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Comparing the Fruit Rind Scarring That Three Early-Season Pests Cause in Mandarin Species and Sweet Orange

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Insects including katydids, earwigs, and citrus thrips attack young citrus fruit early in the season, shortly after petal fall. The feeding damage caused by these pests can leave scars on the rind that persist to harvest. As a result, the quality of the fruit can be downgraded at the packinghouse from "fancy" to "choice" or "juice," resulting in lost economic value. For each pest, unique treatment options are available; likewise, unique management approaches are recommended. Correctly identifying the pests and their associated damage is the first step to responding appropriately.

Mandarin acreage in California has significantly increased in recent years, but previous studies of early-season rind scarring were based on sweet orange. This photographic guide provides information about three key insect pests and compares the damage they cause to mandarin species with the damage they cause to sweet orange (fig. 1). This guide complements a photographic guide (Grafton-Cardwell et al. 2003) that is limited to photos of orange and provides information on scarring not caused by the insects highlighted in this guide, including other pests and mechanical and chemical damage. For information on how to monitor for and respond to potentially damaging insect infestations, refer to the UC Integrated Pest Management website, ucanr.edu/agriculture/citrus/.

Figure 1. Young citrus fruit are vulnerable to feeding damage by some insect pests. Areas of feeding damage can be seen on *Citrus sinensis* cv. Parent Navel fruitlets (A). The scarring damage may cause the fruit to abscise, or may persist as a scar on fruit that is retained to harvest. A large scar is visible on mature *C. sinensis* cv. Washington Navel fruit (B). Fruit with heavy scarring will be downgraded at the packinghouse. A fruit with a large scar is seen at the center of a harvest bin (C). *Photos:* Bodil N. Cass.

Citrus species

Citrus fruit's susceptibility to damage depends on the citrus species. This publication highlights key differences in the rind damage that katydids, earwigs, and citrus thrips cause to orange and mandarin. It also highlights differences in the damage that these pests cause to different mandarin species. For citrus species that are susceptible to damage, it is important to carefully monitor groves when the fruit are young, recognize the damage caused by the three insect pests, and conduct the appropriate management tactics. For citrus species that are naturally resistant to a particular pest, you can often rely on the plant's own defenses. The photographs in this guide are based on research conducted on specific cultivars and may extend to other related cultivars within each species. The section below presents key information about species of orange and mandarin and the types of damage caused by katydids, thrips, and earwigs.

Note: Varieties shown in bold have been assessed for citrus thrips susceptibility. Mandarin varieties shown with underlining have been assessed for fork-tailed bush katydid susceptibility. Mandarin varieties shown in italics have been assessed for earwig susceptibility.

Sweet orange

Species: *Citrus sinensis*

Varieties: Navels: ***Washington navel***; Valencias: Blood/pigmented orange

Katydid damage: Deep, round scar on side of fruit

Earwig damage: Deep scar varying in shape

Thrips damage: Calyx-end ring scars common; stylar-end ring scars less common; some fruit deformity

Mandarin-type groups

"True" mandarin species and their hybrids

Species: *Citrus reticulata*

Varieties: ***Tango***, **W. Murcott Afourer**, **Daisy**, **Fairchild**, **Gold Nugget**, **Tahoe Gold**, **Yosemite Gold**, Kinnow, Pixie, Shasta Gold

Katydid damage: Infrequent, very small, superficial damage

Earwig damage: Infrequent, very small, superficial damage

Thrips damage: Thrips scarring less common, often seen as stylar-end ring scars; some fruit deformity

Clementine

Species: *Citrus clementina*

Varieties: ***Clemenules***, **Fina**, ***Fina Sodea***, **Nour**, **Oroval**, **Sidi Aissi**, Algerian, Caffin, Oro Grande

Katydid damage: Deep, jagged scar

Earwig damage: Deep scar varying in shape

Thrips damage: Calyx-end ring scars; stylar-end ring scars; some fruit deformity

Satsuma

Species: *Citrus unshiu*

Varieties: **Frost Owari**, **Miho Wase**, **Okitsu Wase**

Katydid damage: Not studied

Earwig damage: Not studied

Thrips damage: Calyx-end ring scars common; stylar-end ring scars; some fruit deformity

An important conclusion of the research is that the *Citrus reticulata* group is very resistant to rind damage by katydids and earwigs and less susceptible to damage by citrus thrips than sweet orange and other mandarin groups; thus, the *C. reticulata* group requires fewer pest management inputs. Below, significant differences in the presentation of the damage that these three pests cause in mandarin and orange are noted.

