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SURVIVAL OF ADULT ASIAN CITRUS PSYLLID, *DIAPHORINA CITRI* (HEMIPTERA: PSYLLIDAE), ON HARVESTED CITRUS FRUIT AND LEAVES

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The Asian citrus psyllid, *Diaphorina citri* Kuwayama (Hemiptera: Psyllidae), is an important citrus pest primarily because it vectors bacteria putatively responsible for huanglongbing disease, one of the most serious diseases of citrus worldwide (Halbert & Manjunath 2004). Both the psyllid and pathogen have been introduced into Florida (Bové 2006). The psyllid has spread to other citrus production areas in the USA including Texas (French et al. 2001), where huanglongbing has not been observed although the psyllid is widespread. Pertinent to this report is that the psyllid has been found in California a number of times since 2008 (Halbert et al. 2010) and once in Arizona in backyard citrus trees near Yuma during 2009 (Bech 2009). Permanent establishment of the psyllid has apparently occurred in California but only in the Los Angeles area, and establishment has not yet occurred in Arizona. Preventing establishment of the psyllid in an area being invaded may be achieved through concerted eradication efforts in conjunction with the establishment of large quarantine areas to assist in preventing the spread of the psyllid with harvested fruit trucked to areas where the psyllid has not been found. In fact, adult psyllids have been found with fruit transported after harvest (Halbert et al. 2010). However, no information was available regarding psyllid survival on harvested fruit, which could be valuable in determining if or when fruit from an infested grove might safely be moved after harvest. Because leaves sometimes contaminate bins of fruit during harvest, information on the survival of psyllids on leaves could also be valuable in determining when harvested fruit might be moved. We therefore conducted 2 experiments on survival of adult psyllids on harvested fruit and leaves.

In 1 survival experiment, psyllids were confined to the following: detached mature leaves, detached stems with mature leaves, or detached stems without leaves from 4 citrus cultivars [grapefruit – *Citrus paradisi* Macf. cv. 'Ray Ruby'; sweet orange – *C. sinensis* (L.) Osbeck cv. 'Valencia'; and 2 tangors (*C. reticulata* Blanco × *C. sinensis*) cvs. 'Temple' and 'Murcott']. Fruit were harvested leaving a 30 cm stem of leaves attached to each fruit, after which the fruit was removed. For detached leaves, 4 leaves were clipped from a stem and placed together into a clear plastic, vented 3.78 L container with a screw top lid (Mainstays™ canister, Wal-Mart, Bentonville, Arkansas). Stem samples were also placed individually into containers—each detached stem was 15 cm long with or without 4 attached leaves. After placing the plant material into containers, 30 adult psyllids were introduced into each container. These psyllids were from a colony previously described (Hall et al. 2007). In addition to containers with plant material, psyllids were placed into a container with no plant material. The experiment followed a randomized block design with 4 replications. Infested containers were maintained in an environmental chamber at 25 °C, 75% humidity, and 14 h daily illumination; the number of dead psyllids in each container was counted daily except weekends. A separate set of containers with similar plant samples from each cultivar was used to assess dehydration of the plant material over time. There were 3 replications of each plant material for each cultivar.

In the absence of plant material, moderate numbers of psyllids survived for several d but 100% mortality occurred within 6 d (Fig. 1). Survival of adults on stems without leaves was similar to adult survival in the absence of food. Adults survived longer on detached stems with leaves or on detached leaves. When confined to detached stems with leaves or detached leaves from 'Murcott' or 'Temple' trees, 100% mortality occurred within 8 or 9 d. Adults survived longer on detached stems with leaves, or on detached leaves, from grapefruit or sweet orange trees, with 1 to 4% surviving for 10 d on grapefruit samples and 4 to 14% surviving for 10 d on sweet orange samples. Longer survival of the psyllid on the grapefruit and sweet orange samples was attributed to these plant materials being larger and containing more water than the 'Murcott' and 'Temple' plant materials.

In the second survival experiment, psyllids were confined to fruit with or without an attached stem with mature leaves. For each of the 4 citrus cultivars at harvest time, fruit were collected from trees leaving a 30 cm stem of leaves attached to each fruit, after which either the stem was removed or the stem was trimmed to a 15 cm length leaving 4 leaves. Each fruit with or without a stem of leaves was placed into a container with 30 adult psyllids. In addition to containers with plant material and psyllids, psyllids were introduced into a container with no plant material. The experiment followed a randomized block design with 4 replications. The infested containers were maintained in an environmental chamber as described above and examined to count the number of dead psyllids daily except weekends.

