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Application of micronutrients

pros and cons of the different application strategies

IFA International Workshop on Micronutrients

27 February 2006, Kunming, China

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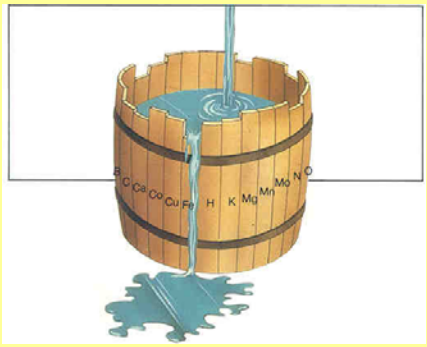
Balanced feeding

- First rule: Always balanced feeding needed
- Analyse the element(s) in the minimum and make sure these elements are part of your fertilization schemes



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Essential nutrients

- **Primary nutrients (N-P-K)**
  - **N** ammonium, nitrate, urea
  - **P** phosphate
  - **K** potassium
- **Secondary nutrients**
  - **Ca** calcium
  - **Mg** magnesium
  - **S** sulfur as sulfate
- **Micro nutrients**
  - **Fe** iron
  - **Mn** manganese
  - **Zn** zinc
  - **Cu** copper
  - **B** boron as borate
  - **Mo** molybdenum as molybdate

2^+ or 3^+ ions can be chelated

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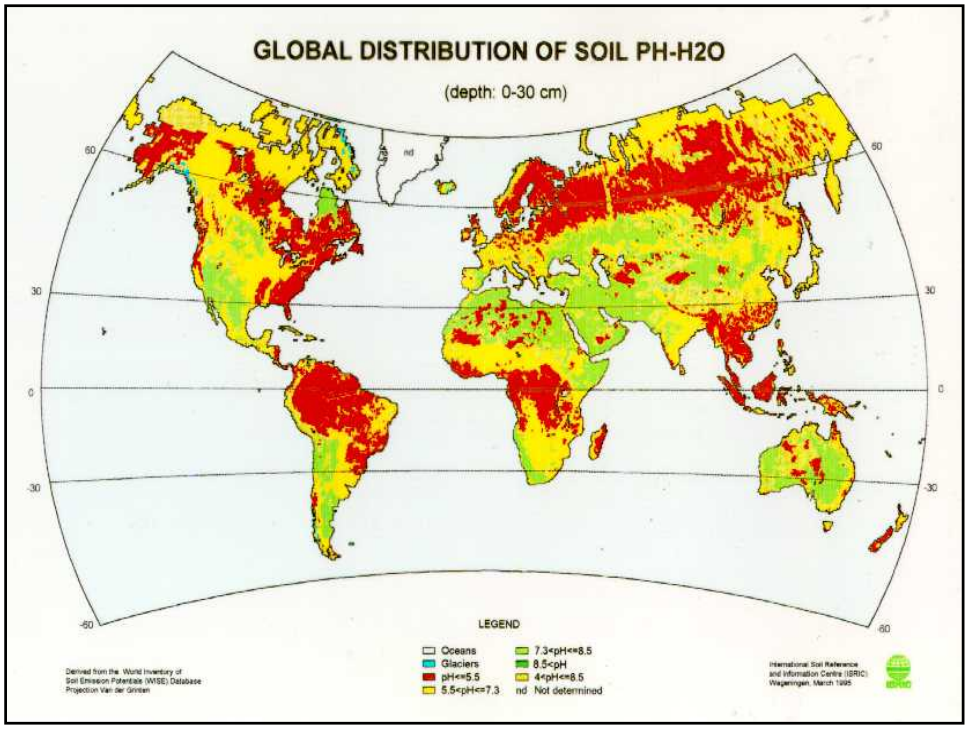

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Choices in application

- Micronutrients = small amounts
- So, foliar application instead of soil application is a choice
- Either alone, or combined with major element fertilizers
- Next to this, there is soilless culture where always all micronutrients are needed

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Soil application – When preferred

- If the plant is able to take it up: roots must be active
- Equal spreading should be possible, like with fertigation
- When there is no blocking (by adsorption) of the element by the soil or when this can be avoided by using chelates

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Soil application - injection

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Soil application

Wheel injection

Row fertilization

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Soil application

Precision liquid fertilization

Seed or fertilizer drilling unit

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Why *chelated* micro's in NPK's

- Better availability in most soils
- Fe from $FeSO_4$ not available for plants at all
- Blocking of Fe and Zn by P
- $CuSO_4$ hygroscopic and Cu blocked by P
- Micro-granule particle size (no dusting)
- Low in heavy metals

