

How do I develop a sound pistachio nutrition management program?

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Cooperative Extension

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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. Louise Ferguson, 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, Madera County Farm Advisor
- Bob Beede, Kings County Farm Advisor

Nutrition Management Involves

Knowledge of:

- Site/Soil characteristics and chemistry
- Plant requirements
- Cropping history
- Fertilizer inputs
- Cultural practices (Irrigation, vegetation management, pruning)
- Tissue analysis
- Observation and judgement

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 corals, alkali patches, etc.)
- Soil series: Mg, K availability (dolomite, gypsum, lime)
- Irrigation waters differ in nutrient content

Essential Elements for Pistachio Nutrition: 14

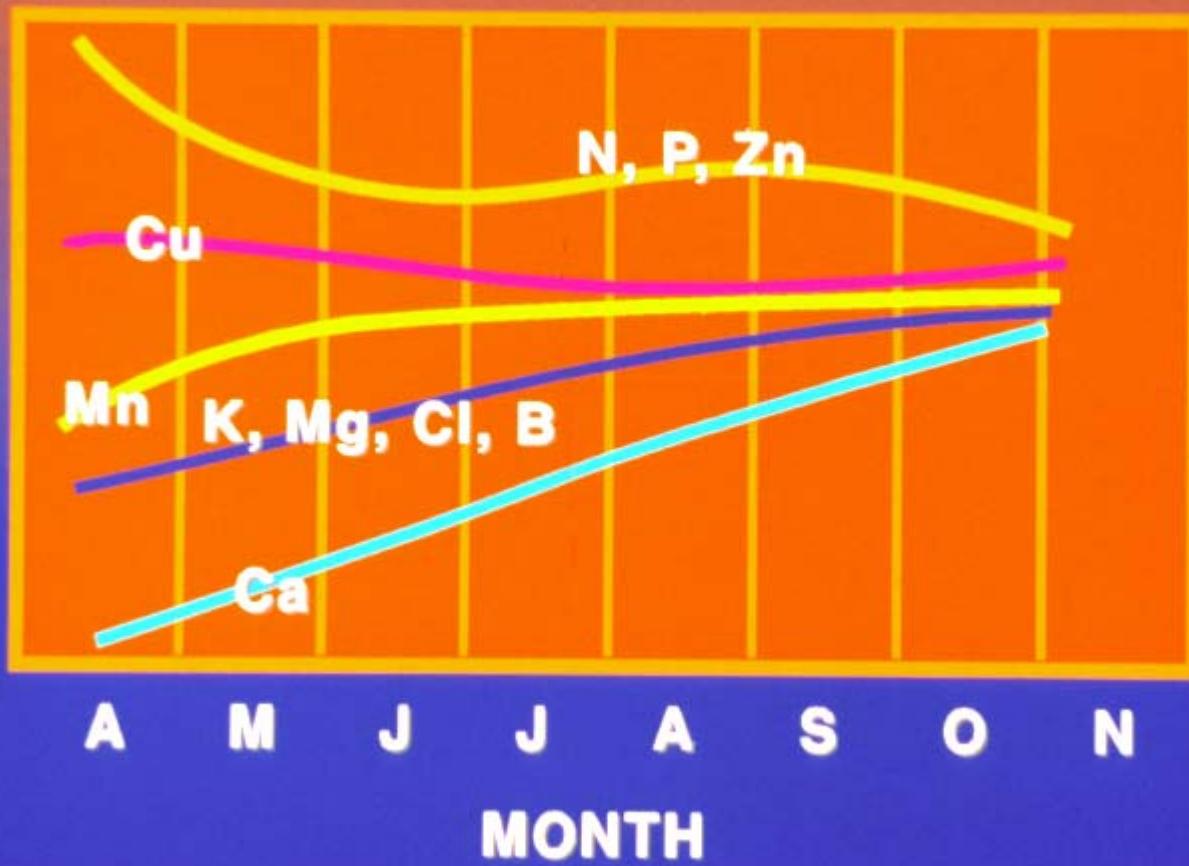
Macronutrients

Nitrogen
Potassium
Phosphorus
Magnesium
Calcium
Sulfur

Micronutrients

Zinc
Boron
Iron
Manganese
Copper
Chloride
Nickel
Molybdenum

Nutrient Curves through Season



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.**
- **Best performed in late July to early August**

