Examining the interaction of ethylene and temperature on the postharvest quality of 'Hass' avocado

M. L. Arpaia, J. Sievert, K. Fjeld, S. Collin and M. Toyota
Dept. of Botany and Plant Sciences, University of California, Riverside

We continued the work initiated in 2004-2005 which is focused on two aspects of ethylene treatment of 'Hass' avocado in the postharvest environment. In the previous year, using fruit from a single location, we examined a matrix of postharvest ethylene treatments either prior to or after low-temperature storage. In this funding cycle, we selected specific treatments from the previous year for additional study. In 2005-2006 we obtained fruit from 3 growers in Ventura County: Moorpark, Saticoy and Fillmore. We divided our tests into two sections: one examining the impact of preharvest ethylene treatment on subsequent storage potential and the other examining the response of the fruit to ethylene following storage. Table 1 presents the dry matter and harvest dates of the fruit used in these tests. Fruit harvested on January 23, April 24 and July 17 were used in the pre-storage ethylene tests and fruit harvested on March 20, June 5 and August 24 were used in the post-storage ethylene test. The fruit for all tests were harvested in the morning and then transported to the F. G. Mitchell Postharvest laboratory at the UC Kearney Ag Center in Parlier. The fruit were held overnight at 54 F, then sorted and assigned to the various treatments the following day.

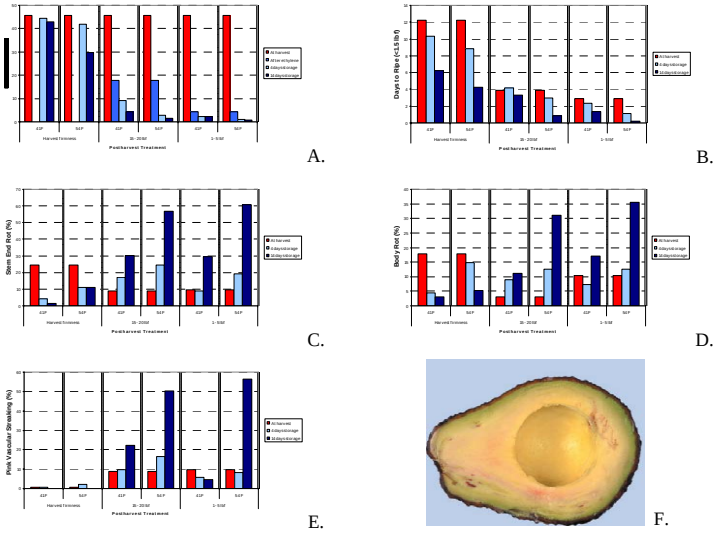

Figure 1. Means presented are the averages across the 3 grower lots and 3 harvests. A) The average flesh firmness (lbf, measured with an 8 mm tip) following ethylene treatment to varying flesh firmness and storage at either 41 or 54 F. B) The average days to flesh firmness of < 1.5 lbf following ethylene pretreatment and storage. C) The overall incidence of stem end rot following ripening at 68 F after various ethylene treatments and storage. D) The overall incidence of body rots following ripening at 68 F after various ethylene treatment and storage. E) The overall incidence of pink vascular staining following ripening at 68 F after various ethylene treatments and storage. F) An example of pink vascular and flesh staining (Photo from the IAQ Manual).

Pre-storage ethylene treatments. A common practice in the California industry is to pre-ripen fruit at the packinghouse prior to shipment although the impact of such practices is on fruit quality is poorly understood. We examined the impact of ripening fruit to different stages of ripeness (indicated by firmness), followed by cooling and storage. We examined the following variables: stage of ripeness, storage duration and storage temperature. We used three stages of fruit ripeness: harvest firmness (approximately 45 lbf), 15-20 lbf (approximately the time of "button popping") and near to eating ripeness (1-5 lbf). We held fruit in storage following treatment for 0, 4 or 14 days at either 54 F or 41 F (95% RH). Following storage the fruit were held at 68 F (90-95 % RH) until ripe. The fruit were then evaluated for the presence/absence and severity of postharvest decay and various physiological disorders.

