Soil Basics Zinc Foliar Products on Almond Tissue Nutrition

Research Summary for

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October 2019

Background

The United States produced 80% of the almonds in the world in 2017, with California as the sole producer in the nation[2]. In 2018, 1.09 million acres of almonds were harvested – which produced 2.28 billion pounds of almonds[1]. At $5.47 billion[1], almonds are the third most valuable commodity produced in California behind dairy products and grapes[2]. Kern county and Fresno county lead the state in almond production. 2017 was a record-breaking year for almond production in California, with a 9.84% increase in total value from the previous year[2].

Almonds grow best in areas with warm, dry summers where temperatures are moderate. Trees are often planted 16‘ x 22‘ and begin commercial production 2-3 years after planting. The trees are dormant from November through January and generally bloom in February or March. The nut begins growth in April and will continue development through June. Once the hull of the almond cracks and dries, the trees are mechanically shaken. Farmers typically leave almonds on the ground for a week or two to harden before sweeping them into rows and collecting them.

As a high-value crop, almonds can be input-intensive. Drip irrigation, fungicide and insecticide applications, and specialty fertilizers are common. Nutrient requirements for almonds include 250 lbs of nitrogen, 150 lbs of potassium, 2-5 lbs of boron, and 10-15 lbs of zinc per acre each year.

Zinc is one of the most common foliar nutrient sprays applied to almonds in California, and can be sprayed at leaf fall, during the dormant season, and during spring. Zinc is a regulatory, functional, or structural component of many cofactors and enzymes that drive metabolic reactions and is essential for optimal plant growth. It is taken up in the Zn^{2+} or the $ZnOH^{+}$ forms. It is thought to be only slightly phloem-mobile, with ZIP proteins enabling loading. It travels as a complex with organic acids or proteins when being remobilized to other regions of the plant. The objective of this study was to quantify and compare nutrient assimilation resulting from foliar applications of Soil Basics’ Oasis and Helix Zinc products.

[1] NASS. 2018. State Agriculture Overview: California. USDA, Washington DC.
[2]California Agricultural Production Statistics. 2018. California Agricultural Statistics Review 2018 Report. CDFA, California.

Materials and Methods

The trial was established in a twelve-year-old block of Nonpariel almonds (Monterey and Fritz pollinators excluded) in Sanger, California. The soil series is Ramona loam, a fertile soil with stream terrace and alluvial fan parent material. The trial area was drip-irrigated and maintained with fertility and pesticides according to grower standard practice, with the exception of foliar micronutrient applications.

Plots consisted of one tree, with one-tree and one-row buffers. Treatments were replicated four times, arranged in a randomized complete block design (table 1).

Treatment Details		
Treatment	*Product Details*	*Product Rate*
Untreated	n/a	n/a
Helix Zinc	6.5% zinc, 3.8% sulfur	1 qt/ac
Oasis Zinc	6.5% zinc, 3.5% sulfur	1 qt/ac
Oasis Zinc + N-Phase	Oasis Zn: 6.5% zinc, 3.5% sulfur N-Phase: 18.38% nitrogen	Oasis Zn: 1 qt/ac N-Phase: 2 pt/ac

Table 1. Treatment products, nutrient percentage, and rate.

The treatments were foliar applied two weeks post-bloom, on April 1 (figure 1). A Stihl mistblower backpack sprayer was used to apply products at 150 gal/ac (figure 2).

Figure 1. Trees at time of application.

Figure 2. Sprayer used to apply trial treatments.

Tissue samples were taken just prior to application and 2, 4, 7, and 14 days post-application. Each treatment sample was composed of at least 50 leaves from each plot. Leaves were acid washed: rinsed with distilled water, soaked in 0.5% solution of phosphorus-free detergent for five minutes, rinsed with distilled water, soaked in 0.1 molar HCl acid solution for five minutes, and soaked in distilled water. Leaves were then analyzed for nutrient content by a commercial laboratory.

Results and Discussion

Throughout the sampling period, the range of tested zinc values in untreated plots remained between 36 and 48 ppm (figure 3). These levels are considered adequate, falling within the university-suggested sufficiency range. Untreated tree zinc content was fairly constant with the exception of a slight peak on day 4. Prior to application, Helix Zinc plots had nearly 10ppm less zinc than the other treatment plots.

