CONTROL OF BEAN THRIPS AND LIGHT BROWN APPLE MOTH WITH VAPORMATE™

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Quarantine and biosecurity issues related to the presence of various insects and diseases in citrus fruit and table grapes continue to expand. Citrus pests, including bean thrips (*Caliothrips fasciatus*), have been one of the challenges the citrus industry must overcome when it exports navel oranges overseas, especially to Australia and New Zealand. A systems approach has been adopted that involves special orchard practices and packinghouse procedures, and cutting of fruit from each orchard to be shipped to check for the presence of bean thrips. Occasionally, despite all these efforts, bean thrips are found and the fruit cannot be shipped or loads that pass through the systems approach are found in Australia infested with thrips. These loads may be subjected to methyl bromide fumigation at the expense of the shipper or outright rejected. With the phasing out of methyl bromide, this fumigation will not be possible unless an alternative treatment is found. A reliable, non-damaging treatment is needed to assure control of bean thrips in oranges destined for export.

Native to Australia, light brown apple moth, LBAM (*Epiphyas postvittana*), has been recently found in several counties of California and may be spreading. The larvae feed on a wide range of plants, including fruit crops, broad-leaved weeds, some vegetables and ornamentals. LBAM is a threat to the California agriculture industry. Efforts are underway to either eradicate this new pest or find a treatment to control it on harvested commodities before the latter are exported nationally or internationally.

We have developed an effective treatment with Vapormate™ fumigation that provides complete control of bean thrips and light brown apple moth. Vapormate™ contains 16.7% ethyl formate by weight in liquid carbon dioxide. Ethyl formate is a natural plant volatile and has been widely used as a fumigant for pests associated with dried fruit. Ethyl formate was previously registered in the US for control of insect pests in raisins, but the registration expired in the 1980s. Once Vapormate™ is registered in the US, it could be used as a phytosanitary treatment.

Commercial fumigations of bean thrips and navel oranges were conducted from March through April 2011. A 20 foot marine container (17'8"x7'5"x7'1" inside dimensions) was used for the fumigations. The chamber was loaded with 8 pallets of navel oranges arranged into 2 rows of 4 pallets each for a total of 432 boxes. Navel oranges were infested with bean thrips, and the infested fruit were packed into boxes and randomly placed at different levels within each pallet. The container's refrigeration system was used to circulate the air and maintain the fruit at the treatment temperature of 5°C. After 24 hours, 5.2 kg of Vapormate was introduced into the chamber to achieve 31 mg/L ethyl formate concentration. After the 1 hour commercial fumigation, infested oranges were retrieved and held at 20°C. Mortality evaluation was conducted the following day by cutting thin slices through the orange peel and flesh starting just below the navel. A total of 35,511 thrips were included in the three fumigations and all three fumigations/replicates resulted in 100% mortality.

Multiple experiments were conducted in the laboratory to assess the quality of navel oranges after exposure to 1% Vapormate™ and cold storage. The lab scale forced air fumigation chamber (1038.4L) was used with a total of 6 boxes per fumigation at a slow speed of air circulation. Oranges infested with bean thrips were dispersed throughout the load. Vapormate™ was dispensed until the required amount was achieved, and the 1 hour time for the fumigation began. Ethyl formate concentration was monitored after 10, 30, 45 and 60 minutes during the fumigation. The fruit were transferred to 5°C for 5 weeks storage. After storage, the fruit were transferred to 20°C for 2 weeks for weight loss determination. Peel damage, firmness, titratable acidity (TA), soluble solids content (SSC), decay, and ethyl formate residual concentration were measured. There was no effect of the Vapormate treatment on navel orange parameters used for quality evaluation. Weight loss was similar between treatments. Bean thrips mortality was 100% with 6,928 insects.

Previous tests showed that light brown apple moth adults and larvae were much easier to kill with Vapormate than pupae and eggs. Three and 4-day-old eggs were clearly the most resistant life stages. To test the tolerance of table grapes to EF, one of the highest dose and exposure time treatments that have been demonstrated to be effective against all light brown apple moth life stages, 124 mg/L EF for 4 hours at 15 or 20°C, was used to treat Thompson Seedless and Autumn King seedless table grapes. Twelve packed grape boxes were placed into the forced air fumigation chamber overnight at 15°C or 20°C. 60ml portion cups containing 3-day and 4-day-old eggs of light brown apple moth were placed inside the grape bags in the boxes. A portable ethyl formate analyzer was placed in one of the boxes to monitor the highest concentration of ethyl formate. After fumigation, one box from each treatment, including the control, was used for initial evaluation and the remaining boxes were stored at 0°C for 3 week before final quality evaluation.

For both varieties, Vapormate treatment had no effect on berry firmness, soluble solids, titratable acidity, shatter, or ethanol concentration. No ethyl formate residues were detected in the berries. For 'Autumn King', berry browning was significantly lower in fruit treated with Vapormate at 15°C compared to Vapormate at 20°C. The rachis browning score was similar between control and treated fruit at 20°C, but was higher (slight rachis browning) in the fruit treated with Vapormate at 15°C. The overall score for fruit appearance was worse in the Vapormate treatment at 15°C compared to Vapormate at 20°C. For 'Thompson Seedless' grapes, there was somewhat less berry browning in the Vapormate treated berries, but only a significant difference between the control at 15°C and the Vapormate at 20°C, with less berry browning in the Vapormate treatment at 15°C. The rachis browning score was significantly higher in both Vapormate treatments compared to the control, but were rated as only slight rachis browning.

Navel oranges tolerate the Vapormate treatment required for control of bean thrips very well. Table grape quality was somewhat reduced by Vapormate treatment in some cases. Additional treatments wih Vapormate that have also been demonstrated to control LBAM eggs should be tested.