Applying calcium fertilizers through drip-tape to increase cantaloupe storage quality

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Introduction

Shipments of cantaloupe from CA to the east coast of the USA and Canada are very common and take about 4 days. To reduce fuel costs, growers and shippers are considering switching to coast-to-coast train transportation, which takes at least 5 days. Melons exported from California to Asian markets must maintain fruit firmness for several weeks during ocean transit (Johnstone et al., 2008). Soft fruit is the most common reason for shipment rejection by distributors. A truckload of cantaloupe rejected by east coast receivers will cost growers at least $25,000. For example, one of the Del Monte Fresh Produce farms, Wenden Farm, had as many as 20 rejections in one day ($500,000 loss) due to soft fruit in 2007.

Dipping cantaloupe fruits into calcium solution after harvest increases fruit firmness and shelf life (Lester and Grusak, 1999, 2001). However, this is not suitable for California because we pack and ship melons directly from field harvest, making a post-harvest dip impractical (Lester and Grusak, 2004). In 2001 and 2002, Dr. Gene Lester of USDA-ARS at Weslaco, TX received a grant from the California Melon Research Board (no 58-6204-1-005) to study the effect of foliar application of chelated calcium on fruit quality. He found that at least four repeated foliar applications were required to increase melon fruit firmness and storage quality and that the effect is more significant on honeydew than on cantaloupe (Lester and Grusak, 2004). The continued rapid rise in fuel prices makes it very costly to apply foliar calcium fertilizers four times a season. Four ground rig applications also represent significant field traffic that can compact the soil and decrease yield.

In 2005 and 2006, Tim Hartz (2008a) of University of California, Davis conducted a study supplying cantaloupe plants with surface drip irrigation. Cantaloupe was fertigated with calcium nitrate, calcium thiosulfate, and calcium chloride 20-30 days before harvest (about 10-20 days after flowering). None of the fertigation treatments affected fruit firmness.

To effectively enhance fruit firmness, calcium fertilizers have to be provided to cantaloupe plants starting at the flowering stage. Cantaloupe fruits accumulate 80% of final calcium in the first 20 days after flowering (Bernadac et al., 1996). A non-replicated experiment in central Arizona by the chief grower of Del Monte Fresh Produce, Scott Tollefson, showed the type of calcium fertilizer has significant effect on fruit quality. When applied every 4-5 days from flowering until first harvest, common calcium fertilizers such as calcium nitrate and calcium chloride did not improve cantaloupe fruit firmness significantly. However, EDTA-chelated calcium fertilizer such as Agri-cal significantly increased cantaloupe fruit firmness.

Most soils in CA and AZ have both high calcium and high magnesium and sodium contents (Lester, 2002). As population grows, a greater portion of the higher quality water is distributed for residential water use. Growers in CA now have to use lower quality water with high sodium and low calcium. The net result is a low Ca/Mg and Ca/Na ratios, which means a high ratio of sodium ions in the irrigation water. Irrigating with water that has a high sodium ratio leads to soft fruit with reduced shelf life. Applying calcium fertilizer in the irrigation water can increase the Ca/Mg and Ca/Na ratios, effectively reducing the sodium ratio and increasing melon firmness (Navarro et al., 2000; Carvajal et al., 2000; Kaya et al., 2003).

Procedures

The study was conducted at the University of California West Side Research and Extension Center. On 23 Jun, cantaloupe, cv. 'Oro Rico', seeds were sown in a Panoche clay loam. The field was irrigated with sub-surface drip (Netafim, 0.16 gph emitters at 12 inch spacing), 2 lines per bed 20" off center on beds spaced 80" center-to-center. The tape was at a depth of 10" to 12". Each plot consisted of one bed, 150 ft long. The experimental design was a randomized complete block with four replications.