Katydids, earwigs, and citrus thrips

Katydids, earwigs, and citrus thrips are considered significant pests of orange production in California due to the feeding damage they cause to young fruit. Fork-tailed bush katydids and citrus thrips are endemic to the region, whereas European earwigs are introduced. All three insects are polyphagous, with broad diets beyond just the citrus species. Citrus thrips have a long history of pesticide resistance problems, and fork-tailed bush katydids and earwigs have emerged more recently at the

Figure 2. A young second-instar fork-tailed bush katydid nymph (A). A fifth-instar fork-tailed bush katydid nymph feeding on a fruit (B). An adult fork-tailed bush katydid (C). *Photo 2A:* Elizabeth E. Grafton-Cardwell. *Photo 2B:* Bodil N. Cass. *Photo 2C:* Jack Kelly Clark.

forefront of important pests following the decline in use of broad-spectrum pesticides.

Fork-tailed bush katydid, Scudderia furcata Brunner von Wattenwyl (Orthoptera: Tettigoniidae)

Fork-tailed bush katydids are bright green and resemble grasshoppers with long antennae (fig. 2). Adult female fork-tailed bush katydids lay gray, flat, oval eggs inside the edges of leaves where they have been feeding. Nymphs are wingless and have black antennae with white bands. Nymphs emerge in spring, go through six to eight instars (stages of development between molts), and take 2 to 3 months to mature. The first five instars are the most damaging to young citrus fruit. Fork-tailed bush katydids are commonly found in the San Joaquin Valley.

Sweet orange

Katydid nymphs often feed on young sweet orange fruit following petal fall (fig. 3). The damage can range from surface injury to deeply chewed holes, with subsequent buildup of scar tissue. Heavily damaged fruit may abscise (shed), but if retained, the damage generally is round and may cause distortion of the expanding fruit. A few katydids can damage a large number of fruit in a short time.

Clementine

Fork-tailed bush katydids are significantly damaging pests of clementine mandarin. As with the feeding damage seen on young orange fruit, katydid nymphs cause a range of feeding damage to young clementine fruit, from surface injury to deeply chewed holes (fig. 4). However, compared to the circular scars seen in orange, the resulting scars in mandarin are more irregular and jagged, sometimes webbed. Maturing clementine fruit severely damaged by katydids may also split along the scar late in the season and then drop prematurely from the tree.

Other mandarin species

Laboratory and field testing demonstrated that katydids are not pests in "true" mandarin, *C. reticulata* ('Tango' and 'W. Murcott Afourer'). Katydid nymphs may be present in the groves of these cultivars, but they do not feed on the fruit. They may taste the fruit, causing small, superficial scratches, but the scratches do not develop into perceptible scars at harvest (fig.5). More substantial feeding on the fruitlets of these cultivars is exceedingly rare, and most damaged fruit quickly abscise. This natural resistance to katydid feeding may extend to other *C. reticulata* cultivars.

European earwig, Forficula auricularia Linneaus (Dermaptera: Forficulidae)

European earwigs are recognized by their forceps-like cerci (fig. 6). Males have stout, strongly curved cerci that are widely separated at the base, while females possess slender, straight pinchers that are close together. Earwigs have wings under short, hard wing covers, but they seldom fly. First-instar nymphs are very small and white, but as earwigs mature, they become darker in color. Eggs are laid in cavities in the soil, and first- and second-instar nymphs live in the soil. Third- or fourth-instar nymphs climb into the trees and feed on flowers, leaves, and fruit. Nymphs cause more fruit damage than adult earwigs, whose feeding habits are more predatory.

