Micronutrient Sources

Selecting a micronutrient source requires consideration of many factors.

- Compatibility with N-P-K fertilizers
- Convenience in application
- Agronomic effectiveness
- Cost per unit of micronutrient

Which Micronutrients

- Iron
- Zinc
- Copper
- Manganese
- Boron
- Molybdenum

Classes of Micronutrients

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

Ammonium, Nitrate, Chloride and combination products

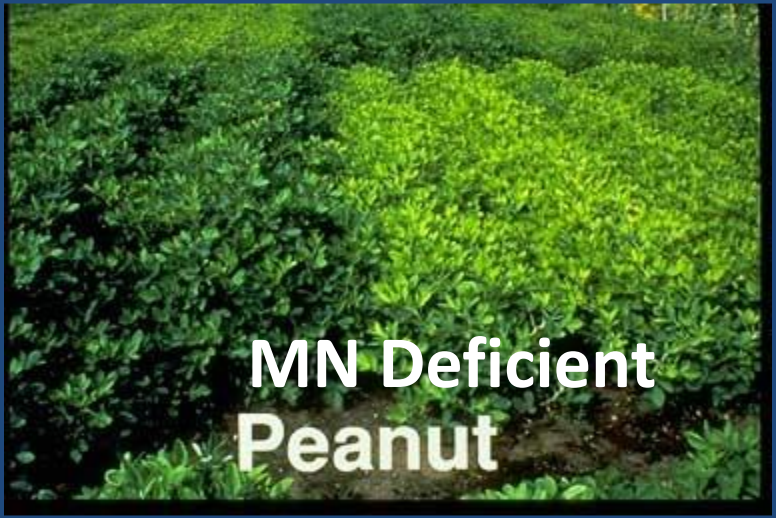
Nitrate and chloride solutions of zinc, magnesium, calcium, manganese and copper are widely used to provide essential elements in plant growth .

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.

Typical Deficiencies

- Corn- Zinc Deficient, GMO ZN&MN, Boron
- Soybean- MN deficient, Boron
- Tomato- ZN, MN, Boron
- Citrus- ZN, FE, MN, Boron
- Melon- MN, CU, Boron
- Peanut- MN, Boron
- Cotton- MN, Boron, ZN

Deficiencies



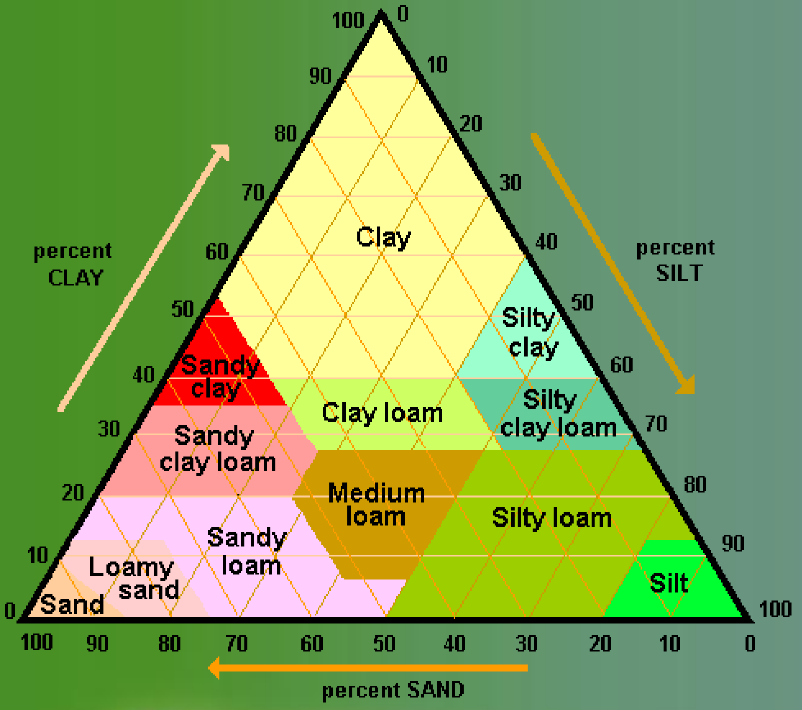
Boron Deficiencies

Iron Deficiencies

Iron deficient Corn

Iron deficient Turf

Soil Classification can affect nutrient availability



- % sand, silt and clay effects cation exchange capacity.
- Sandy soils are more susceptible to leaching.
- % sand, silt and clay can affect microbial activity.