Critical and Suggested Levels for Mature Tree in late July/August Leaf Samples

<u>Element</u>	<u>Suggested Range</u>
Nitrogen (N)	2.5 – 2.9%
Phosphorous (P)	0.14 - 0.17%
Potassium (K)	1.8 – 2.2%
Calcium (Ca)	1.3 – 4.0%
Magnesium (Mg)	0.6 – 1.2%
Boron (B)	120 – 250 ppm
Zinc (Zn)	10 – 15 ppm
Copper (Cu)	6-10 ppm

Critical and Suggested Levels for Mature Tree in August Leaf Samples

<u>Element</u>	<u>Suggested Range</u>
Sodium	not established
Chlorine	<0.2%

NITROGEN USAGE AND FERTILIZATION OF PISTACHIOS

Steven Weinbaum, Richard
Rosecrance and Craig Kallsen

Nitrogen Deficiency Symptoms





FACTORS AFFECTING THE NITROGEN FERTILIZATION REQUIREMENT

- Tree age (primarily a factor during development)
- Cropping history
- Fertilizer application method
- Nitrogen content of irrigation water (10 ppm $\text{NO}_3\text{-N}$ provides 27 lbs. of actual N per acre-foot of water!)
- Nitrogen stored in soil as nitrate or in organic matter
- Presence and type of cover crop
- Irrigation efficiency
- Nitrogen source- Organic versus synthetic

Estimate of Soil N Demand over the Alternate Bearing Cycle

Cropping Status	Spring Flush	Nut Fill	Post Harvest	Total
----- lbs N/acre -----				
ON	46	103	*	150
OFF	60	76	*	136

Total Stored Nutrients at the end of the season

Cropping Status	N	P	K	Ca	Mg
ON	13	30	47	36	8
OFF	101	12	82	30	14

Apply Nitrogen in the Spring and Early Summer

- Make limited applications during the spring flush (late March to mid-May)
- Apply the remainder during June or early July to meet the demands of nut fill or storage (off year).

Immature Tree Nitrogen Requirements

• First Leaf	0 - 0.1	pounds/tree
• 2nd Leaf	0.15 - 0.2	pounds/tree
• 3rd Leaf	0.25 - 0.35	pounds/tree
• 4th Leaf	0.5 - 0.6	pounds/tree
• 5th Leaf	100 – 120	pounds/acre
• 6th Leaf	120 – 130	pounds/acre
• 7 th Leaf	135 – 150	pounds/acre

REMEMBER,

- Annual nitrogen applications should be tailored to the individual orchard based on leaf-tissue sampling, canopy condition, and yield performance
- Nitrogen does not put more flower buds on the tree or compensate for poor practices affecting nut development.

