Calcium Foliar Products on Apple Tissue Nutrition

Research Summary for

Julie Sannar
Soil Basics Corporation

Prepared by

Megan Townsend
Crop Matters
January 2018

Background and Objective

The United States is the second largest producer of apples worldwide, and Washington state by far leads the nation in apple production. About 6 of every 10 apples consumed in the United States were grown in Washington. 2016 state yield was 132.9 million 40-pound boxes, and 2017 was forecasted to result in 130.9 million boxes. More than 175,000 acres of the state are developed apple orchards, and they contribute well over $1 billion to the state's economy.

Calcium is a constituent of plant cell walls and is crucial in their structural rigidity. Calcium also plays a role in membrane permeability and function. Cytosolic calcium ions relay messages, and calcium can also serve a counter-cation. Calcium deficiencies can cause physiological disorders in harvested plant organs, primarily due to the breakdown of cell wall and membrane integrity. Bitterpit in apples is one of the most economically-significant problems growers face. Accordingly, calcium is the most common foliar nutrient spray applied to tree fruit in Washington state. Growers will typically apply calcium products ten to twenty times at 1 to 2 week intervals before harvest. The objective of this study was to quantify and compare nutrient assimilation and movement resulting from foliar applications of Soil Basics' Oasis Calcium and several competitive products.

Materials and Methods

The study was placed within a 10-acre block of V-trellised, non-bearing, second-year conventional Fuji apples in Wenatchee, Washington (figure 1). Four treatments were replicated four times each, with a replicate consisting of three consecutive trees (table 1). The experiment was arranged in a randomized complete block design with three trees as buffers between each plot. Rates of the liquid products were designed to apply equivalent amounts of active ingredient.

Treatment	Manufacturer	Product Calcium Content	Product Rate
Untreated	N/A	N/A	N/A
Oasis Calcium	Soil Basics	6%	2 qt/100 gal
ProCal	NutriCal	8%	1.5 qt/100 gal
Calcium Chloride	several	32%	4 lb/100 gal

Table 1. Treatment products, manufacturer, calcium percentage, and rate.

The treatments were applied June 16, 2017. A backpack sprayer with a single Teejet stainless steel flat fan 8003 nozzle was used to apply products, and the solution was sprayed to runoff on the lower foliage, up to the second supporting wire at 48 inches.

Tissue samples were taken 3, 5, 7, and 14 days post-application. Within each treatment, two samples were analyzed: a sample of the lower treated leaves (30-40" from the ground) and a sample of the upper leaves (67-85" from the ground). Each treatment sample was composed of at least 75 leaves taken 6-8 inches from shoot tips. Samples were taken to a commercial laboratory for nutrient analysis.

Figure 1. Orchard where calcium foliar products trial placed.

Results and Discussion

Like the zinc products tested in the companion study, the calcium products evaluated did not result in dramatic increases in treated lower foliage. The ranges of calcium concentrations were small, falling between 0.60% and 1.02%. Product application increased calcium levels no more than 35%.

Calcium chloride was the only product that generated increased calcium levels in lower leaves relative to the untreated lower leaves at every sampling date (figure 2). Calcium chloride application also resulted in the greatest calcium content concentration of any treatment, experienced at the final sampling date. Oasis Calcium followed a similar pattern of leaf calcium concentration over time as calcium chloride: an increase in concentration (relative to untreated) at day three, a sharp decrease at day five, and an increase between days five through fourteen. Meanwhile, ProCal-treated foliage and untreated foliage steadily increased at all sampling dates.

Calcium chloride and Oasis Calcium achieved marked increases in calcium levels relative to untreated in lower leaves at day three, but Oasis Calcium did not appear effective thereafter. Sampling soon after application would best capture tissue nutrition differences as a result of Oasis Calcium application. ProCal was less effective than the other products, with generally lower calcium concentrations. By day fourteen, only calcium chloride yielded appreciably higher calcium content, while the other products had values almost equivalent to untreated.