TETRA MICRONUTRIENTS

Soil Application

- Broadcast with a Liquid or Dry blend of NPK
- 2X2 Starter with a liquid or dry blend of NPK
- In-Furrow Pop-Up with a low rate/low salt index NPK plus enhancement.

Source must fit grower management style

Adapted for starter fertilizer

Relative Effectiveness

- The true benefit of any fertilizer nutrient is in the amount that is actually taken up by the crop. Yield gains come from the nutrients being in the correct chemical form, place, time, and amount that the crop requires.
- Crops take up only those nutrients that are dissolved in the soil solution. Therefore, the solubility of fertilizer sources equates to their availability and is critical to properly feeding a crop.

CSU STUDY

- Colorado research indicates that total zinc (Zn) content of a fertilizer is not enough to determine its effectiveness for a crop grown on soils low in available Zn. A greenhouse study found that degree of water solubility is an important factor.

Costs

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

$- Zinc Sulfate

$$- Ammoniated Zinc

$$$- Zinc Oxy-Sulfate

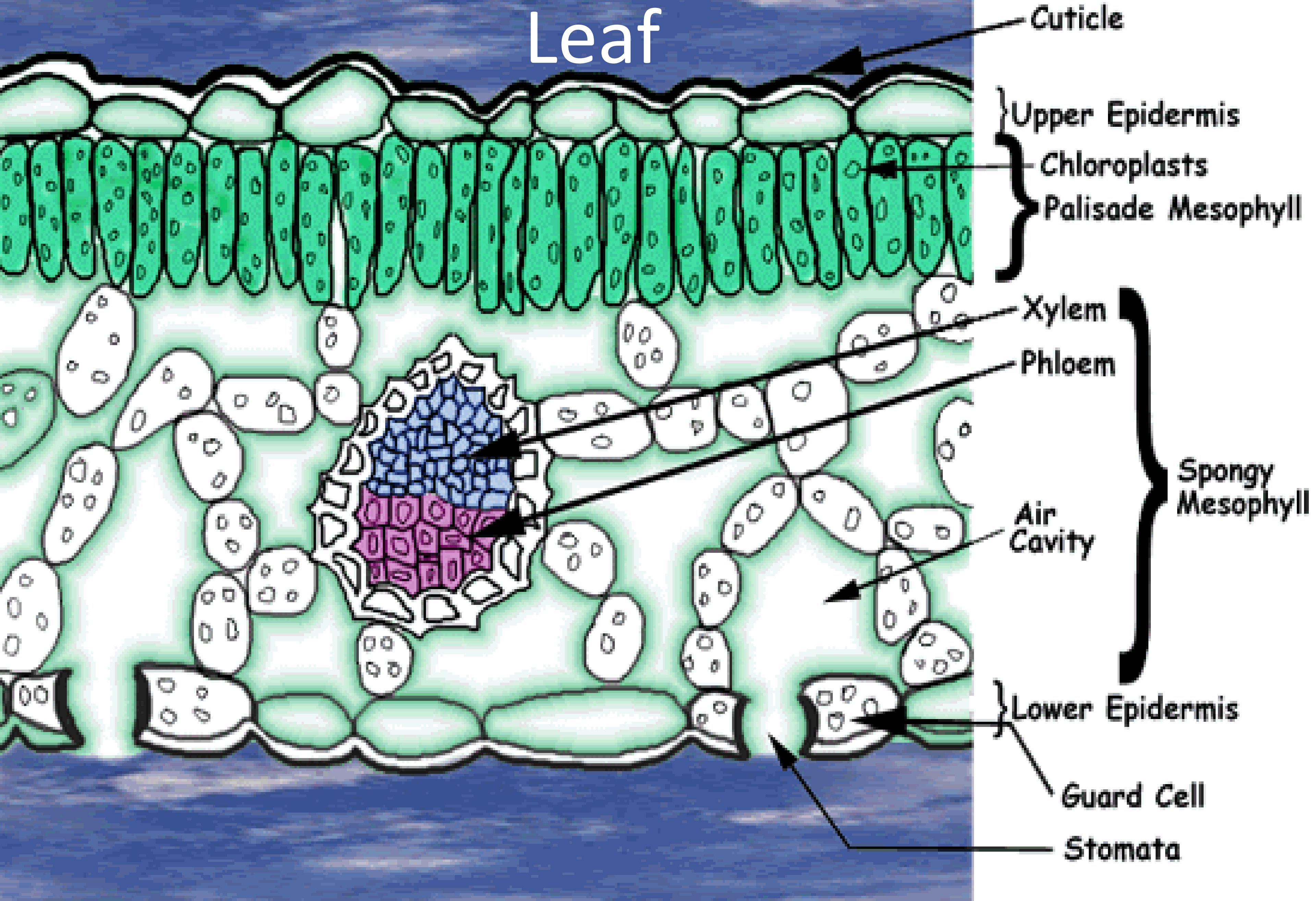
$$$$- Zinc Complexes

$$$$$- Zinc Chelates (EDTA)

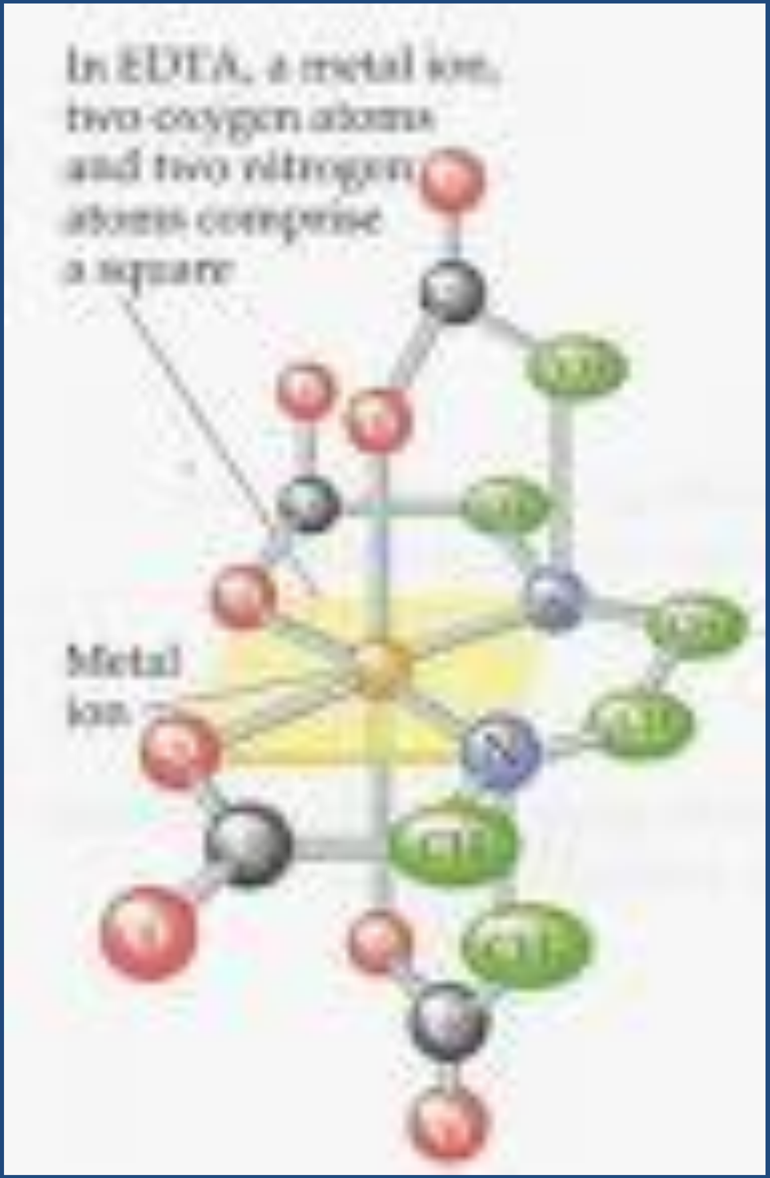
Foliar Nutrient Uptake Principles Nitrogen & Zinc

