2015- Micronutrient Uptake and Sources

Salesman's Name
November 2013

PLANT NUTRITION

CHEMISTRY

- Solubility
- Chelate vs. Complex
- Compatible

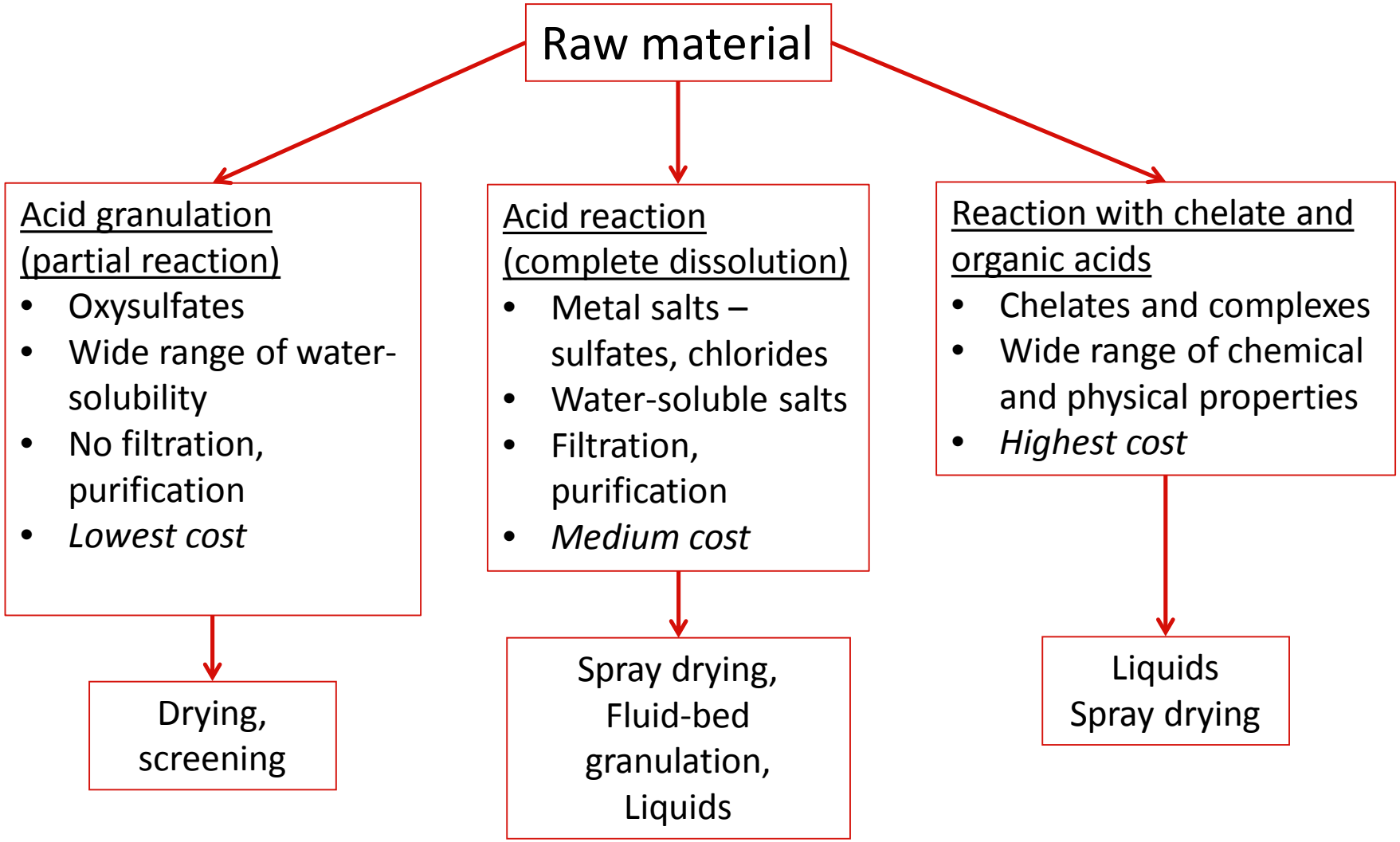
PHYSIOLOGY

- ROOT
- SEED
- LEAF

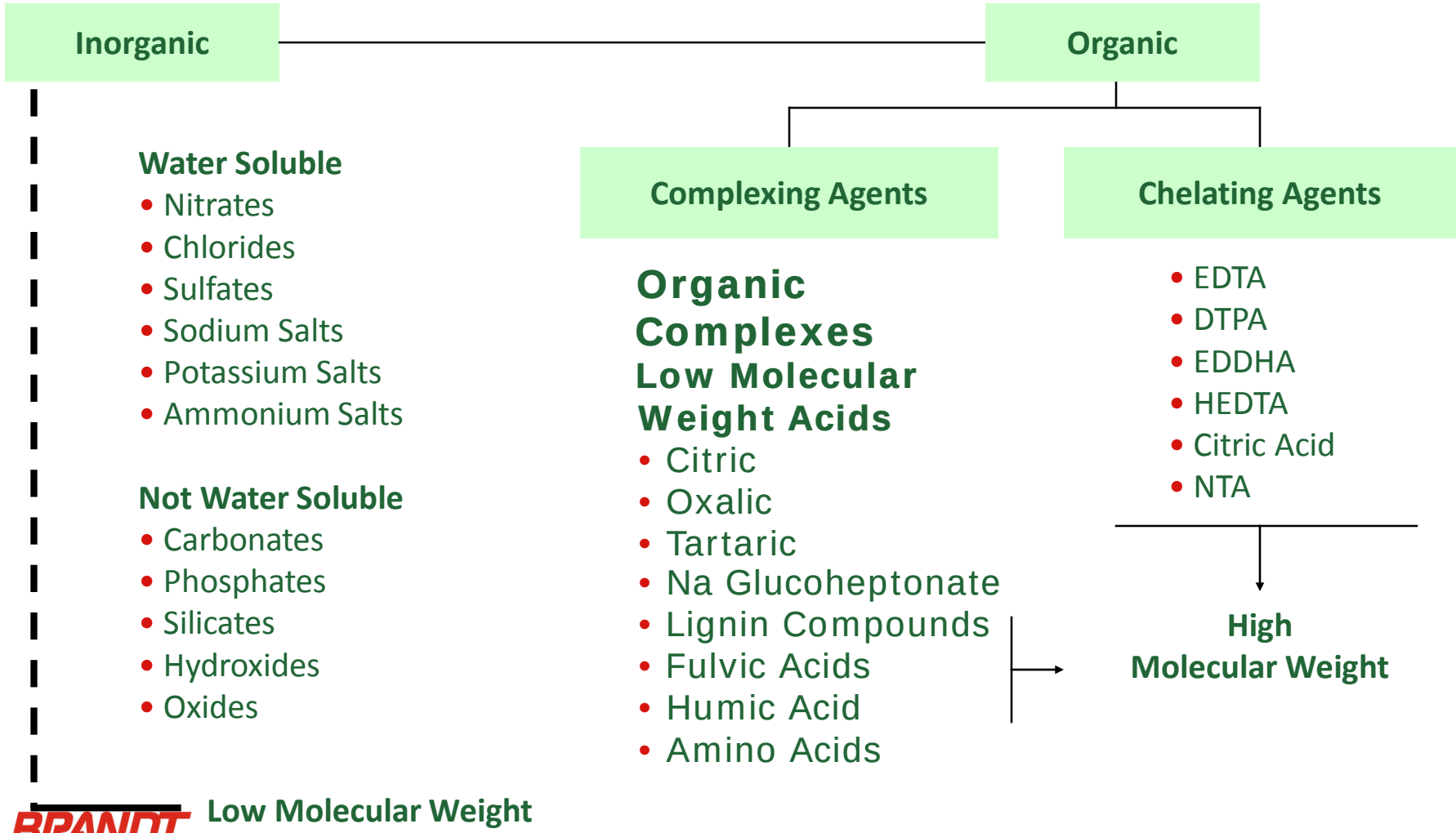
AGRONOMY

- Return on Investment
- Transient Nutrient Deficiency

Micronutrient Manufacturing Processes



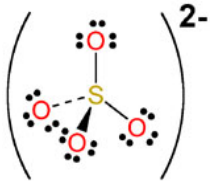
Nutrient Forms

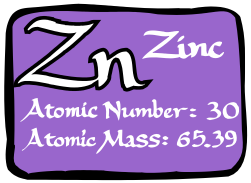


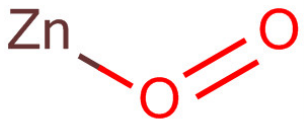
INORGANIC SALTS

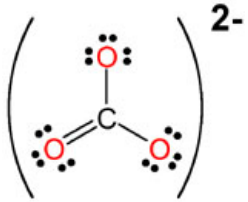
SOURCE

- Metal exposed
