Cost Effective Zinc Nutrition
Scott Johnson – UC Pomology Specialist
Kearney Ag Center
Peach Rootstocks and Zn Uptake
December 2006 Shoot Zn

Shoot Zn (ppm)

Nemaguard | Controller 5 | Controller 9 | Hiawatha
---|---|---|---
20 | 40 | 20 | a

Legend:
c
b
Applying “Root Bags” with Sulfur, Urea and Zinc Sulfate to the Planting Hole in Spring 2006

July Leaf Zn (ppm)

<table>
<thead>
<tr>
<th>Site 1</th>
<th>Control</th>
<th>150 g Zn Sulfate</th>
</tr>
</thead>
<tbody>
<tr>
<td>2006</td>
<td>b</td>
<td>a</td>
</tr>
<tr>
<td>2007</td>
<td>b</td>
<td>a</td>
</tr>
</tbody>
</table>
EnviroSul
MICRONUTRIENTS

SULPHUR 65% + ZINC 18%

GUARANTEED MINIMUM ANALYSIS

Sulphur (S) 65.00%
Zinc (Zn) 18.00%

TIGER MICRONUTRIENTS

NET WEIGHT / Poids Net
25 KG / 55.115 LBS

CODE 615/G
Granular ZnO + Sulfur Material Added to Planting Hole of Peach (1.25 lbs/tree)

![Bar graph showing comparison of July Leaf Zn (ppm) between Control and Granular ZnO + S treatments.]

- Control: b
- Granular ZnO + S: a

The graph indicates a significant increase in July Leaf Zn concentration with the Granular ZnO + S treatment compared to the Control.
Granular ZnO + Sulfur Material Added to Planting Hole of Peach (1.25 lbs/tree)

Control

Granular ZnO + S

July Leaf Zn (ppm)

b
b

a

a

Treatment

Control

Granular ZnO + S

2008

2009
Zinc Materials Added to Planting Hole of Friar / Nemaguard Plums

February 2009

July 2009 Leaf Zn (ppm)

UTC

1/4# 1/2# 1# Granular ZnO + S

d d d cd

1/4# 1/2# 1# ZnO

cd bc cd

1/8# ZnSO₄

July 2009 Leaf Zn (ppm)

UTC

1/4# 1/2# 1# Granular ZnO + S

d d d cd

1/4# 1/2# 1# ZnO

cd bc cd

1/8# ZnSO₄

July 2009 Leaf Zn (ppm)

UTC

1/4# 1/2# 1# Granular ZnO + S

d d d cd

1/4# 1/2# 1# ZnO

cd bc cd

1/8# ZnSO₄

July 2009 Leaf Zn (ppm)

UTC

1/4# 1/2# 1# Granular ZnO + S

d d d cd

1/4# 1/2# 1# ZnO

cd bc cd

1/8# ZnSO₄
# Nutrient Elements in Stone Fruit

**Level in leaves**

<table>
<thead>
<tr>
<th>Nutrient</th>
<th>Deficient below</th>
<th>Optimum range</th>
<th>Toxic over</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>PEACHES AND NECTARINES</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>N</td>
<td>2.3</td>
<td>2.6 - 3.0</td>
<td>-</td>
</tr>
<tr>
<td>P</td>
<td>-</td>
<td>0.1 - 0.3</td>
<td>-</td>
</tr>
<tr>
<td>K</td>
<td>1.0</td>
<td>Over 1.2</td>
<td>-</td>
</tr>
<tr>
<td>Ca</td>
<td>-</td>
<td>Over 1.0</td>
<td>-</td>
</tr>
<tr>
<td>Mg</td>
<td>0.25</td>
<td>Over 0.25</td>
<td>-</td>
</tr>
<tr>
<td>Cl</td>
<td>-</td>
<td>-</td>
<td>0.3</td>
</tr>
<tr>
<td>S</td>
<td>-</td>
<td>-</td>
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</tbody>
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<td><strong>PLUMS</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>N</td>
<td>-</td>
<td>2.3 - 2.8</td>
<td>-</td>
</tr>
<tr>
<td>P</td>
<td>-</td>
<td>0.1 - 0.3</td>
<td>-</td>
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<tr>
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<tr>
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<tr>
<th>Nutrient</th>
<th>ppm</th>
</tr>
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<tbody>
<tr>
<td>Fe</td>
<td>60</td>
</tr>
<tr>
<td>Mn</td>
<td>20</td>
</tr>
<tr>
<td>Zn</td>
<td>15</td>
</tr>
<tr>
<td>B</td>
<td>18</td>
</tr>
<tr>
<td>Cu</td>
<td>-</td>
</tr>
<tr>
<td>Mo</td>
<td>-</td>
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<td>18</td>
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<tr>
<td>B</td>
<td>25</td>
</tr>
<tr>
<td>Cu</td>
<td>4</td>
</tr>
<tr>
<td>Mo</td>
<td>-</td>
</tr>
<tr>
<td>Zinc in Dormant Shoots (ppm)</td>
<td>Deficient</td>
</tr>
<tr>
<td>-----------------------------</td>
<td>-----------</td>
</tr>
<tr>
<td></td>
<td>6.4</td>
</tr>
<tr>
<td></td>
<td>8.1</td>
</tr>
<tr>
<td></td>
<td>10.1</td>
</tr>
</tbody>
</table>
Orchard Survey - Zinc