1. Cuticle biology
2. Smaller molecules = Better uptake
3. More soluble materials = Better uptake
4. Longer time on leaf or shoot = Better uptake
5. Optimum rate

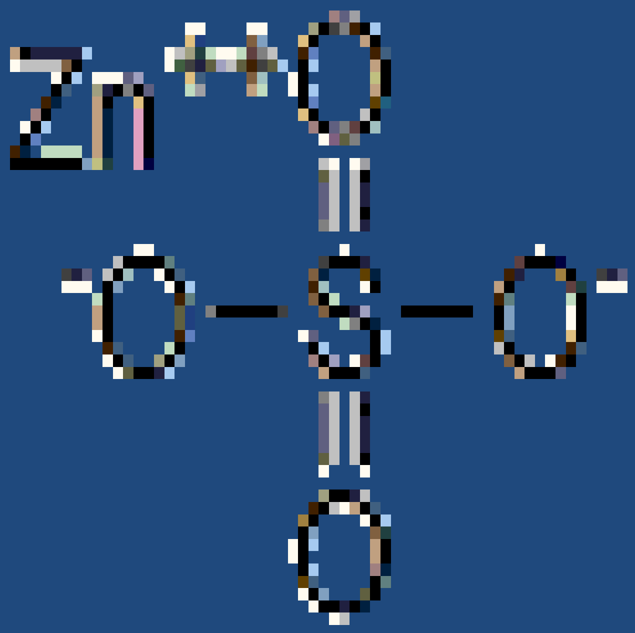
Leaf


Cuticle
Upper Epidermis
Chloroplasts
Palisade Mesophyll
Xylem
Phloem
Spongy Mesophyll
Air Cavity
Lower Epidermis
Guard Cell
Stomata

Size Matters



Enters with ease



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.