- Water Solubility
- Not Complexed



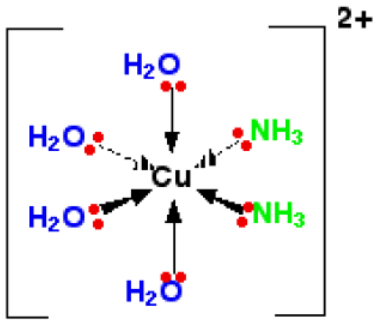




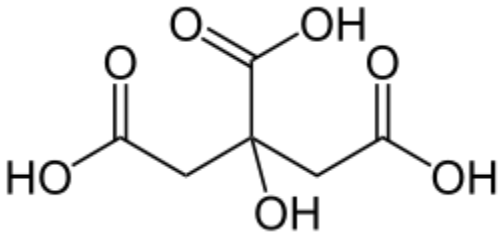


COMPLEX:

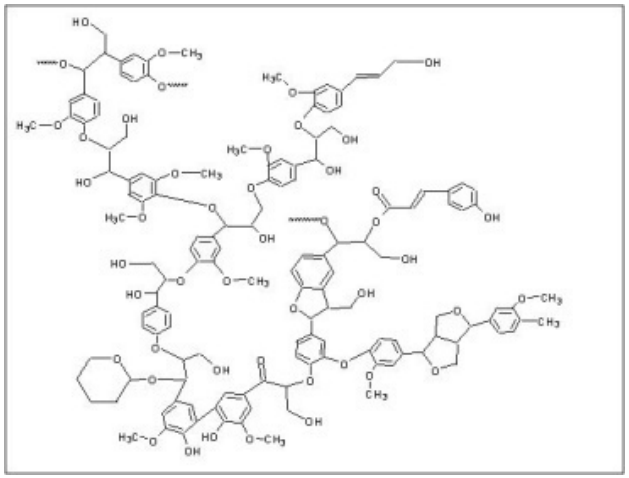
The term **complex** in chemistry, also called a "coordination compound" or "metal complex", a structure consisting of a central atom or molecule connected to surrounding atoms or molecules.



Ammoniated



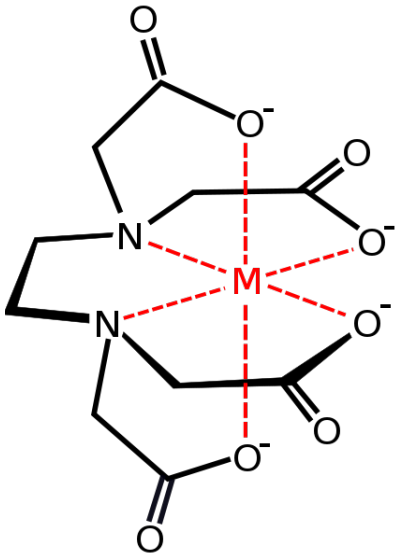
Citric Acid

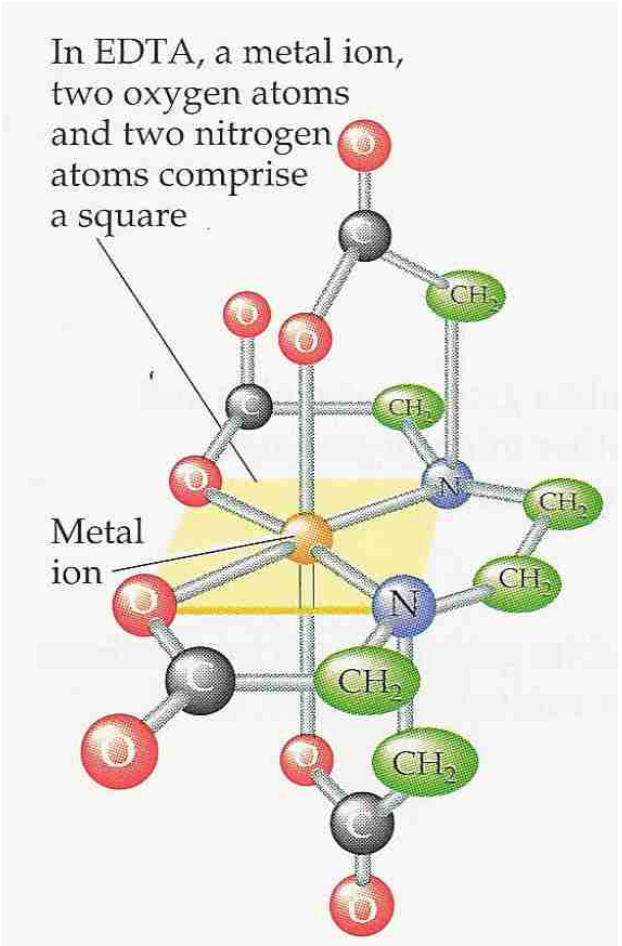


Lignin / Humic

CHELATE

a compound containing a ligand (typically organic) bonded to a central metal atom at two or more points.