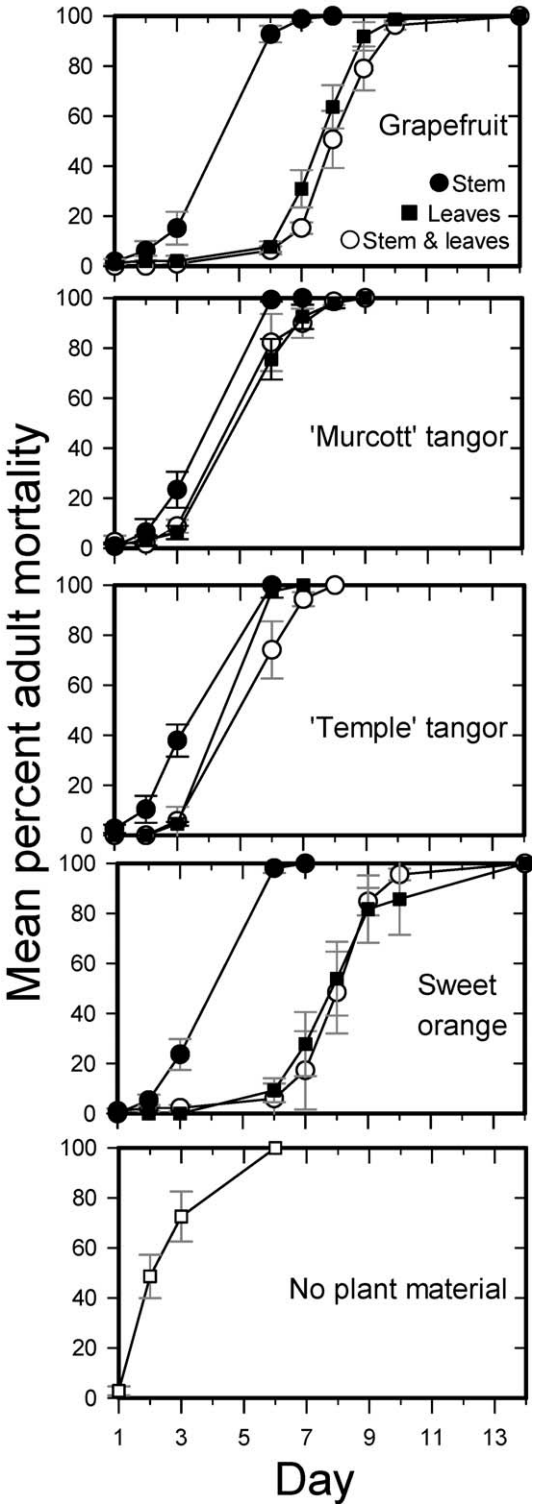

Fig. 1. Mortality of adult Asian citrus psyllid feeding on detached stems with mature leaves, on detached stems without leaves or on detached mature leaves from four citrus cultivars (first experiment).

Survival of adults in the absence of plant material during the second experiment was similar to that in the first experiment (Fig. 2). Adult survival on fruit without a stem of leaves was similar among the four cultivars (10 to 13 d). Survival increased when adults were confined to individual fruit with an attached stem of leaves, although the length of survival differed among the four cultivars. Some adults confined to 'Temple' fruit with a stem of leaves survived for 16 d with 100% mortality occurring within 18 or 19 d. Adults survived longer on grapefruit or 'Murcott' fruit with stems of leaves, with 100% mortality not occurring until around 24-26 d. Survival of adults was longest when they were confined to sweet orange fruit with an attached stem of leaves—30 d elapsed before 100% mortality occurred.

Adults confined to fruit without a stem were often observed in a feeding position on the fruit. When adults were confined to fruit with an attached stem of leaves, the adults were usually observed feeding on the leaves or stem. Comparing the 2 experiments, adults survived longer on stems with leaves when the stem was attached to a fruit than when the stem was detached – it was probable a stem of leaves attached to a fruit dehydrated slower than a detached stem of leaves.