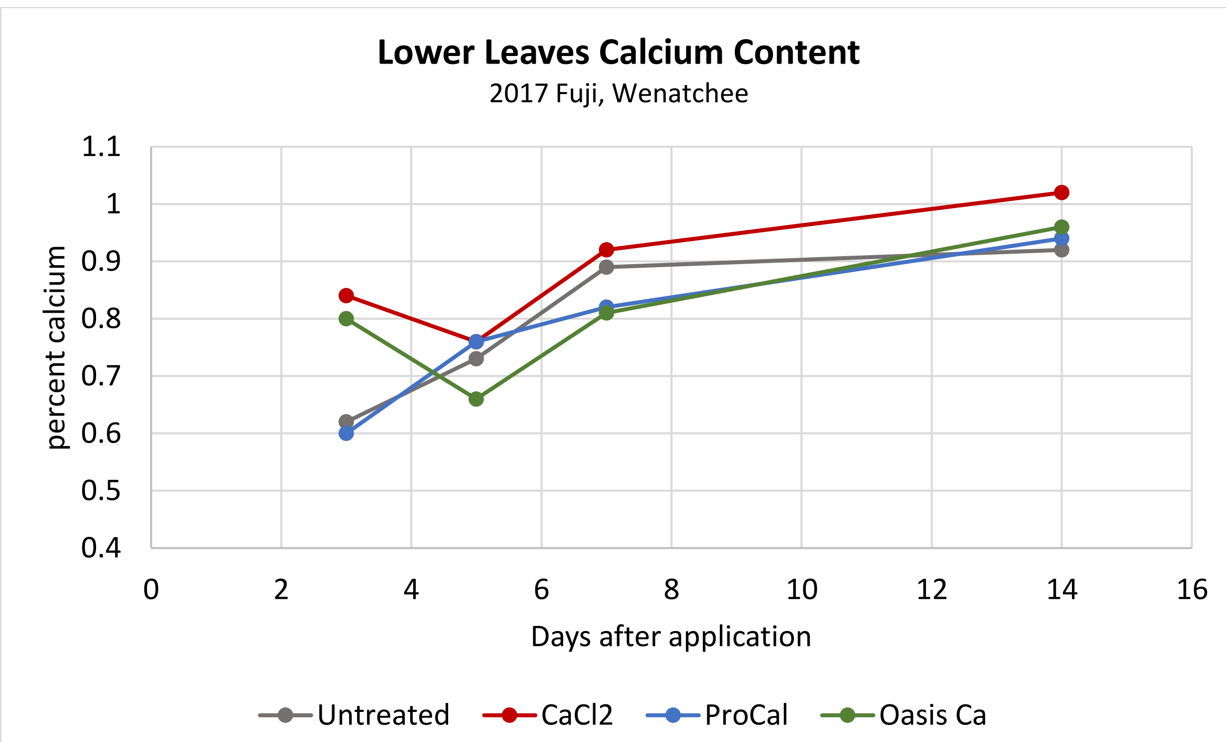

Figure 2. Parts per million calcium in lower treated leaves at 3, 5, 7, and 14 days post-application for each of the treatments.

All treated and untreated samples followed similar trends in upper leaves calcium concentration (figure 3). Calcium concentration increased over time, but did not increase considerably relative to untreated leaves. The greatest disparity was observed in ProCal-treated foliage. While a marginal increase in calcium concentration was experienced at the first sampling date, foliage exhibited lower calcium levels than all other treatments at all subsequent sampling dates. Based on this data set, no movement of calcium was observed due to application of any product.