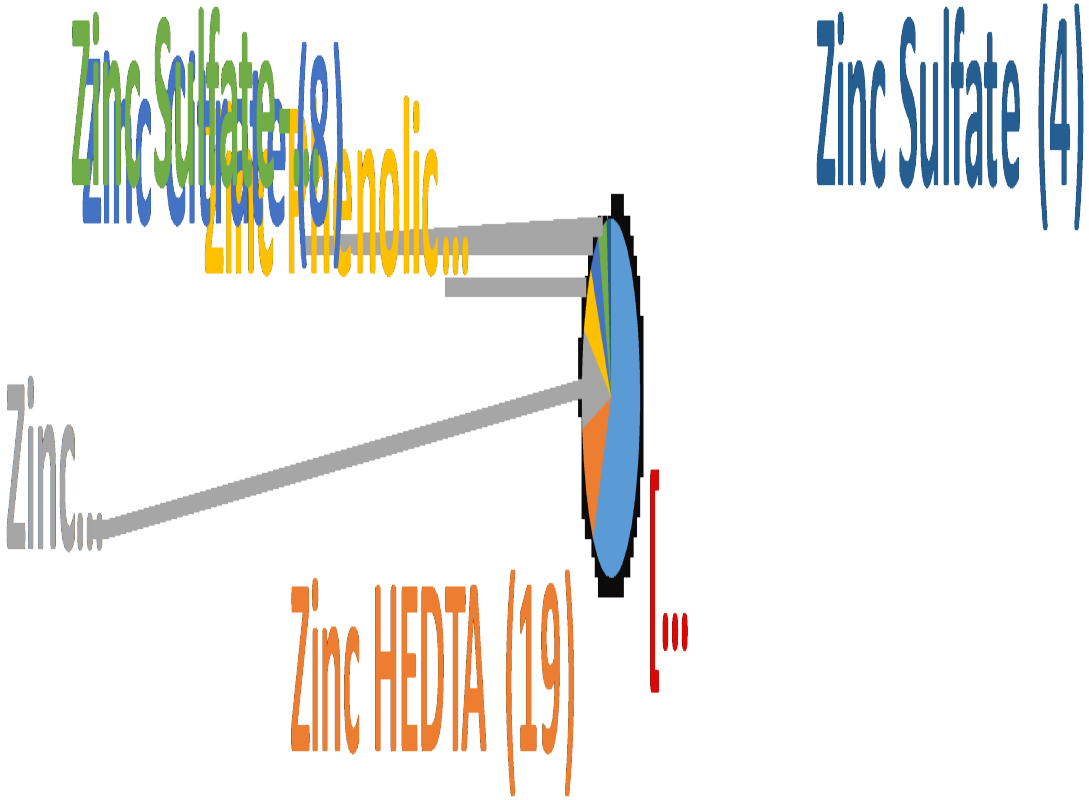




Compatible

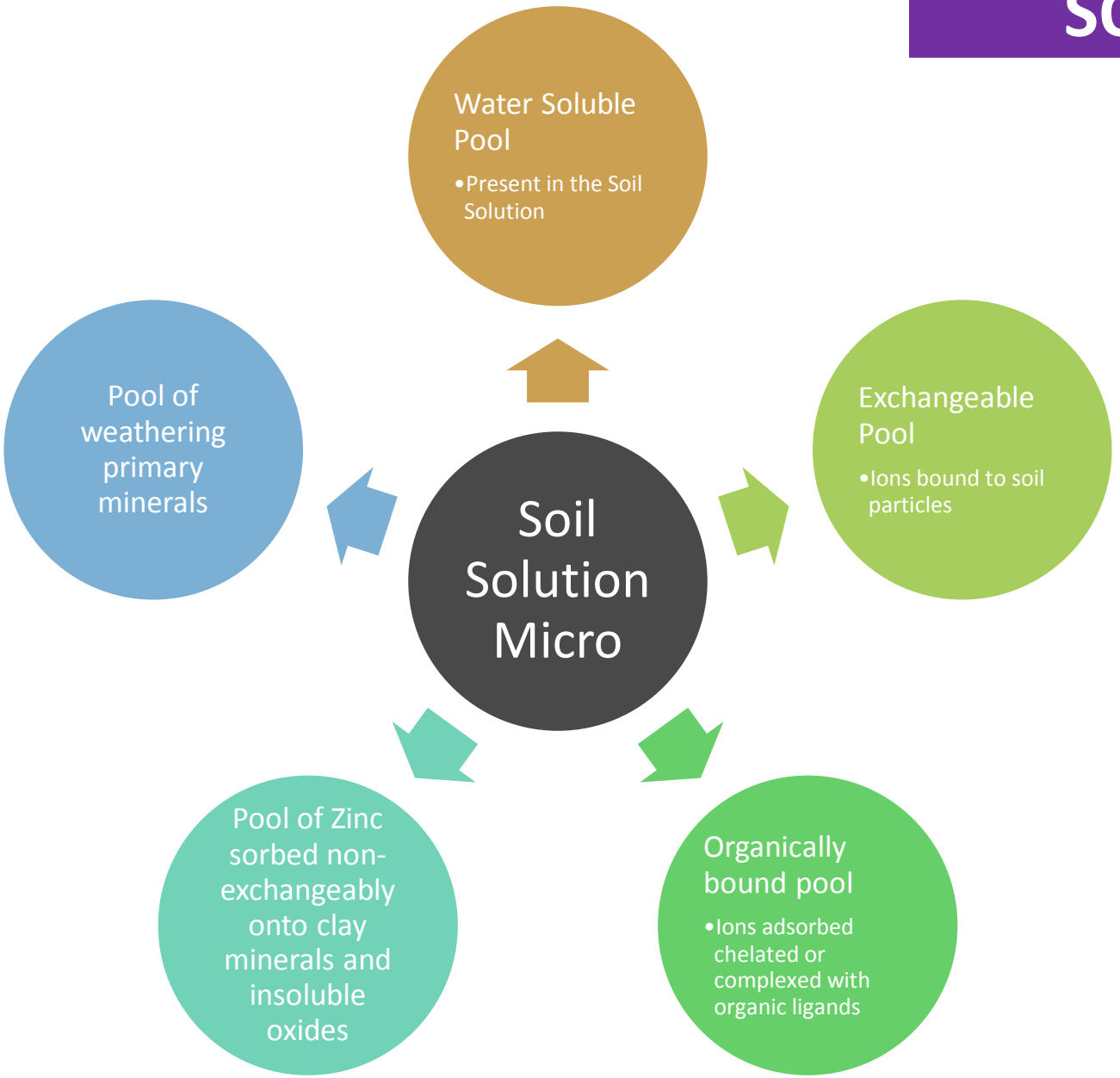
Two Stages

- IN A TANK
- IN THE SOIL SOLUTION



PERCENTAGE OF SOLUBLE ZINC REMAINING AFTER 4 MINUTES IN A 10-15-0 FERTILIZER SOLUTION

SOIL


Water Soluble Pool
•Present in the Soil Solution
Exchangeable Pool
•Ions bound to soil particles
Organically bound pool
•Ions adsorbed chelated or complexed with organic ligands
Pool of Zinc sorbed non-exchangeably onto clay minerals and insoluble oxides
Pool of weathering primary minerals
Soil Solution Micro

SOLUBILITY

SALTS

PROS
- Cost
- Solubility

CONS
- Metal Exposed
- Metal Exposed

COMPLEX

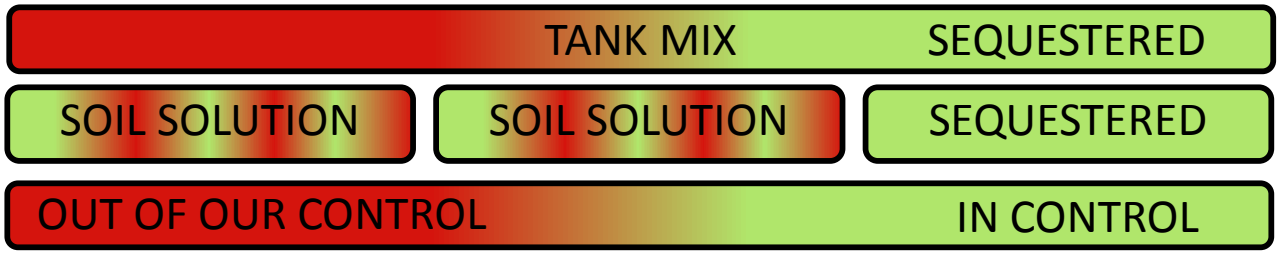
PROS
- Cost
- Natural systems a plant utilizes to solubilize and translocate minerals.

