Pistachio Micronutrient Management

Giulia Marino
Extension Specialist in Orchard Systems
University of California, Davis

9th Advances in PISTACHIO PRODUCTION
November 16, 2020

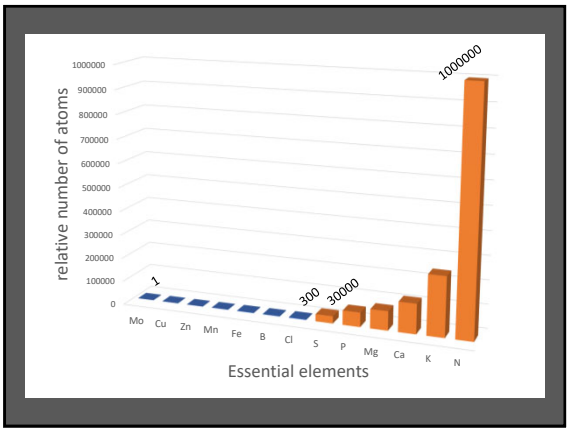
Essential Elements for Pistachio Nutrition

- Essential nutrient: a nutrient that is required for plant growth – omission will cause death or abnormal growth, cannot be replaced by other
- Essential for proper function of many biochemical reaction
- Their balance can affect plant health and productivity

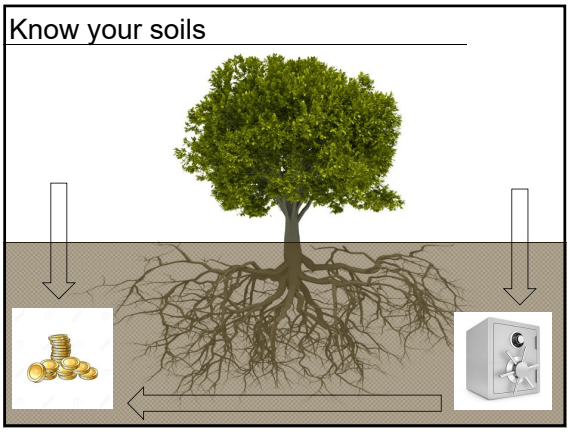
Essential Elements for Pistachio Nutrition

Macronutrients	Micronutrients
Nitrogen	Zinc
Potassium	Boron
Phosphorus	Iron
Magnesium	Manganese
Calcium	Copper
Sulfur	Chloride
	Nickel
	Molybdenum

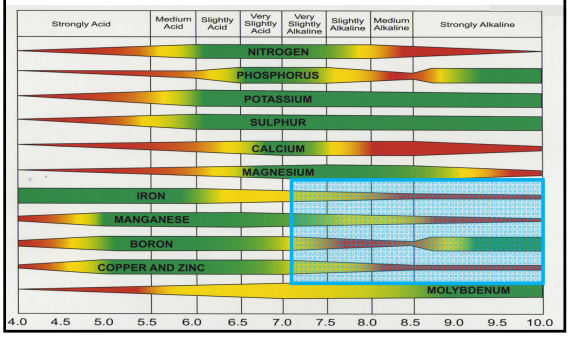
Micronutrients are needed in much lower concentrations



Know your soils



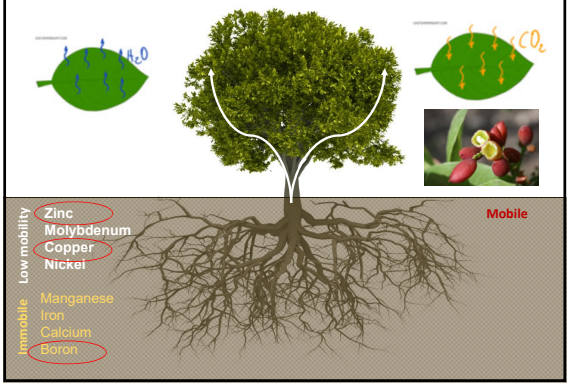
Soil pH and Nutrient Solubility



Nutrient uptake

- Poor irrigation system design and scheduling
- Drought or flooded soils
- Weed competition
- Poor root growth: presence of hardpans, poor water infiltration, perched water tables, alkali spots
- Salinity (soil or water), pH, nutrient fixation
- Low soil temperature (microbial activity, root activity)
- Weather/climate, limitations of tree uptake and transport
- Nutrient imbalance and toxic elements
- Low or high native soil fertility for one or more nutrients
- Root disease

Know how they move in the tree



Nutrient mobility influences management

Immobile or low mobile elements 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

Rootstock effect on micronutrient concentration

Rootstock	B (ppm)	Zn (ppm)	Cu (ppm)
P. atlantica	194 a	16 b	15 b
P. integerrima	164 a	14 a	12 b
Hybrids	148 b	14 b	13 b

