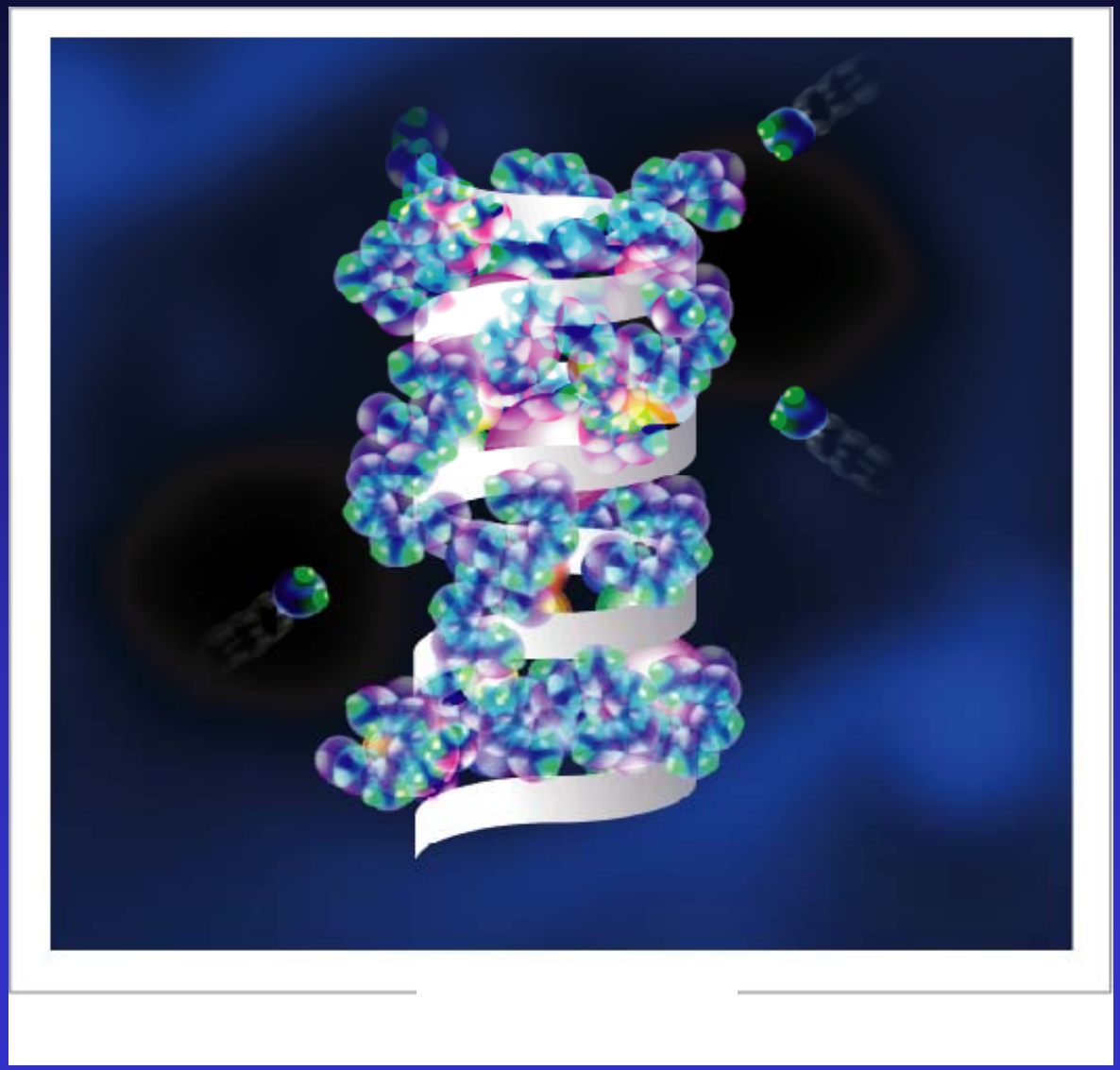


ORGANIC ACIDS MOVE TO SOIL



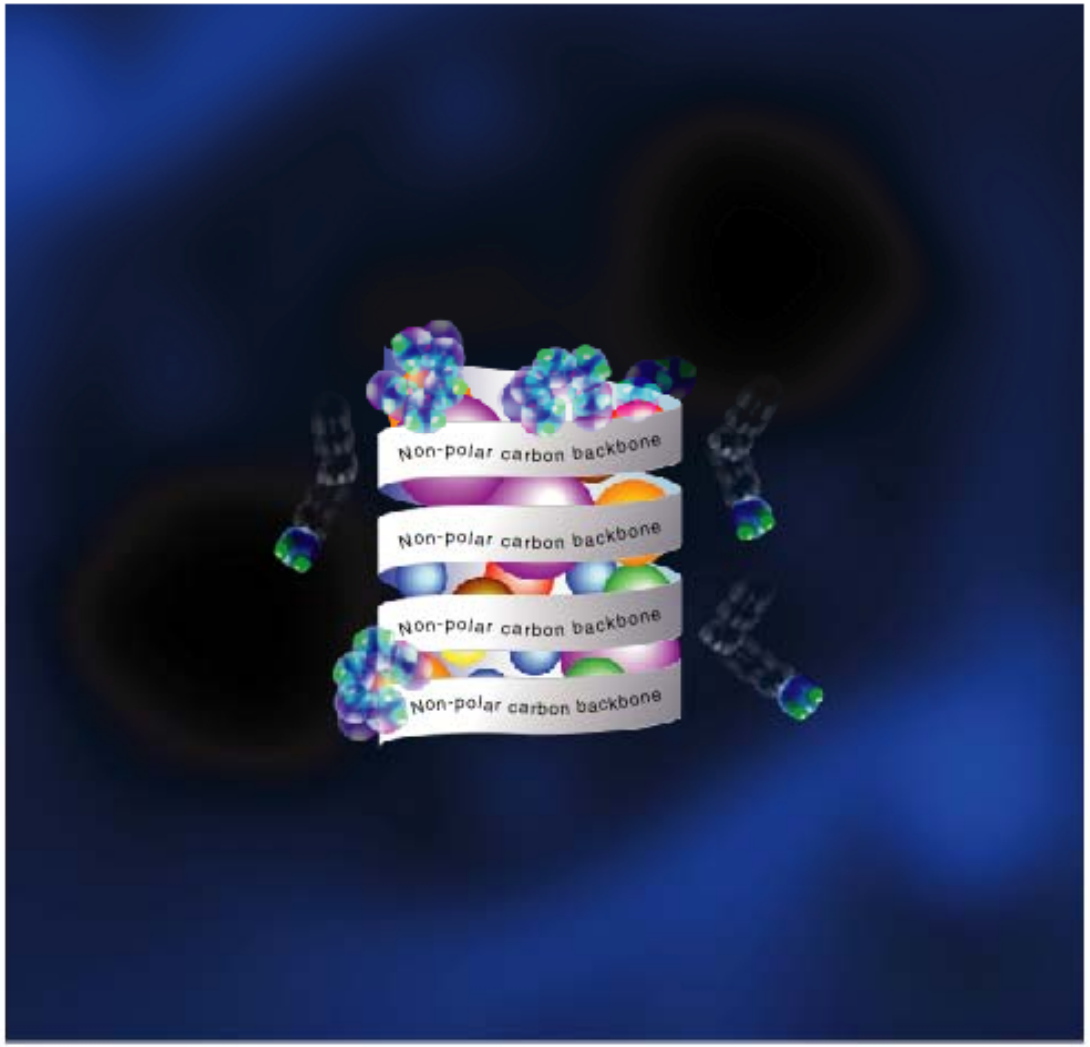


IF ORGANIC ACIDS HAVE POSITIVE SITES AND CAN BE HYDRATED…



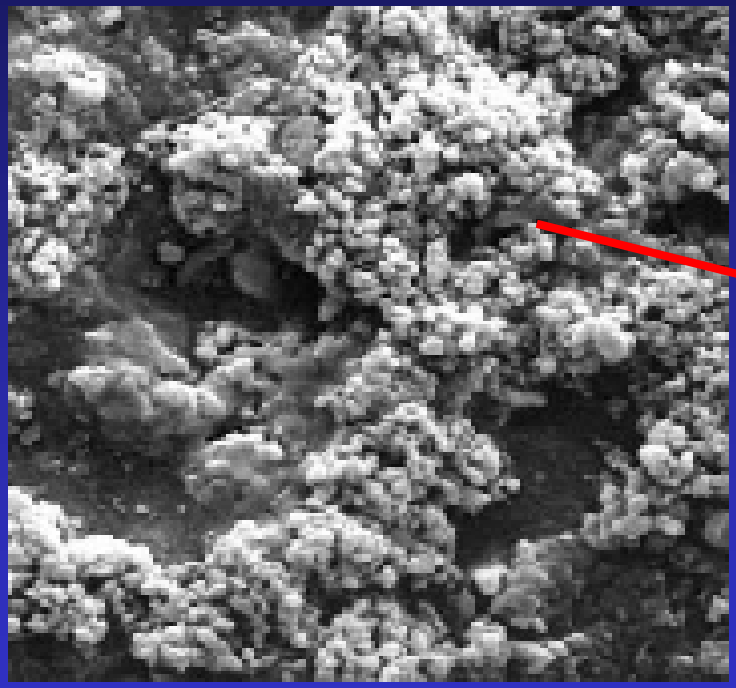
WHY DO THEY CAUSE WATER REPELLENCY ?