CONS
- Weaker bonds with minerals especially at increasing pH's

CHELATE

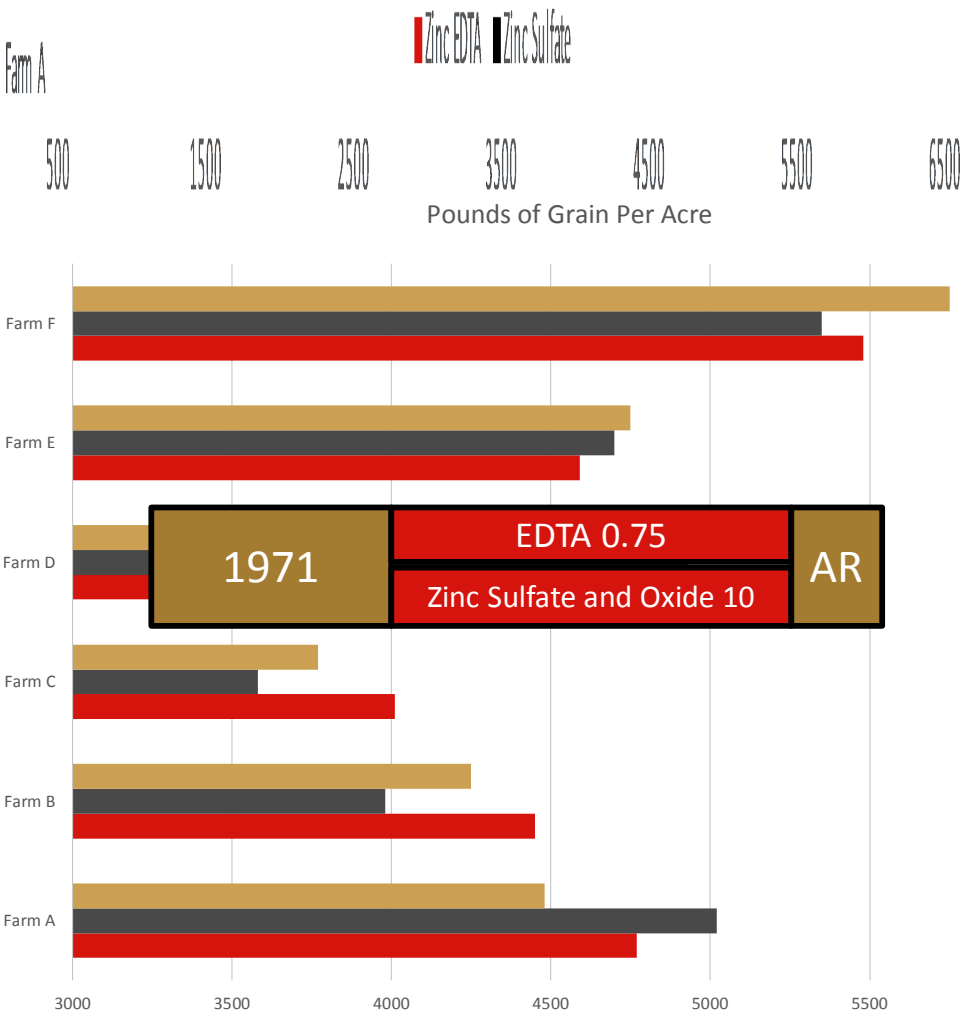
PROS
- Very stable in tank and soil solution

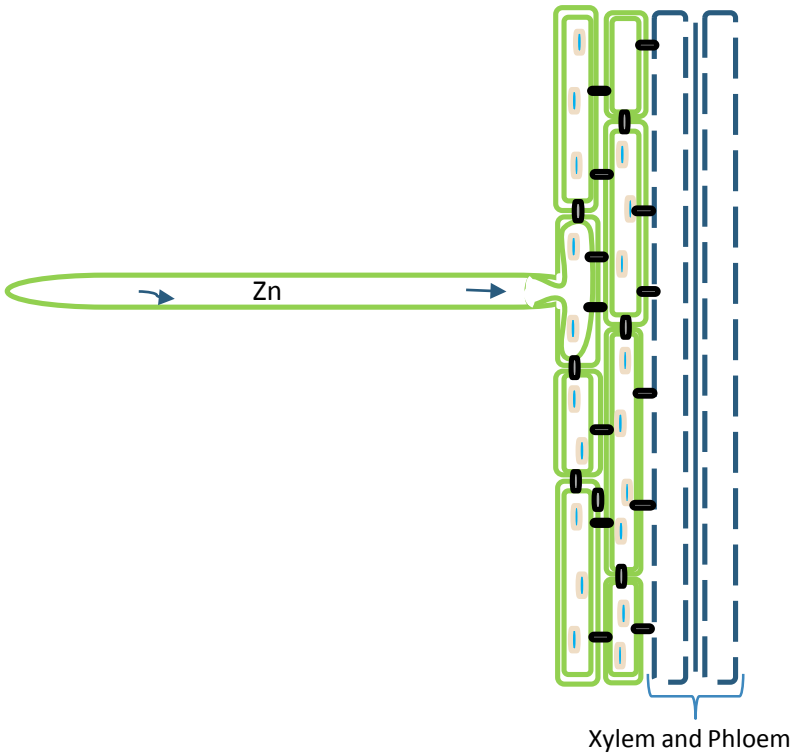
CONS
- Chelates can compete with plants for minerals like Calcium no good in a foliar case.



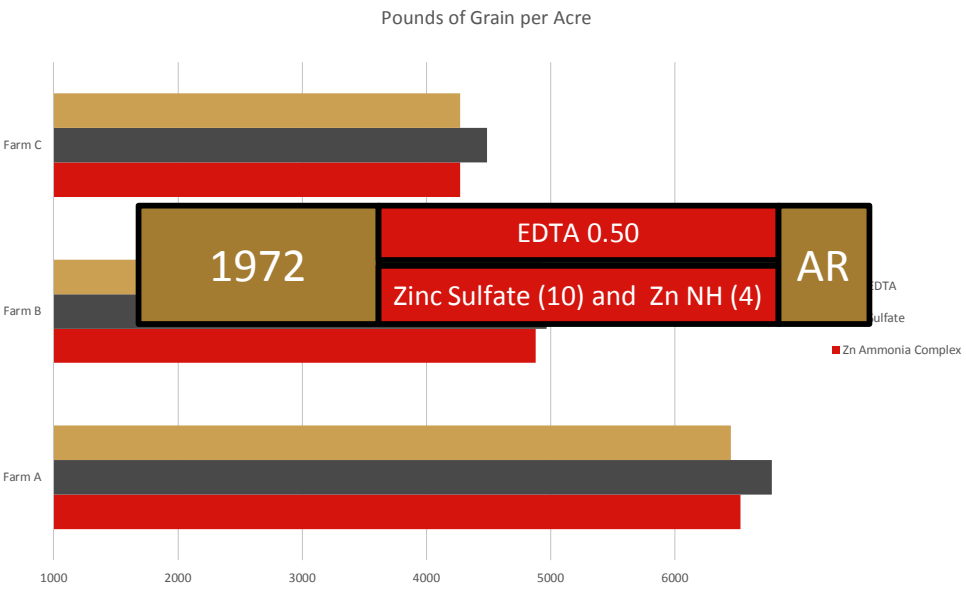
PHYSIOLOGY


1970
EDTA 1.6
Zinc Sulfate 10
AR


Zinc EDTA
Zinc Sulfate
Farm A
500
1500
2500
3500
4500
5500
6500
Pounds of Grain Per Acre
Farm F
Farm E
Farm D
Farm C
Farm B
Farm A
1971
EDTA 0.75
Zinc Sulfate and Oxide 10
AR
3000
3500
4000
4500
5000
5500
Zinc EDTA
Zinc Sulfate
Zinc Oxide