After application, zinc accumulation followed a logarithmic curve for all tested products. Leaf absorption was seen in all treatment plots by day 2. Oasis Zinc and Helix Zinc plots continued increasing in zinc content through day 7, while the maximum leaf zinc content in Oasis Zinc + N-Phase was observed on day 4. Slight declines in treatment zinc content were evident by 14 days after application, though values were still greater than untreated.

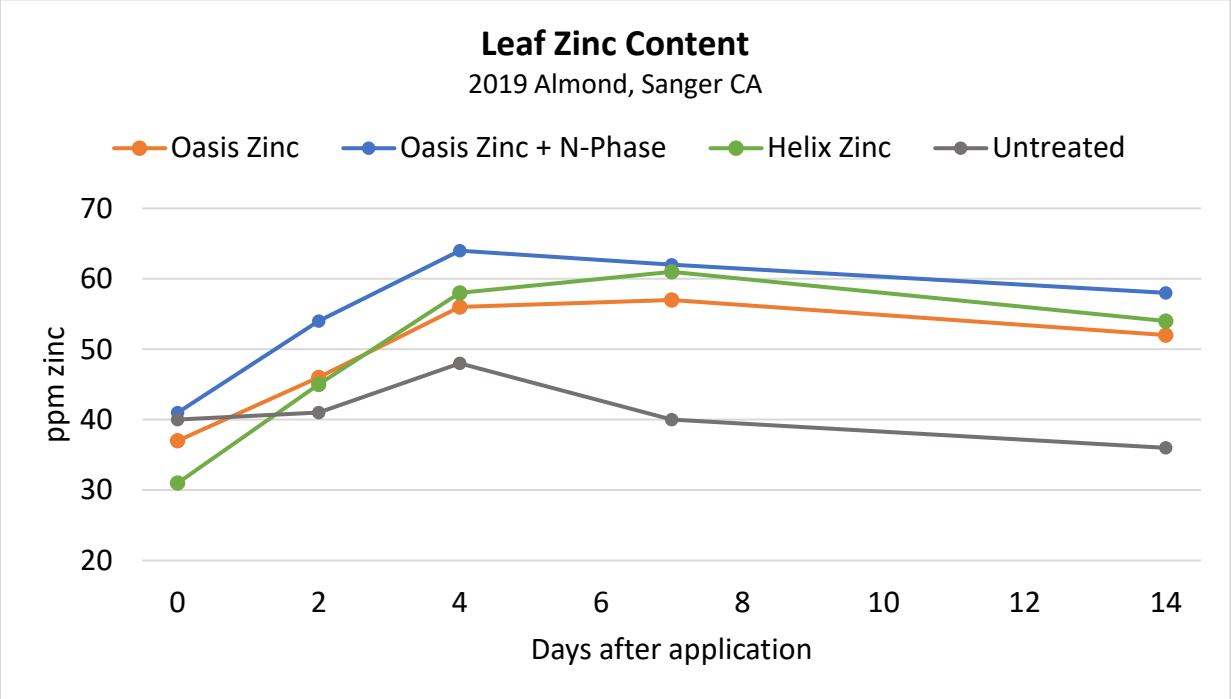

Figure 3. Parts per million zinc in leaves pre-application and 2, 4, 7, and 14 days post-application for each of the products and untreated.

Comparing relative to pre-application values, Helix Zinc was the top performing micronutrient fertilizer (figure 4). By day 7, tissue zinc content had nearly doubled. Oasis Zinc and Oasis Zinc + N-Phase were quite similar. N-Phase may have slightly improved efficacy shortly after application, as evident 2 and 4 days after treatment spray.

Comparing each sampling date as a stand-alone value, Oasis Zinc + N-Phase produced the highest zinc contents. Helix Zinc was intermediate, and Oasis Zinc trailed. All treatments clearly improved tissue zinc concentrations relative to untreated (figure 5).

