PISTACHIO MICRONUTRIENT MANAGEMENT

Robert H. Beede
University of California
Cooperative Extension, Emeritus
HTTP://CEKINGS.UCDAVIS.EDU

8th Advances in PISTACHIO PRODUCTION
November 14-16, 2017

THANKS TO ALL!

- Dr. Kay Uriu, UCD Pomology Professor, retired
- Jim Pearson, UCD Staff Research Associate, retired
- Rocky Teranishi, Madera County Farm Advisor, retired
- Karl Opitz, Extension Specialist, Retired
- Dr. James Wolpert, Extension Specialist, Viticulture
- Dr. Scott Johnson, Extension Specialist, Pomology
- Dr. Patrick Brown, UCD Pomology
- Dr. Steve Weinbaum, UCD Pomology
- Dr. Richard Rosecrance, Chico State University
- Craig Kallsen, Kern County Farm Advisor
- Dr. Brent Holtz, San Joaquin County Farm Advisor
- Bob Beede, Kings County Farm Advisor

KNOW YOUR SOIL!
STUDY THE LOCAL SOIL SURVEY AND ASK SOIL SCIENTISTS

1. Parent material: Granitic, Volcanic, Sedimentary
2. Geologic History: Terrace, alluvial, floodplain
3. Location: Distance from parent material source affects texture, alkalinity, and stratification
4. Cropping History: What is typical and best use?

SOIL TYPE AND TEXTURE, PH AND IRRIGATION WATER ALL AFFECT NUTRIENT AVAILABILITY

Effect of Soil pH:

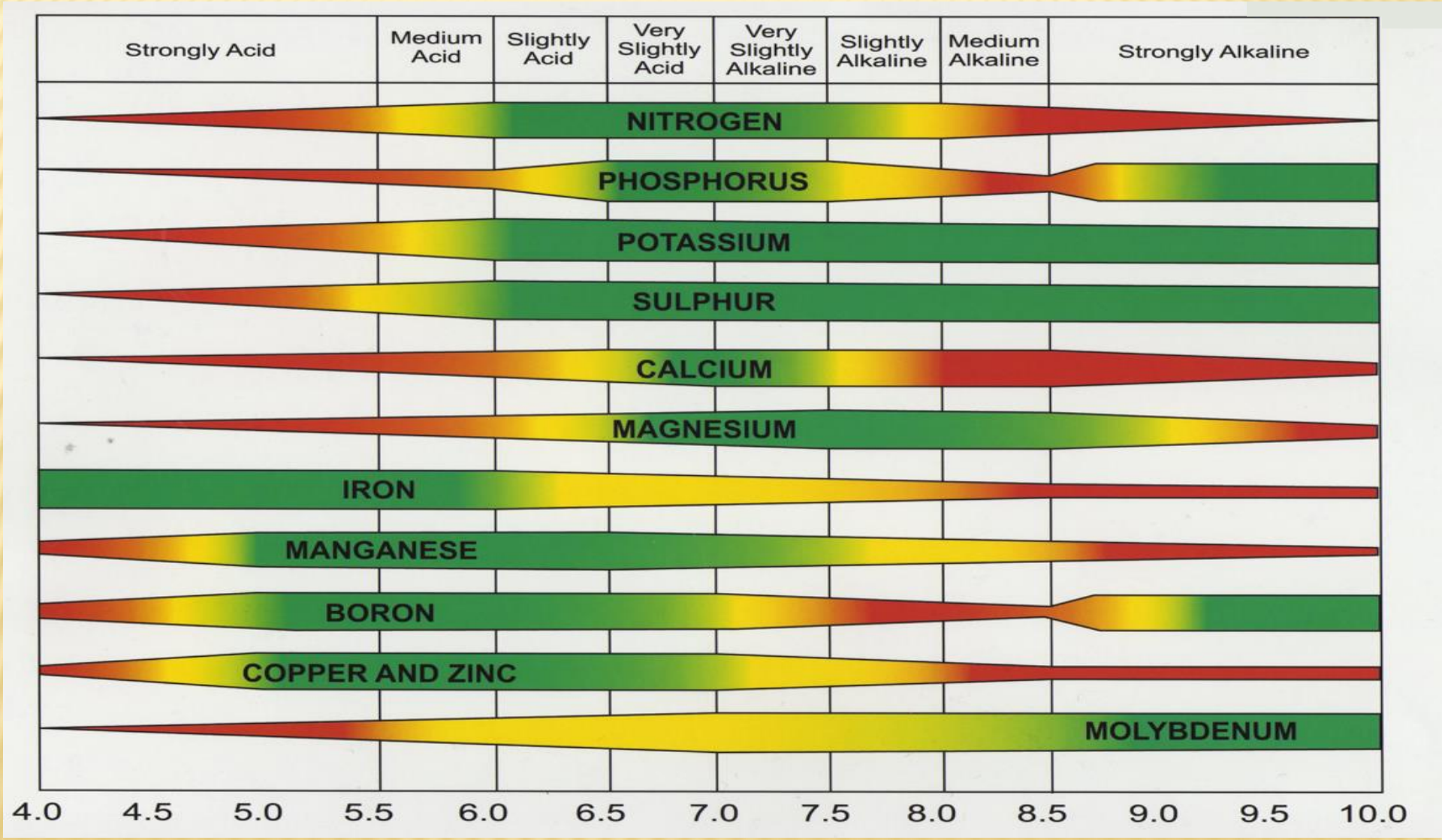
pH >7.5 < Zn, Cu, Mn, Fe

pH < 6.0 < P, Ca, B

- **Old river beds, sandy soils, cuts or fills, old corrals, alkali patches, etc.)**
- **Soil series: Mg, K availability (dolomite, gypsum, lime)**
- **Irrigation waters differ in nutrient content**

SOIL PH AND MINEROLOGY DETERMINES NUTRIENT SOLUBILITY

(KNOWLEDGE OF SOLUBILITY CHARACTERISTICS OF YOUR SOILS IS IMPORTANT.)



