Yield and Postharvest Quality of Cantaloupe Melons as Affected by Calcium Foliar Applications

Jorge M Fonseca
The University of Arizona – Yuma Agricultural Center

Abstract

The effect of pre-harvest foliar application of calcium on yield and postharvest quality of whole and fresh-cut cantaloupe melons was investigated. The calcium product (Nutrical®) was applied five times before harvest to a melon field at 2 quarts/acre with a volume of 50 gallons/acre. The supplemented calcium increased by over 10% the weight of melons and increased external firmness at harvest but soluble solids was lower in treated melons than in the control. After 21 days of storage at 40 – 45 °F however, there was not difference in quality factors. Melons were processed in cubes and packaged in plastic lidded containers. The overall quality of calcium treated cubes was better after 5 and 10 days of storage. Juice leakage was also higher in the control than in the treated fruits after 5 days. After 10 days the L values were lower in the control than in the treated fruits indicating that the tissue was darker in the control, which was an indicative of more water soaked tissue. In further trials conducted the following Spring the results obtained at harvest showed differences only in weight of melons that underwent water stress. The overall results in different experiments in the Yuma area indicate that application of foliar calcium can increase yield of melon crops, notably, when the plants undergo environmental stress.*

Introduction

Arizona ranks second among the states in production of cantaloupe melons. An interesting fact is that the cantaloupes from Arizona are the first USA melons that come to the local market during early Spring and the last melons in late Fall. The temperatures at harvest are commonly lower (Fall) and higher (Spring) than most other regions, which result in additional stress. The soil where melon is produced in Arizona appears to have good content of calcium, however, due to the low mobility of calcium in the plant some growers still consider the addition of calcium important. It was found important to determine to what extend calcium application benefit yield and quality of melons.

Minimally processed vegetables have become an important and expanding segment in the food industry. Several studies have shown that calcium application during pre- and postharvest terms may increase the quality of fresh cuts. We are not aware of any work in the low desert of Arizona and California addressing the influence of calcium applications on quality of fresh cuts.

In an early work in 2003, inconsistent results were obtained with application of calcium products sprayed during the last three weeks before harvest. Those preliminary results showed no effect in yield but several postharvest variables were positively affected. This prompted us to investigate further a calcium product as both a yield increaser and a postharvest shelf-life enhancer. Thus, it was the object of this work to evaluate the effect of calcium applied five times before harvest to a melon field on yield and different quality parameters of intact and fresh-cut melons.

This is a part of the University of Arizona College of Agriculture and Life Sciences 2005 Vegetable Report, index at http://cals.arizona.edu/pubs/crops/az1382/

Materials and Methods

The study was conducted on Cantaloupe melons cv Gold Express, cultivated at The University of Arizona- Yuma Agricultural Center, in Yuma, Arizona.

An initial trial was planted on August 24th, 2004. The experiment was allocated in a ½ acre, using 12 beds of 600 ft. Each replicate consisted of 3 beds of 300 ft. The product (Nutrical®) was applied five times (at 2 quarts/acre). The temperature during all five applications was 70-85 °F. The application volume was 50 gallons/acre.

The melons from four replicates were harvested on November 10, 2004. Randomly chosen melons were fully matured, of uniform size and with no visible injury, insect damage or disease. After 48 hours, a group of melons were cut in cubes of 1-2 sq. inches (2.5-5.0 sq. cm) and placed in low-density polyethylene lidded containers. The temperature during processing was 40-45 °F. The plastic containers contained approximately 250 g ± 25 (approximately 1 lb) of processed melons.

During the Spring 2005 two trials were also conducted, following similar cultivation practices to those described for the Fall trial and with four applications of calcium. Harvest was conducted during the first two weeks of July, 2005. In one trial, the last irrigation was done two weeks before harvest, to impose stress to the plants. Results from postharvest evaluations were not available at the time this report was done.

Evaluations

At harvest, a 10 ft bed was selected randomly per replicate from within the middle of the plots and the following parameters were evaluated:

1) Number of ripe fruits. This was the amount of fruits that were ripe at the moment of the first harvest.
2) Number of non-ripe fruits. This was the amount of fruits that were still at an immature stage at the moment of the first harvest.
3) External Firmness. Measured with a penetrometer with lbf units, and conducted by taking three measurements approximately 1 inch below the equator, after carefully removing a thin section of the peel. Firmness was considered at the first indication of tissue collapse. This indicates the external consistency of the melon.
4) Internal Firmness. Was evaluated by cutting the peel and rind of the melon one inch below the equator and taking three measurements. Firmness was considered when the penetrometer was introduced 1 cm into the pulp, as indicated by the tip of the penetrometer. This indicated the consistency of the pulp.
5) Soluble Solids (°Brix). Five fruits per replicate were measured with a refractometer. Three samples were taken per fruit right below equator.
6) Weight of ripe fruits. All the ripe fruits in the 10 ft plot were each weighted and an average per fruit was calculated.
7) Weight of non-ripe fruits. All the non-ripe fruits in the 10 ft plot were each weighted and an average per fruit was calculated.
8) Diameter of ripe fruits. Each ripe fruit was evaluated for diameter with a caliper. Reporting units were cms. Based on diameter, commercial sizing can be calculated per treatment.
9) Calcium content. The stem base and surrounding peel was removed and the underneath tissue, rind and epidermis, was considered for calcium analysis. Four composite samples (of five fruits each) were delivered to Agri-Trend Laboratories in Yuma, AZ, for calcium analysis. This is reported in content percentage.

