2015- Micronutrient Uptake and Sources

Salesman's Name
November 2013
Micronutrient Manufacturing Processes

Raw material

- Acid granulation (partial reaction)
  - Oxysulfates
  - Wide range of water-solubility
  - No filtration, purification
  - Lowest cost
  - Drying, screening

- Acid reaction (complete dissolution)
  - Metal salts – sulfates, chlorides
  - Water-soluble salts
  - Filtration, purification
  - Medium cost
  - Spray drying, Fluid-bed granulation, Liquids

- Reaction with chelate and organic acids
  - Chelates and complexes
  - Wide range of chemical and physical properties
  - Highest cost
  - Liquids Spray drying
Nutrient Forms

Inorganic

- Water Soluble
  - Nitrates
  - Chlorides
  - Sulfates
  - Sodium Salts
  - Potassium Salts
  - Ammonium Salts

- Not Water Soluble
  - Carbonates
  - Phosphates
  - Silicates
  - Hydroxides
  - Oxides

Organic

- Complexing Agents
  - Organic Complexes
    - Low Molecular Weight Acids
      - Citric
      - Oxalic
      - Tartaric
      - Na Glucoheptonate
      - Lignin Compounds
      - Fulvic Acids
      - Humic Acid
      - Amino Acids
  - Chelating Agents
    - EDTA
    - DTPA
    - EDDHA
    - HEDTA
    - Citric Acid
    - NTA

- Low Molecular Weight

High Molecular Weight
INORGANIC SALTS

- 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.

![Citric Acid]

![Lignin / Humic]

SOURCE
CHELATE

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

In EDTA, a metal ion, two oxygen atoms and two nitrogen atoms comprise a square.
Two Stages

- IN A TANK
- IN THE SOIL SOLUTION

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

- **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**
**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.

**TANK MIX**
- **SEQUESTERED**
- **SOIL SOLUTION**
- **SEQUESTERED**
- **OUT OF OUR CONTROL**
- **IN CONTROL**
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

Source

Salts
Complex
Chelate

Compatible

Tank Mix

PHYSIOLOGY

AGRONOMY

LEAF

Presentation title in footer (if desired)
“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

2 Pathways

- Lipophilic Pathway
  - Stomata’s
- Hydrophilic Pathway
  - Hydrophilic Pores
  - Imperfections of cuticle

Most Fertilizers and Micronutrients
(Any active ingredient that is water soluble)
Direct Penetration of Mineral Salts Through Intact Cuticles is Highly Improbable

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

Example: $\text{NH}_4\text{NO}_3$ solution

\[
c = 0.1 \text{ mol/L} \\
c = 4 \text{ nmol/L} \\
= 0.000004\%
\]

“There must be a second pathway in the cuticle”

Polar Pores

(Schönherr 1976, 2000, Schreiber 2005)
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)

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- Phosphates
- Silicates
- Hydroxides
- Oxides

Organic

Complexing Agents

Sugar Alcohols
Low Molecular Weight Acids
- Citric
- Oxalic
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- Na Glucoheptonate
- Lignin Compounds
- Fulvic Acids
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Low Molecular Weight

High Molecular Weight

Low Molecular Weight
INORGANIC SALTS

- Metal exposed
- Water Solubility
- Not Complexed
ORGANIC

- Carbon containing compounds
- Chelated and Complexed

Diagram:

- Organic Compounds
  - Carbohydrates
    - Sugars
  - Lipids
    - Oils
  - Proteins
    - Amino acids
  - Nucleic Acids
    - DNA
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
Synthetic Chelates

- EDTA
- EDDHA
- DTPA
- HEDTA
- NTA

- pH range
- Synthetic
- Metal scavenger
- Carcinogenic

Metal-EDTA complex
THANKS TO

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