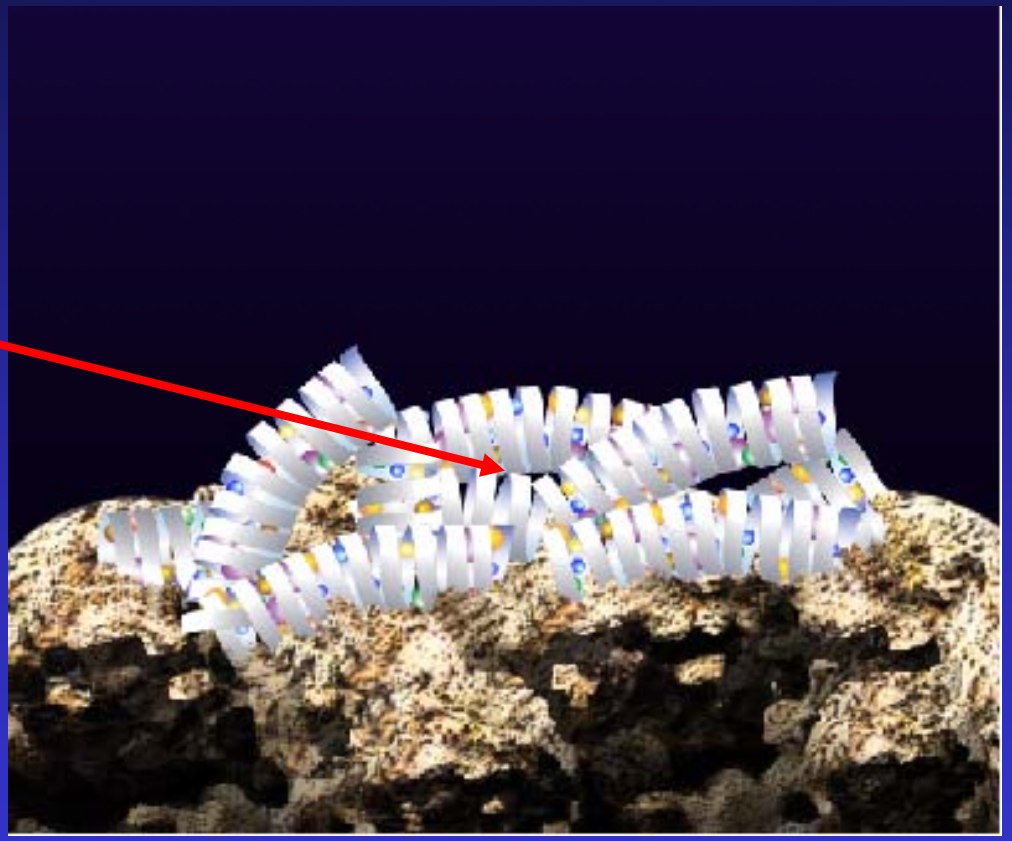
BECAUSE THEY BECOME **WATER REPELLENT**
WHEN CONDITIONS CHANGE FROM
COOL / MOIST TO **HOT / DRY**



THE ORGANIC ACID LOOSES ITS STRUCTURAL INTEGRITY

WATER REPELLENT ORGANIC ACID LAYER

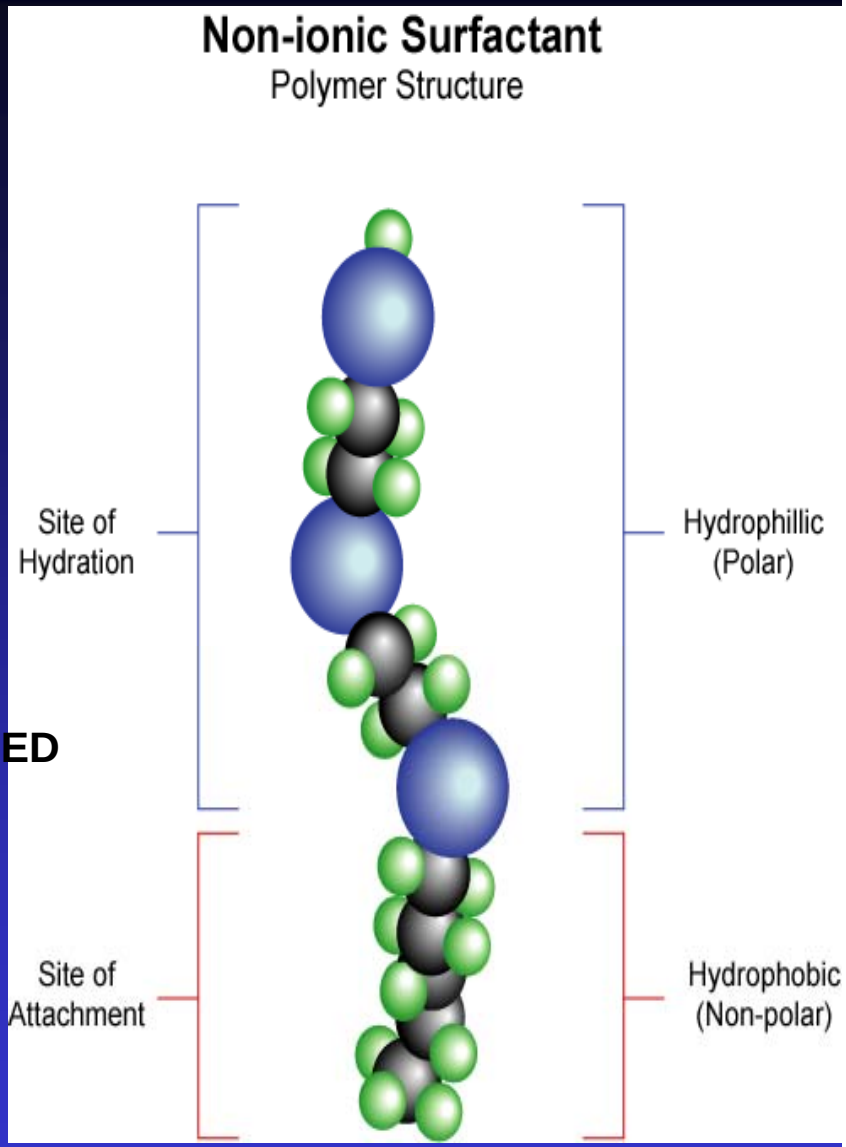




ORGANIC ACID MAGNIFIED 35,000 TIMES (SEM)

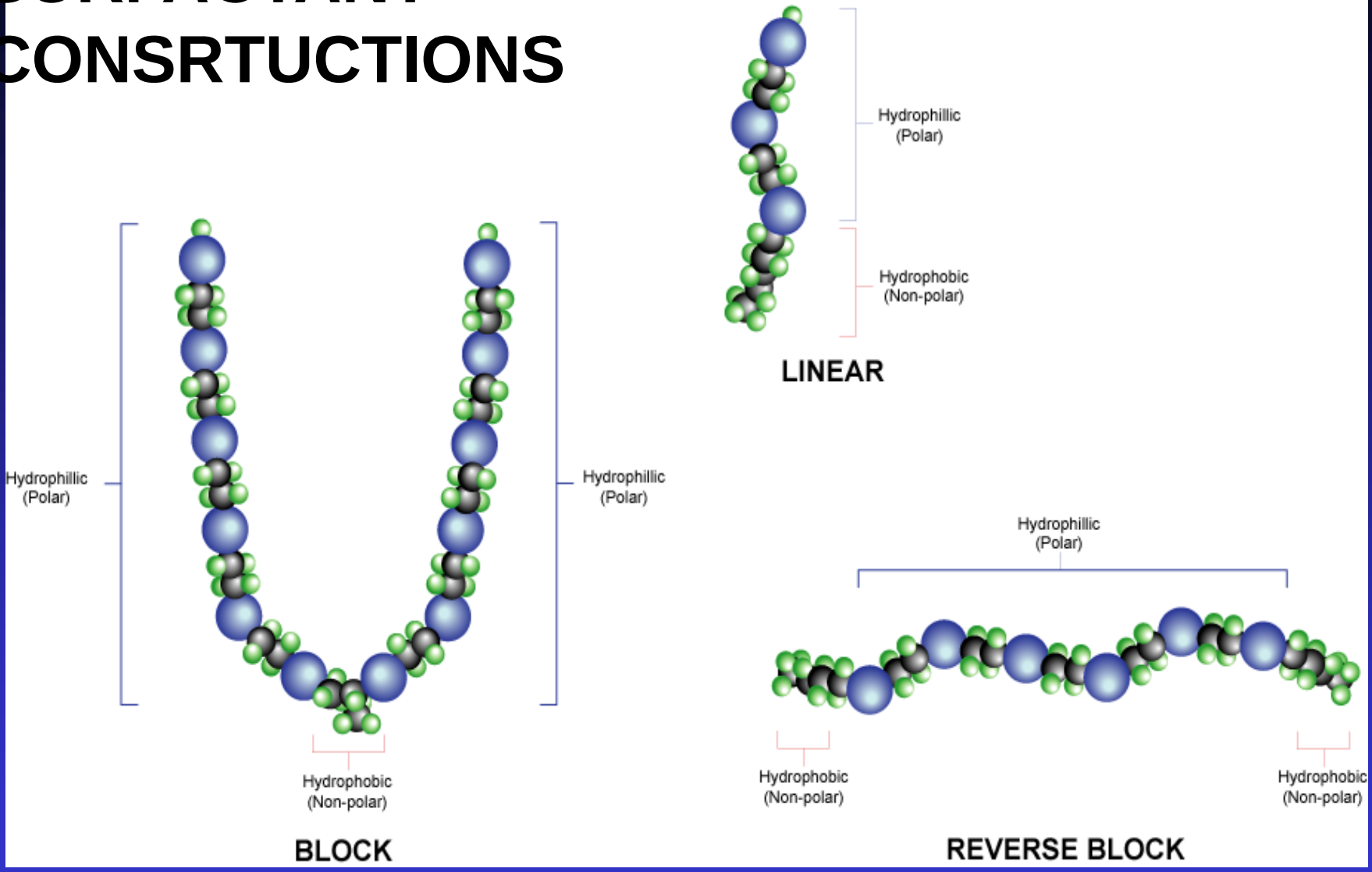
SURFACTANT FACTS

1. NOT ALL SURFACTANTS ARE THE SAME
2. SURFACTANTS PROVIDE HYDRATION SITES
3. SURFACTANTS ESTABLISH A "PATTERN OF HYDRATION"
4. "PATTERNS OF HYDRATION" ARE DETERMINED BY TYPE OF SURFACTANT USED
5. SURFACTANTS DON'T CURE OR PREVENT WATER REPELLENCY, <u>THEY TREAT IT</u>