Intact melons were stored for 21 days, after which the fruits were evaluated for:

1) Overall visual quality. This was rated using a hedonic 0-9 scale where 9 was excellent, 7 was good, 5 was fair, 3 was poor and 1 was unusable. Salability point in this scale was 6.
2) Soluble Solids (°Brix). Five fruits per replicate were measured with a refractometer. Three samples were taken per fruit right below equator.
3) External Firmness. Measured with a penetrometer with lbf units, and conducted by taking three measurements approximately 1 inch below the equator, after carefully removing a thin section of the peel. Firmness was considered at the first indication of tissue collapse. This indicates the external consistency of the melon.
4) Internal Firmness. Was evaluated cutting the peel and rind of the melon one inch below the equator and taking three measurements. Firmness was considered when the penetrometer was introduced 1 cm into the pulp, as indicated by the tip of the penetrometer. This indicates the consistency of the pulp.
5) Soft Decay. This was an evaluation of the number of fruits (from out of ten) that showed soft tissue combined with dark peel.

Fresh-cut melons were evaluated after 5 and 10 days of storage. Evaluations parameters were:

1) Overall visual quality was rated using a hedonic 0-9 scale where 9 was excellent, 7 was good, 5 was fair, 3 was poor and 1 was unusable. Salability point in this scale was 6.
2) Juice leakage. Measured in terms of ml of juice accumulated at the bottom of package per 100g of fresh pulp.
3) Color was measured using a C-400 Minolta Chroma meter. The L*, a*, b* scale was used, with L* denoting lightness, where 0 is black and 100 is white, a* green (negative) to red (positive), b* blue (negative) to yellow (positive).

For subjective parameters the criteria used was based on the opinion of three different judges, and the evaluations were carried by one person.

The experimental design was a randomized complete block with 4 replicates. This design was used for the placement of treatments in the field. Data were subjected to analysis of variance (ANOVA) at $p \leq 0.05$ to determine statistical significance. Mean comparisons were conducted using Fisher's Protected LSD Method at $p \leq 0.05$ (SAS Institute, Cary, NC).

Results and Discussion

In the trial conducted during Fall the application of calcium evidenced a significant increase of yield, averaging an increase of over 10% per fruit. Average fruit weight of the calcium treatment was 952.5g while the control treatment was 844.9g. The treated fruit showed higher external firmness (22.32 lbf) than the control (16.30 lbf), however, treated fruits also showed inferior amount of soluble solids (7.07) as compared to the control (8.75). The two treatments were similar in other parameters of evaluations such as diameter, internal firmness, number of ripe and non-ripe fruits and calcium content in the epidermis of the stem base (Table 1).

Interestingly, we found no difference in calcium content between treatments. In several reports it has been shown that calcium is hardly translocated from nearby leaves to the fruits. It is more likely that the calcium supplied by Nutrical® had the effect within the tissue sprayed, and that included the fruit. This can only be demonstrated if future studies include treatments of Nutrical® when the fruits are covered.

Another factor to consider is that the fruits of this study were under severe stress during the last two weeks before harvest, as low temperatures (below 50 °F) were intermittent at night time and water was not well provided during this period of time. Calcium supplementation to the plants may be more critical in times when surface and cell walls need more stability to tolerate the adverse effects of the environment. The soluble solids were below 9, the recommended °Brix for cantaloupes, at harvest, which revealed that the quality of the melons was not the most desirable.

After 21 days of storage the quality of the two treatments were similar. Factors evaluated at this point such as soluble solids content, external firmness, internal firmness and soft decay incidence all showed similar levels for both treatments (Table 2). The observed difference in soluble solids at harvest disappeared after 21 days of storage. This is likely a result of cantaloupe, as any climacteric fruit, having an abrupt change of ethylene production after harvest and accelerating ripening during storage. The nutritional sources of the control and of the Nutrical® treatment needed for the conversion of carbon assimilates and breakdown of long carbohydrates into simple sugars was likely the same for both treatments, since despite the difference at harvest all melons reached the same level of "sweetness" after three weeks. Cantaloupes reach the retailers commonly in one to three weeks, thus, the negative effect observed at harvest may not be a concern at the retail level.

Overall quality of fresh-cut melon treated with calcium was better after 5 and 10 days of storage. Juice leakage was higher in the control than in treated product after 5 days of storage. The control had lower L* values than Nutrical®, indicating that the control had more dark tissue than calcium treated product (Table 3). The results with fresh-cut melons revealed a positive effect of calcium on the pulp of the cantaloupes. Since we obtained no difference in calcium content in the stem base, it would be interesting to find out whether calcium is producing an effect in the pulp by an indirect way (e.g., lowering stress in the surface of the melon during growth). Microfiltration through the rind is another possibility, but this has only been observed when calcium was applied during postharvest handling in solutions at lower temperature than that of the melons.