Optimal Levels of Leaf Nitrogen

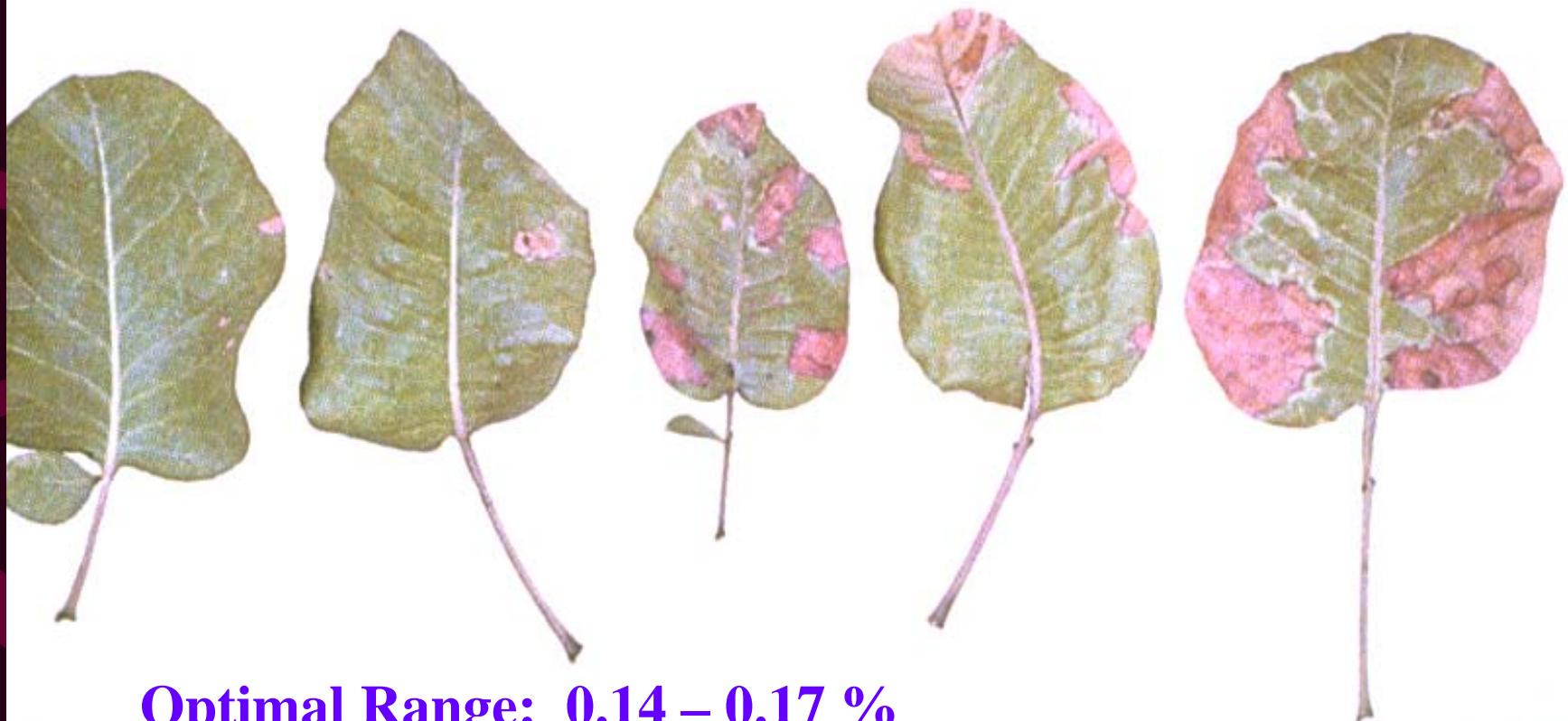
- 2.6 - 2.9% for young rapidly growing immature trees.
- Greater than 2.3% for mature trees. Levels greater than 2.5% have not improved plant performance.

Watch Late Nitrogen Applications

- Applications in September can encourage excessive vegetative growth for OFF trees or young Kermans on *P. integerrima* rootstock.
- Delaying dormancy greatly increases the risk of freeze damage to younger trees.