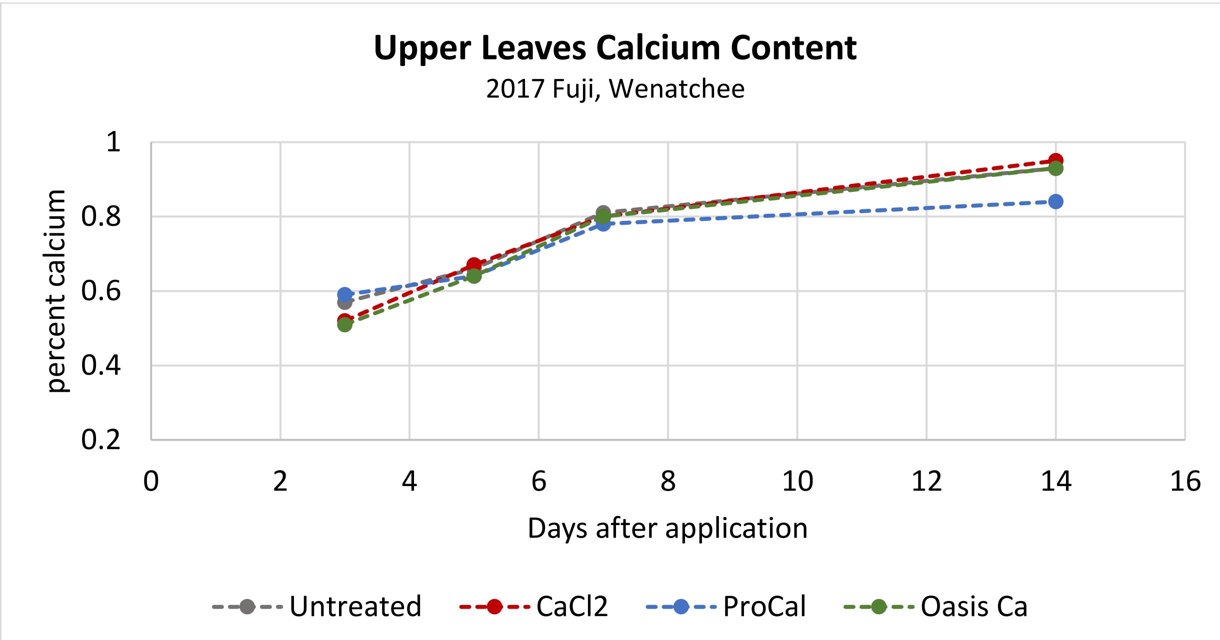

Figure 3. Parts per million calcium in upper unsprayed leaves at 3, 5, 7, and 14 days post-application for each of the treatments.

Considering grower costs, calcium chloride costs a grower about $32.00/50 pounds, ProCal costs a grower $29.40/gallon, NutriCal costs $28.00/gal, and Oasis Calcium costs $38.50/gal. After three days, the price per calcium ppm increase (lower treated leaves relative to untreated) equates to $0.01/acre per ppm for calcium chloride and $0.10/acre per ppm for Oasis Calcium. Calcium chloride is the most economical and was effective in this study. However, calcium chloride can damage foliage with its high chloride content, resulting in leaf burn.

Largely, the observed calcium concentrations were at the low end of the acceptable range for apple leaves. Values above 1.0% are considered optimum, and only one sample met this benchmark during the study.

Three days after application, calcium chloride and Oasis Calcium led to 35% and 29% increases, respectively, in the lower treated leaves. However, the remainder of the sampling times out to fourteen days post-treatment did not reveal consistent calcium increases relative to untreated, with the exception of perhaps calcium chloride. Overall, this study does not provide evidence that product application resulted in sustained increase in calcium concentration. Both treated and untreated leaves experienced only small fluctuations in calcium content over the sampling period after day three. Additionally, without statistical backing, it is possible that these later changes in calcium content relative to untreated could be attributed to variation.