NUTRIENT MOBILITY INFLUENCES NUTRIENT MANAGEMENT AND THE EFFICACY OF FOLIAR FERTILIZERS

Immobile elements (Mn, Fe, Cu, Ca, Zn) require a consistent supply throughout plant growth. Uptake, movement and distribution in the plant is directly related to water movement in the plant.

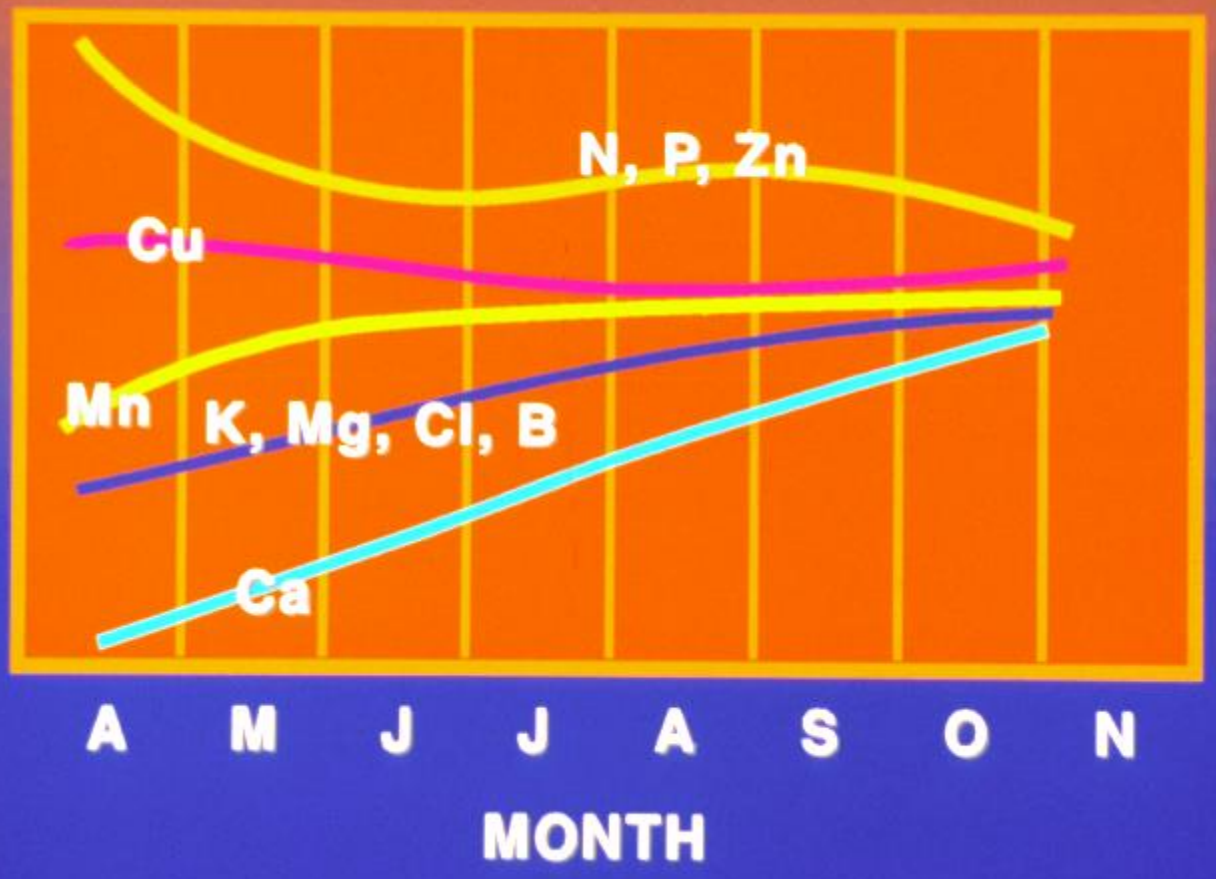
- ✧symptoms appear rapidly in young tissues
- ✧consistent supply during growth is required (soil or foliar)
- ✧foliar fertilizers will only have a short term benefit

Mobile elements (N, K, Mg, S, P, B, Cl) can be stored and remobilized within the plant. Movement is driven by photosynthesis and plant growth (demand).

- ✧symptoms appear in old tissues
- ✧foliar and soil fertilizers can have a long term benefit