Phosphorous Deficiency in Pistachio

Annual Export: About 30 pounds



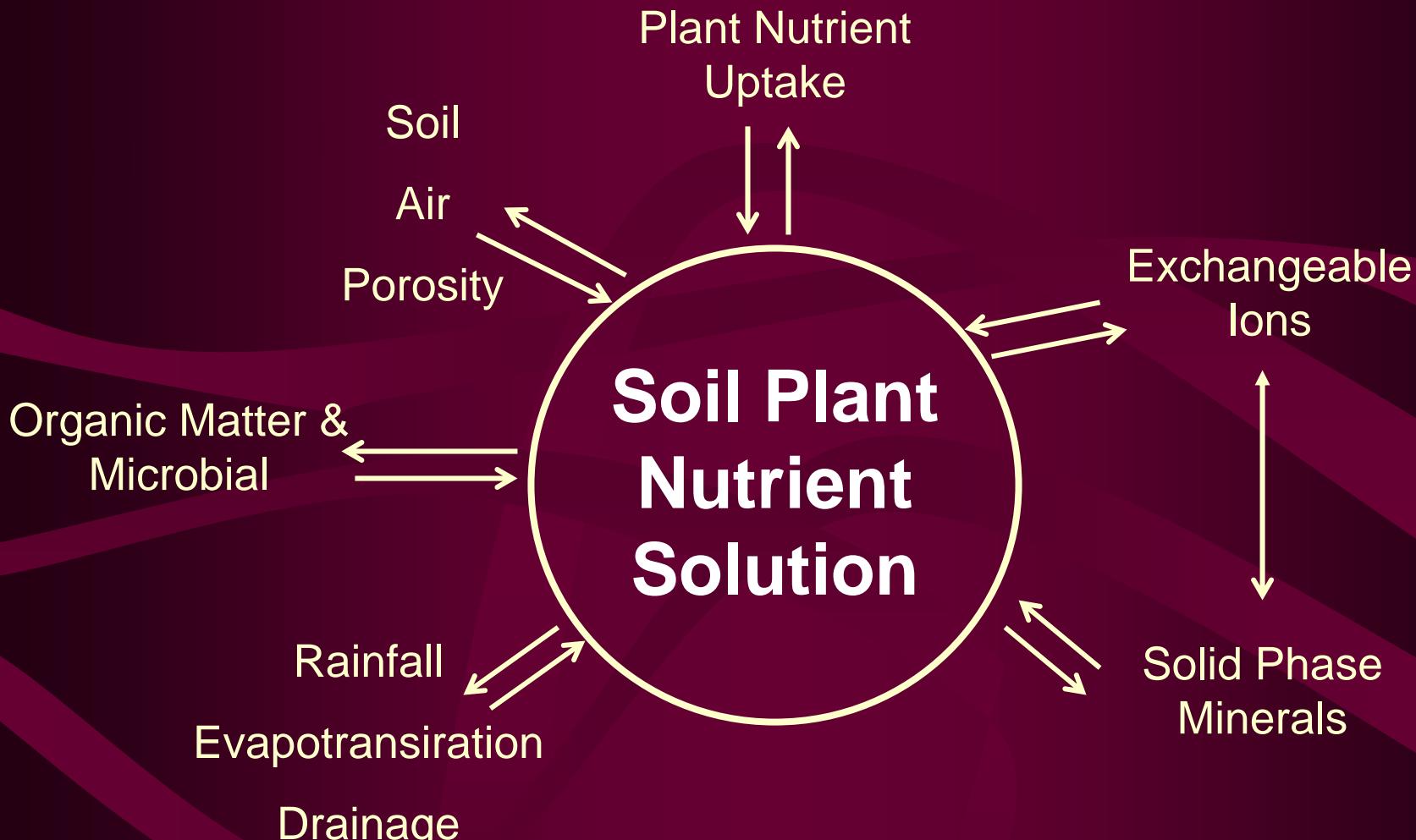
Optimal Range: 0.14 – 0.17 %

Potassium (K)

- Involved in regulation of nutrient uptake, water balance, Sugar and protein synthesis
- Represents about 1-4% of the total plant dry weight
- Plays a major role in oil accumulation during nut fill
- Found in large quantities in California soils
- Availability is strongly dependent on soil clay content which “fixes” K onto soil particles.

Small Soil Chemistry Lesson

Dynamic Equilibrium that occurs in soils



* Saturation extract tries to mimic inner circle

Potassium deficiency :

- Appears in early to mid-summer
- Symptoms most severe on older leaves of current season shoots
- Trees show slow growth and smaller leaves
- Trees may look normal but produce yields below potential

Potassium (K)

Deficiency Symptoms

Suggested leaf
tissue
concentration:

1.8 – 2.2 %



Estimate of K Uptake over the Alternate Bearing Cycle

Cropping Status	Spring Flush	Nut Fill	Post Harvest	Total
----- lbs K/acre -----				
ON	0	192	18	210
OFF	1	91	0	92

based on differences in tree K content.

Nutrients Removed in 1 Ton of Grapes

Averages in Literature

Nutrient		Kg/Ton
Potassium	K	2.5
Nitrogen	N	1.5
Phosphorus	P	0.3
Calcium	Ca	0.5
Magnesium	Mg	0.1
Iron	Fe	0.00525
Zinc	Zn	0.00058
Copper	Cu	0.00055
Boron	B	0.00033

Fertigating or soil banding potassium in neutral, loam soils at the rate of 100-200 lbs K/acre increased:

- Soil and leaf K concentrations
- Individual nut weight and total yield/acre
- Split percentage
- Percentage of filled nuts (i.e. reduced blanking)

Potassium Source did not Affect Response.

- Potassium chloride (KCl) 52% K:
well drained, non-saline, well
irrigated soils!
- Potassium sulfate (K₂SO₄) 44% K:
\$375/ Ton
- Potassium nitrate (KNO₃) 37% K

Consider Product Solubility for Fertigation

- Potassium Chloride: 2.9 pounds per gallon water (70⁰F)
- Potassium Sulfate: 1.0 pound
- Potassium Nitrate: 2.8 pounds

**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

Factors Affecting Soil-Zinc Availability

3. High Magnesium or Phosphorous reduces Zinc availability
4. Methyl Bromide fumigation causes temporary loss of mycorrhizal fungi
5. 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

Information courtesy of Louise Ferguson, et al.

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.