![Bar Chart]

**January Shoot Zn (ppm)**

Number of Orchards

- 5 ppm: 0 orchards
- 10 ppm: 1 orchard
- 15 ppm: 2 orchards
- 20 ppm: 8 orchards
- 25 ppm: 5 orchards
- 30 ppm: 5 orchards
- 35 ppm: 6 orchards
- 40 ppm: 2 orchards
- 45 ppm: 2 orchards
- 50 ppm: 3 orchards
Zinc in September Shoots (ppm) – Low in the Canopy

<table>
<thead>
<tr>
<th>Deficient</th>
<th>Sufficient</th>
<th>High</th>
</tr>
</thead>
<tbody>
<tr>
<td>6.4</td>
<td>26.0</td>
<td>92.0</td>
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</tbody>
</table>
# Zinc Materials

**Basic Chemicals**
- Zn sulfate
- Zn oxide
- Zn carbonate
- Zn chloride
- Zn oxysulfate
- Zn nitrate

**Chelates & Complexes**
- EDTA
- Lignosulfonate
- Amino acid
- Sugar
- Citric acid
- Fulvic acid, humic acid
Cost of Zinc Materials - October 2007

- Zn Metalosate: 6.8% at $33.51
- Zn Fulvic: 10% at $17.01
- N Zn: 5% at $16.51
- Zn Leonardite: 6.5% at $15.19
- Zn EDTA: 9% at $12.88
- Zn Ligno-Sulfonate: 7% at $9.15
- ZnO Suspension: 40% at $7.55
- Neutral Zn: 52% at $4.12
- Zn Sulfate: 36% at $2.22
- Zn Oxide: 80% at $1.15
Leaf & Fruit Damage on Peach, Plum and Apricot Trees Sprayed in April with Different Formulations of Zn at 1,000 ppm

- Nitrate
- EDTA
- A.A. Complex
- Lignosulfonate
- Sulfate
- Fulvic
- Neutral -52%
- Control

Damage Rating

- Fruit damage
- Leaf damage

0 1 2 3 4 5
Damage Rating
Leaf Area of Individual Leaves

Node from Time of Treatment

Leaf Area (cm²)

Control
Sulfate
Nitrate
Carbohydrate
Oxide
### Comparing Zinc Formulations

<table>
<thead>
<tr>
<th>Ranking</th>
<th>Formulation</th>
<th>Anion Size</th>
<th>Solubility (g/100 H₂O)</th>
<th>Phytotoxicity</th>
</tr>
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<tbody>
<tr>
<td><strong>Most Effective</strong></td>
<td>Zinc Chloride</td>
<td>35</td>
<td>432</td>
<td>High (58*)</td>
</tr>
<tr>
<td><strong>Almost As Good</strong></td>
<td>Zinc Nitrate</td>
<td>62</td>
<td>324</td>
<td>High (54)</td>
</tr>
<tr>
<td></td>
<td>Zinc Nitrate Mix</td>
<td>62 &amp; 96</td>
<td>324</td>
<td>High (59)</td>
</tr>
<tr>
<td><strong>Next Best</strong></td>
<td>Zinc Sulfate</td>
<td>96</td>
<td>50</td>
<td>Moderate (12)</td>
</tr>
<tr>
<td></td>
<td>Zinc Carbohydrate</td>
<td>96 &amp; ?</td>
<td>High</td>
<td>Moderate</td>
</tr>
<tr>
<td></td>
<td>Zinc Polyamine</td>
<td>96 &amp; 75-204</td>
<td>High</td>
<td>Moderate</td>
</tr>
<tr>
<td></td>
<td>Zinc Glycine</td>
<td>96 &amp; 75</td>
<td></td>
<td>Moderate (15)</td>
</tr>
<tr>
<td><strong>Less Effective</strong></td>
<td>Zinc EDTA</td>
<td>292</td>
<td>High</td>
<td>Low</td>
</tr>
<tr>
<td></td>
<td>Zinc Leonardite</td>
<td>1000+</td>
<td>High</td>
<td>Low</td>
</tr>
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<td></td>
<td>Zinc Oxysulfate</td>
<td>16 &amp; 96</td>
<td>1.3</td>
<td>None</td>
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<td><strong>Least Effective</strong></td>
<td>Zinc Phosphite</td>
<td>79</td>
<td>?</td>
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<td></td>
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<td>Insoluble</td>
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Zinc Materials