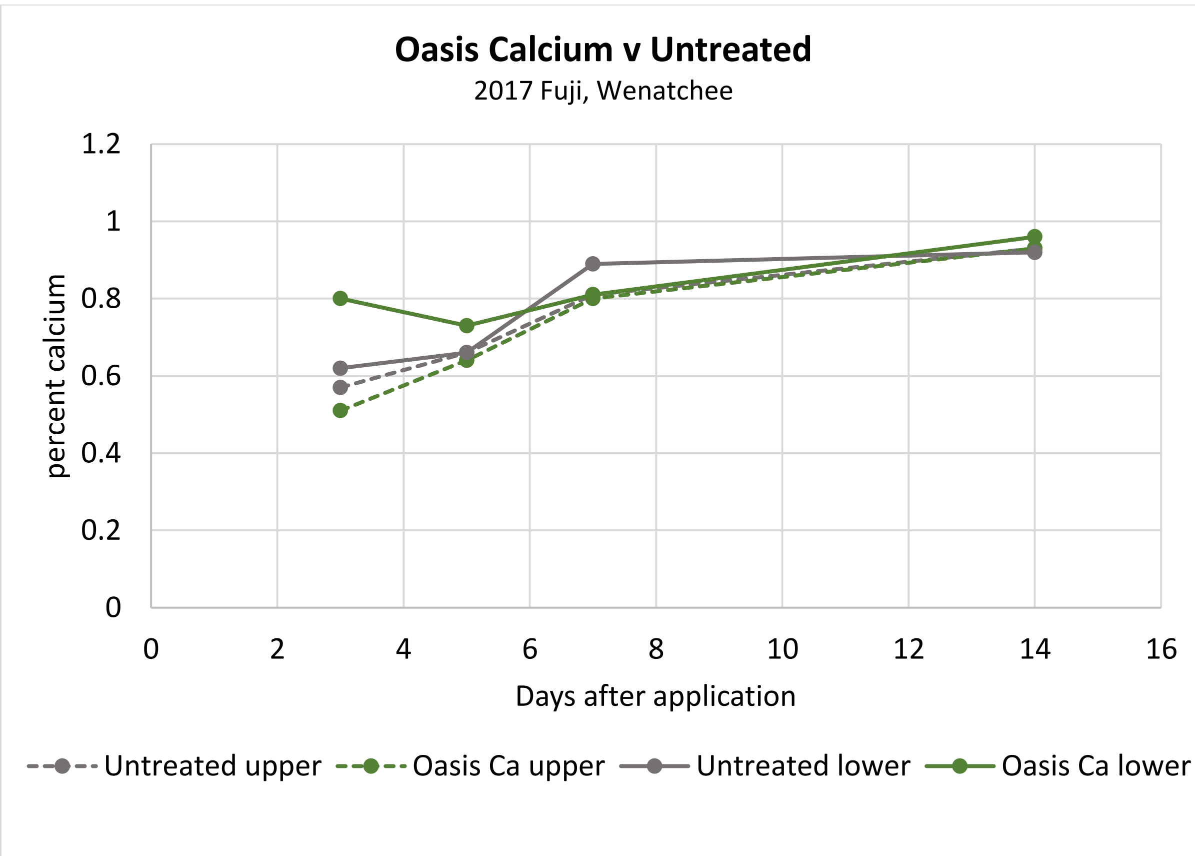

Figure 4. Parts per million calcium in lower and upper Oasis Calcium and untreated leaves at 3, 5, 7, and 14 days post-application.

Appendix: Tissue nutrient analyses

3 days post-application

Lower leaves				
	Untreated	*Oasis Calcium*	*ProCal*	*$CaCl_2$*
N (%)	2.75	2.89	2.78	2.83
P (%)	0.29	0.36	0.27	0.29
K (K)	2.51	3.13	2.44	2.52
S (%)	0.17	0.21	0.16	0.17
Ca (%)	0.62	0.8	0.6	0.84
Mg (%)	0.22	0.27	0.21	0.24
B (ppm)	8	10	9	8
Zn (ppm)	31	21	23	30
Mn (ppm)	56	62	51	64
Cu (ppm)	8	10	7	9
Fe (ppm)	322	359	308	459
Na (%)	0.01	0.02	0.01	0.01
Upper leaves				
	Untreated	*Oasis Calcium*	*ProCal*	*$CaCl_2$*
N (%)	2.57	2.56	2.48	2.46
P (%)	0.28	0.26	0.27	0.25
K (K)	2.33	2.22	2.33	2.17
S (%)	0.16	0.15	0.15	0.15
Ca (%)	0.57	0.51	0.59	0.52
Mg (%)	0.2	0.2	0.21	0.19
B (ppm)	8	7	8	7
Zn (ppm)	19	24	26	10
Mn (ppm)	48	44	52	45
Cu (ppm)	8	8	7	6
Fe (ppm)	223	207	213	214
Na (%)	0.01	0.01	0.01	0.01