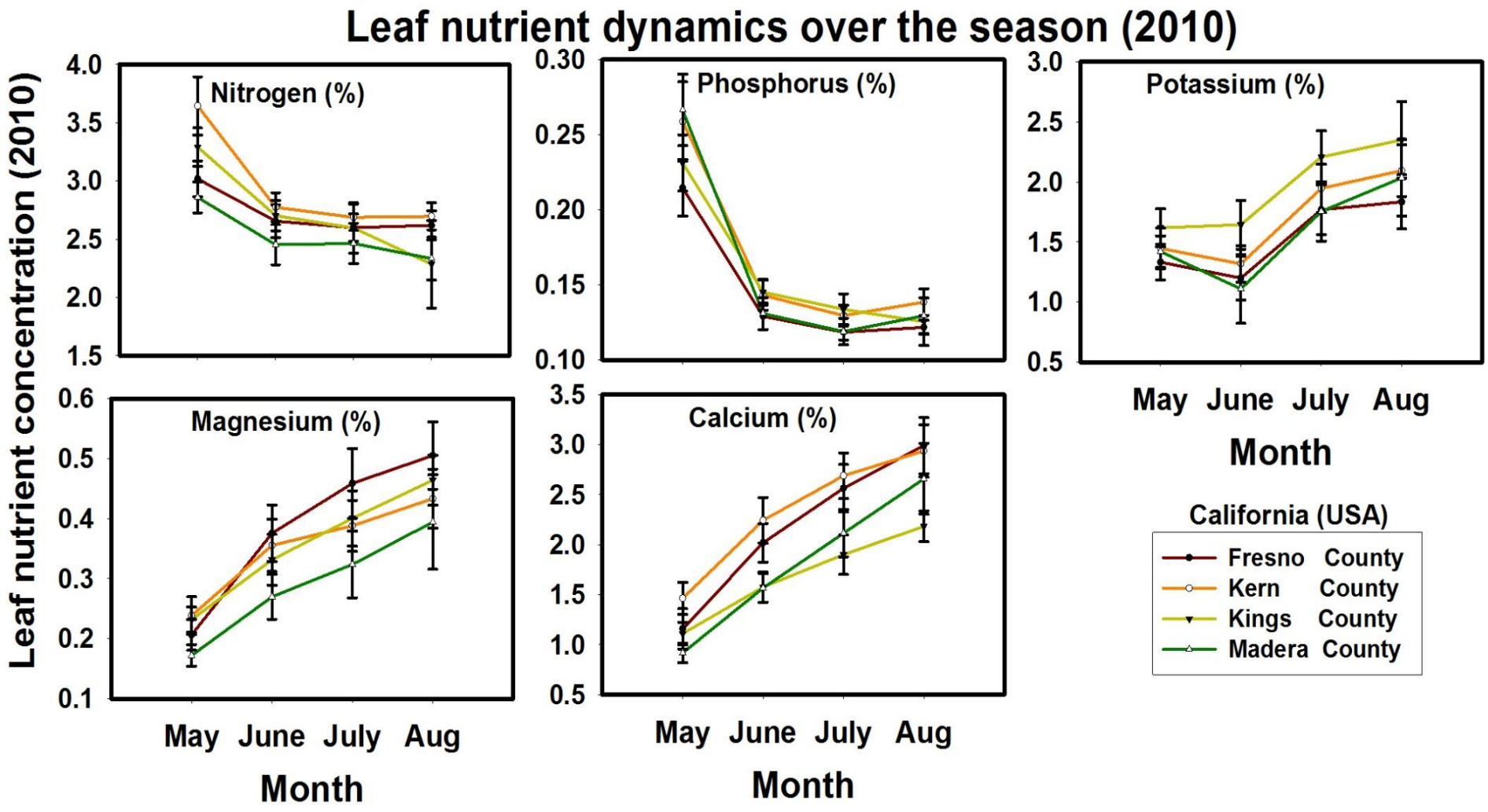

No Foliar Zn-Sulphate
Fall Foliar Zn-Sulfat
40 lbs acre x 5 yrs
Zinc foliar applications have only a local effect on sprayed leaves

Nutrient Curves through Season



NEW RESEARCH BASED PISTACHIO SEASONAL NUTRIENT CURVES

BROWN, ET. AL.



ANNUAL LEAF TISSUE SAMPLING:

- A plant-based measurement which integrates all the factors associated with nutrient extraction from the soil that it inhabits.
- Provides cause for further evaluation of soil and water quality, and fertilization practices.
- Can now be performed in April and late July to early August.
- Diagnostic analyses performed anytime.

Critical And Suggested Levels For Pistachios In Late July/August. Subterminal Leaves

Element	Critical Value	Suggested Range	Reference
Nitrogen (N)	1.8%	2.2 -2.5%	Weinbaum, et.al. 1988, 1995
Phosphorus (P)	0.14%	0.14-0.17%	
Potassium (K)	1.6%	1.8 - 2.0 %	Brown, et.al. 1999
Calcium (Ca)	1.3% (?)	1.3-4.0%	
Magnesium (Mg)	0.6% (?)	0.6-1.2%	**New critical value: 0.45%**
Sodium (Na)	(?)	(?)	
Chlorine (Cl)	(?)	0.1-0.3%	
Manganese (Mn)	30 ppm	30-80 ppm	
Boron (Bo)	90 ppm	150-250 ppm	Uriu,1984; Brown, et.al.,1993
Zinc (Zn)	7 ppm	10-15 ppm	Uriu and Pearson.1981, 1983,1984,1986
Copper (Cu)	4 ppm	6-10 ppm	Uriu, et.al. 1989

ppm = parts per million or milligrams/kilogram dry weight.

% = parts per hundred or grams/kilogram dry weight

ESSENTIAL ELEMENTS FOR PISTACHIO NUTRITION: 14

Macronutrients

Nitrogen
Potassium
Phosphorus
Magnesium
Calcium
Sulfur

Micronutrients

Zinc
Boron
Iron
Manganese
Copper
Chloride
Nickel
Molybdenum

IN THE CENTRAL VALLEY OF CALIFORNIA, DEFICIENCIES OF THE FOLLOWING MICRONUTRIENTS ARE MOST LIKELY:

- **Zinc**
- **Copper**
- **Boron (east side soils; acidic soils, pure irrigation water)**

THE ROLE OF ZINC IN PLANTS

- Required for Auxin (NAA) formulation
- Auxin involved in cell elongation
- Associated with chloroplast formulation
- Essential for pollen development, flower bud differentiation and fruit set

SYMPTOMS OF ZINC DEFICIENCY

Optimal leaf tissue concentration: 10 – 15 ppm

FACTORS AFFECTING SOIL-ZINC AVAILABILITY

1. pH
   - Solubility decreases 100 fold for each unit increase in pH
     - pH 5 = 10^{-4} M (6.5 ppm)
     - pH 8 = 10^{-6} M (0.007 ppm)
2. Cut areas likely to be more deficient
3. Sandy soils lower CEC and Zinc

FACTORS AFFECTING SOIL-ZINC AVAILABILITY

4. High Magnesium or Phosphorous reduces Zinc availability
5. Methyl Bromide fumigation causes temporary loss of mycorrhizal fungi which chelate elements
6. Calcareous materials (lime) reduce Zinc availability

EFFECT OF ROOTSTOCK ON MICRONUTRIENT CONCENTRATION IN ‘KERMAN’ PISTACHIO LEAVES

rootstock	B	Zn	Cu
	ppm	ppm	ppm
atlantica	194 a	16 b	15 b
integerrima	164 a	14 a	12 b
atl. x int.	148 b	14 a	13 b