This research gave insight into probable survival rates at 25 °C (75% humidity) of adult *D. citri* contaminating a load of fruit leaving a citrus grove. We found limited information on post-harvest temperatures fruit may be subjected to during transport from a grove: Grierson & Hayward (1958) used a temperature of 24 °C to simulate the temperature of fruit at dumping, and Hinds (1962) reported that the temperature of fruit being trucked in ventilated containers ranged from 27 °C at loading to 21 °C at dumping. Based on published information on the longevity of adult psyllids at different temperatures (Liu & Tsai 2000; Nava et al. 2007), longer survival would generally be expected at cooler temperatures (e.g., 20 °C) than at hotter temperatures (e.g., 32 °C). The temperature within a load of fruit likely varies depending on location within the load, and survival therefore would also depend on psyllid location within the load.

Collectively, the results of this study indicated that shipments of fruit contaminated by adult psyllids would be of concern if the shipment is moved from an area quarantined for psyllids into areas where the psyllid is not known to occur. Psyllids contaminating a load of fruit could survive for 10 d or longer, during which time they might escape into an area not previously infested. This risk would be increased if leaves are present in a load of fruit.

Summary

Prompted by regulatory concerns of Asian citrus psyllid accidentally being transported

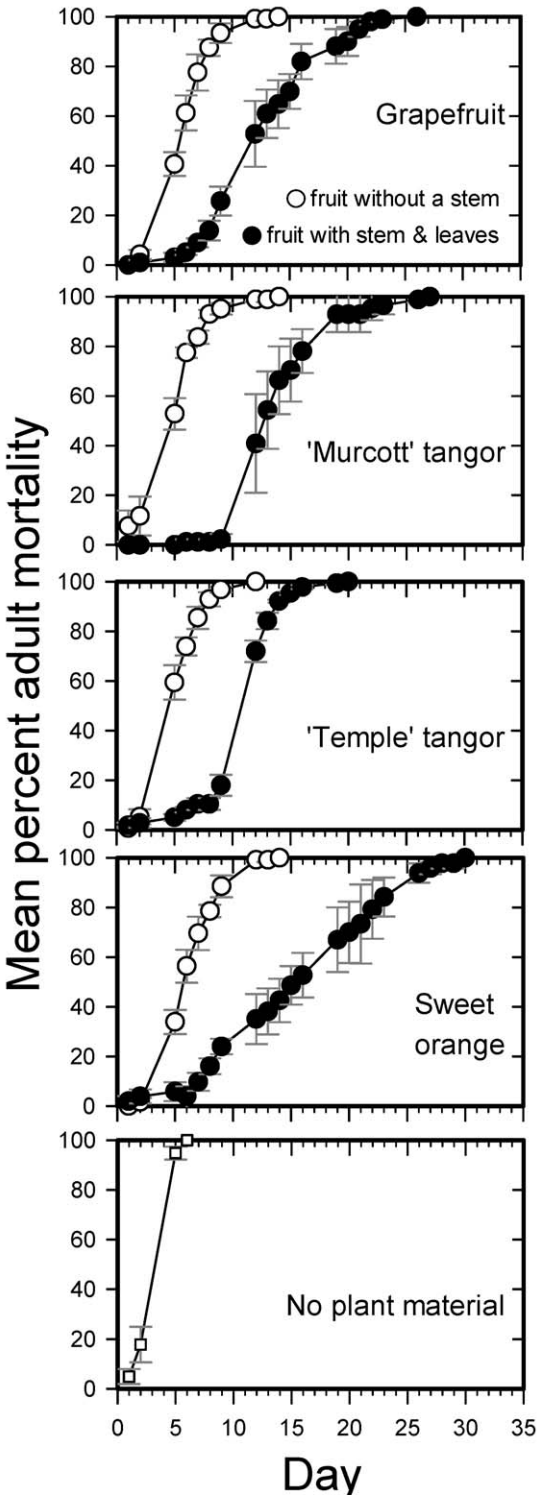

Fig. 2. Mortality of adult Asian citrus psyllid feeding on fruit with an attached stem of mature leaves or on fruit without a stem (second experiment).

from areas infested by the psyllid to areas not infested, survival of adults was investigated on harvested fruit and leaves of 4 citrus cultivars at 25 °C (75% relative humidity). The combined results of 2 experiments indicated that, in the absence of plant material, at least some adults survived for up to 6 d; that at least some adults survived for 10 to 13 d on harvested fruit in the absence of leaves; and that depending on the cultivar some adults survived for 6 to around 12 d on detached leaves or detached stems with leaves. Survival of adult psyllids was longest (a maximum of 17 to 29 d depending on cultivar) when they had access to fruit with an attached stem of leaves. The presence of adult psyllids in shipments of fruit from an area quarantined for the psyllid would therefore be of concern to regulatory agencies trying to limit spread of *D. citri*.

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