TREAT OR PREVENT CONDITIONS OF WATER REPELLENCY

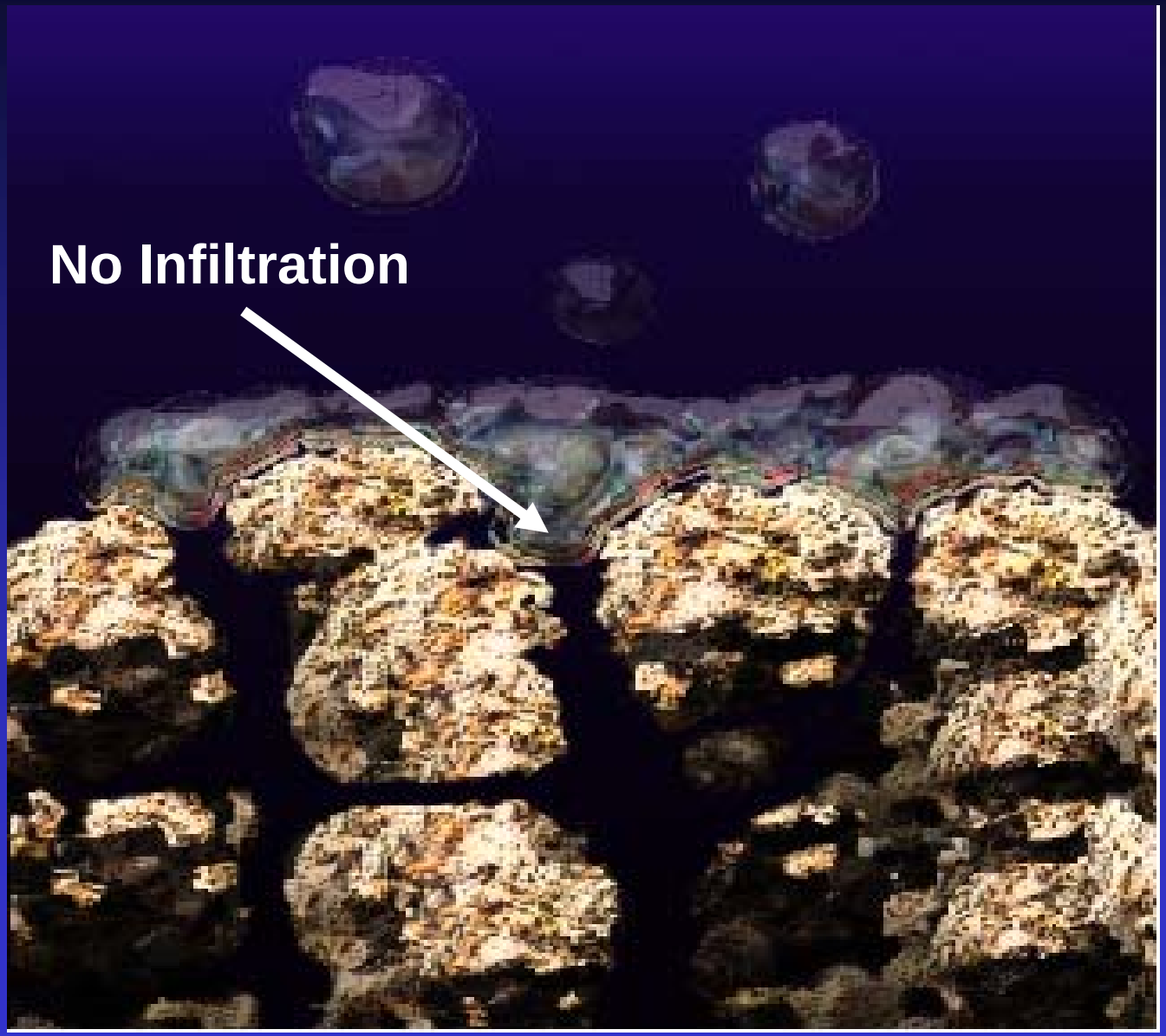
SURFACTANT CONSRTUCTIONS



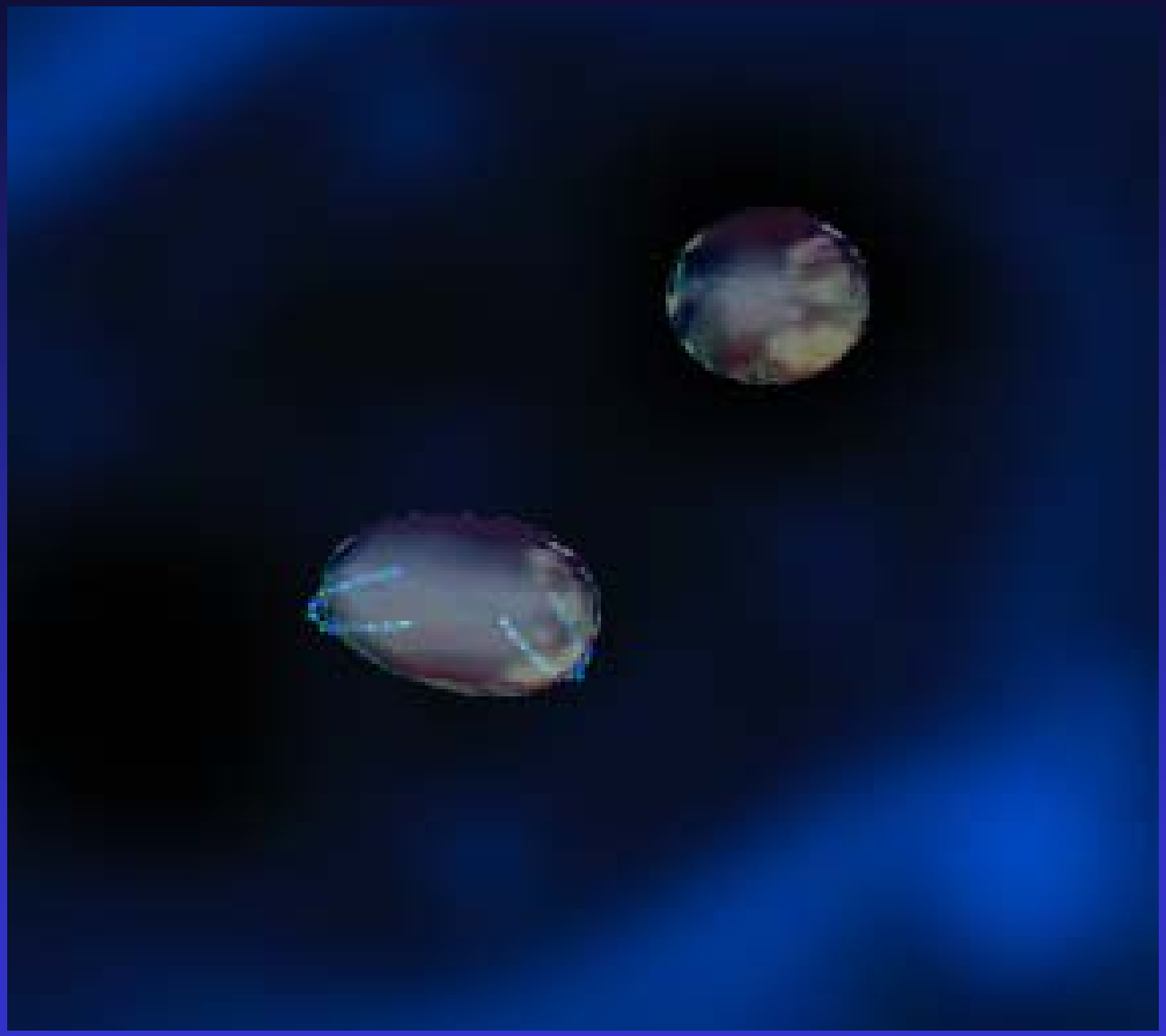
IS THE KEY TO

MANAGEMENT OF WATER REPELLENCY

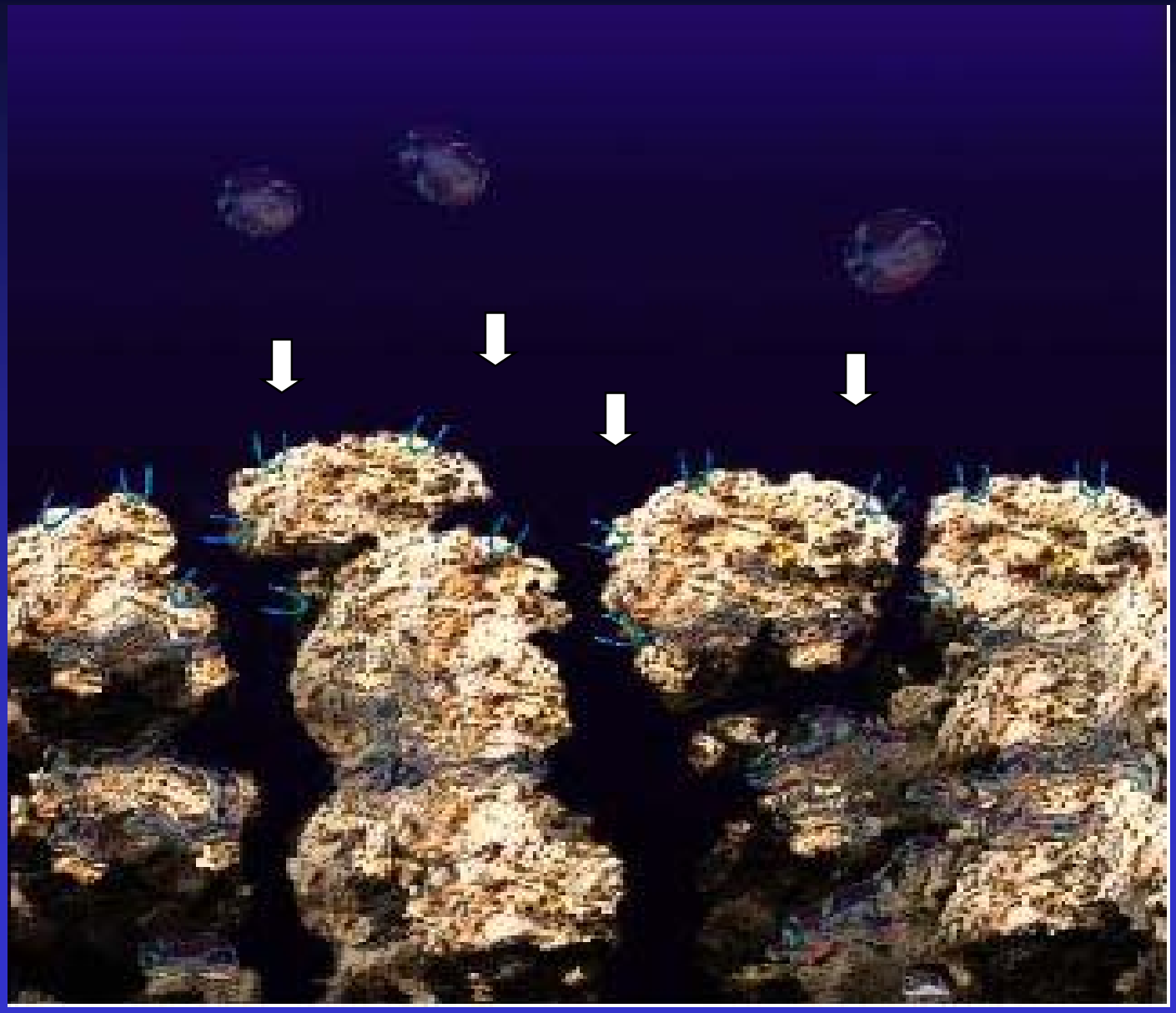
SURFACE TENSION PREVENTS INFILTRATION



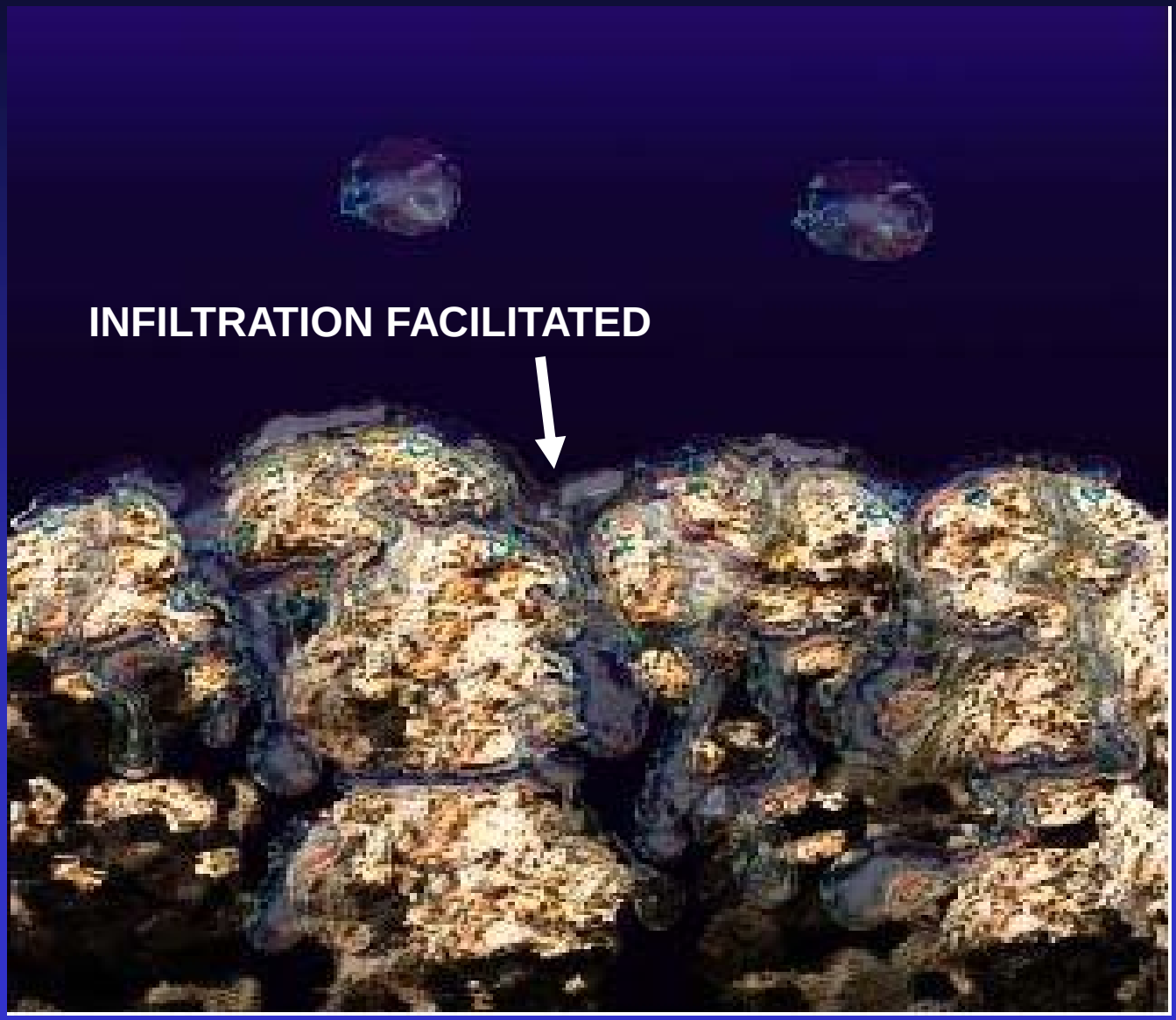
SURFACTANT CARRIED IN IRRIGATION WATER



SURFACTANT REMAINS ON SOIL



SURFACE TENSION REDUCED



TO FACILITATE OF FUTURE IRRIGATION

Summary

- **Water Repellency is:**
  - Progressive in Nature
  - Naturally Occurring
  - There is NO Cure

So… You must manage or treat the repellency of the non-polar Organic Acid soil coatings

Seed or sod?

- Seed
  - Advantages
    - No layering problem
  - Disadvantages
    - Longer time before ready for play