Recent Zinc Research Supports The Difficulty in Achieving ABsorption

FREP Project: Improving Zinc Uptake in Peach and Pistachio

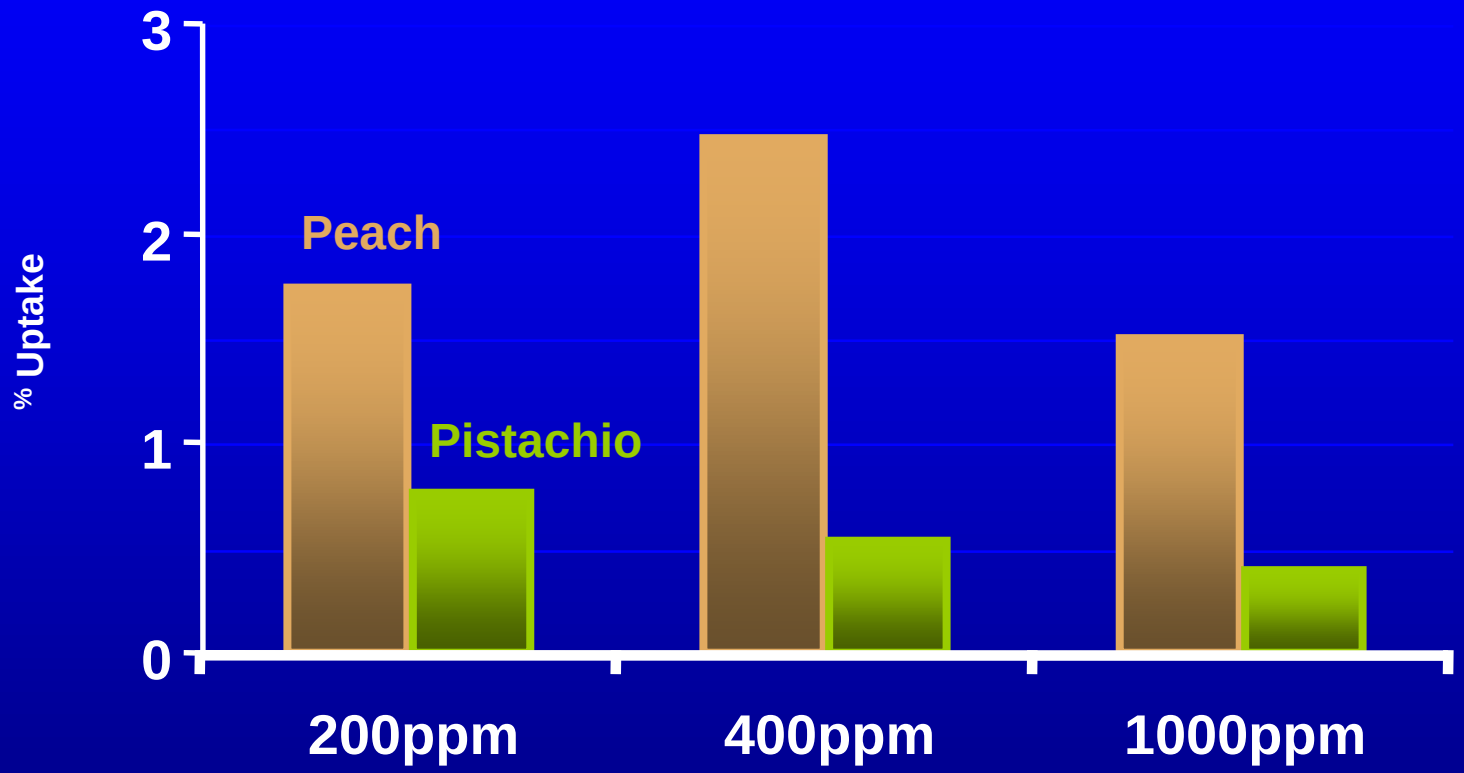
Dr. Scott Johnson, Specialist UC Davis Plant Science, KAC. Project Leader

