Citrus producers in the California Central Valley are faced with a significant problem due to the presence of bean thrips in navel oranges destined for Australia. Our objective is to confirm effective control of bean thrips with ethyl formate and to thoroughly test the tolerance of navel oranges to effective treatments.

Our initial work showed that concentrations of ethyl formate as low as 0.5% gave 100% control of bean thrips, and we have also shown that this treatment is effective at temperatures as low as 41°F. With collaboration from Sunkist Growers Association, we received navel oranges from late November to the first week of April 2008. Half of the oranges were waxed with either Carnauba, Shellac, or hybrid waxes and the other half were field run and unwaxed. The packed oranges we received were of export quality and were treated with different concentrations of ethyl formate at different temperatures and times to determine their tolerance.

Waxed (Carnauba, Shellac, and Hybrid waxes) and unwaxed oranges were treated in separate jars. CO2 and air were flushed through the jar until the jar atmosphere stabilized at 9% CO2 to simulate the amount of CO2 that would be present in the commercial formulation of ethyl formate (VapormateTM). After treatment, the oranges were checked for possible ethyl formate damage, placed into citrus boxes, and transferred to 41°F for 3 weeks storage. At the time of removal, they were again checked for damage before transfer to a humidified 68°F room for 7 days or more before final evaluation.

There were no differences between the different waxes in regard to ethyl formate tolerance by navel oranges. The only phytotoxicity observed in response to ethyl formate treatment was for unwaxed fruit, suggesting that wax not only protects oranges against pathogens and water loss, but also prevent damage symptom development following ethyl formate fumigation. Wax treated fruit were treated with concentrations up to 2% ethyl formate without injury (at least 2-fold higher than the effective concentration). Free moisture on the oranges during the ethyl formate fumigation did not cause or enhance phytotoxicity by ethyl formate.

In March 2008, a large test was conducted with four strains of navel oranges. The fruit were harvested from the navel orange strain trial at Lindcove. Fruit were treated with 0.5 or 0.75% ethyl formate before or after waxing and packing at the Lindcove Research and Extension Center. Fruit were stored for 3 weeks at 41°F prior to a complete quality evaluation. An additional set of fruit were waxed and packed, stored for 3 weeks and then fumigated with ethyl formate. There was no effect of the treatment on fruit quality, with only very slight peel damage across all the treated and untreated fruit.

We also began working with The Linde Group (formerly BOC Gases) on the mechanisms for commercial use of Vapormate™ and to set up our laboratory for use of Vapormate, as well as assisting them with information as they begin the registration process.
Figure 1. Mortality of bean thrips following ethyl formate fumigation with 0.5% CO2 for 1 hour at 41°F showing little to no damage and no difference between treated and untreated fruit.

Figure 2. Average peel damage score for four strains of navel oranges treated with 0 or 0.5% ethyl formate before or after waxing and before or after 3 weeks of storage at 41°F showing little to no damage and no difference between treated and untreated fruit.

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