    - Not as wear tolerant

Seed or Sod?

- Sod
  - Advantages
    - Ready to play quicker
    - More mature-more wear resistant
  - Disadvantages
    - Soil, sand or soil layer

Which Cultivar to Chose

Number of tillers per unit are of creeping bentgrass cultivars compared to annual bluegrass

Number of tillers per sq decimeter	Cultivars
600-900	Penncross
1200-1600	Pennlinks, Providence, L-93, Crenshaw
2200-2800	A-4, G-2, G-6, T-1 etc.
3500 plus	Annual bluegrass

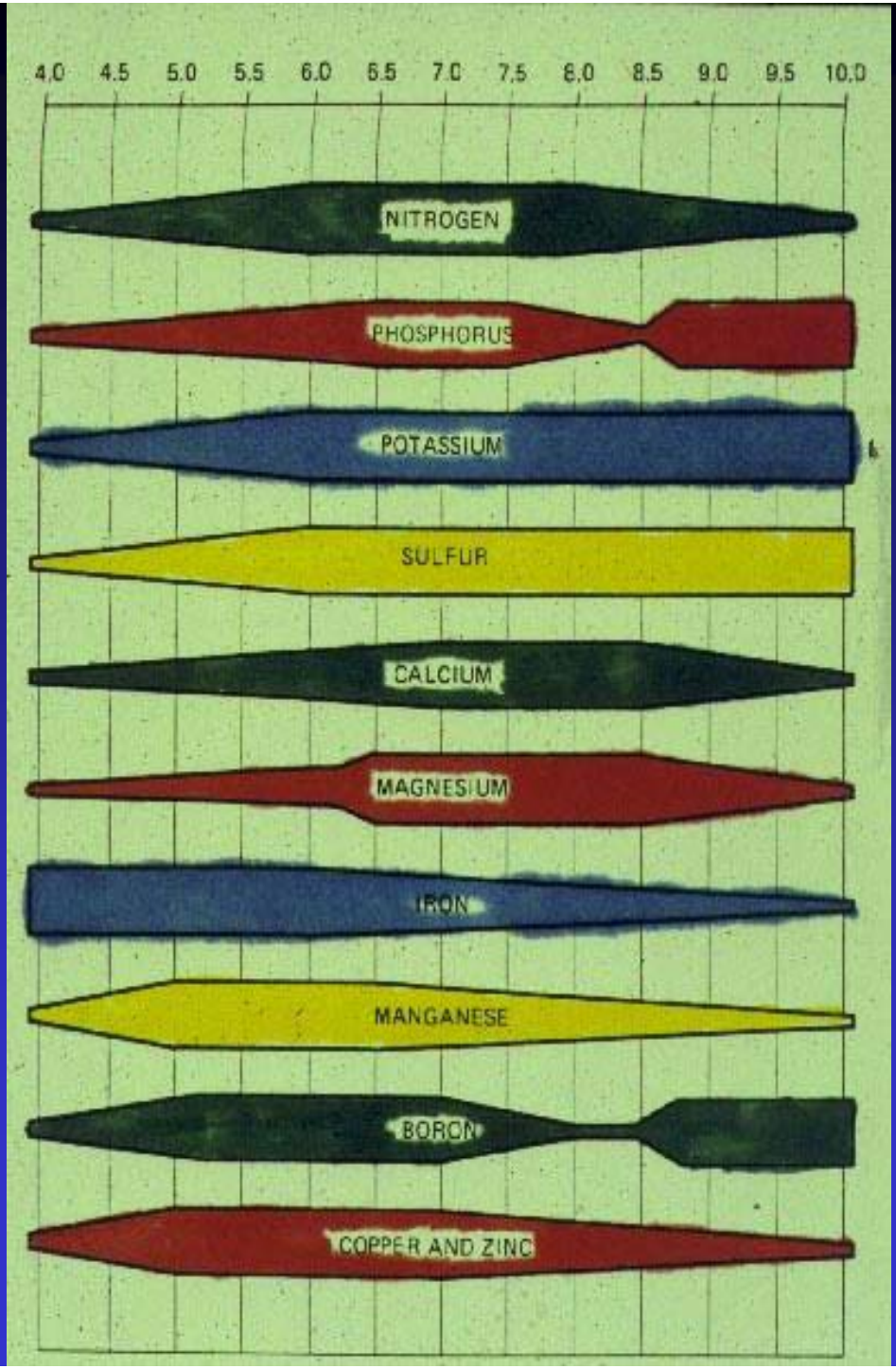
Creeping bentgrass-Greens

- Which cultivars
  - Penn A-1 through A-6?
  - T-1, Alpha?
    - Sand topdress every week

Creeping bentgrass-Greens

- Which cultivars
  - L-93, Southshore Pennlinks, Providence?
  - Penncross
    - Top dress every 3 weeks