Becky Phene, Staff Research Associate, UC Kearney

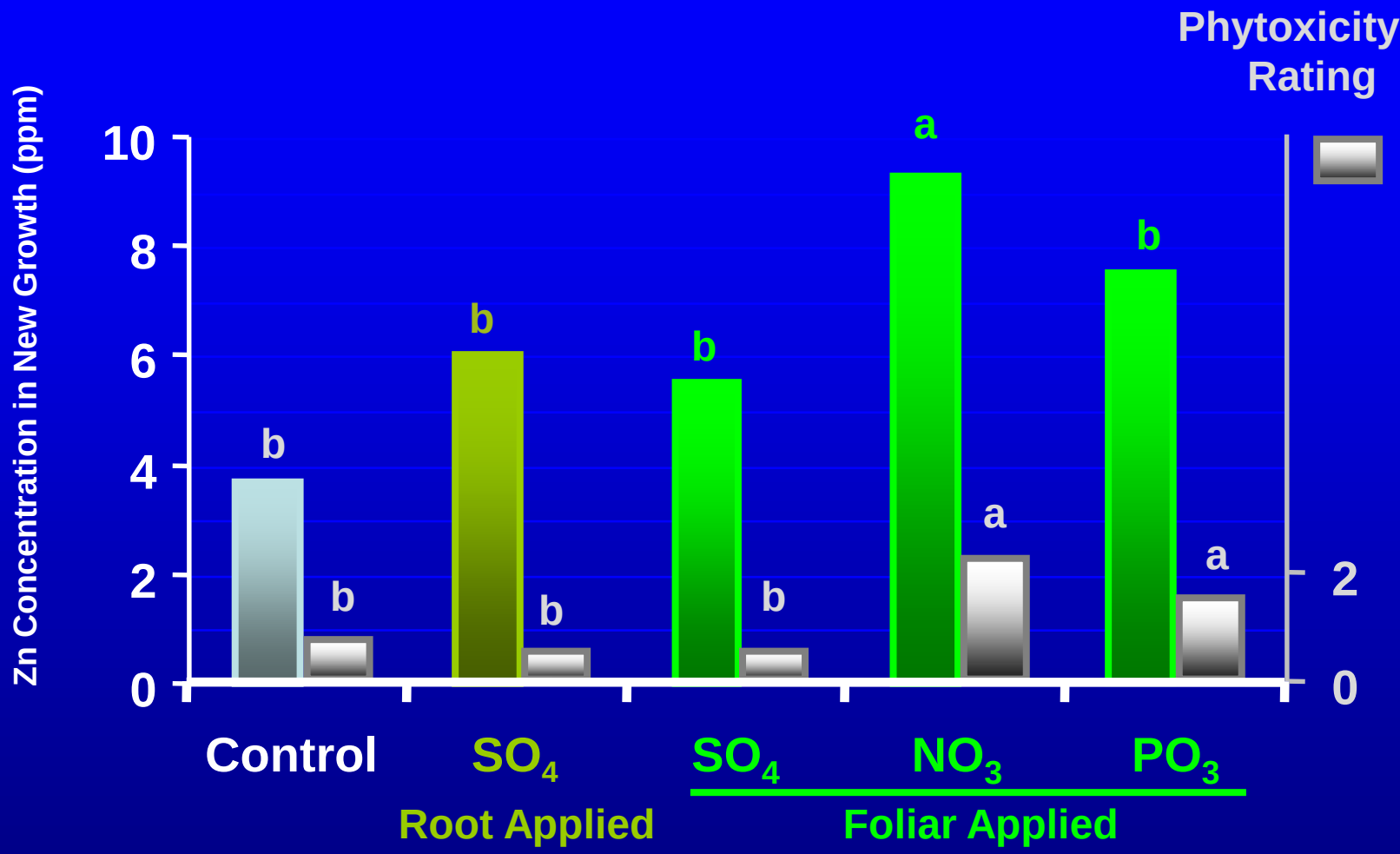
Robert Beede, UC Farm Advisor, Kings County

Thanks to S&J Nursery and Lane Millar for Tree Donation!

$^{68}Zn\ SO_4$ Applied to Peach and Pistachio Seedlings - Uptake of Zn



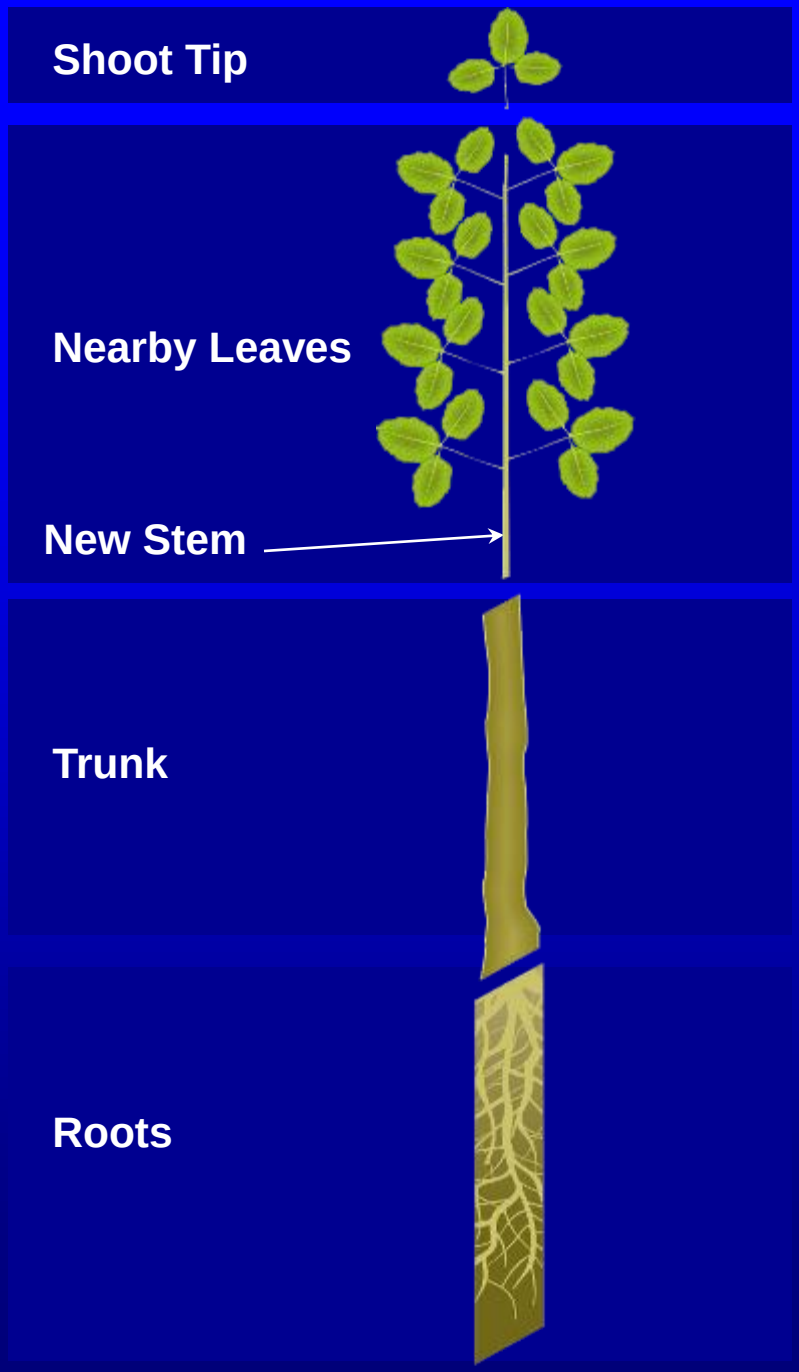
Zn Formulations Applied to Zn Deficient Pistachio Seedlings