Be careful what you spray and how concentrated

Relative Effectiveness

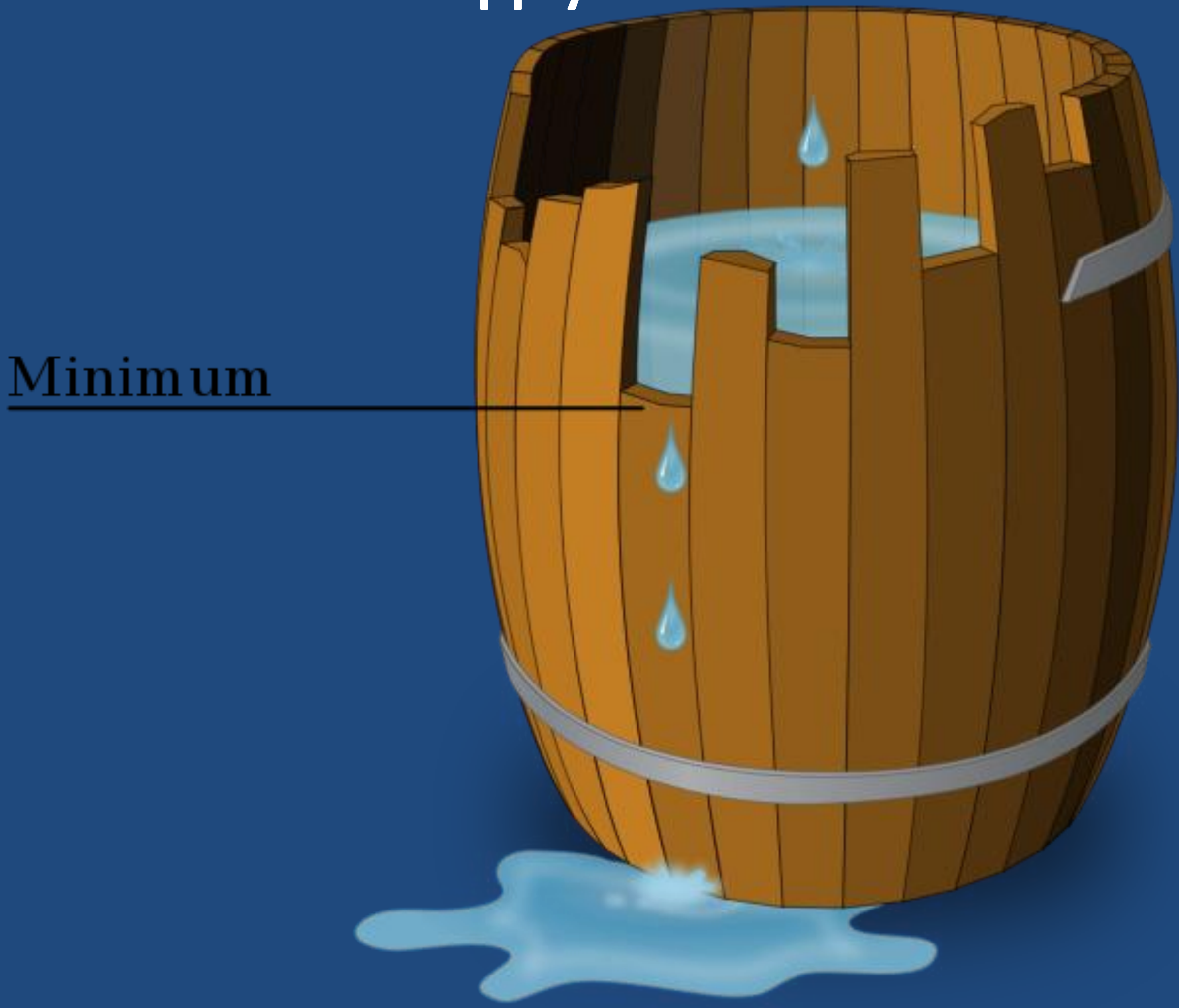
Figure 1	Corn Growth (% of maximum)	Column1	Column2
Per cent Water solubility	5.0 lbs/acre	10 lbs/acre	20 lbs/acre
	Zinc Applied (lbs/acre)		
5	61.70%	62.40%	72.50%
10	64.40%	65.60%	78.30%
15	66.80%	68.50%	82.90%
20	69.10%	71.30%	86.60%
25	71.30%	73.90%	89.50%
30	73.30%	76.30%	91.70%
35	75.20%	78.60%	93.50%
40	77.00%	80.70%	95.00%
45	78.60%	82.60%	96.10%
50	80.20%	84.50%	97.00%
55	81.70%	86.20%	97.70%
60	83.00%	87.80%	98.20%
65	84.30%	89.20%	98.70%
70	85.50%	90.60%	99.00%
75	86.60%	91.90%	99.30%
80	87.70%	93.10%	99.50%
85	88.70%	94.20%	99.70%
90	89.60%	95.30%	99.80%
95	90.50%	96.20%	99.90%
100	91.30%	97.10%	100.00%

Cost vs. Benefit

Figure 2	Equivalent Effective Rates	Column1	Column2
Fertilizer Solubility	Application Rate (lbs/acre)	Effectiveness	Relative Value
95%	5	90.50%	100%
70%	10	90.60%	50%
30%	20	91.70%	25%

Summary

-Just as the capacity of a barrel with staves of unequal length is limited by the shortest stave, so a plant's growth is limited by the nutrient in shortest supply.



Conclusion

- Selecting a micronutrient source requires consideration of many factors, such as compatibility with N-P-K fertilizers, convenience in application, agronomic effectiveness and cost per unit of micronutrient.