Micronutrient Technology

Eric McGee, PhD, CPAg

PLANT NUTRITION






Together, we make ideas that work.™

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Agenda – Micronutrients

1. Intro
2. Sources - Inorganic, Complexes/Chelates
3. Technology
4. Efficacy Research
5. Summary

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Intro - Micronutrients

Essential: Zn, Fe, Mn, Cu, B, Mo, Cl and Ni

Beneficial: Co, Si, Na and Se

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Micronutrient Sources

- Oxides or Carbonates
  - Insoluble metal-oxygen compounds
  - Limited uptake
  - Must be finely ground or reacted to be useful
  - Soil acidity releases micronutrients

- Examples
  - Zinc Oxide, Calcium Carbonate

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Micronutrient Inorganic Sources

- Oxy-sulfates
  - Metal oxide partially acidulated to increase solubility
  - Water solubility is directly related to acidulation
- Sulfates/Nitrates/Chlorides
  - Oxides completely reacted with acid
  - Highly water soluble

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Correcting Nutrient Deficiencies

Inorganic sources

- Water solubility is more important than type
- Commercial zinc sulfate monohydrate (36%) is 100% water soluble
- Other sources include
  - Zinc oxide - insoluble
  - Zinc carbonate – insoluble
  - Zinc Nitrate - soluble

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Chelates

Chelation =

Combining metal cations such as:

Ca^{2+}, Mg^{2+} ,Fe^{3+}, Cu^{2+}, Zn^{2+}, Fe^{2+}, Mn^{2+}

with organic molecules (chelates) to form ring-like, stable, neutral or negatively charged, water soluble molecules that prevent nutrient precipitation while improving plant uptake efficiency.

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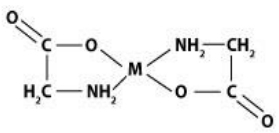
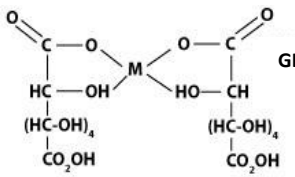
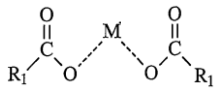
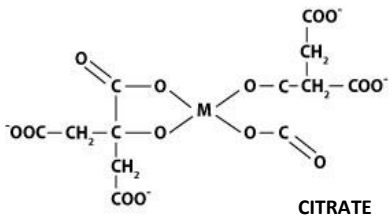
Types of Chelates

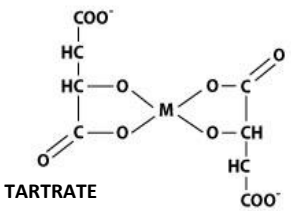
- Synthetic
  - EDTA (Ethylenediamine tetraacetic acid)
  - HEDTA (N-hydroxyethy-lethylenediamine triacetic acid)
  - EDDHA (Ethylenediamine di(o-hyroxyphenylacetic acid)
    - EDDHA is best choice for alkaline soils.
- Natural











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Correcting Deficiencies with Chelates

Synthetic chelates (i.e. EDTA)

- Organic molecule that wraps around a ion
- Charge on ion is neutralized
- Prevent reactions in fertilizer blends and tank mixes
- Allows ion to move down into soil
- Can hold on to nutrient to tightly
- Can be phytotoxic
- Environmental issues

Natural chelates (i.e. Polysaccharides)

- Lower binding strength
- Vary in percent of chelation

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Protection in Blends

Percentage of zinc in original form after 4 min with 10-34-0 solution

Zinc Source	% as original source
Zn-EDTA	100
Zn-HEDTA	19
Zn(NO3)2-UAN	15
Zn-Phenolic acid	11
Zn-Citrate	8
ZnSO4-NH3 complex	8
ZnSO4	4

Picanso, 1984. Chelated Micronutrients: Why, when and how to use them Farm Chem. 147(5): 38-41.