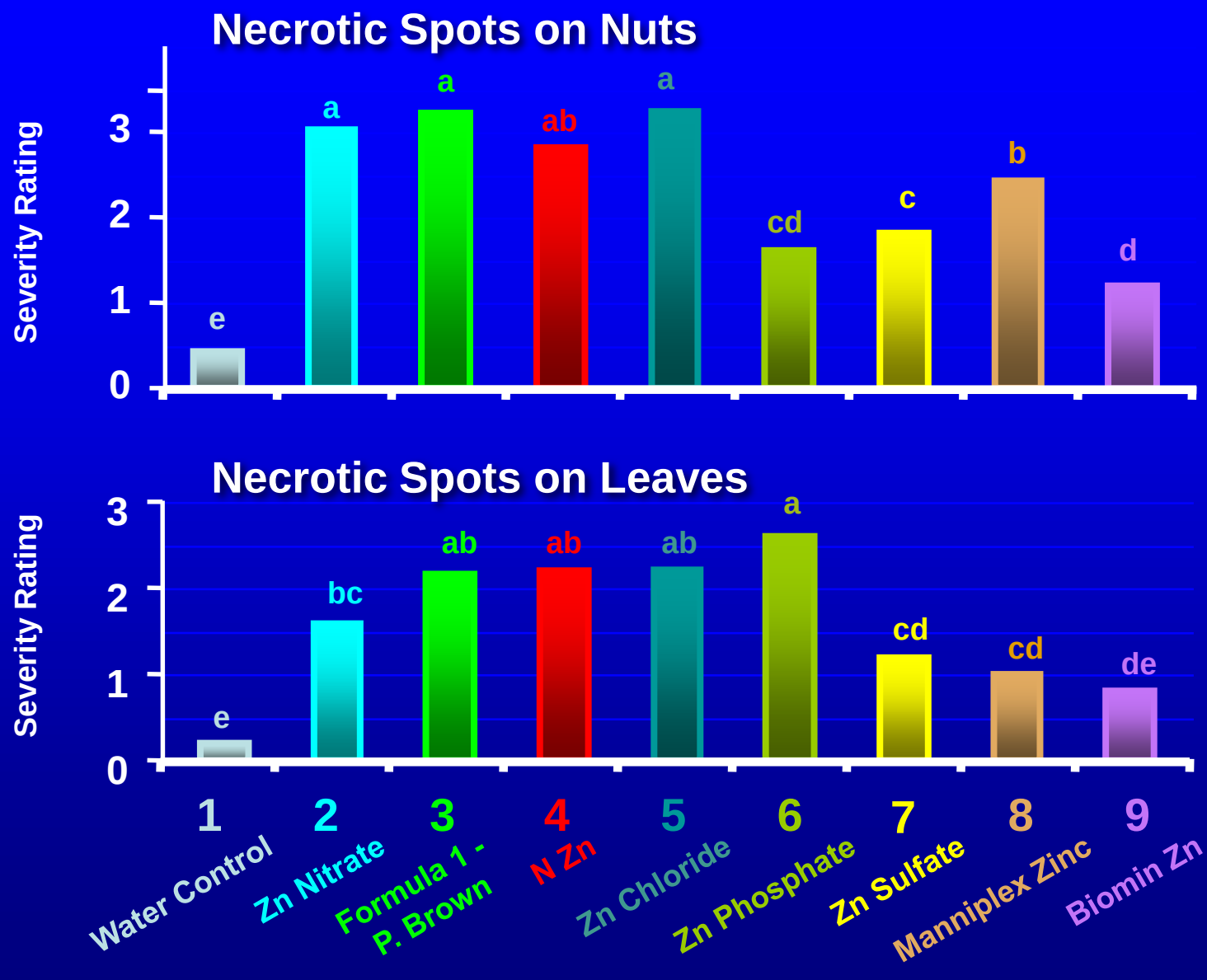
$^{68}Zn\ SO_4$ Applied to Basal Leaves of Actively Growing Pistachio Nursery Trees