The Black Layer


4.0
4.5
5.0
5.5
6.0
6.5
7.0
7.5
8.0
8.5
9.0
9.5
10.0
NITROGEN
PHOSPHORUS
POTASSIUM
SULFUR
CALCIUM
MAGNESIUM
IRON
MANGANESE
BORON
COPPER AND ZINC

pH Reduction with Sulfur

- A) Green
  - 1) 20% $CaCO_3$ in upper 7 inches of root zone
  - 2) Equivalent to 10,000 lbs of $CaCO_3$
  - 3) Applying - 10 lbs S/1000 ft^2/yr
- B) Results - 1000-1500 years to dissolve $CaCO_3$ in this green

N. Christans
Iowa State U.

Neutralizing 1% of $CaCO_3$

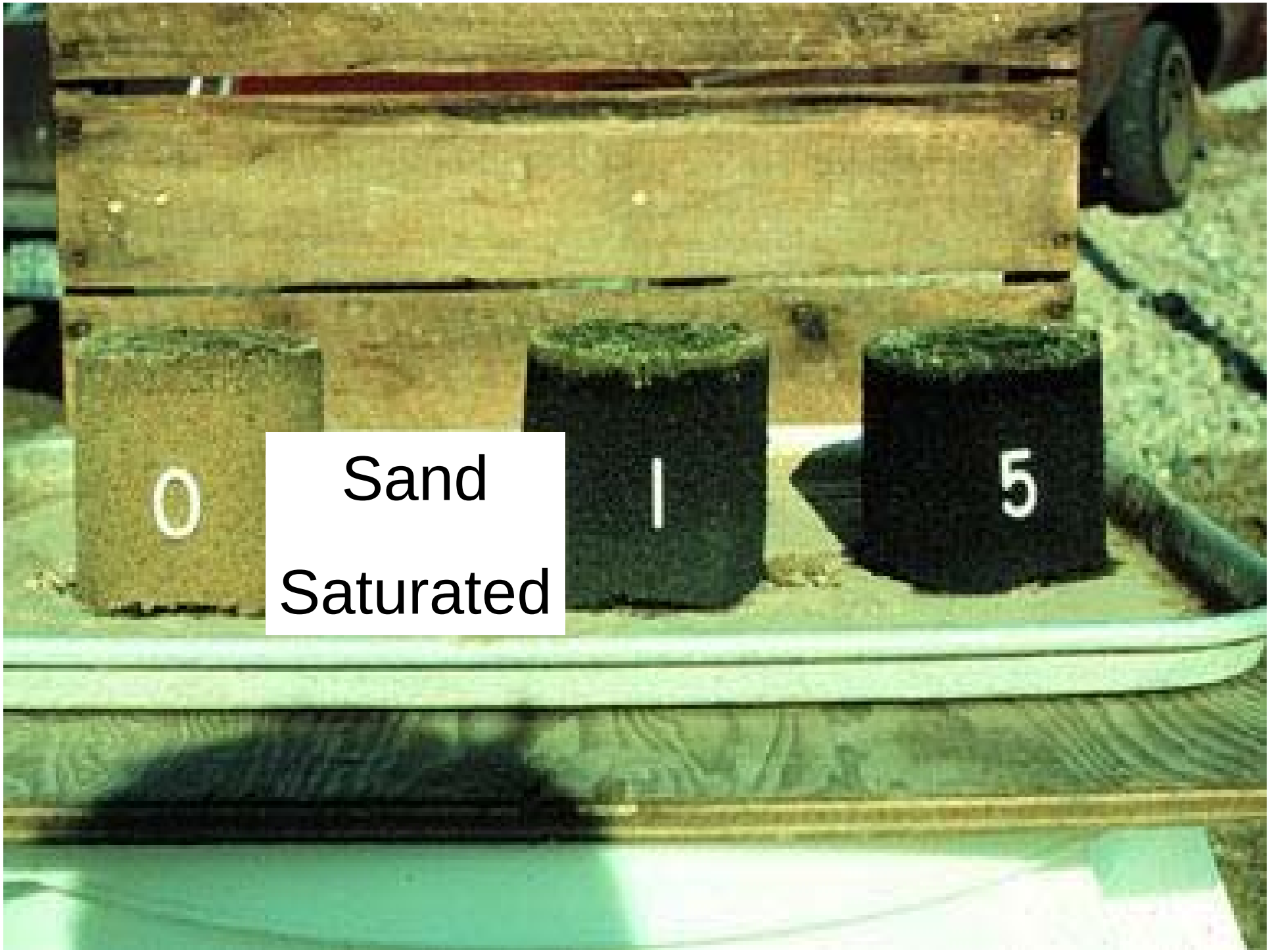
- 1) 7 inches deep
- 2) 68 tons of H_2SO_4
- 3) Cost - at 1.45/lb =

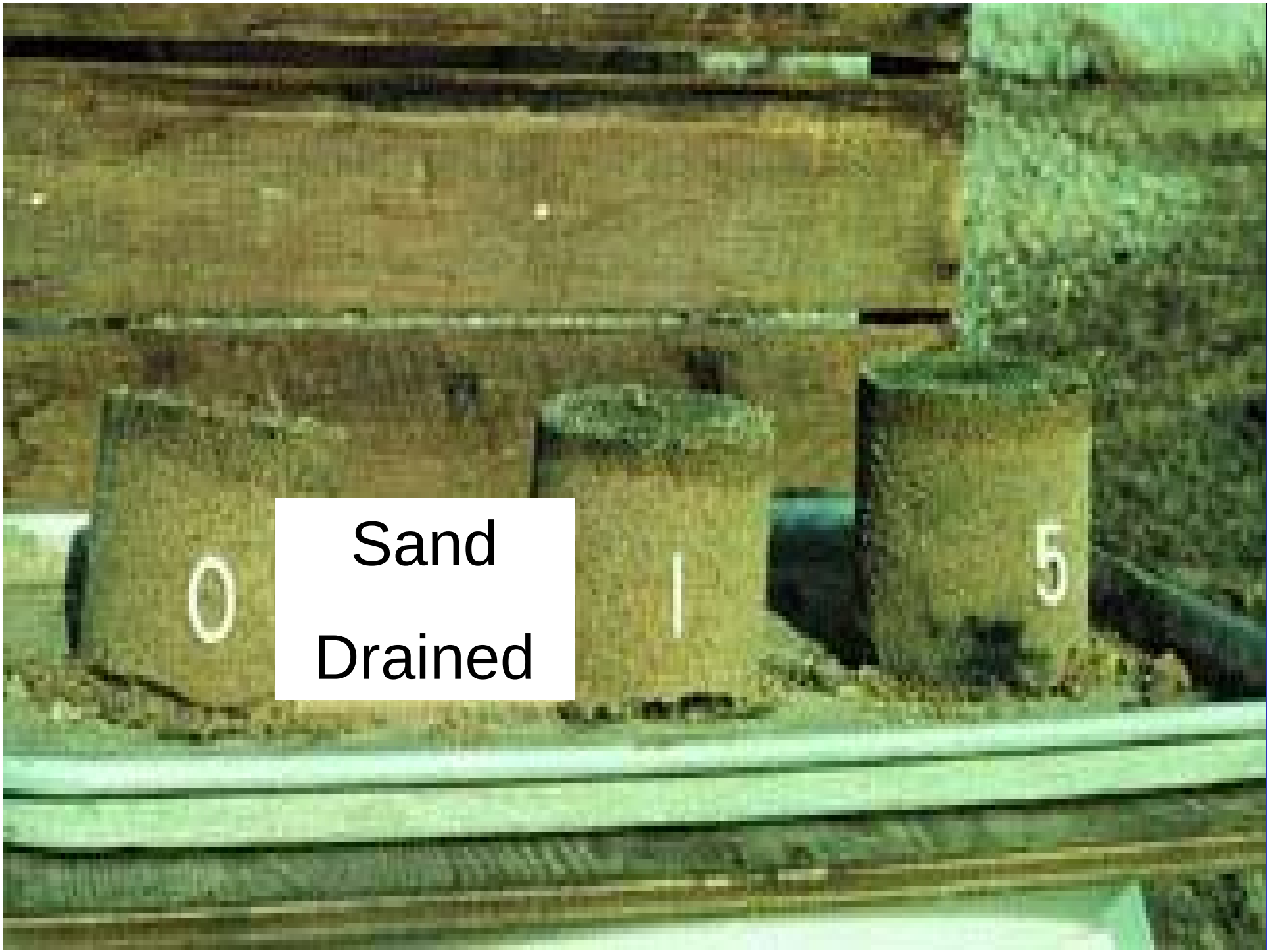
$190,000 to neutralize 1% of $CaCO_3$ in green