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Patrick Brown Foliar Zinc Studies

Ranking	Formulation	Anion Size	Solubility (g/100 H_2O)	Phytotoxicity
Most Effective	Zinc Chloride	35	432	High
Almost As Good	Zinc Nitrate	62	324	High
	Zinc Nitrate Mix	62 & 96	324	High
Next Best	Zinc Sulfate	96	50	Moderate
	Zinc Carbohydrate	96 & ?	High	Moderate
	Zinc Polyamine	96 & 75-204	High	Moderate
	Zinc Glycine	96 & 75		Moderate
Less Effective	Zinc EDTA	292	High	Low
	Zinc Leonardite	1000+	High	Low
	Zinc Oxysulfate	16 & 96	1.3	None
Least Effective	Zinc Phosphite	79	-	Low
	Zinc Oxide Suspension	16	Insoluble	None

Peach, Almond, Lab and Field Tests:

Analysis of 5 independent model and field trials.

Source - Plant Nutrition Basics: Understanding the Principles to Optimize the Practices, Patrick Brown, PhD, UC Davis.

Meta analysis of 8 Arabidopsis Foliar Trials.

Material Name*	Concentration (ppm)	Overall Ranking 1 = no significant difference from control; 2-4 = small increase in tissue Zn; 5-7 = consistent and significant increase in tissue Zn; 8-10 = consistent very significant increase in tissue Zn.	Comments
Zinc FL 1-0-0	400 ppm	1	40% Zn as Zinc Oxide. Miscible in water, solubility limited.
Neutral Zinc	400 ppm	1	52% Zinc Oxide and Sulphate.
Zn Phosphate/Oxide	400 ppm	3	52% Zn as phosphate/oxide mixture. Miscible in water, solubility limited.
Zinc Fulvic Acid	400ppm	4	7% Zinc fulvic acid complex.
Zinc Sulfate	400 ppm	5	36% Zinc sulfate. Variability in response between experiments.
Chelate Zn 1	400 ppm	6	9% synthetic chelated Zn.
Zinc Lignosulfonate	400 ppm	6.5	7 – 10% Zinc sulfate Lignosulfonate.
Chelate Zn 2	400 ppm	6.6	8% Zn. hydroxy-carboxylic. amino acid complex.
Zinc nitrate	400 ppm	7.0	10% Zn as Zn nitrate. Variability in response between experiments.
Zn Phosphate/Oxide	5000 ppm	7.2	52% Zn as phosphate/oxide mixture. Miscible in water, solubility limited.
Amino Zn 1	400ppm	7.2	5.8% Zn Amino Acid.
Complex Zn 1	400 ppm	7.3	7% Zinc Sulfate, Citric Acid, Glycine.
Amino Zn 2	400 ppm	7.3	7% Amino complexed Zn.
Complex Zn 2	400 ppm	7.3	8% Zinc.
Zinc EDTA	400 ppm	8	10% EDTA complexed Zn.
Neutral Zinc	1860 ppm	8	52% Zinc Oxide and Sulphate.
Zinc Sulfate	1500 ppm	8	36% Zinc sulfate.
NZn	400 ppm	8.4	5% Zn as Zn Nitrate with Urea and Urea Ammonia Nitrate.
Zn CHO complex 1	400 ppm	8.6	6% Zinc carbon complex.
Zinc CHO Complex 2	400 ppm	9	7% Zinc carbon complex.
UC Davis Formula 1	1000 ppm	10	25% Zn. Non-commercial product. Zn sulfate and Zn nitrate with organic complex and adjuvants.

Source - Plant Nutrition Basics: Understanding the Principles to Optimize the Practices, Patrick Brown, PhD, UC Davis.

Summary of Dr. Brown's Findings

"Results of these trials suggest that many of the foliar Zn materials available for use in the marketplace work to varying degrees and that many of the higher priced liquid products, especially those 'complexed' with sugar and polysaccharide molecules are highly effective."