% Uptake

.4	Shoot Tip
2.0	Nearby Leaves
1.1	New Stem
0	Trunk
0	Roots

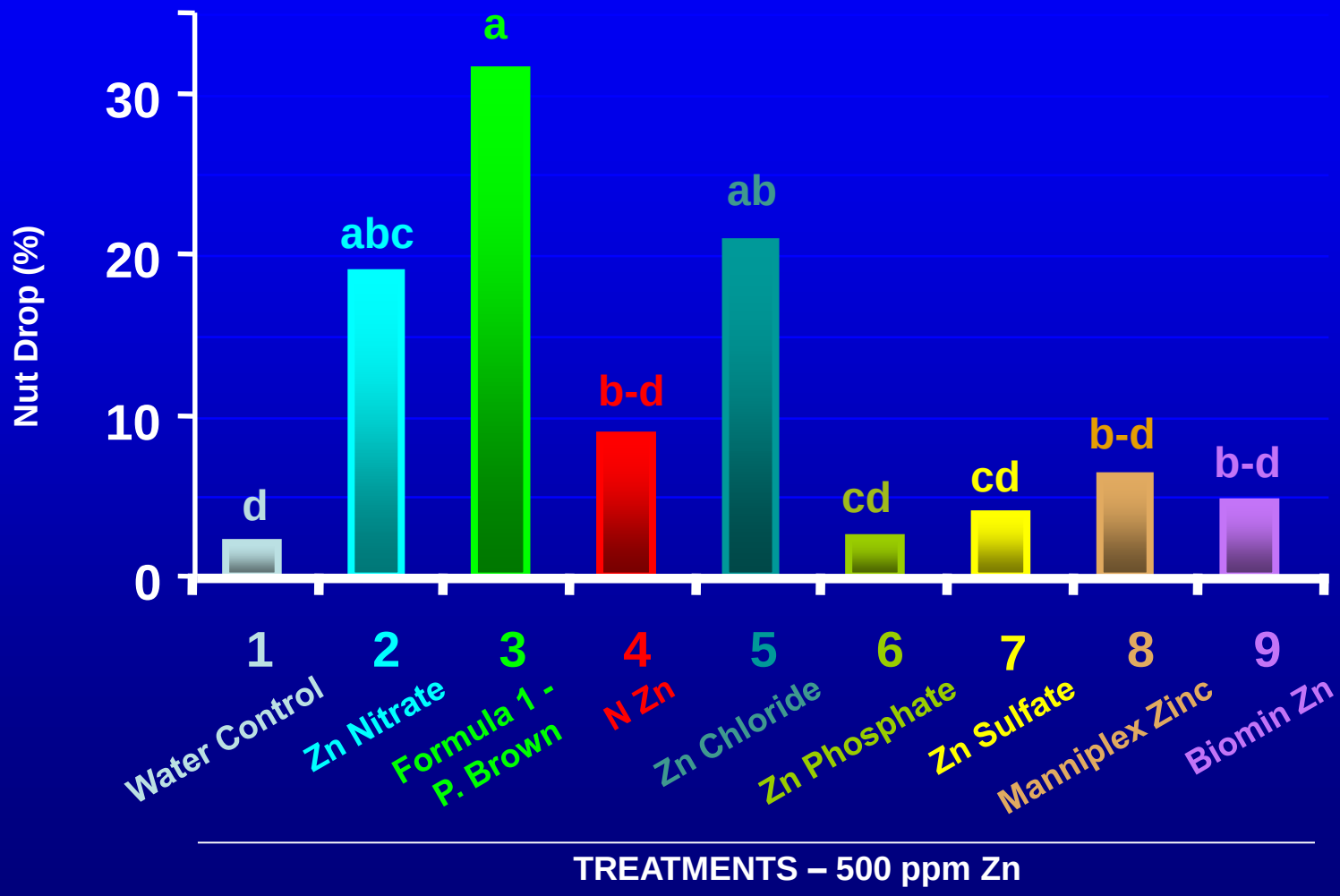


Zinc Phytotoxicity Test. BB Nut Stage, Drench Treatment. KAC.



TREATMENTS – 500 ppm Zn, EQUAL TO ABOUT 1 LB ZINC SULFATE/ 100 GAL.

Zn Formulations (500 ppm Zn) Sprayed on Mature Pistachios
Spring Nut Drop



Comparing Pistachio and Peach

Foliar Zinc Applications

1. Always lower efficiency in pistachio
    a. 2 to 100x less than peach
    b. Lower mobility in pistachio
2. Periods of lowest efficiency
    a. Late dormant – March
    b. Late fall – end of October
3. Periods of highest efficiency
    a. Young leaves in spring – beware phyto
    b. Earlier in the fall – September?

CORRECTING ZINC DEFICIENCY

- **Fall application in late October (50% defoliation) requires high rates of Zinc Sulfate 36% powder at 40 pounds/100 gal. water. Liquid Zinc Sulfate 12% also effective at 10 gal./100 gal. water.**

- **Delayed dormant timing (early March) also effective at above rates.**

- **Much lower rates required at 50% leaf expansion (late April) before leaves complete wax development. Two pounds Zinc Sulfate 36% per acre. Buffer with citric acid to pH=5.0.**

- **In season sprays correct deficiency on new growth, NOT old. Zinc is very immobile. Repeated treatments may be required.**

Foliar Fertilization Strategies for Pistachios

PI's: Dr. Carol Lovatt, UCR, and Robert Beede, UCCE, Kings Co

TWO YEAR FREP PROJECT, 2011-12: SOUTHWEST KINGS COUNTY
COOPERATOR: PARAMOUNT FARMING. 20 ACRE TRIAL WITH 11 TREATMENTS APPLIED AT DELAYED DORMANT, 50% LE, & NUT FILL

SUMMARY

1. **LB UREA (6 LBS/100) AIDS IN THE UPTAKE OF ZINC AND BORON AT BOTH BUD SWELL AND LEAF EXPANSION (LE). Nitrate did not show similar effect on uptake.**

2. **FOLIAR K DID NOT INCREASE TISSUE LEVELS. RESPONSE DILUTED BY GROWTH?**

3. **FOLIAR UREA INCREASED LEAF NITROGEN LEVEL.**

4. **NUTRIENT ABSORPTION HIGH AT 50% LEAF EXPANSION.**

COPPER (CU) DEFICIENCY

COPPER DEFICIENCY: WHAT WE KNOW…

- Available copper content of San Joaquin Valley soils about 1.5 ppm by DTPA extraction method

- Trend toward less deficiency in soils with high, but not toxic salt levels. Alkaline soils may complex copper for uptake

- Rootstock effect on deficiency symptoms may be associated with differences in organic acids and complexing agents produced by roots. May also simply be higher vigor.

- Properly timed foliar applications the most effective in providing rapid correction

CORRECTING COPPER DEFICIENCY

- **Apply one-third to one-half pound of 14.5% Copper EDTA as a foliar treatment at 50% leaf expansion (late April)**
- **Can be mixed with Zinc and pyrethroid insecticide treatment**
- **Include in nutrient mixes to be applied several times in the spring**

CORRECTING ZINC AND COPPER DEFICIENCY THROUGH THE DRIP

Craig Kallsen

Fertigating with zinc and copper materials in alkaline soils was not effective due to fixation of the positively charged metal ions to soil particles.