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Soil application

- *Physical restraints:*

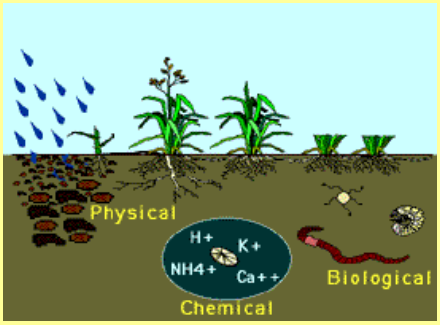
Soil too cold or too wet

- *Chemical restraints:*

Metals precipitates as insoluble compound

- *Biological restraints:*

Root diseases



Solution: foliar application

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Foliar application – when preferred

- When plant cannot take it up via the roots: soil too wet or too cold
- When equal spreading via the soil is difficult
- When spreading via foliar with e.g. pesticides equipment is possible
- When (developing) fruits are the target

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Pivot sprayers

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When to expect deficiencies

- Fe – on high pH soils
- Mn/Zn/Cu/B – on high pH soils
- Zn/Cu – on organic peat soils
- Mo/B – on low pH soils
- All elements: when not present in the mother material of the soil – especially in poor, sandy soils

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Iron (Fe)

- Often best results with soil application
- Iron chelates a necessity
- Choice of chelate should depend on pH
- When soil application is impossible: 2nd choice is foliar application
- Also with foliar iron chelates will give the best results
- No other complex or inorganic product can give overall the same results

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Fe availability

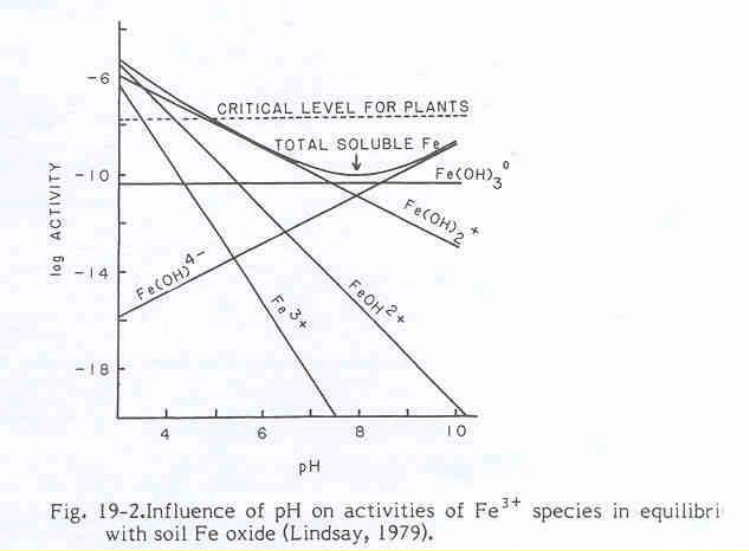

Fig. 19-2.Influence of pH on activities of Fe^{3+} species in equilibri with soil Fe oxide (Lindsay, 1979).

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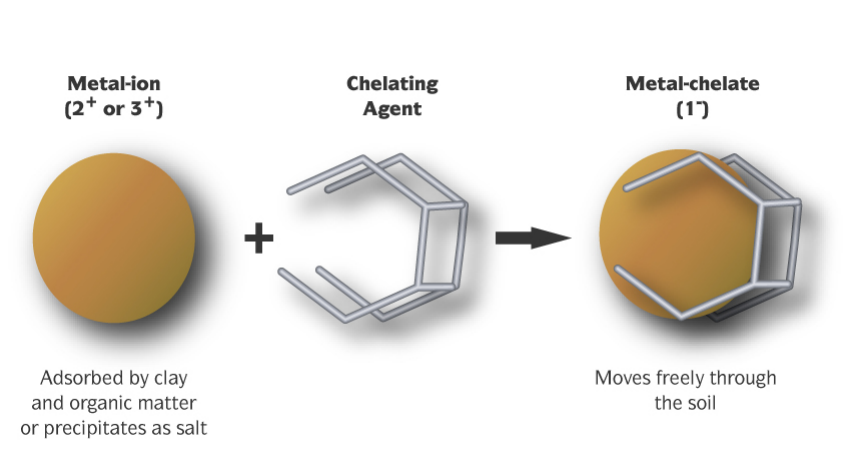
Different chemical behavior



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Fe - choice of chelate - soil

- Fe-EDDHMA or Fe-EDDHA: for sure best option in alkaline soils.
- The higher the pH/the more clay, the more important the 'ortho-ortho' content of the EDDH(M)A will be: ask your supplier
- Fe-DTPA for soils around pH 6 to 7
- Fe-EDTA only in acidic soils (pH<6).