5 days post-application

Lower leaves				
	Untreated	*Oasis Calcium*	*ProCal*	*$CaCl_2$*
N (%)	2.77	2.95	2.75	2.71
P (%)	0.27	0.27	0.28	0.26
K (%)	2.5	2.5	2.74	2.49
S (%)	0.15	0.17	0.16	0.14
Ca (%)	0.66	0.73	0.76	0.76
Mg (%)	0.24	0.27	0.26	0.24
B (ppm)	19	21	26	22
Zn (ppm)	16	17	17	16
Mn (ppm)	54	58	55	60
Cu (ppm)	8	8	8	7
Fe (ppm)	370	332	278	427
Na (%)	0.01	0.02	0.02	0.02
Upper leaves				
	Untreated	*Oasis Calcium*	*ProCal*	*$CaCl_2$*
N (%)	2.6	2.55	2.5	2.45
P (%)	0.25	0.26	0.25	0.25
K (%)	2.36	2.33	2.34	2.4
S (%)	0.14	0.13	0.13	0.14
Ca (%)	0.66	0.64	0.64	0.67
Mg (%)	0.24	0.23	0.23	0.23
B (ppm)	18	19	18	19
Zn (ppm)	14	14	14	13
Mn (ppm)	52	50	54	51
Cu (ppm)	7	7	6	6
Fe (ppm)	335	348	315	276
Na (%)	0.01	0.01	0.01	0.01

7 days post-application

Lower leaves				
	Untreated	*Oasis Calcium*	*ProCal*	*$CaCl_2$*
N (%)	2.77	2.74	2.74	2.69
P (%)	0.29	0.27	0.27	0.27
K (%)	3.02	2.66	2.76	2.72
S (%)	0.18	0.17	0.16	0.17
Ca (%)	0.89	0.81	0.82	0.92
Mg (%)	0.29	0.3	0.27	0.28
B (ppm)	23	22	23	22
Zn (ppm)	18	17	17	17
Mn (ppm)	72	63	57	60
Cu (ppm)	8	8	8	7
Fe (ppm)	654	662	686	521
Na (%)	0.02	0.02	0.03	0.02
Upper leaves				
	Untreated	*Oasis Calcium*	*ProCal*	*$CaCl_2$*
N (%)	2.65	2.58	2.47	2.68
P (%)	0.27	0.25	0.25	0.27
K (%)	2.63	2.71	2.63	2.61
S (%)	0.16	0.15	0.14	0.16
Ca (%)	0.81	0.8	0.78	0.8
Mg (%)	0.27	0.25	0.24	0.25
B (ppm)	19	20	19	20
Zn (ppm)	17	14	14	17
Mn (ppm)	62	54	54	56
Cu (ppm)	7	7	7	7
Fe (ppm)	562	344	395	358
Na (%)	0.01	0.01	0.01	0.01

14 days post-application

Lower leaves				
	Untreated	*Oasis Calcium*	*ProCal*	*$CaCl_2$*
N (%)	2.55	2.68	2.77	2.66
P (%)	0.28	0.26	0.28	0.27
K (%)	2.82	2.6	2.72	2.72
S (%)	0.15	0.16	0.16	0.17
Ca (%)	0.92	0.96	0.94	1.02
Mg (%)	0.33	0.34	0.33	0.32
B (ppm)	22	24	24	22
Zn (ppm)	16	15	17	16
Mn (ppm)	63	62	62	62
Cu (ppm)	8	7	8	8
Fe (ppm)	478	542	600	585
Na (%)	0.01	0.01	0.01	0.01
Upper leaves				
	Untreated	*Oasis Calcium*	*ProCal*	*$CaCl_2$*
N (%)	2.76	2.67	2.71	2.83
P (%)	0.27	0.23	0.23	0.26
K (%)	2.59	2.66	2.49	2.62
S (%)	0.17	0.16	0.15	0.17
Ca (%)	0.93	0.93	0.84	0.95
Mg (%)	0.31	0.33	0.3	0.35
B (ppm)	19	8	7	11
Zn (ppm)	15	14	14	15
Mn (ppm)	66	24	31	28
Cu (ppm)	8	7	7	7
Fe (ppm)	456	126	184	126
Na (%)	0.01	0.01	0.01	0.01