Source - Brown and Burger. 2008. Development of a model system to test foliar fertilizers for use in the turfgrass industry. *Turfgrass and Environmental Research Online Vol. 7(12).*

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Independent Research - Almonds

- Three year zinc study on Almonds
- Sixth leaf Padre's
- Application First Season
  - 1.5 qt. at 75% bloom (for flower drop evaluation)
    - No reduction in flower drop or yield
  - 1.5 qt. at tender leaf (nutritional)
  - 1.5 qt. at three weeks after full bloom (nutritional)
  - 100 gal/ac water
  - Organosilicone at 10 oz/100 gal

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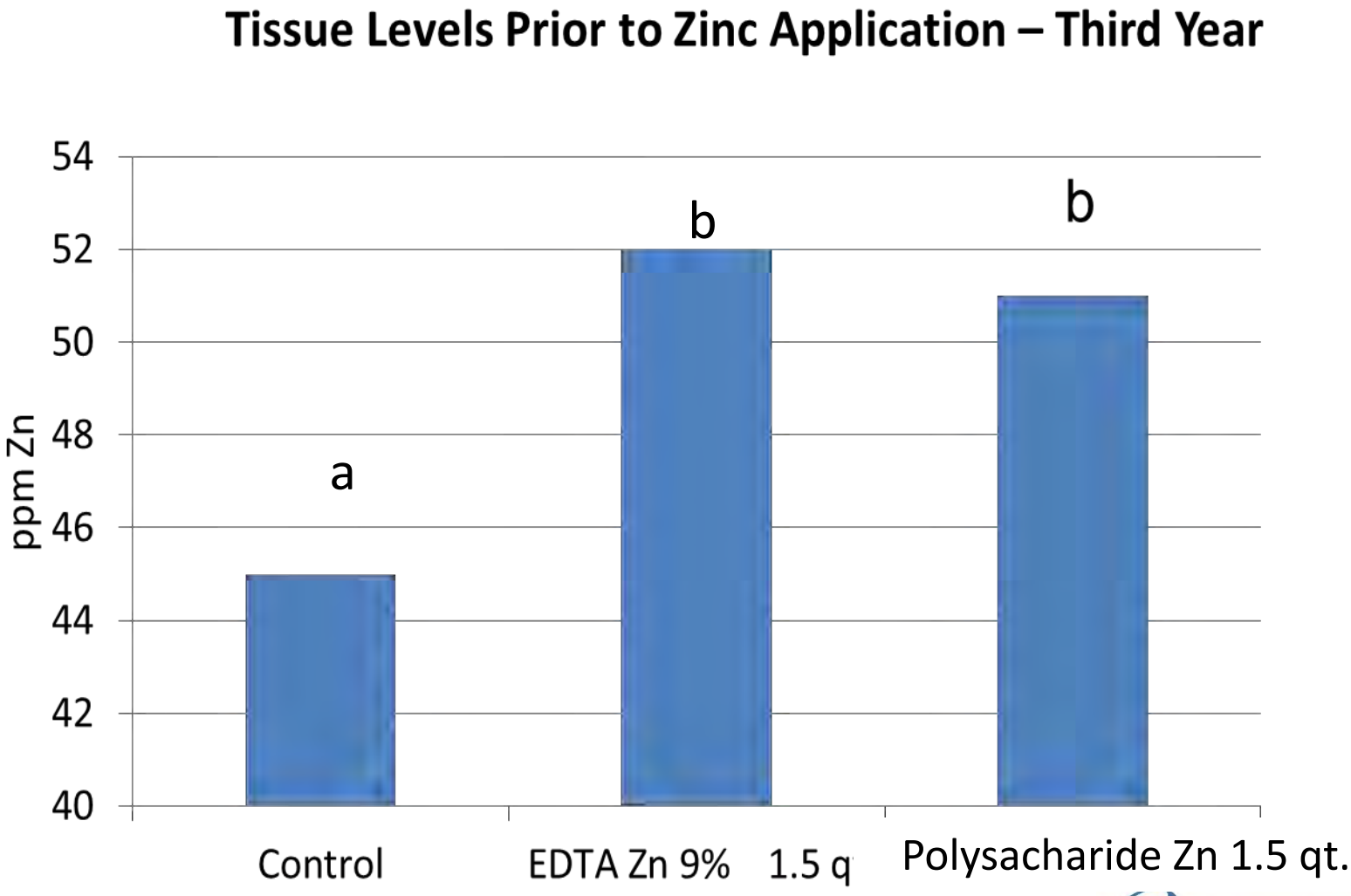
Independent Research - Almonds