The results from the most recent trials conducted during Spring 2005 showed no differences when water was supplied regularly (Table 4). In the second trial, in which water was withdrawn during the last two weeks the weight of the treated fruits was higher than the control (Table 5). These results seem to add to the hypothesis that foliar calcium in Yuma melon crops only makes a difference in yield when the plants are under stress. This will be examined further, since it could be of help for growers under certain conditions. Moreover, it will be important to determine whether fewer applications of calcium can yield similar results in crops under stress.

In summary, the results from this study indicated that the yield and quality of cantaloupes melons grown in Arizona during the Fall, under similar conditions as those that prevailed in this experiment (environmental stress during the last several weeks before harvest), can be enhanced with multiple calcium applications. The increase in yield was over 10% and the enhancement of quality was better observed in terms of firmness at harvest and reduction of juice leakage and of water-soaked tissue of fresh-cut products. A negative point observed at harvest, of lower soluble solids, was not observed after three weeks of storage. Further trials conducted during the following Spring showed no differences in any of the parameters of evaluation except for weight of fruits in the trial with melons subjected to water stress. The latter could indicate that foliar applications of calcium are only critical for crops that undergo stress during the last stages of growth which needs to be confirmed. It would be important to determine whether fewer applications can yield the same benefits obtained in this study.

Acknowledgments

The assistance of Ramiro Galvez was critical for the completion of this work.

Table 1: Yield and quality of cantaloupe melons at harvest as affected by NUTRICAL applied five times before harvest.

Treatment	Control	NUTRICAL	LSD ($_{0.50}$)
°Brix	8.75 a	7.07 b	1.57
External firmness	16.30 a	22.32 b	3.15
Internal firmness ns	4.52	4.56	
Number ripe fruits (10 ft) ns	11.5	8.5	
Diameter (cm) ns	11.75	11.83	
Weight (g)	844.9 a	952.5 b	95.86
Number non-ripe fruits ns	7.5	6.5	
Weight non-ripe fruits ns	593.8	478.5	
Calcium content in stem base epidermis(%) ns	0.192	0.175	

Values followed by different letters in the same row are significantly different ($P<0.05$); *ns* indicates no significant differences among values in the same row.

Table 2: Postharvest quality of cantaloupe melons as affected by NUTRICAL after 21 days of storage.

Treatment	Control	NUTRICAL	LSD ($_{0.50}$)
°Brix ns	9.22	9.20	
External firmness ns	23.38	23.62	
Internal firmness ns	8.16	9.52	
Soft decay (% fruits) ns	38.9	30.2	
Overall quality ns	6.9	7.2	

Values followed by different letters in the same row are significantly different ($P<0.05$); *ns* indicates no significant differences among values in the same row.

Table 3: Quality of fresh-cut melons as affected by NUTRICAL, after 5 and 10 days of storage.

Treatment	Control	NUTRICAL	LSD ($_{0.50}$)
Juice leakage at 5^{th} d (ml/100g)	0.41 a	0.08 b	0.27
Overall Quality at 5^{th} d	7.68 a	8.03 b	0.31
Juice leakage (ml/100g) ns	0.58	0.71	
Overall quality	6.50 a	7.29 b	0.71
Minolta L*	60.36 a	62.80 b	2.06
Minolta a* ns	8.73	8.84	
Minolta b* ns	31.75	32.68	

Values followed by different letters in the same row are significantly different ($P<0.05$); *ns* indicates no significant differences among values in the same row. Evaluation was conducted after 10 days of evaluation unless other wise indicated

Table 4: Yield and quality of cantaloupe melons at harvest as affected by NUTRICAL applied four times before harvest, during the Spring 2005.

Treatment		Control	NUTRICAL	LSD ($_{0.50}$)
°Brix	ns	9.34	9.75	
Internal firmness	ns	3.82	3.27	
Number ripe fruits (15 ft)	ns	35.20	33.20	
Diameter (cm)	ns	13.78	13.85	
Weight (g)	ns	1524.03	1511.78	
Number non-ripe fruits	ns	4.4	4.0	

Values followed by different letters in the same row are significantly different ($P<0.05$); *ns* indicates no significant differences among values in the same row.

Table 5: Yield and quality of cantaloupe melons at harvest as affected by NUTRICAL applied four times before harvest, during the Spring 2005. The melons underwent water stress during the last stages of growth.

Treatment		Control	NUTRICAL	LSD ($_{0.50}$)
°Brix	ns	9.40	8.58	
Internal firmness	ns	3.24	3.79	
Number ripe fruits (15 ft)	ns	24.50	28.60	
Diameter (cm)	ns	13.70	13.64	
Weight (g)		1457.86 a	1519.17 b	60.90
Number non-ripe fruits	ns	2.0	2.0	

Values followed by different letters in the same row are significantly different ($P<0.05$); *ns* indicates no significant differences among values in the same row.