Zn
Xylem and Phloem

PHYSIOLOGY



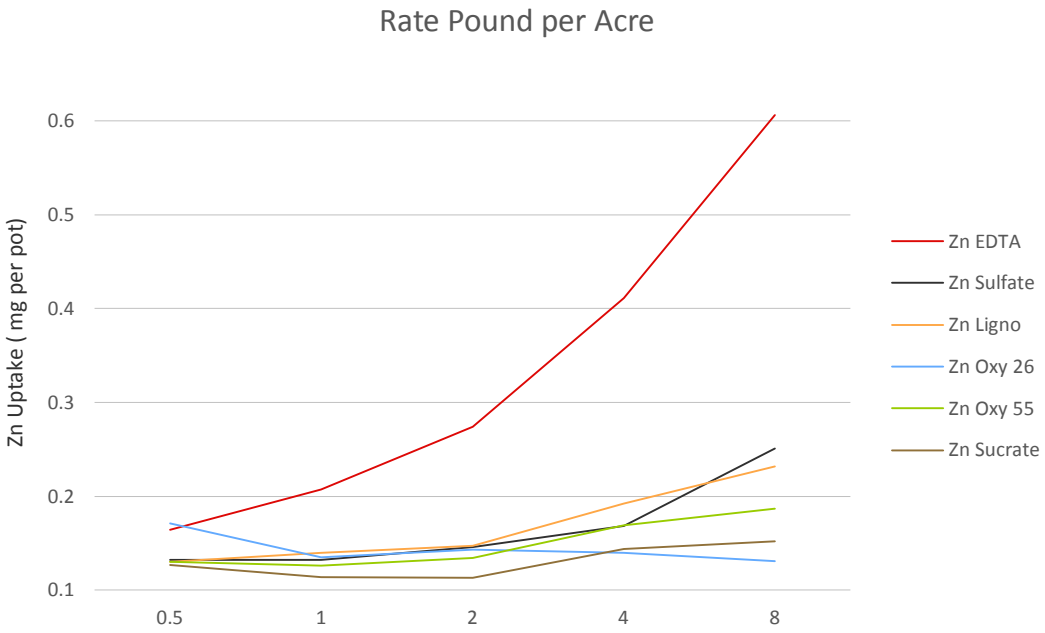
1970	EDTA 1.6 Zinc Sulfate 10	AR
1971	EDTA 0.75 Zinc Sulfate and Oxide 10	AR

SUMMARY

- 1968 to 1972
- University of Arkansas
- Rice
- 25 Locations

" Extrapolating from all the data a zinc rate of 7 to 10 Lb. per acre of zinc in the inorganic form or 0.75 to 1.0 lb. per acre in the chelated form is needed to adequately prevent the occurrence of chlorosis on these alkaline soils " …

RELATIVE AVAILABILITY COEFFICIENT



Zinc Uptake

SOURCE	RAC
Zn EDTA	100
Zn Sulfate	23
Zinc Ligno	22
Zn Oxy Su 26	0.5
Zn Oxy 55	12
Zn Sucrate	5

- Colorado State University
- Corn
- Pots
- W.J Gangloff, D.G. Westfall, G.A. Peterson and JJ Mortvedt

MICRONUTRIENTS FOR FOLIAR APPLICATION

CHEMISTRY

PHYSIOLOGY

AGRONOMY

Source

Compatible

LEAF

Salts

Complex

Chelate

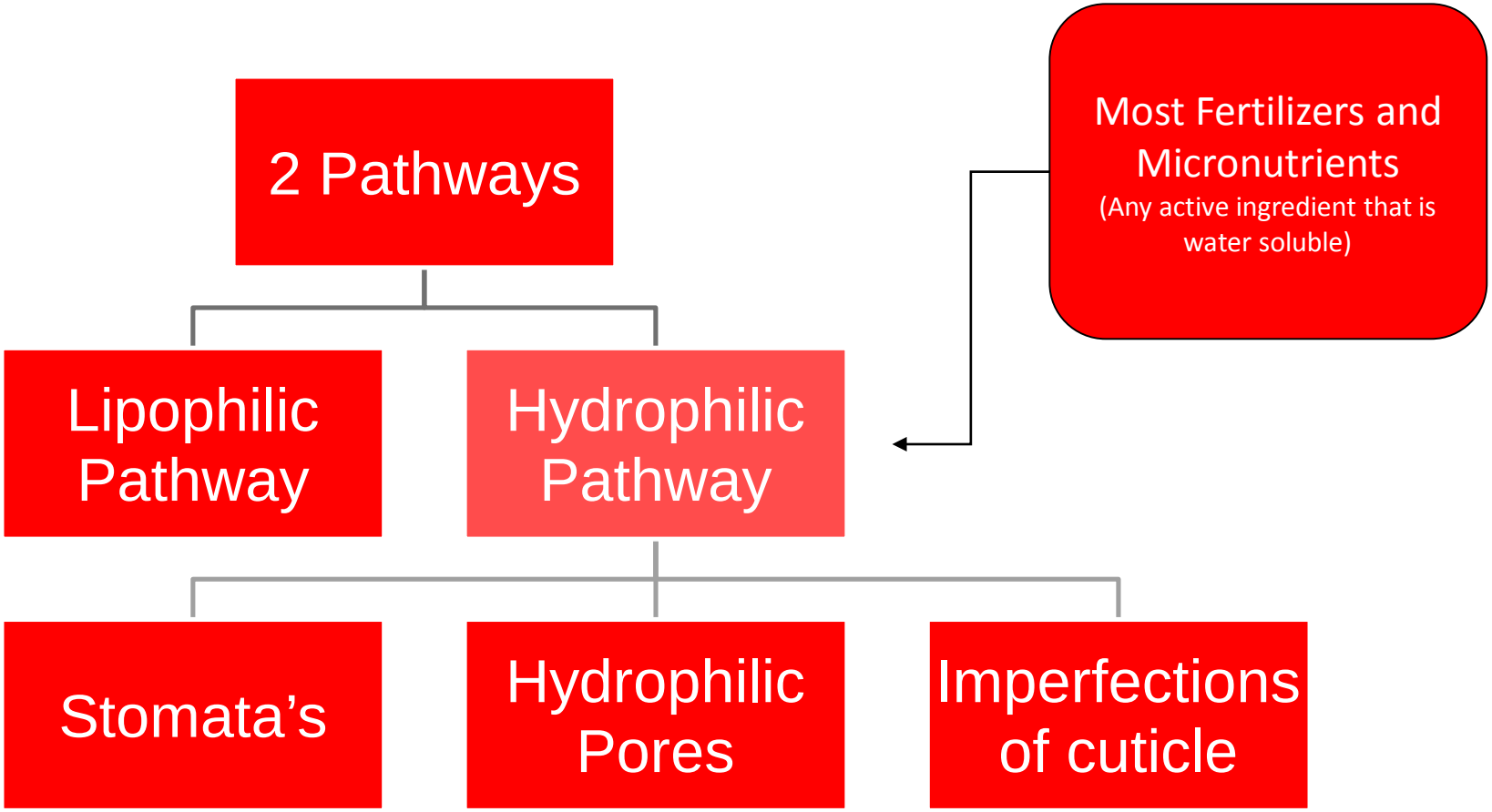
Tank Mix

"The Cuticle is the Most Limiting Factor to Foliar Applications of Polar Salts"