Zinc Nitrate Mixes

- Not cheap
- Very soluble
- Very phytotoxic
- Not used much
- 4 to 7% zinc
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Zinc Materials

**Zinc Sulfate**
- Inexpensive
- Very soluble
- Widely used
- Considered to be effective
- Can be phytotoxic
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Zinc Materials

Basic or Neutral Zinc

- Cost = 2x Zn sulfate
- Mostly insoluble
- Widely used
- Considered to be effective
- Not phytotoxic
- Can be mixed with oil
Strategies with Zinc Sulfate  
(Timing, Rate, etc)  

1. Spring – Phytotoxicity concerns  
2. All Season – Low rate  
3. Fall or Dormant
Fruit Damage from Zinc Sprays
Zinc Materials

Basic or Neutral Zinc

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(Timing, Rate, etc)

1. Spring – Phytotoxicity concerns
   Zn Oxide or Neutral Zn?
2. All Season – Low rate
3. Fall or Dormant
Strategies with Zinc Sulfate
(Timing, Rate, etc)

1. Spring – Phytotoxicity concerns
   Zn Oxide or Neutral Zn?
2. All Season – Low rate
   Efficiency?
3. Fall or Dormant
Nursery Trees in Pots - Fall Foliar $^{68}$ZnSO$_4$
Rates and Timing - $^{68}$Zn in Plant

$^{68}$Zn From Fertilizer (mg)

$^{68}$Zn
From Fertilizer (mg)

Treatment - ppm Zinc

UTC
1,000
2,000
5,000

Oct 24
Nov 16
Strategies with Zinc Sulfate
(Timing, Rate, etc)

1. Spring – Phytotoxicity concerns
   Zn Oxide or Neutral Zn?
2. All Season – Low rate
   Efficiency?
3. Fall or Dormant
   Early fall better than late fall
   Use rate that doesn’t defoliate quickly
Nursery Trees in Pots - Application to Dormant Shoots

$^{68}\text{ZnSO}_4$ vs. $^{68}\text{ZnO}$ - % of Applied Taken Up

<table>
<thead>
<tr>
<th>Treatment</th>
<th>% Uptake</th>
<th>% Uptake</th>
</tr>
</thead>
<tbody>
<tr>
<td>UTC</td>
<td>0</td>
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</tr>
<tr>
<td>$^{68}\text{ZnSO}_4$</td>
<td>3</td>
<td>2</td>
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<tr>
<td>$^{68}\text{ZnO}$</td>
<td>1</td>
<td>1</td>
</tr>
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</table>

UTC: Unknown

% Uptake: January

% Uptake: November

UTC: Unknown

$^{68}\text{ZnSO}_4$: November

$^{68}\text{ZnO}$: January

Note: Values with different letters (a, b, c, d) indicate statistically significant differences.
Surface Area of a Peach Shoot

Leaves = 1405 cm²
Shoot = 38 (1/40)
Buds = 7.6 (1/200)
Scars = 0.7 (1/2000)
Strategies with Zinc Sulfate
(Timing, Rate, etc)

1. Spring – Phytotoxicity concerns
   Zn Oxide or Neutral Zn?
2. All Season – Low rate
   Efficiency?
3. Fall or Dormant
   Early fall better than late fall
   Use rate that doesn’t defoliate quickly
   Fall better than dormant