Symptoms of 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
- 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

Craig Kallsen

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

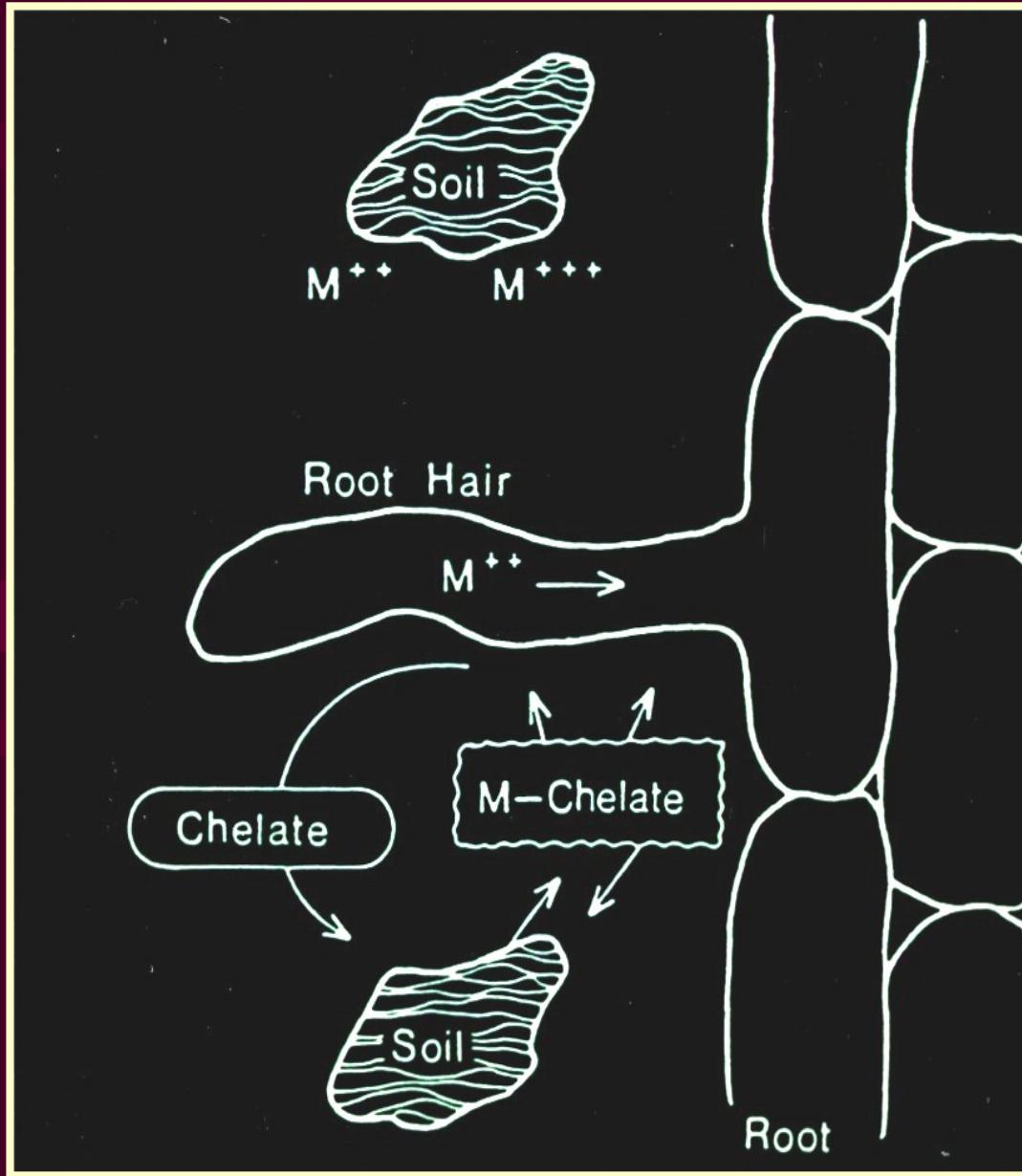
Acidifying soil with sulfuric acid or sulfur dust where lime is present, can correct some nutrient deficiency problems in alkaline soils:

- 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

What Role do Humic Acids Play in Plant Nutrition?

It is generally agreed among nutrition researchers that humic acids have the potential to improve plant nutrient availability by chelating essential elements in the soil.