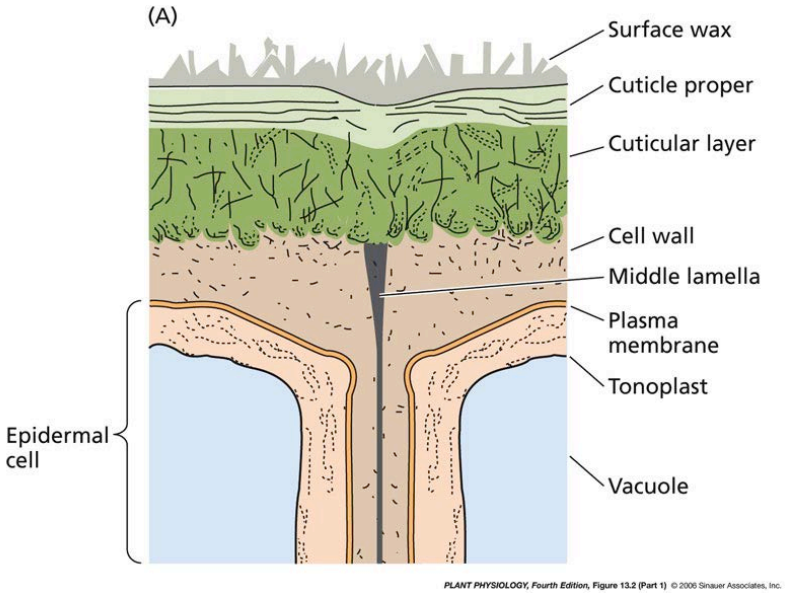
Foliar formulations are specifically designed to get micronutrients past the leaf cuticle into the intercellular spaces better than any other foliar micronutrients on the market.

Maximizing Foliar Potential

Foliar Applied Actives – 2 Pathways

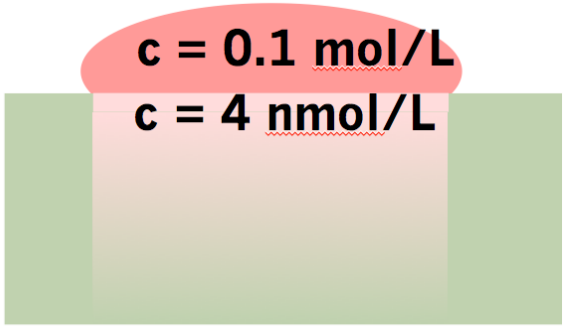


Direct Penetration of Mineral Salts Through Intact Cuticles is Highly Improbable



Mineral nutrient salts have an extremely low solubility in the lipophilic cuticle

Example: NH_4NO_3 solution



= 0.000004%

Courtesy Thomas Eichert

"There must be a second pathway in the cuticle"

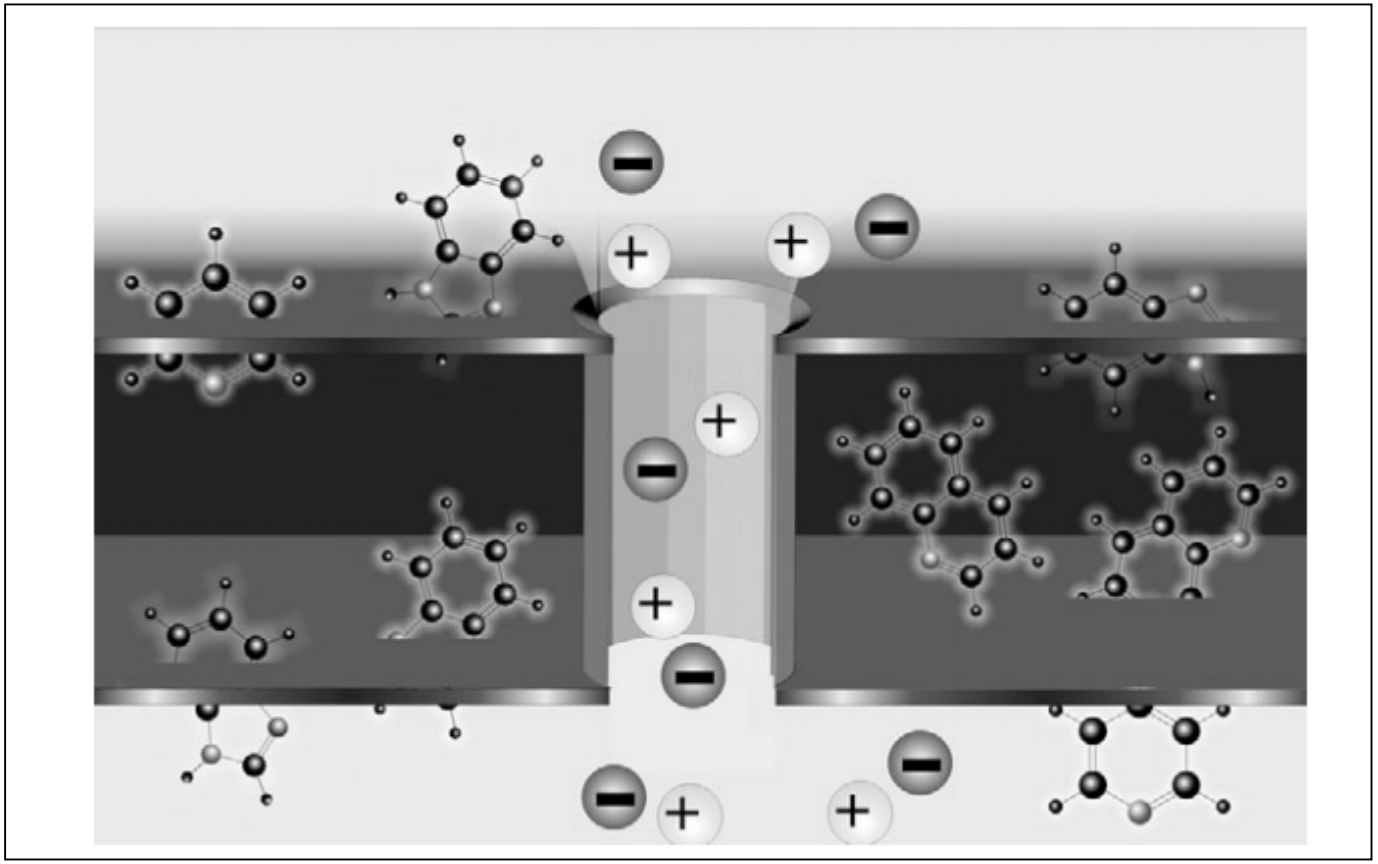
Polar Pores

(Schönherr 1976, 2000, Schreiber 2005)