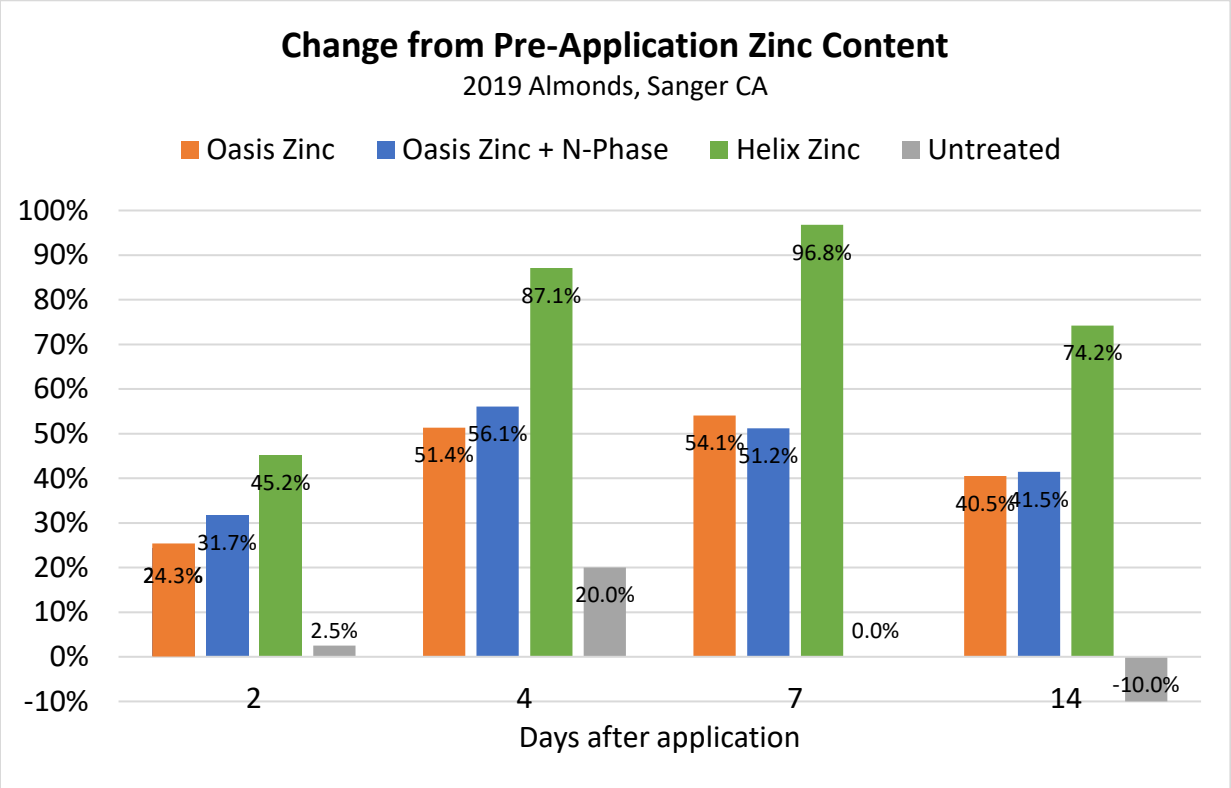

Figure 4. Percent increase or decrease in leaf zinc content for each product relative to the pre-application value at 2, 4, 7, and 14 days post-application.