Mean Separation at 10% Level

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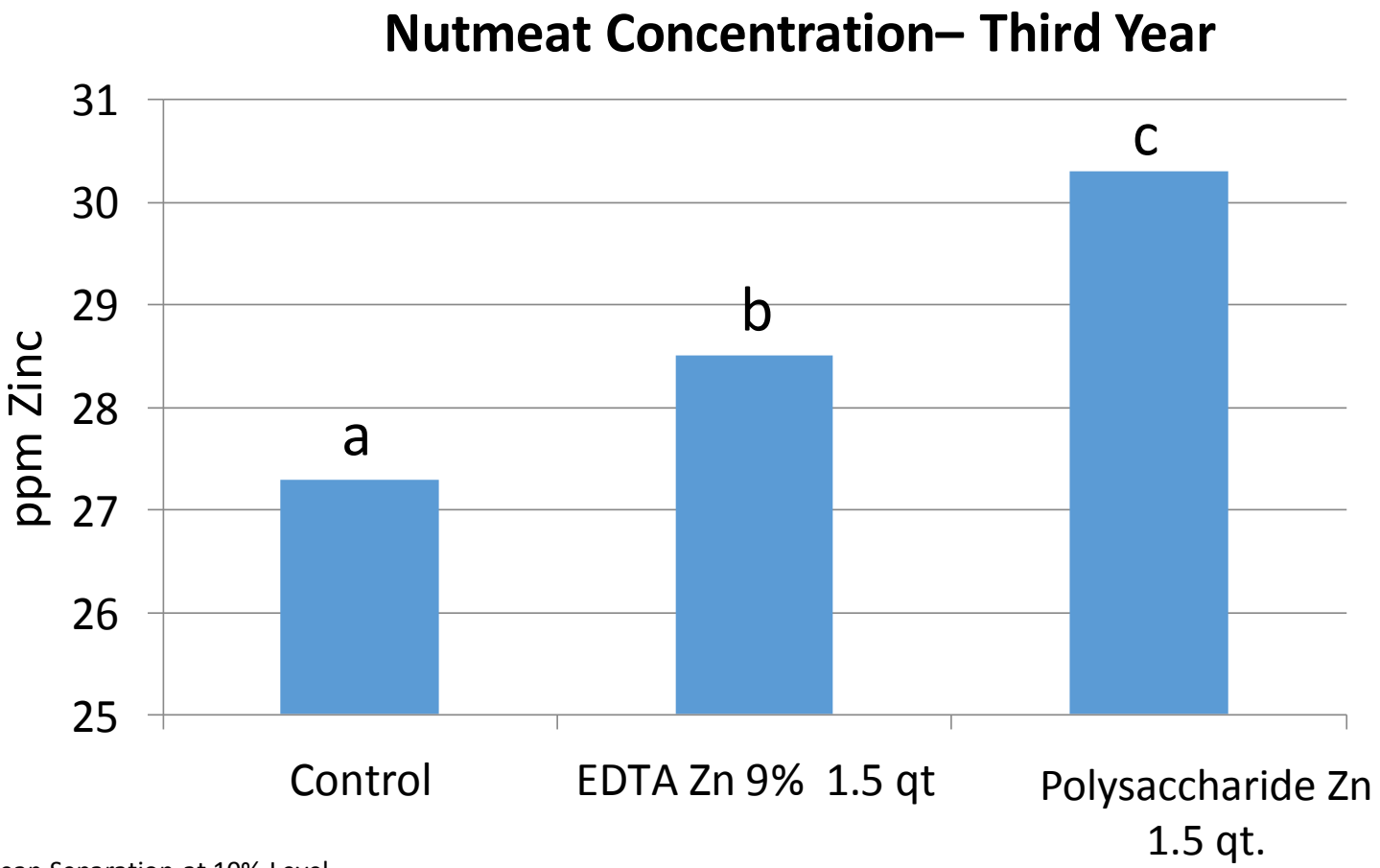
Independent Research - Almonds



Mean Separation at 10% Level

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Summary

- Water solubility = nutrient availability
- Compatibility is important in soil and tank mixes
- Protection of mineral lowers risk of phytotoxicity
- Small molecules that are taken up, move in the plant and are bioavailable, work best.

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Thank You!

Questions?

Eric McGee, PhD
ericm@qualitechco.com
(559) 285-8566