BRANDT

Polar Pores

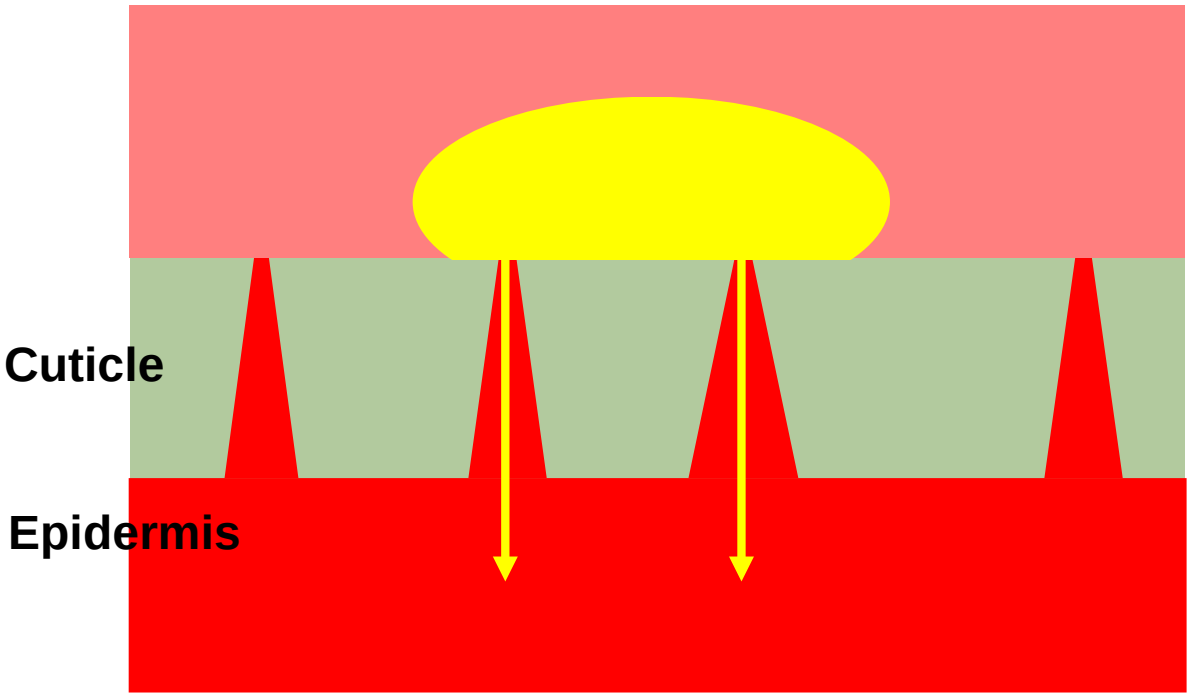
Purely theoretical but supported by experimental data.



Schönherr 2006

Polar Pores: Movement of hydrophilic solutes in water clusters sorbed in the cuticle

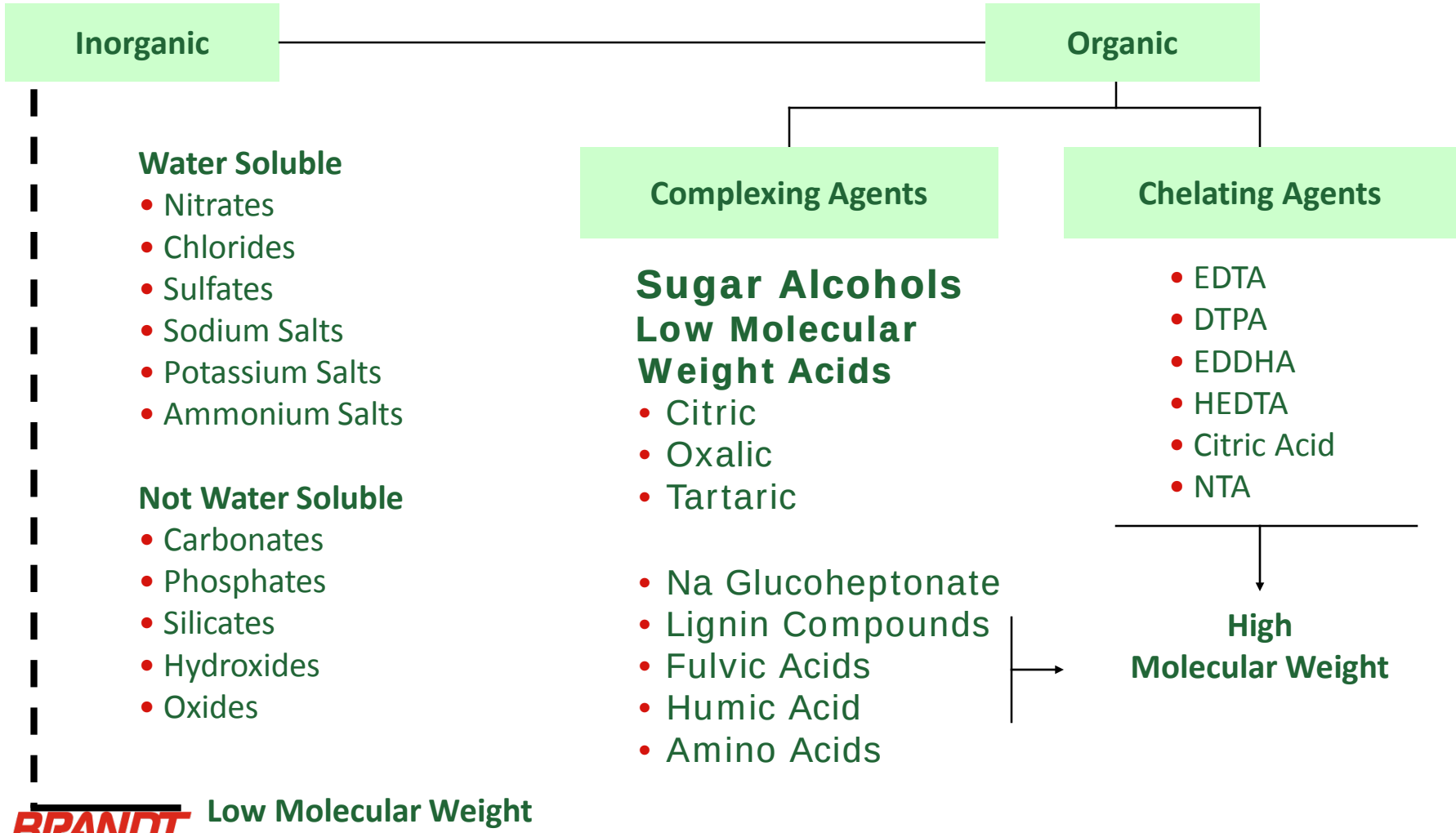
Moist air: pores open (swelling of the cuticle)
Size of 1-5nm. (Nitrate 0.2nm, EDTA 1.3nm)



Based on: Eichert and Fernández (2012), in : Maschner 3rd ed.

Water provided by both sides of the cuticle

Nutrient Forms



INORGANIC SALTS

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- Water Solubility
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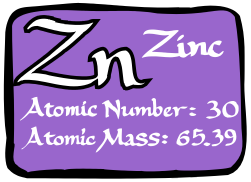
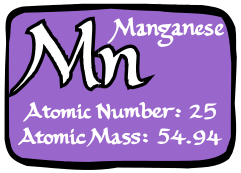
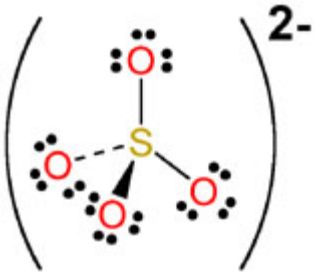
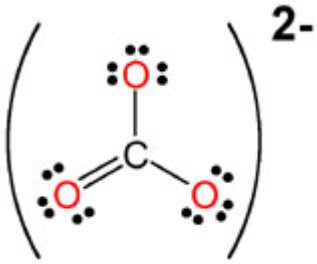