Treatments were as follows:

1) **Cal Source** 0.902 gal/acre/application (1 lb Ca/acre/ap). Contains 9%N, 3% K, 9% Ca, 15% Zn & B, amino acid chelates. Wt./ga.=12.3 lbs.
2) **Gold-N-Grow** 1.77 gal/acre/application (1 lb Ca/acre/ap). Contains 11%N, 5% CA, 2% Mg, 6% B. Wt./ga is 11.29 lbs.
3) **Calcium Thiosulfate** 11.98 gal/acre/application (7.5 lb Ca/acre/application) Contains 0%N, 10% S, 6% CA. Used higher rate as per standard practice. Wt/ga. is 10.43 lbs.. Cost is $314/ton or `$1.64/ga.
4) **Super Cal** (Same formulation as AgriCal). 0.904 gal/acre/application{contains 0%N, 2.20 lbs/acre/ap.). Chelated with a sugar-based proprietary blend.
5) **Untreated control**.

Calcium-containing fertilizers were injected into a manifold with "FlexFlow®" Blue-White Industries electric metering pumps over 45 minutes to one hour. The water ran for 45 minutes to one hour after the calcium injection to flush out any residual. All Calcium materials were injected on 23, 30 Jul, 5, 13, 21 and 28 Aug. At the time of the first application, there were 1 to 3 flowers per plant. The day after each injection, UN 32 was injected at a level necessary to ensure that each treatment received equal amounts of nitrogen.

At daybreak on 9 Sep, 20 medium sized fruit (12's) were selected from each plot and placed into two cartons. The ten fruit in the first carton were taken into the laboratory. A central 1.5 in disc was cut from each fruit and a stand-mounted penetrometer used to determine flesh firmness at five points per disc. A digital refractometer was used to determine soluble solids from a composite three core sample taken from each fruit. The second carton of ten fruit from each plot (replicate) was placed in cold storage at 5.6 C (42.0^{o}F) and stored for 7 days. On 15 Sep, these fruit were removed from cold storage to acclimate to the same 20 C temperature of carton sampled on 9 Sep. The next morning fruit were tested for flesh firmness and brix. To determine yield, a 50 ft-long area in each plot was measured and fruit at ¾ slip were counted and sizes were determined on 9, 14 and 18 Sep.

5. Results.

Yield, e.g. total cartons per acre, was generally similar for all treatments. There were a few instances of statistically significant differences for size categories, but none that showed a trend. The first pick yielded over 600 total cartons per acre for each treatment, somewhat less for the second, and in the 300's for the third harvest (Tables 1-4). Brix was around 8.5% for all treatments.

Melon firmness did decrease slightly (1-8%) during cold storage, but no calcium supplement had a measurable effect (Table 7). Possible reasons include:

1) The overall reduction in firmness while in storage was too small to show treatment differences.
2) In this experiment, all fruit were harvested early, transported less than a mile, and placed in the cooler before noon. Commercially harvested fruit may remain in the field throughout the heat of the day and require several miles of transport before cold storage.
3) None of the supplements tested has an effect on melon firmness.
4) Fertigation with calcium in any form does not affect melon firmness.
5) Cultural or environmental conditions in this specific experiment were not favorable.
6) Any affect that the calicium application may have had was too small for detection under the conditions of this study.

Our data do not support the application of calcium supplements through drip irrigation to enhance melon storage or yield. However, many growers do fertigate with calcium. We also see reports from California and Arizona of unpublished studies that show improved storage when melons are fertigated with calcium. We welcome any suggestions or information that might shed new light on improving melon storage and shipping.

Table 1. Production levels for each size category at ¾ to full slip and cracked or rotten fruit on 9 Sep. at UC West Side Research Extension Center 2009.

Treatment	cartons per acre							fruit per acre	
	6	9	12	15	18	23	total	rot	cracked
Cal Source	21.8	145.1	302.0	100.1	25.4	7.1	601.6	228.6	32.7
Gold-N-Grow	38.1	134.2	269.4	141.5	32.7	0.0	615.9	98.0	32.7
Calcium Thiosulfate	21.8	127.0	280.3	126.3	32.7	14.2	602.1	98.0	0.0
Super Cal	5.4	145.1	285.7	163.3	67.1	11.4	678.0	195.9	32.7
Untreated	32.7	166.9	280.3	91.4	29.0	7.1	607.4	65.3	0.0
LSD	NS*	NS	NS	66.7	NS	12.1	NS	NS	NS
CV (%)	139.61	43.63	26.83	34.77	95.72	98.67	19.40	124.48	278.89

* NS = not significant at P=0.05

Table 2. Cartons of fruit per acre for each size category at ¾ to full slip and cracked or rotten fruit on 14 Sep at UC West Side Research Extension Center 2009.

