Project Concluding: Summary Report

Improving Postharvest Quality of Stored Lemons

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The goal of this research was to reduce economic losses to the lemon industry due to postharvest decay and to increase postharvest quality and storage life of lemons using the inexpensive naturally-occurring compounds spermidine, spermine and salicylic acid applied as a dip or drench after washing or in the storage wax. If successful, the research would identify a less-expensive material that is as effective or more effective than GA_3 combined with 2,4-D.

On June 13th, 2005, we harvested more than 1,650 fruit from each of three lemon orchards in Fillmore, California. We were able to improve the statistical power of the study by harvesting fruit from three separate lemon orchards in Fillmore with each orchard having three replications of each treatment. The orchards were, respectively: 10-year-old Limco 880 Lisbon lemon on Macrophylla rootstock, 20-year-old Limco 880 Lisbon lemon (rootstock unknown), and 12-year-old Limco 880 Lisbon lemon on Macrophylla rootstock. Only light to dark green fruit with intact green buttons were collected for the research.

Immediately after harvest, the fruit were transported to the Lindcove REC and held overnight under refrigeration at 55 to 60 ºF. On June 14th, 2005, each grower replicate was washed and tunnel dried without heat and with low HPW. Fruit were evaluated for quality, and acceptable fruit were randomized into treatments by replications, by orchard, and labeled accordingly.

Fruit were treated by submersion in the following solutions: (1) spermidine (100 $mg \cdot L^{-1}$) for 2 minutes; (2) spermidine (100 $mg \cdot L^{-1}$) for 6 minutes; (3) spermine (100 $mg \cdot L^{-1}$) for 2 minutes; (4) spermine (100 $mg \cdot L^{-1}$) for 6 minutes; and (5) salicylic acid (400 $mg \cdot L^{-1}$) for 6 minutes. All fruit were waxed [Stay Fresh 705 with Imazilil® (IMZ), Freshguard 2000 ppm]. For waxing, replications by treatment were combined to have sufficient fruit to mimic commercial waxing. At this time the control fruit were treated with (1) wax (Stay Fresh 705) with Imazilil® (IMZ, Freshguard 2000 ppm) and (2) wax + IMZ + 2,4-D (225 ppm) + GA_3 (50 ppm).

After treatment, approximately 60 fruit per treatment per replication per grower were stored at 54 ºF at the Kearney Agricultural Center. All lemons were placed into storage on June 14th. The first set of fruit were removed from storage and evaluated on July 13th with subsequent evaluations made every 2 weeks until bronzing (approximately 16 weeks). The following data were collected: peel color, fruit weight, puncture resistance, button condition, and weight loss. Final analysis will include: peel color, puncture resistance, % juice, total soluble solids, % acidity, weight loss, external fruit conditions (decay, visual quality, pitting, button condition), and internal membrane staining.

No treatment delayed fruit color development as effectively as the GA_3 + 2,4-D treatment. With regard to button quality, the data are very variable, but in general treating fruit with GA_3 + 2,4-D delayed the change in button color from green to straw to black. Overall button loss was low with all treatments being equally effective in keeping the buttons attached.

There were no significant effects due to treatment on fruit firmness through week 6. However, by week 8, fruit treated with GA_3 + 2,4-D were significantly firmer than fruit in all other treatments (P < 0.0001).

Applying differential polyamine treatments to lemons at the UC Lindcove Research and Extension Center.

The fresh weight of fruit treated for 2 or 6 minutes with spermidine or 2 minutes with spermine was not significantly different from fruit treated with GA_3 + 2,4-D at the end of 8 weeks, with fruit in these treatments losing only 6% of their fresh weight. Only fruit treated with GA_3 + 2,4-D were stored beyond 8 weeks, which resulted in a significant loss in fruit weight (P = 0.0097).

After 8 weeks of storage, fruit in all treatments had equal soluble solids (SS) concentrations, total acidity (TA) and soluble solids to acidity ratios. Fruit treated with spermine for 2 or 6 minutes or salicylic acid for 6 minutes had a percent juice content equal to that of fruit treated with GA_3 + 2,4-D at the end of 8 weeks, whereas fruit treated with spermidine for 2 minutes or 6 minutes or wax only had a lower percent juice content than the GA_3 + 2,4-D control by the 8^{th} week of storage.

Fruit decay was low through week 6 of storage and was greatest at week 8 with no significant differences among treatments through week 8. Fruit treated with GA_3 + 2,4-D had significantly more decayed fruit at week 10 than all other treatments ($P = 0.0773$) but there were no significant differences in treatment effects on the cumulative number of decayed fruit by week 12.

Peel pitting and membrane staining were present at very low levels in all orchards (membrane staining was most prominent in orchard 1) with all treatments having equal amounts of each disorder.

With exception of delaying color development of the peel and button, fruit treated with spermine for 2 minutes were equal in all quality parameters to fruit treated with GA_3 + 2,4-D. It would be of benefit to determine (1) whether spermine could replace 2,4-D to maintain the quality of the stored lemons or whether the addition of spermine to the GA_3 + 2,4-D treatment would have additive or even a synergistic effect in improving fruit quality of stored lemons. Spermine is inexpensive to use and therefore could be a cost-effective alternative to 2,4-D.