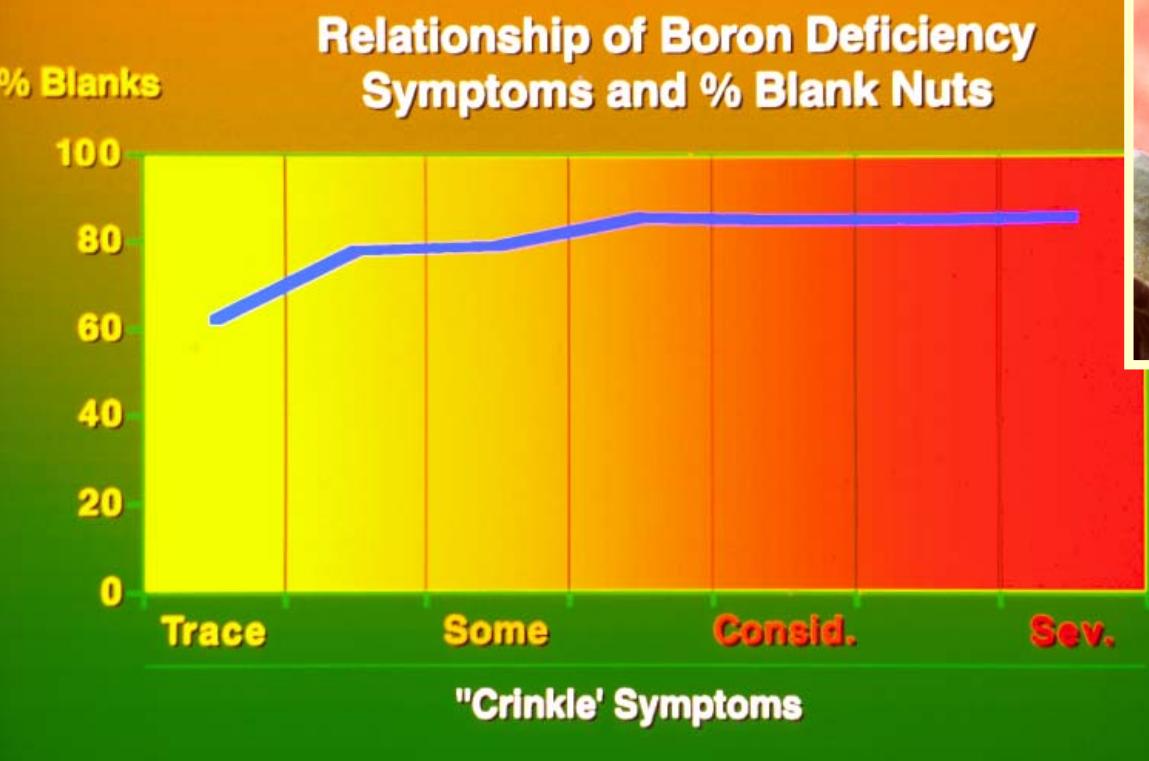
Mobilization of soil metal ions by chelates (after Lindsay [1974])

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 yellow, 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: 2-4 ounces of Solubor product per tree. (16-32 lbs/acre). Easily applied through the drip system or in the herbicide spray.
- To improve fruit set under marginal B levels, apply 5 pounds of Solubor per acre in the delayed dormant period (late February to early March). If combined with zinc, buffer to pH=5.0 for improved Zinc uptake.
- Monitor leaf and soil levels to avoid toxicity. Boron is VERY insoluble in the soil. Hence, it does NOT leach easily!

Magnesium (Mg) Nutrition

- A 4000 pound crop requires about 65 pounds/acre. Only 10 of it is in the fruit! Rest is in the leaves that get recycled.
- Young trees often more susceptible until their roots penetrate subsoils higher in Mg.
- Highly calcareous soils can limit Mg availability
- High K can antagonize Mg absorption
- Mg a main constituent of chlorophyll, essential for photosynthesis
- Mg mobile in plants and hence, can be translocated to younger tissue

Magnesium Deficiency Symptoms:

- Leaf symptoms begin mid-season on lower (basal), older leaves
- The tips and margins of the leaves begin to fade in color (chlorosis)
- This chlorosis then burns, leaving an inverted “V” of green tissue in the center of the leaf.

Magnesium Deficiency

-- Zinfandel



Manganese (Mn) Deficiency Symptoms:

- Also occurs mid-season on lower leaves.
- 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



**In the Central Valley of California,
the elements that are more likely to
be at toxic levels are:**

- boron
- sodium
- chlorine

Salt Toxicity

**July/August
leaf tissue
Chlorine (Cl)
concentration
> 0.3 ppm**



Slide Courtesy of
Louise Ferguson

Effect of Saline Irrigation on Average Annual Individual Tree Yield by Rootstock, 1997 - 2002



Boron toxicity symptoms

leaf tissue B > 400 ppm



Preemergent herbicide
damage may look similar to
nutrient deficiencies.



Thank You for Your Attention!