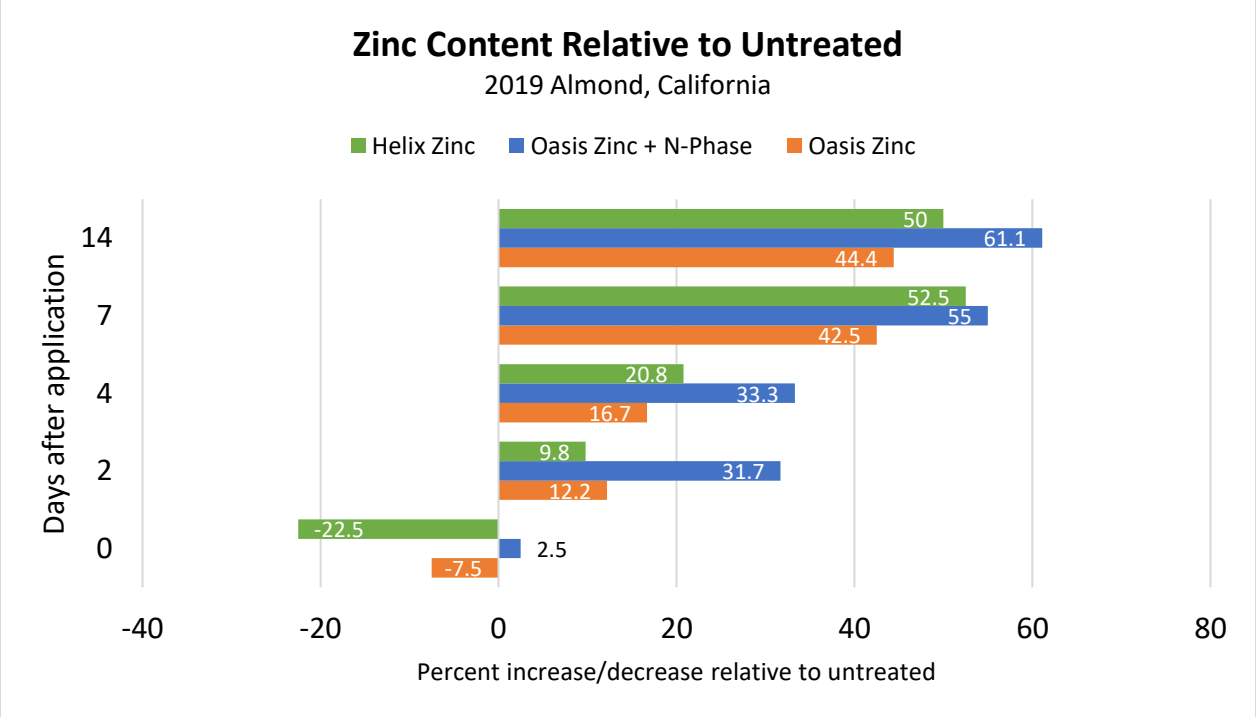

Figure 5. Percent increase or decrease in leaf zinc content for each product relative to untreated pre-application, 2, 4, 7, and 14 days post-application.

Conclusions

Oasis Zinc + N-Phase resulted in the highest zinc content recorded in the study (4 days after application) but had the highest pre-application zinc concentration as well. The addition of N-Phase improved efficacy of Oasis Zinc, particularly 2 and 4 days after application. Helix Zinc could arguably be considered the top performer in total zinc assimilation, increasing 95% relative to its pre-application value by day 7.

Other nutrient levels were similar between treatments (appendix). Nitrogen content was not clearly influenced by N-Phase.

Appendix: Tissue nutrient analyses

Pre-application

	Oasis Zinc	*Oasis Zinc + N-Phase*	*Helix Zinc*	*Untreated*
N (%)	3.91	4.14	4.07	4.09
P (%)	0.6	0.66	0.66	0.59
K (%)	2.21	2.11	1.9	1.87
Ca (%)	1.24	1.26	1.24	1.21
Mg (%)	0.38	0.37	0.37	0.36
Zn (ppm)	37	41	31	40
Mn (ppm)	130	128	145	149
Fe (ppm)	59	52	49	53
Cu (ppm)	9	9	9	9
B (ppm)	40	42	42	39

2 days post-application

	Oasis Zinc	*Oasis Zinc + N-Phase*	*Helix Zinc*	*Untreated*
N (%)	4.01	4.08	4.05	3.96
P (%)	0.55	0.62	0.61	0.56
K (%)	2.15	2.16	1.83	1.8
Ca (%)	1.33	1.36	1.29	1.24
Mg (%)	0.39	0.39	0.36	0.36
Zn (ppm)	46	54	45	41
Mn (ppm)	131	138	142	155
Fe (ppm)	48	52	48	51
Cu (ppm)	9	9	8	9
B (ppm)	36	41	39	38

4 days post-application

	Oasis Zinc	*Oasis Zinc + N-Phase*	*Helix Zinc*	*Untreated*
N (%)	4.11	4.24	4.27	4.2
P (%)	0.57	0.6	0.62	0.55
K (%)	2.22	2.06	2.03	1.86
Ca (%)	1.49	1.46	1.43	1.33
Mg (%)	0.44	0.44	0.41	0.38
Zn (ppm)	56	64	58	48
Mn (ppm)	147	146	179	156
Fe (ppm)	61	55	53	53
Cu (ppm)	11	11	11	11
B (ppm)	43	44	44	42

7 days post-application

	Oasis Zinc	*Oasis Zinc + N-Phase*	*Helix Zinc*	*Untreated*
N (%)	3.97	3.99	4.09	3.94
P (%)	0.51	0.55	0.54	0.52
K (%)	2.51	2.4	2.05	2.1
Ca (%)	1.5	1.51	1.38	1.5
Mg (%)	0.45	0.45	0.42	0.44
Zn (ppm)	57	62	61	40
Mn (ppm)	151	150	161	174
Fe (ppm)	62	55	64	57
Cu (ppm)	10	10	10	10
B (ppm)	43	46	46	43

14 days post-application

	Oasis Zinc	*Oasis Zinc + N-Phase*	*Helix Zinc*	*Untreated*
N (%)	3.67	3.78	3.83	3.75
Zn (ppm)	52	58	54	36