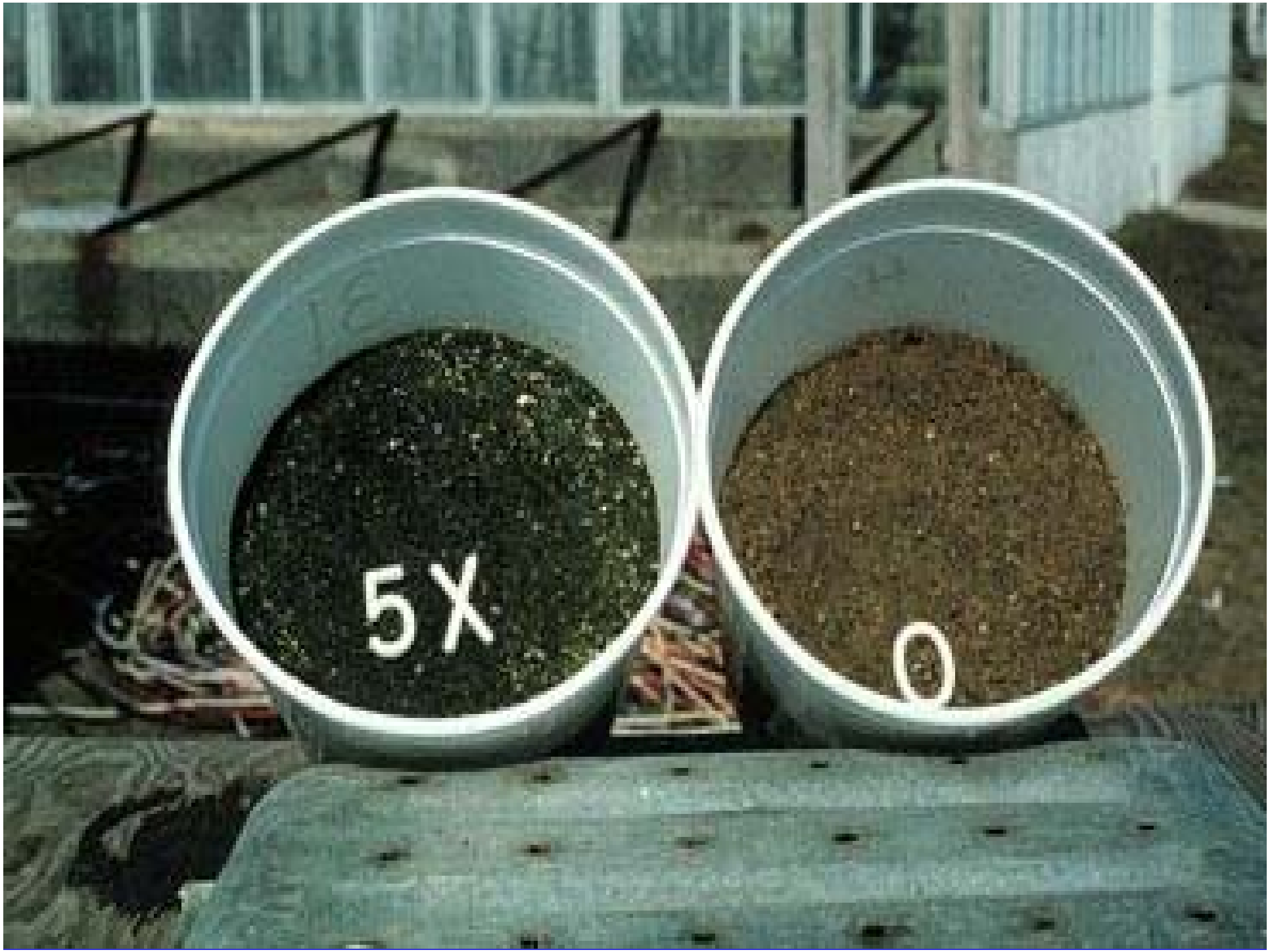
Killorn &
Miller
Iowa State U.

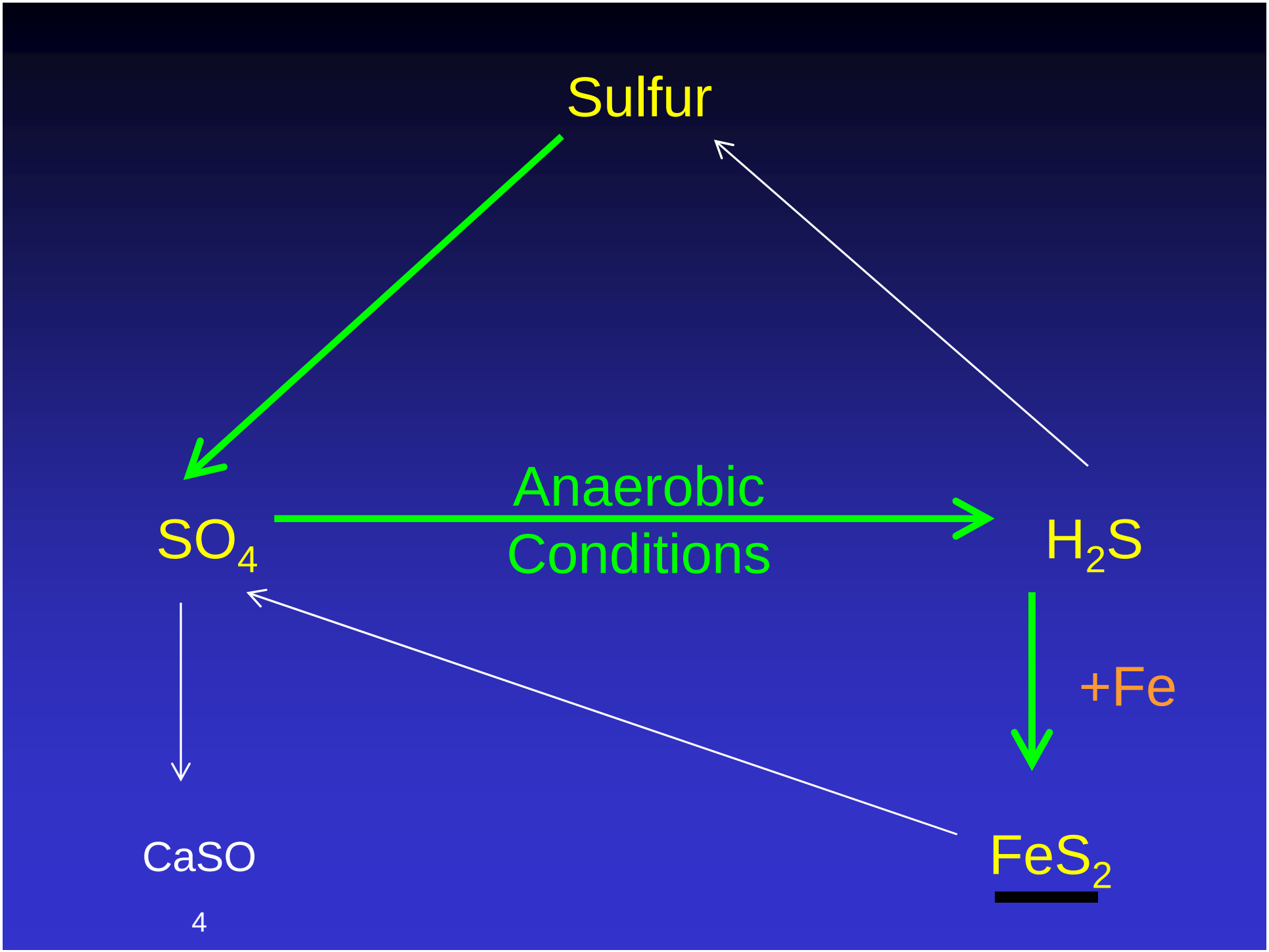
Theories

- Algae
- Root Dysfunction
- Soil Mix
- Mismanagement
- Sulfate Reduction


0
1
5
Sand
Saturated

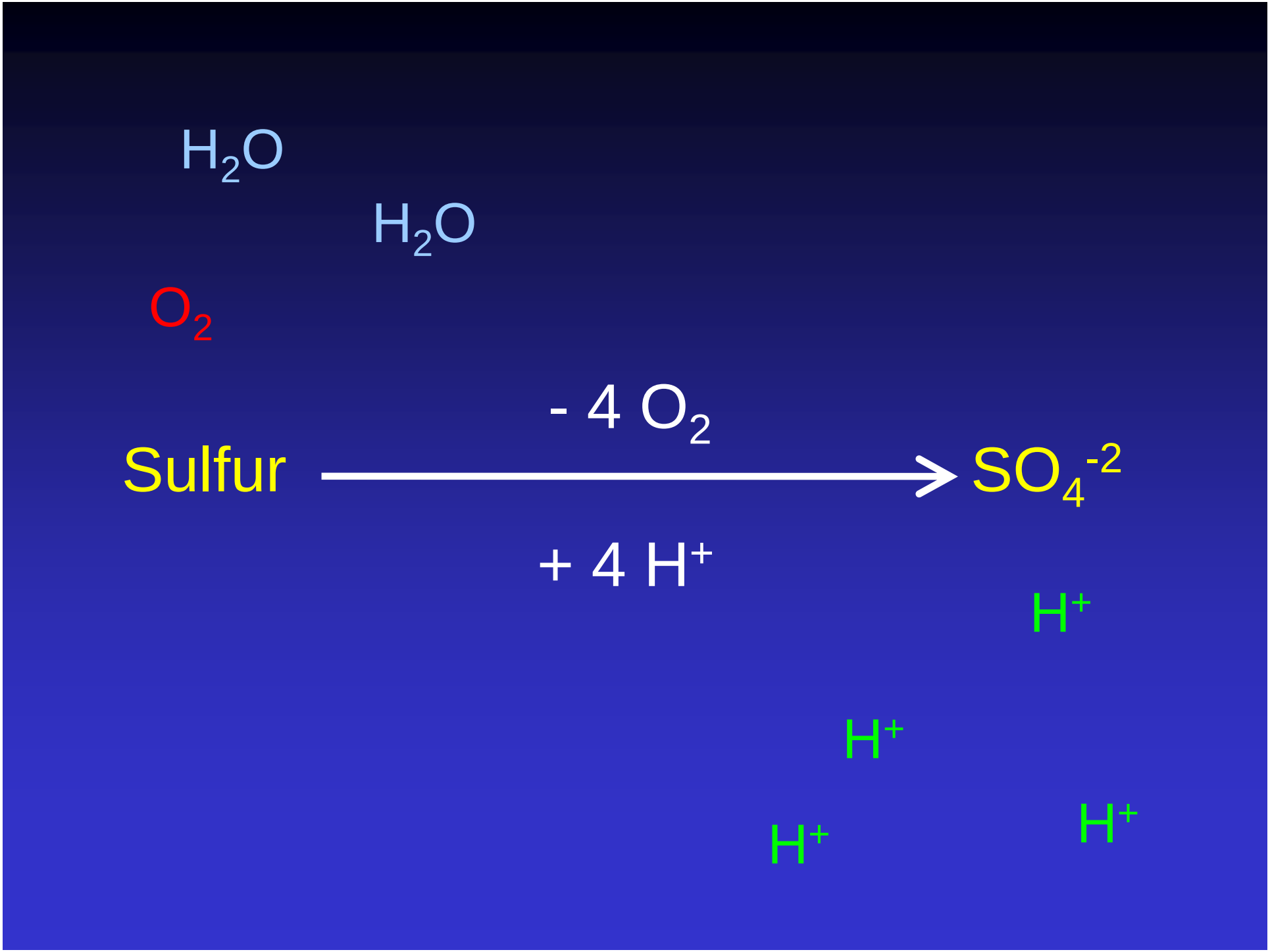

Sand
Drained
0
1
5


5X
0


Sulfur
Anaerobic
Conditions
SO_4
H_2S
+Fe
CaSO
FeS_2

What is pH?