Treatment	cartons per acre							fruit per acre	
	6	9	12	15	18	23	total	cracked	rot
Cal Source	5.4	108.8	179.6	172.0	63.5	18.5	547.8	195.9	98.0
Gold-N-Grow	16.3	112.5	244.9	169.8	74.4	12.8	630.7	98.0	0.0
Calcium Thiosulfate	0.0	123.4	239.5	167.6	76.2	22.7	629.3	195.9	0.0
Super Cal	10.9	101.6	236.7	132.8	25.4	5.7	513.1	32.7	32.7
Untreated	5.4	116.1	190.5	158.9	103.44	15.6	590.0	65.3	0.0
LSD	NS	NS	NS	NS	39.6	NS	NS	NS	95.5
CV (%)	178.81	45.65	27.87	33.94	37.48	87.22	16.96	112.49	237.17

* NS = not significant at P=0.05

Table 4. Cartons of fruit per acre for each size category at ¾ to full slip and cracked or rotten fruit on 18 Sep at UC West Side Research Extension Center 2009.

Treatment	cartons per acre							fruit per acre	
	6	9	12	15	18	23	total	cracked	rot
Cal Source	0.0	47.2	108.8	130.6	61.7	14.2	362.5	65.3	0.0
Gold-N-Grow	0.0	21.8	98.0	100.1	103.47	9.9	333.2	98.0	0.0
Calcium Thiosulfate	0.0	32.7	106.1	121.9	74.4	18.5	353.5	0.0	0.0
Super Cal	10.9	25.4	95.2	104.5	105.2	15.65	356.8	32.7	98.0
Untreated	0.0	36.3	103.4	104.5	72.6	11.4	328.1	0.0	0.0
LSD	8.660	NS*	NS	NS	51.9	NS	NS	NS	NS
CV (%)	258.20	63.51	44.68	36.63	40.36	92.40	24.17	256.40	447.21

* NS = not significant at P=0.05

Table 5. Yield per acre by fruit size, total yield, culls and immature fruit by 18 Sep at UC West Side Research Extension Center 2009.

Treatment	cartons per acre							fruit per acre	
	6	9	12	15	18	23	total	Culls	Immature
Cal Source	27.2	301.1	590.5	402.7	150.6	39.8	1511.9	620.4	1044.9
Gold-N-Grow	54.4	268.5	612.3	411.4	210.4	22.7	1579.8	326.5	1175.5
Calcium Thiosulfate	21.8	283.0	625.9	415.8	183.2	55.4	1585.0	293.9	1600.0
Super Cal	27.2	272.1	617.7	400.6	197.7	32.7	1548.0	457.2	1110.2
Untreated	38.1	319.3	574.2	354.8	205.0	34.1	1525.4	130.6	1306.1
LSD	NS*	NS	NS	NS	NS	NS	NS	451.1	NS
CV (%)	103.19	24.35	11.12	18.99	26.15	54.70	6.07	80.06	39.09

* NS = not significant at P=0.05

Table 6. Melon Calcium Trial – Brix

Treatment	9 Sep	16 Sep	Average
Cal Source	8.382	9.095	8.739
Gold-N-Grow	8.512	9.163	8.838
Calcium Thiosulfate	8.445	8.723	8.584
Super Cal	8.067	8.680	8.374
Untreated	8.267	8.967	8.617
LSD	NS*	NS	NS
CV (%)	6.98	4.68	4.80

* NS = not significant at P=0.05

Table 7. Effect of calcium (Ca) fertigation on cantaloupe firmness for melons harvested 9 Sept 2009 at the West Side Research and Extension Center, Five Points, CA.

	Lbs force		Newtons	
Treatment	Before	After	Before	After
Cal Source	2.93	2.89	13.03	12.85
Gold-N-Grow	2.81	2.65	12.50	11.79
Ca Thiosulfate	2.59	2.27	11.53	10.10
Super Cal	2.69	2.38	11.97	10.60
Untreated	2.91	2.75	12.95	12.24