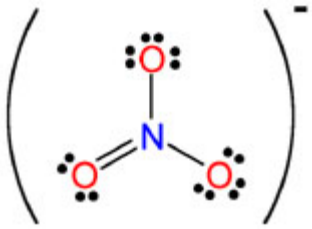




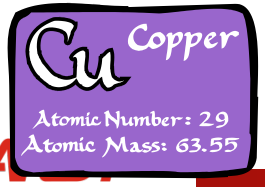
Sulfates

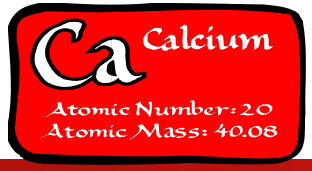


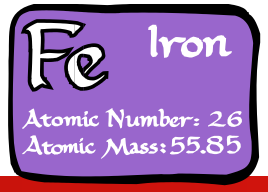
Carbonates



Nitrates

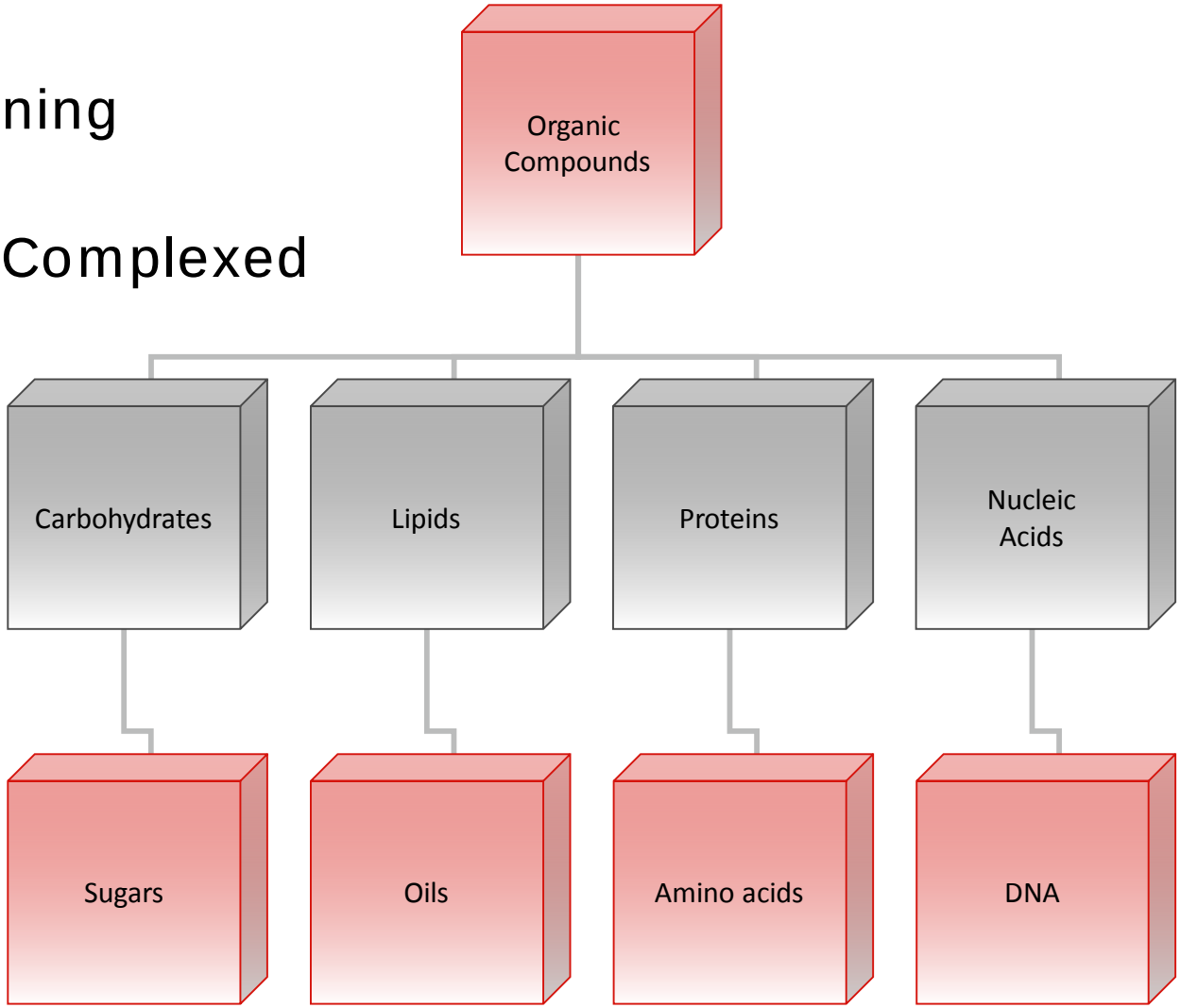






ORGANIC

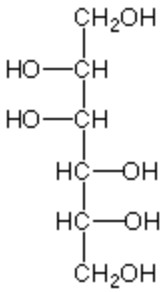
- Carbon containing compounds
- Chelated and Complexed



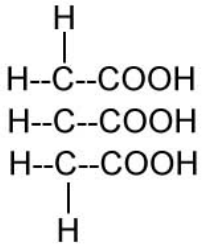
Complexes

- Sugar Alcohols
- Organic Acids
- Glucoheptonates
- Lignin Compounds
- Amino acids

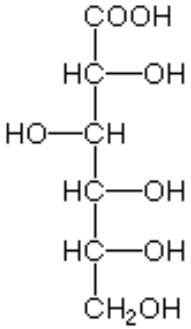
- Water Soluble
- Are present in all biological organisms.



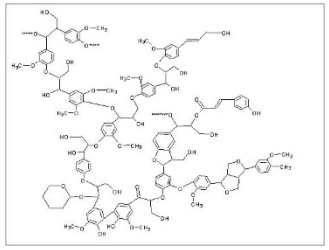
Mannitol



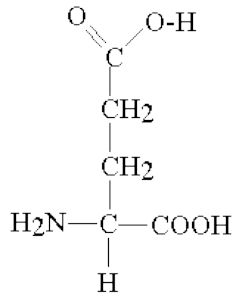
Citric Acid



Gluconic Acid



Lignin
(Courtesy of "Real-World in green chemistry."



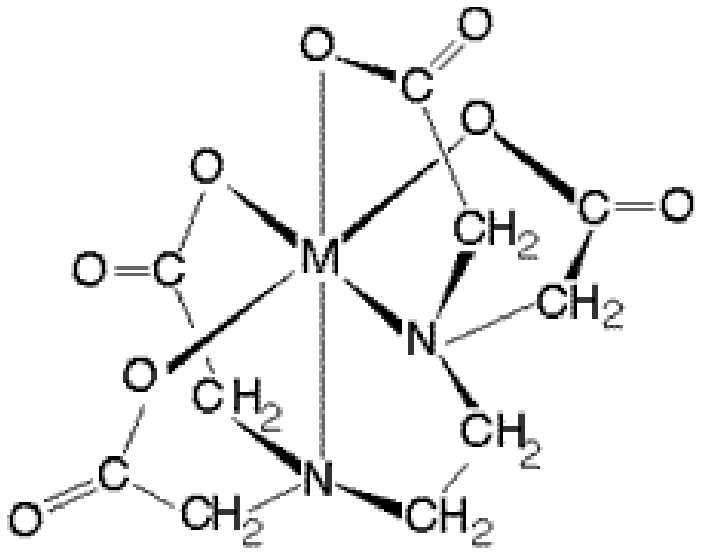
glutamic acid

BRANDT

Synthetic Chelates

- EDTA
- EDDHA
- DTPA
- HEDTA
- NTA

- pH range
- Synthetic
- Metal scavenger
- Carcinogenic



Metal-EDTA complex

THANKS TO

Dr. PATRICK BROWN (UC DAVIS)

ALLAN BLAYLOCK (AGRIUM)