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Fe deficiency apple

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Soil application (Fe)

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Without Fe-EDDHA with Fe-EDDHA

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Fe - choice of chelate - foliar

- In hard water: Fe-DTPA
- In soft water Fe-EDTA
- In hard water, but acidified with acids: Fe-EDTA
- Complexing agents like lignosulfonates, amino acids, citric acids will overall not perform as well as these chelates

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Pear trial- Fe deficiency

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Manganese (Mn)

- Often foliar feeding will give the best results
- Several products possible: inorganics, complexed or chelated.
- Each will work in certain conditions; chelates have the broadest availability guarantee

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Zinc (Zn) and Copper (Cu)

- Often soil application will give a good result
- But in high pH soils, or in low pH peat soils EDTA chelates necessary.
- Foliar application also possible, inorganics often perform, chelates can give more security or mixing possibilities

Zn deficiency corn

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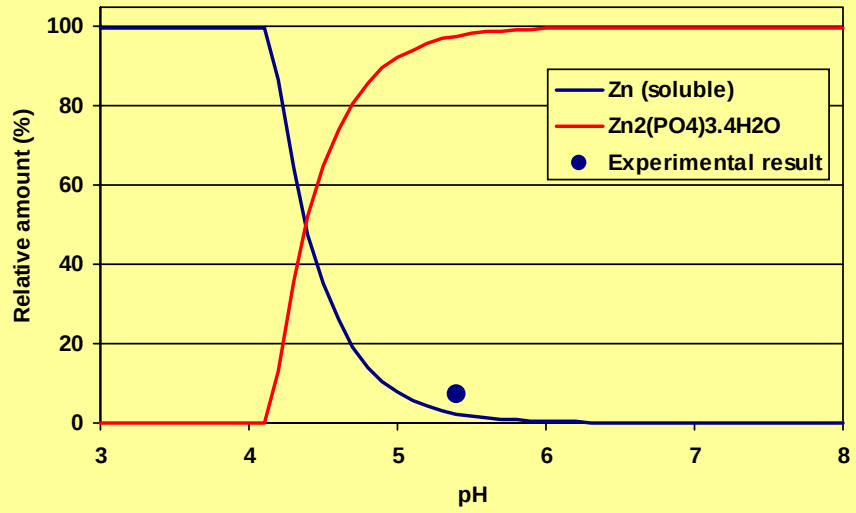
Example: Unchelated Zn with PO_4



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Zn-EDTA with PO_4

Table: Percentage of Zn remaining as original Zn source 4 min after mixing with a 10-15-0 fertilizer solution (Picanso, 1984)

Zn Source	% remaining as original source
Zn EDTA	100
Zn HEDTA	19
$Zn(NO_3)_2$-UAN	15
Zn-Phenolic acid	11
Zn-citrate	8
$ZnSO_4$-NH_3 complex	8
$ZnSO_4$	4

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Corn – Zn – soil applied

Colorado State University, USA

Photo 3. ZnEDTA (0.5 lb of Zn/acre), and Zn Lignosulfonate (0.5 lb of Zn/acre). Forty-one days after planting.

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ZnEDTA ZnLigno

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Copper deficiency

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Copper deficiency due to organic peat soil adsorption

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Metal chemistry

copper chelate + OH^- PO_4^{3-} CO_3^{2-} → clear solution

copper sulfate + OH^- PO_4^{3-} CO_3^{2-} → turbid solution

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Wheat - Cu deficiency

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B and Mo

- Soil application successful in case of absolute deficiency.
- When deficiency is linked to availability issues, go for foliar application
- In plant nutrition B is present as borates and Mo as molybdates: these cannot be chelated, but also do not give the specific problems as with other 2^+ metal ions

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Soilless culture

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Soilless culture

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Soilless cultures (brief)

- Fe only as chelate, otherwise all iron will be lost in the system (in fact these systems could only develop after the invention of iron chelates)
- Fe-DTPA best choice
- Mn/Zn/Cu as sulfates or EDTA chelates, last option is preferred and will also save on the iron
- B as borate and Mo as molybdate

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Conclusion

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Application Nutrient Matrix

	Fe	Mn	Zn	Cu	B	Mo
Foliar	EDTA DTPA	EDTA, Complexes or inorganics	EDTA, Complexes or inorganics	EDTA, Complexes or inorganics	Inorga-nics	Inorga-nics
Soil	EDDHA EDDHMA (DTPA/EDTA)	Mainly inorganics	EDTA	EDTA	Inorga-nics	Inorga-nics
Soilless	DTPA	EDTA or inorganics	EDTA or inorganics	EDTA or inorganics	Inorga-nics	Inorga-nics
Incorporation into NPK's	EDTA DTPA	EDTA or inorganics	EDTA or inorganics	EDTA or inorganics	Inorga-nics	Inorga-nics
When there is a choice: Soil or Foliar?	Soil	Foliar	Both possible	Both possible	Both possible	Both possible

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