Negative log of percent hydrogen ions in the soil


H_2O
H_2O
O_2
- 4 O_2
Sulfur
SO_4^{-2}
+ 4 H^+
H^+
H^+
H^+
H^+

Mathematics of Sulfur

1 S molecule	→	1 SO_4	- 1 oxygen molecule
100 S molecules	→	100 SO_4	- 100 oxygen molecules
1,000,000 S molecules	→	1,000,000 SO_4	- 1,000,000 oxygen molecules

$(NH_4)_2SO_4$

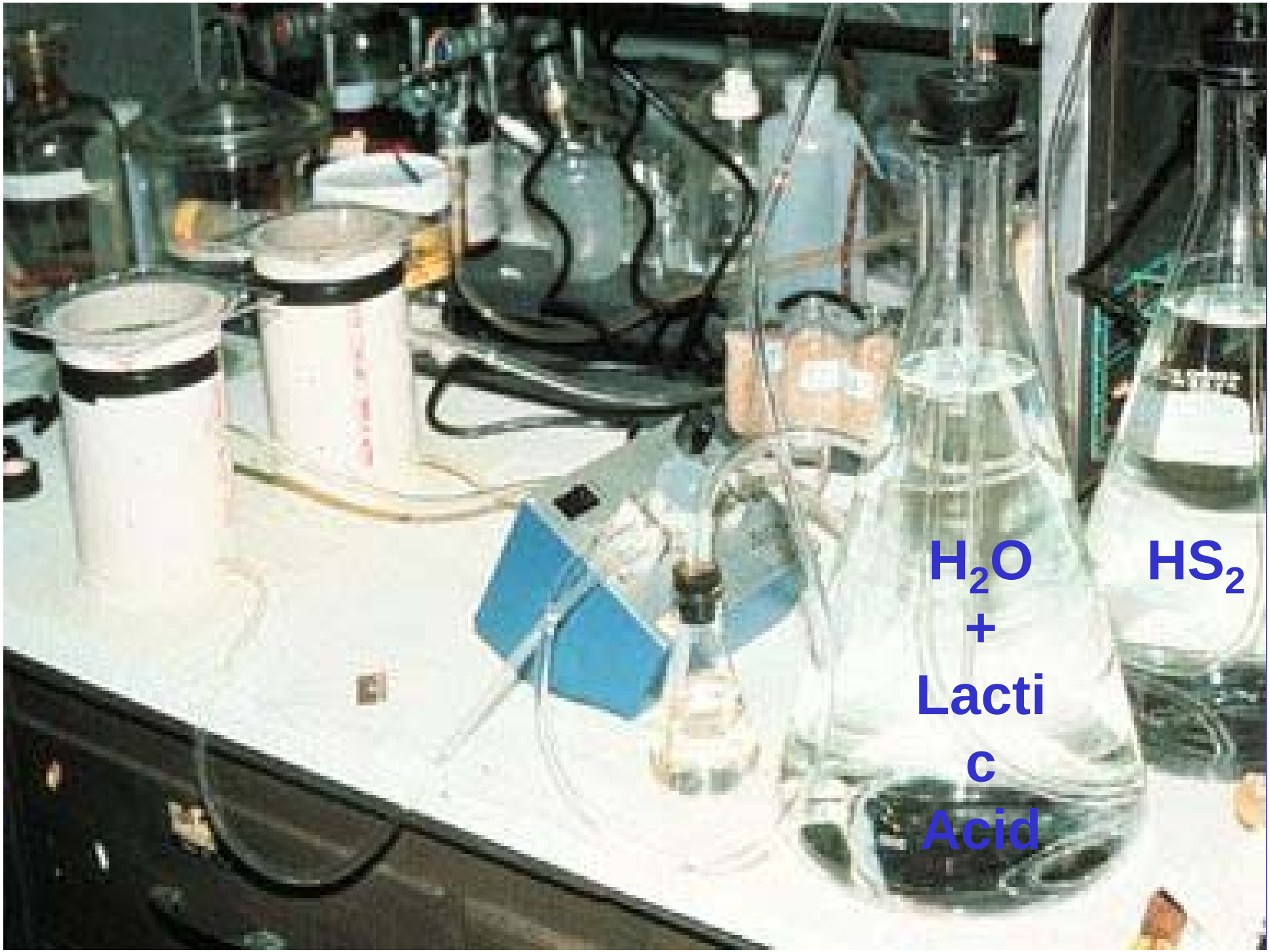
What in ammonium sulfate is responsible for pH reduction?

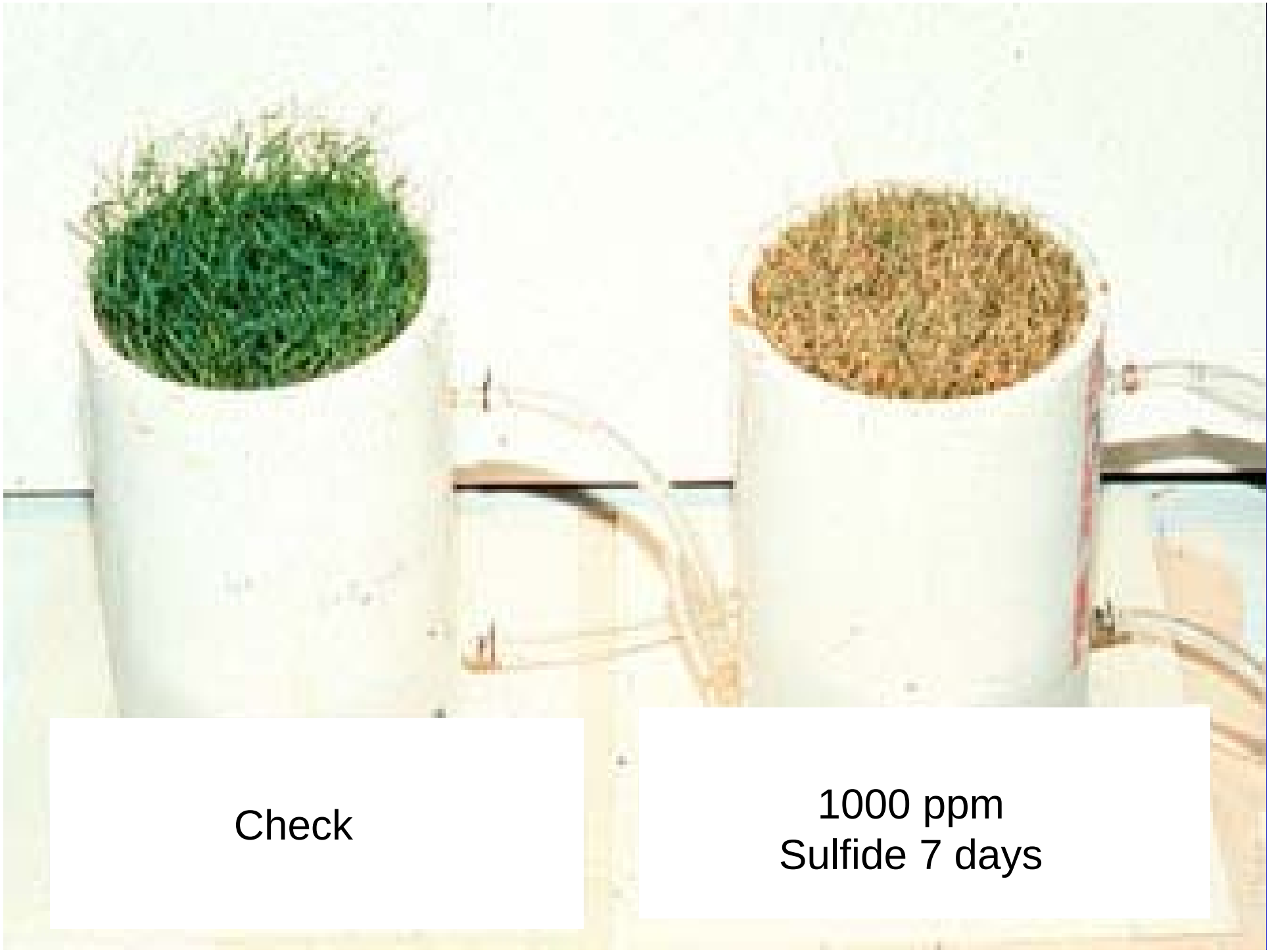
NH_4

The problem is you're all sulfurized

Causes of Anaerobic Condition

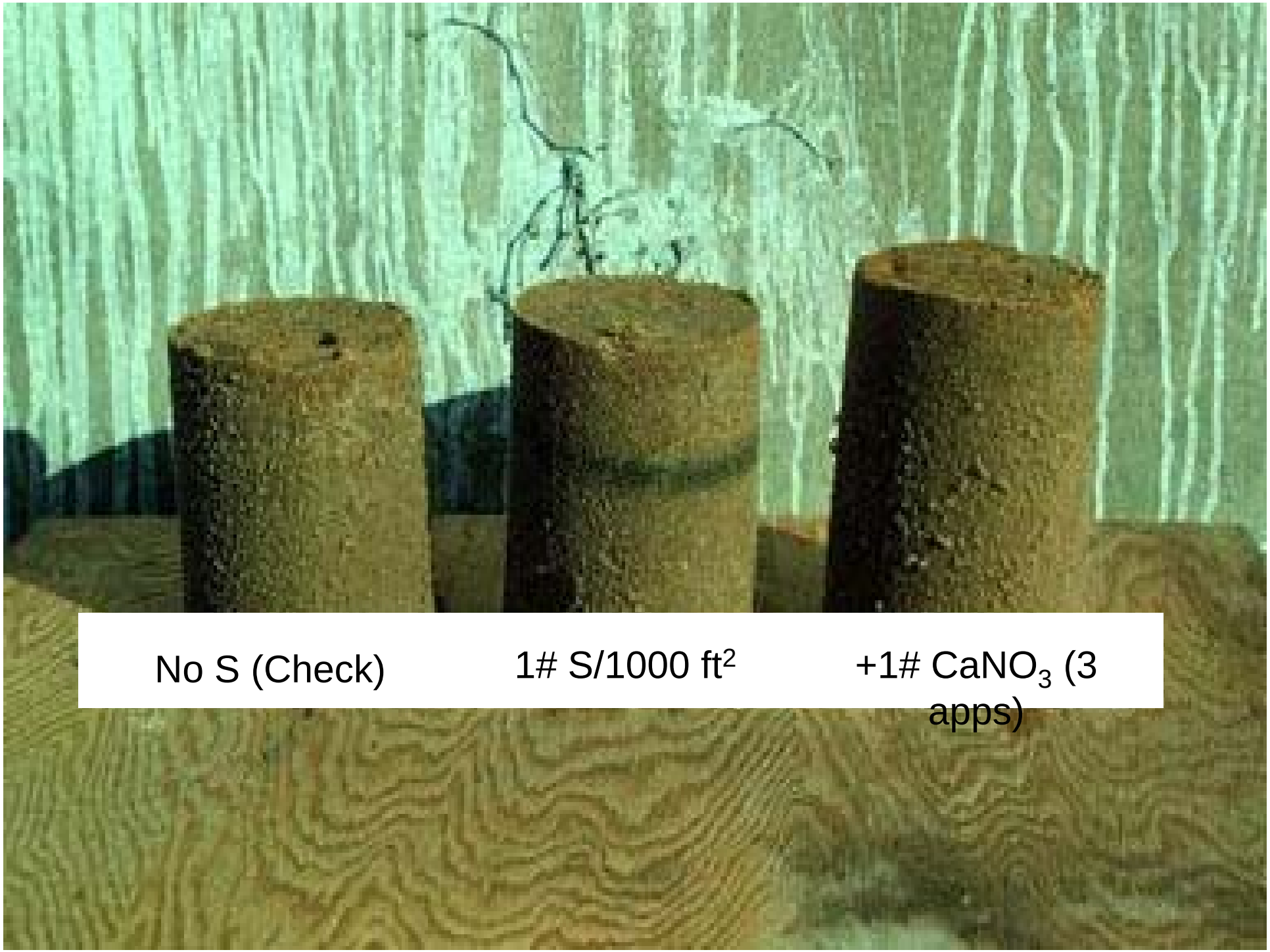
- 1) Excess irrigation
- 2) Heavy rains
- 3) Traffic
- 4) Sulfur