ACIDIFYING SOIL WITH SULFURIC ACID OR SULFUR DUST WHERE LIME IS PRESENT, CAN CORRECT SOME NUTRIENT DEFICIENCY PROBLEMS IN ALKALINE SOILS:

- **zinc, iron, manganese**
- **magnesium**
- **(caution – boron)**

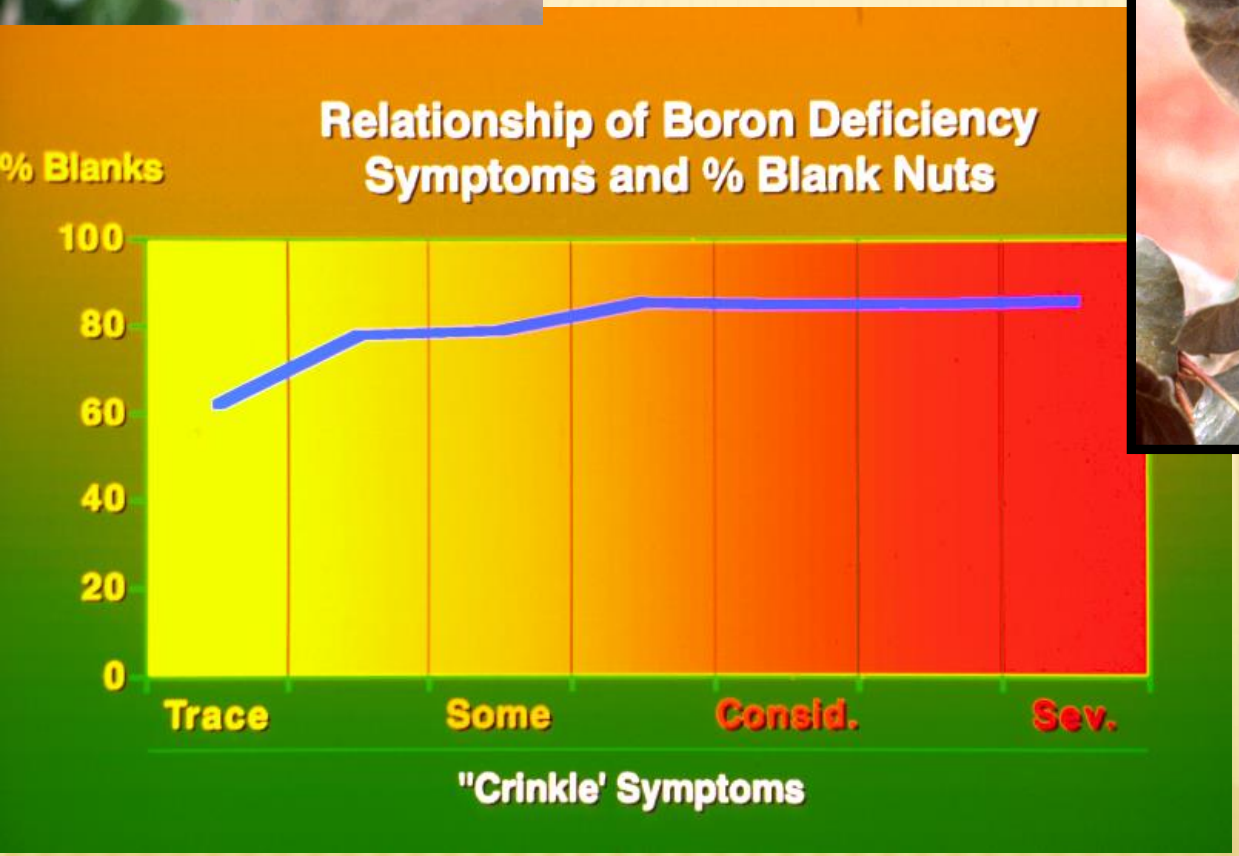
Consider quantity required: 10 ton Sulfuric acid neutralizes a 1% lime content in one acre of soil 6 inches deep (2M lbs!). Localize acidification by banding or through drip.

BORON DEFICIENCY: “CRINKLE LEAF”

THE ROLE OF BORON IN PLANTS:

- **Functions in the differentiation of new cells**
- **When deficient, cells may continue to divide, but their structural parts are not properly or completely formed**
- **Regulates carbohydrate metabolism**
- **Low Boron limits pollen germination and pollen tube growth**
- **Does not move from young leaves to old ones (immobile)**

Boron is important in flowering, pollen viability and nut set in pistachio.



Optimal Leaf tissue B = 120 – 250 ppm

BORON DEFICIENCY SYMPTOMS:

- **Tissue necrosis of growing points and young leaves**
- **Shoot tips die back, terminal bud may remain dormant**
- **Lateral buds sprout, short internodes**
- **Leaves are crinkled , tips curled upward and misshapen**
- **Flower clusters often drop before fruit set.**

CORRECTING BORON (B) DEFICIENCY

- **Because B is phloem immobile in pistachio, adequate amounts must be present in the soil for uptake with water.**

- **For correction the following spring, soil treatments must occur by the end of August. Treat sooner if symptoms appear. Rate: 1-3 ounces of Solubor product per tree. (8-24 lbs/acre). Easily applied through the drip system or in the herbicide spray. Boric acid can also be used, and has become popular due to its liquid formulation and ease of use.**

- **To improve fruit set under marginal B levels, apply 5 pounds of Solubor per acre in the delayed dormant period (mid-March). If combined with zinc, buffer to pH=5.0 for improved Zinc uptake.**

- **Monitor leaf and soil levels to avoid toxicity. Hard to leach out!**

MANGANESE (Mn) DEFICIENCY SYMPTOMS:

- Like Magnesium, Mn occurs mid-season on lower leaves. Deficiency uncommon, but it can occur on very alkaline or acidic, sandy soils

- Chlorosis begins BETWEEN the veins of the leaf, NOT on the margin of the leaf!

- Chlorosis progresses until only slight green tissue right next to the vein remains. Area in the middle will be yellow.

- Symptoms referred to as a “herringbone” pattern.

- Leaves are full size and mature, rather than small and young for Zinc deficiency. Mn does not crinkle the leaf like boron or kill the shoot tips like copper.

MANGANESE DEFICIENCY

MAGNESIUM DEFICIENCY ?

EFFICIENT NUTRIENT MANAGEMENT THE 4 R'S

Nutrients are used most efficiently when you:

Apply the Right Rate

- **Match tree demand with fertilizer supply.**

At Right Time

- **Apply nutrients when root uptake is most active.**

In the Right Place

- **Ensure delivery of nutrients to the active roots and not past the root zone.**

Using the Right Source

- **Choose fertilizers sources that maximize uptake and minimize loss.**

THANK YOU FOR YOUR ATTENDTION!

HAPPY FARMING!