We observed the following:

- ❖ Once fruit softening is triggered with ethylene softening continues even in storage (Figure 1A). More softening occurred at the higher storage temperature (54 F).
- ❖ The impact of storage duration on the rate of ripening is shown in Figure 1B and most evident on the rate of ripening in the "harvest firmness" fruit. The average "days to ripe" drops from 12.25 days at harvest to 6.21 days at 41 F or 4.27 days at 54 F after 14 days storage.
- ❖ The incidence of stem end rot dramatically increased to >50% following 14 days storage at both 41 F and 54 F for both the "15 – 20 lbf" and "1 – 5 lbf" treatments (Figure 1C).
- ❖ The same general trend was observed in relation to the overall incidence of body rots with the highest incidence occurring following storage of the ethylene treated fruit at 54 F (Figure 1D).
- ❖ Most of the body and stem end rots that we observed were graded as "slight", since the incidence of moderate/severe body rots were less than 3%.
- ❖ Figure 1E reports the incidence of pink vascular streaking in the ripe fruit. Our observations during this research study are similar to our experience in 2004-2005. This relative rare disorder (Figure 1F) was most prevalent in ethylene treated fruit that were held at 54 F for 14 days.

Post-storage ethylene treatments. It is an increasingly common practice to ship unripe fruit to a central distribution point and then ethylene treat fruit prior to marketing. Depending on market conditions as well as the source of the fruit, the fruit can vary in age from just a few days to several weeks old. In examining this we stored fruit for 0, 7, 14 or 28 days at 41 F. Following storage the fruit were treated with ~50 ppm ethylene for 0, 24 or 48 hours. The fruit were held at 68 F until ripe (< 1.5 lbf) and then evaluated.

We observed the following:

- ❖ Figure 2A presents the average flesh firmness of the fruit following storage and upon removal from the ethylene treatment . Note that in the "0 days" 24-hour treatment virtually no softening occurs. However, approximately one-third of the firmness is lost following a 48 hours ethylene treatment. As fruit storage progresses, the amount of fruit softening following ethylene treatment increases, indicating that the fruit becomes "more receptive" to the ethylene treatment during storage. A similar phenomenon has been reported for 'Bartlett' pears.
- ❖ Figure 2B presents the average days to eating ripeness. When comparing the first bar of each group note the dramatic reduction in the days to ripe which occurs solely due to storage duration. The other item to notice is that the benefit of ethylene decreases with increasing storage time.
- ❖ Figures 2C and 2D present the data pertaining to the overall incidence of stem end rot and body rots, respectively. If you compare the first bar in each grouping you will note that the overall incidence of stem end rots and body rots decline with storage up to 14 days however increases between 14 days and 28 days. We have observed this same trend in our previous research with 'Hass' avocado. We believe that the higher incidence of decay following ripening of the non-ethylene-treated fruit at 0 days is due to the protracted time for the fruit to ripen. The severity of decay during this project was very slight.
- ❖ We did not observe any marked amounts of pink vascular streaking in these studies. This suggests that the occurrence of this disorder is directly linked to the prior treatment of ethylene in combination with storage, particularly at intermediate temperatures (41-54 F).

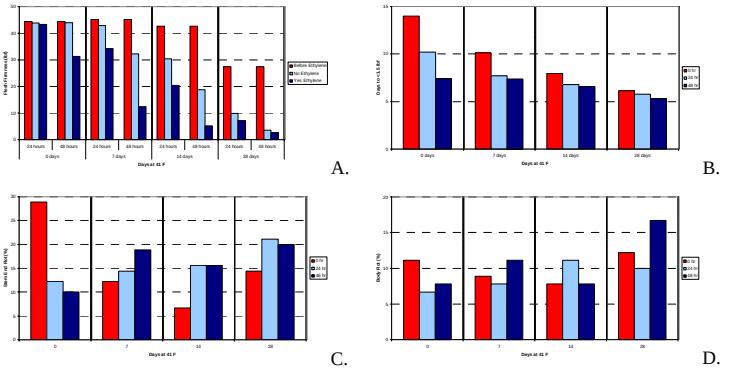

Figure 2. Means presented are the averages across the 3 grower lots and 3 harvests (harvest 3, 2 growers only). A) The average flesh firmness (lbf, measured with an 8 mm tip) following 41 F storage and either a 0, 24 or 48 hour 50-ppm ethylene treatment. B) The average days to flesh firmness of < 1.5 lbf following ripening at 68 F after storage and ethylene treatment. C) The overall incidence of stem end rot following ripening at 68 F after storage and ethylene treatment. D) The overall incidence of body rots following ripening at 68 F after storage and ethylene treatment.