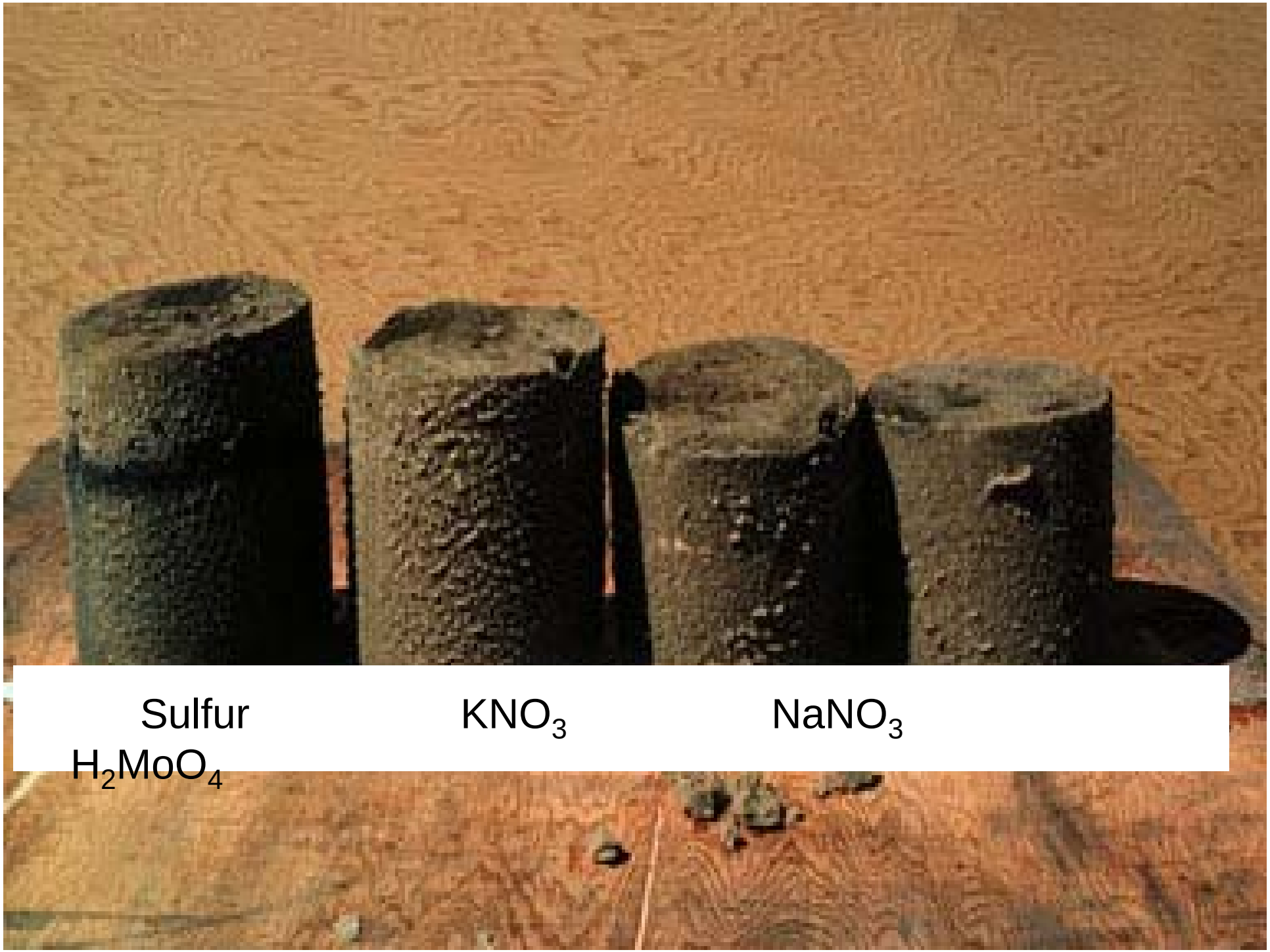

H_2O
+
Lacti
c
Acid
HS_2

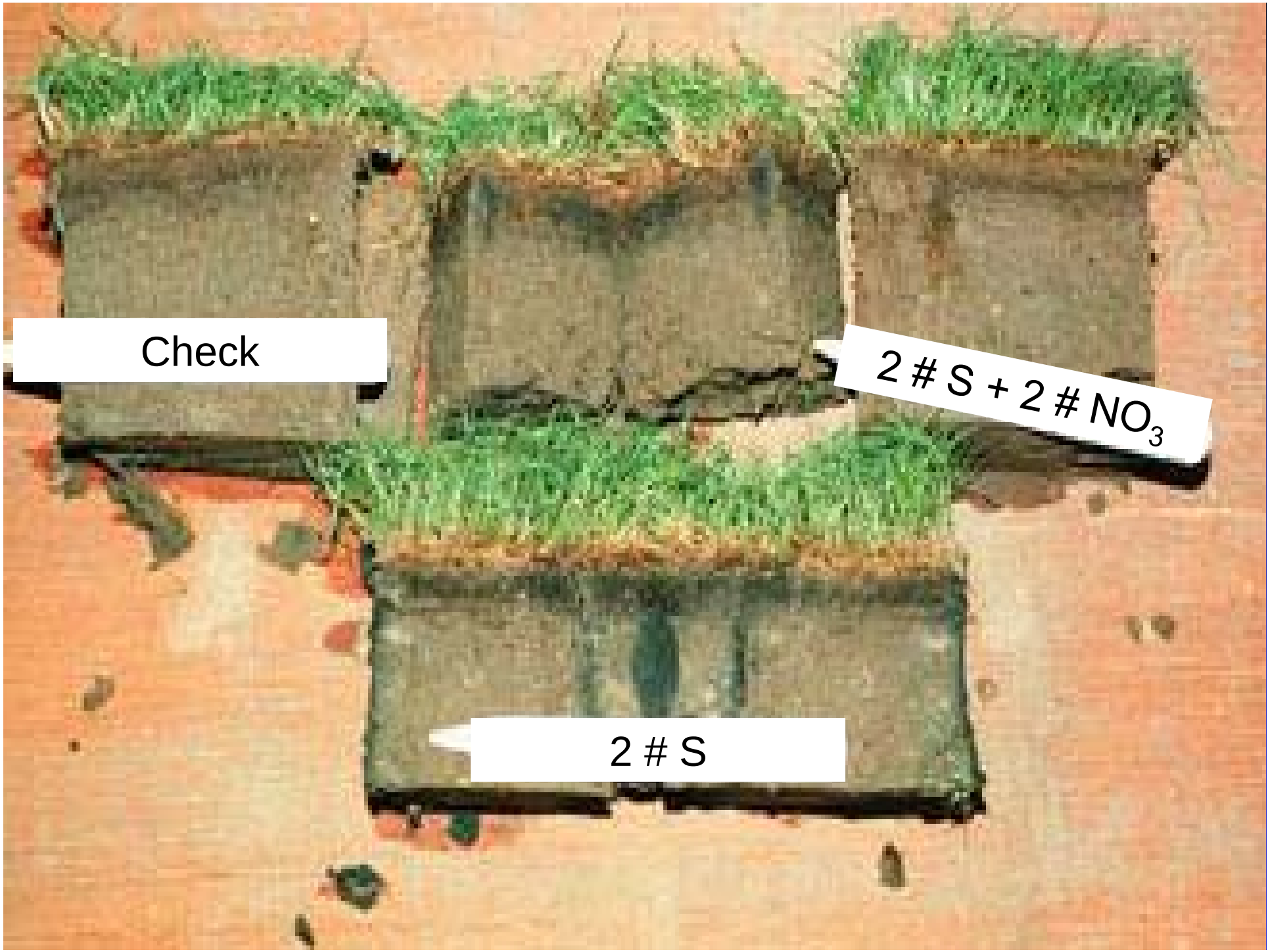

Check
1000 ppm
Sulfide 7 days

Check

1000 ppm
Sulfide 7 days


No S (Check)
1# S/1000 ft2
+1# CaNO3 (3 apps)


Sulfur
KNO_3
$NaNO_3$
H_2MoO_4


Check
2 # S + 2 # NO_3
2 # S

Fertilizer Effect on Turfgrass Plant

- Urea fertilizers - improved turf quality
- Nitrate fertilizers - improved root growth

(University of Georgia)

Black Layer Management

- 1) Aerification
- 2) Light irrigation
- 3) NO_3 - fertilizers
- 4) Avoid sulfur