Micronutrient Sources

Selecting a micronutrient source requires consideration of many factors.

- Compatibility with N-P-K fertilizers and other tank mix partners
- Convenience in application
- Agronomic effectiveness
- Cost per unit of micronutrient
Which Micronutrients

- Iron
- Zinc
- Copper
- Manganese
- Boron
- Molybdenum
The four main classes of micronutrient sources are

1) Inorganic

2) Synthetic chelates

3) Natural organic complexes

4) Other - Nitrate and chloride solutions of zinc, magnesium, calcium, manganese and copper.
- Inorganic sources consist of oxides, carbonates and metallic salts such as sulfates, chlorides and nitrates.

- Sulfates of Fe, Cu, Mn and Zn are the most common metallic salts used in the fertilizer industry because of their high water solubility and plant availability.

- Oxides of Zn are relatively water insoluble and thus must be finely ground to be effective in soils.

- Broadcast applications of Zn oxides should be applied at least 4 months before planting to be effective\(^1\).
Synthetic Chelates are:

EDTA
EDDHA
NTA
DTPA
ETC.

They are water soluble and protect the associated metal from reaction with other ingredients. They are also expensive per unit of nutrient.
Complexes are

Glucoheptonates – Sugars e.g. sugar cane by-products

Ligninsulfonates – Paper industry by product

Citric Acids – from various citrus products

Metal-ammonia complexes such as ammoniated Zn sulfate are also used by the fertilizer industry. Such complexes appear to decompose in soils and provide good agronomic effectiveness\(^2\).

1 Tri-State Agronomic Team
2. Agronomy Dept, Michigan State
Nitrate and chloride solutions of zinc, magnesium, calcium, manganese and copper are widely used to provide essential elements in plant growth.

They are primarily used for soil application although low rates are used for foliar application, care must be taken to avoid foliar burn. The pH usually runs between 2.5 and 4.0. The analysis varies and pH tends to go lower over time.
Some mixtures will heat up.
250 PSI CHEMICAL REACTORS
Cold Mix Plant
Source must fit grower management style
Adapted for starter fertilizer
Costs

Relative cost of source of Zinc micronutrient per water soluble unit.

$- Zinc Sulfate
$$- Ammoniated Zinc
$$$- Zinc Complexes
$$$$$- Zinc Chelates (EDTA)
Foliar Application

• Basically the same for Iron, Zinc, Copper, Manganese and Boron.
• Evaluate the cost.
• More exotic tank mixes e.g. addition of herbicides, fungicides and insecticides require some level of complexing or chelating for compatibility.
Ammonium Thiosulfate
Mixtures to avoid

• Any phosphate and magnesium (except chelate)
• Any calcium and phosphate or sulfate (except chelate)
• Sulfate and phosphate
• Phenoxy and amine products plus sulfate
• High pH added directly to low pH products (vice versa)
• Soluble powders added to 10-34-0
• Non-chelates added to ortho-phosphate
• Etc.
Some mixtures are guaranteed

Calcium Chloride

Ammonium Thiosulfate

Gypsum
GLYPHOSATE and MICROS

However, the prescience of the hard-water cations \( \text{Ca}^{2+} \) and \( \text{Fe}^{3+} \), and the fertilizer \( \text{Mn}^{2+} \), in the spray solution have antagonized Glyphosate efficacy. In solution, Glyphosate is a weak acid and readily forms complexes with cations. When Glyphosate complexes with di- and trivalent metal cations, Glyphosate absorption into and/or translocation within the plant is reduced.
Order of Compatibility

Oxides – Only in Suspensions

Sulfates – in water then into 10-34-0, UAN, Potash mixtures

Complexes – some directly into NPK some dilute with water first
Jar test first.

Chelates (liquid)– direct mix into NPK
Raw Materials For Custom Liquid Products

LOW pH

ACID
Acetic
Boric
Carbonic
EDTA
Formic
Hydrochloric
Lactic
Nitric
Phosphoric
Phosphorus
Sulfuric

HIGH pH

Metal/Base
Ammonia
Calcium
Copper
Iron
Manganese
MEA
Potassium
Sodium
Ulexite
Zinc
## Compatibility / Stability Table

<table>
<thead>
<tr>
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</thead>
<tbody>
<tr>
<td><strong>Analysis</strong></td>
<td>16-0-0-20Zn</td>
<td>8-0-0-10Zn</td>
<td>9-0-0-10Zn-4S</td>
<td>6-0-0-9Zn</td>
</tr>
<tr>
<td><strong>Lbs/Gallon</strong></td>
<td>11.1 ppg</td>
<td>9.6 ppg</td>
<td>11 ppg</td>
<td>10.9 ppg</td>
</tr>
<tr>
<td><strong>Lbs of Elemental Zinc per Gallon</strong></td>
<td>2.22 ppg</td>
<td>.96 ppg</td>
<td>1.1 ppg</td>
<td>1 ppg</td>
</tr>
<tr>
<td><strong>Salt Out/Freeze</strong></td>
<td>-40 F</td>
<td>+20 F</td>
<td>-40 F</td>
<td>+20 F</td>
</tr>
<tr>
<td><strong>Complexing/Chelating Agent</strong></td>
<td>Ammonia</td>
<td>Citric Acid</td>
<td>Citric Acid/EDTA</td>
<td>Pure EDTA</td>
</tr>
<tr>
<td><strong>Zinc Source</strong></td>
<td>Zinc Chloride</td>
<td>Zinc Chloride</td>
<td>Zinc Sulfate</td>
<td>Pure Zinc Oxide</td>
</tr>
<tr>
<td><strong>Mixes with 10-34-0</strong></td>
<td><strong>YES Major Agitation</strong></td>
<td><strong>YES Minimal Agitation</strong></td>
<td><strong>YES Splash Mix</strong></td>
<td><strong>YES Splash Mix</strong></td>
</tr>
<tr>
<td><strong>Mixes with Orthophosphate</strong></td>
<td>NO</td>
<td>NO</td>
<td>NO</td>
<td>YES</td>
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<tr>
<td><strong>Foliar Application</strong></td>
<td>NO</td>
<td>NO</td>
<td>YES</td>
<td>YES</td>
</tr>
<tr>
<td><strong>Irrigation/Fertigation</strong></td>
<td>NO</td>
<td>NO</td>
<td>YES</td>
<td>YES</td>
</tr>
</tbody>
</table>
Summary
Conclusion

• Selecting a micronutrient source requires consideration of many factors, such as compatibility with N-P-K fertilizers or pesticides in foliar application, convenience of application, and cost per unit of micronutrient.
THANKS FOR YOUR TIME!