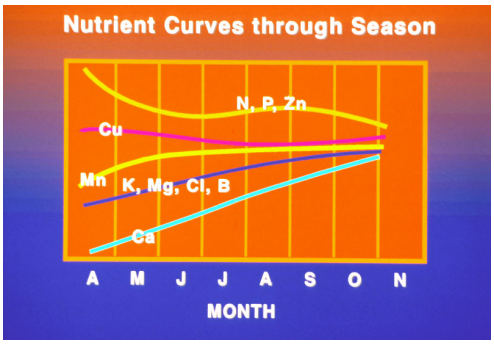
Louise Ferguson

Golden hill and Kerman differ in the rate of Boron uptake (Craig Kallsen)

Critical And Suggested Levels

Element	Critical value	Adequate range
nitrogen (N)	1.8%	2.2–2.5%
phosphorus (P)	0.14%	0.14–0.17%
potassium (K)	1.6%	1.8–2.2%
calcium (Ca)	2.0%	2.1–4.0%
magnesium (Mg)	0.45%	0.5–1.2%
sodium (Na)	—	—
chlorine (Cl)	—	0.1–0.3%
manganese (Mn)	30 ppm	30–80 ppm
boron (B)	90 ppm	150–250 ppm
zinc (Zn)	7 ppm	10–15 ppm
copper (Cu)	4 ppm	6–10 ppm

Values below critical values affect plant growth and yield (sampling in July-August)
Also excess can be toxic or have negative impact on trees performances



The Role of Zinc in the tree

- 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

Critical 7 ppm, Optimal : 10 – 15 ppm

- On younger leaves (immobile)
- Early in the season
- Small leaves (rosette, no elongation)
- Red color
- Late leaf out (not confuse with cold)

Symptoms of zinc deficiency

Zn deficiency

Autumn freeze

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. Sandy soils lower CEC and Zinc
3. High Magnesium or Phosphorous reduces Zinc availability (manure)
4. Methyl Bromide fumigation causes temporary loss of mycorrhizal fungi which chelate elements
5. Calcareous materials (lime) reduce Zinc availability

Correcting zinc deficiency through the drip

Craig Kallsen

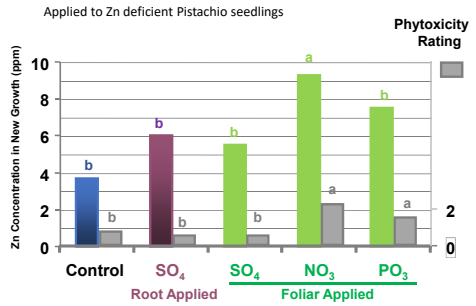
- Fertigating with zinc materials in alkaline soils was not effective due to fixation of the positively charged metal ions to soil particles.

Correcting soil pH

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

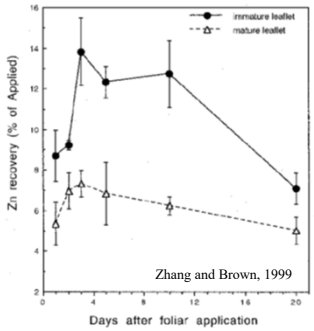
Quantity: 10 ton Sulfuric acid neutralizes a 1% lime content in one acre of soil 6 inches deep (2M lbs!)
Localize acidification by banding or through drip

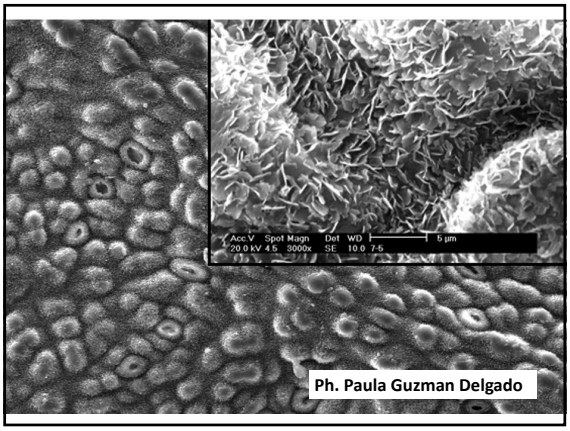
Factor affecting zinc foliar uptake: formulations



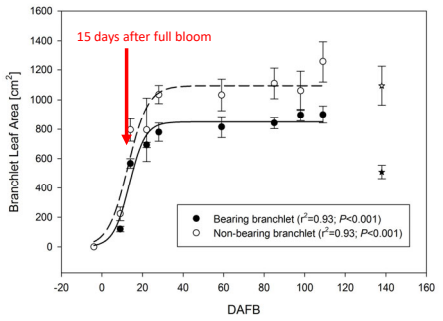
Scott Johnson, Becky Phene, Robert Beede

Factor affecting zinc foliar uptake: leaf age





Leaf expansion and surface properties



Distribution of Foliar Applied Zinc

Zhang and Brown 1999

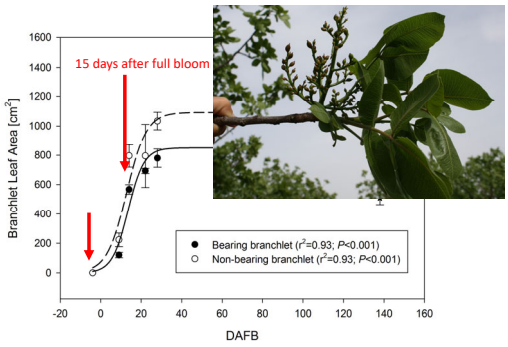
Distribution of 68Zn among different plant organs following foliar application to intact leaves of 2-week-old pistachio seedlings

Zinc distribution (%)	Days after application 2	10
Total recovered	12.5 a[z]	14.8 b
Treated leaf[y]	99.10 a	94.64 b
Stem	0.33 a	2.68 b
Roots	0.10 a	0.75 b
Leaves		
Above treated leaf	0.12 a	1.13 b
Below treated leaf	0.12 a	0.82 b

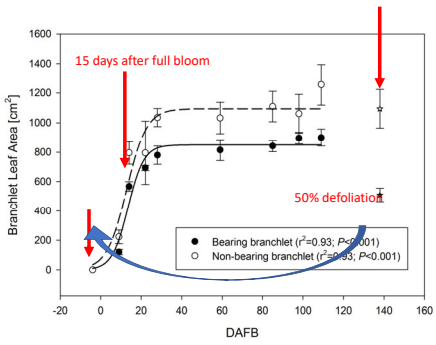
limited mobility

- **Essential for pollen development, flower bud differentiation and fruit set**

Zinc availability at flowering and fruit set



Zinc availability at flowering and fruit set



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.

The Role of Copper (Cu) in the tree

- Chloroplast, photosynthesis and carbohydrate levels
- Lignification of cell walls
- Pollen formation and fertilization

Symptoms of copper (Cu) deficiency

Optimal : 10 – 15 ppm, critical: 4 ppm

- On younger leaves (immobile)
- Undeveloped terminal leaves (clover shaped)
- Appears in the middle in the summer
- defoliation

Symptoms of copper (Cu) deficiency

- Terminal leaves summer dieback
- Curling into a shepherd crook shape
- Dark lesion
- Shriveling

Copper and zinc deficiency are similar

…and may happen together

- Young, early bearing trees
- Alkaline soils may complex copper for uptake
- Rootstock effect on deficiency symptoms (may be associated with different vigor)
- Deficiency not correlated to low soil content (Beede, 1989)
- Soil application of copper sulfate may not have effect
- Properly timed foliar applications the most effective in providing rapid correction (low mobility)

Correcting copper deficiency

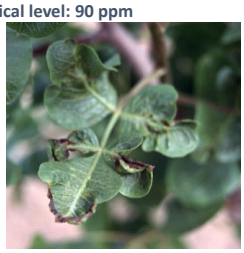
- Apply one-third to one-half pound of 14.5% Copper EDTA in 100 gallons of water as a foliar treatment at 50% leaf expansion (late April)
- $CuSO_4$ 25% at half pound per 100 gallons may cause phytotoxicity
- Can be mixed with Zinc and pyrethroid insecticide treatment

The Role of Boron in Trees

- 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

Symptoms of Boron deficiency

Optimal level: 120 – 250 ppm, critical level: 90 ppm



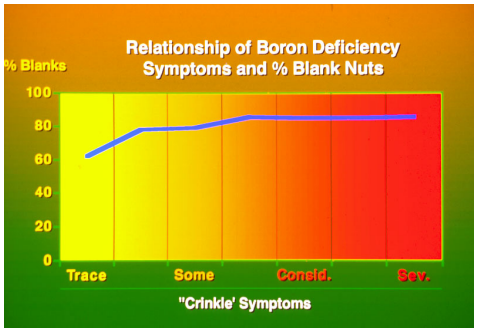
- Appear early in the season
- Shoot Tip dieback
- Lateral buds sprout, short internodes

- Wrinkled and deformed leaves
- Tissue necrosis
- Petiole and stem thicken

Symptoms of Boron deficiency

- Crinkle, thicker, leathery leaf
- Vein elevated over the surface
- Leaf tip curl upward

Symptoms of Boron deficiency



Flower clusters often drop before fruit set.

Correcting boron deficiency

- Soil deficiency in east side of the San Joaquin Valley
- Does not move from young leaves to old ones (immobile)
- Soil treatments by the end of August or sooner if symptoms appear, with Solubor (20.5%) at 8-24 lbs/acre (1 to 2 once per tree) trough the drip system or in the herbicide spray
- To improve fruit set under marginal B levels, foliar sprays of Solubor apply 5 pounds of Solubor per /100 gallons/acre in the delayed dormant period, bud swell (mid-March).
- If combined with zinc (post bloom), 3 pounds per gallons and buffer to pH=5.0 for improved Zinc uptake.

Boron Toxicity

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

Pictures Courtesy of Flo Trouillas

Thank you!