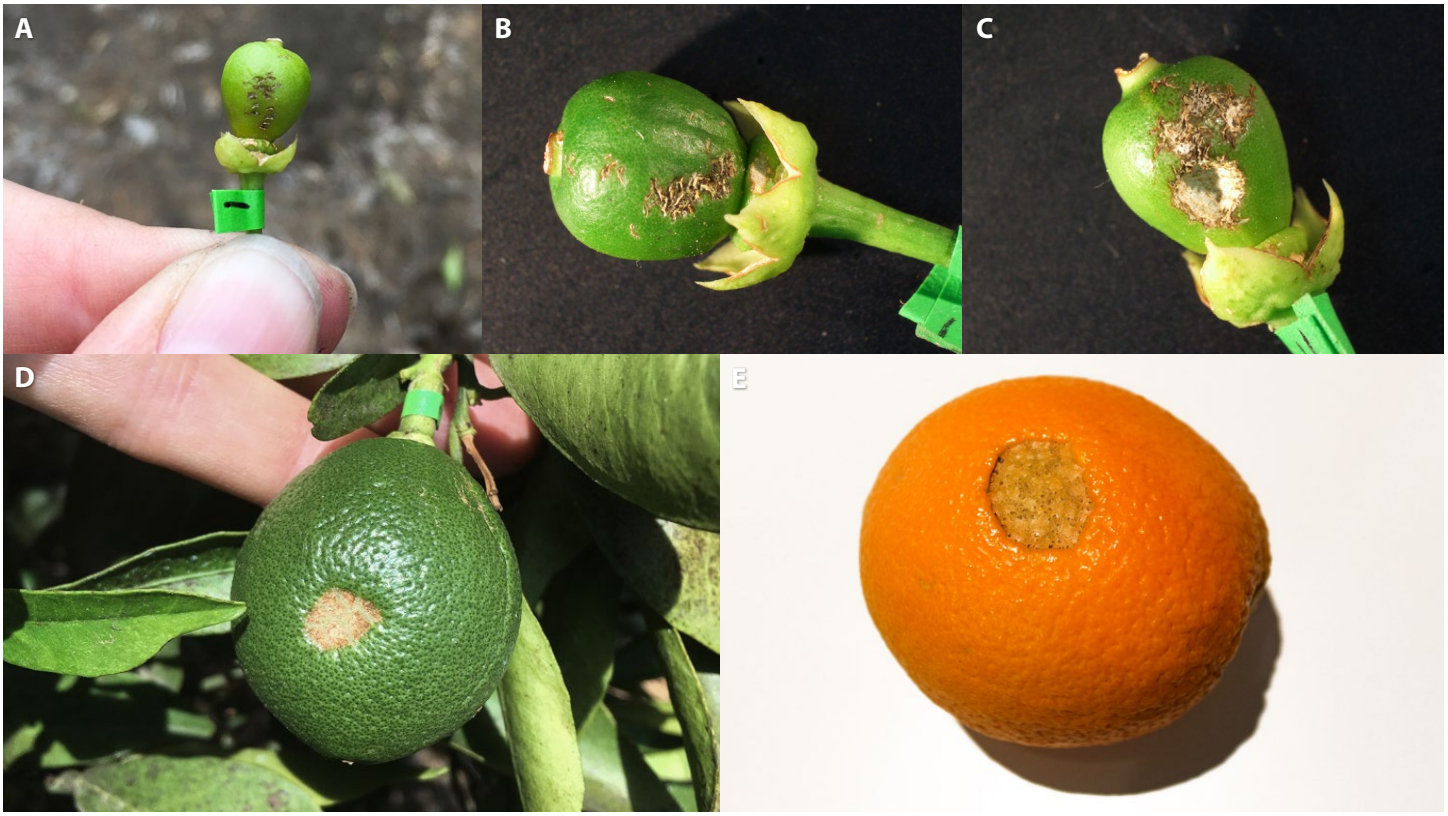

Figure 3. Katydids feed on young sweet orange fruitlets. The feeding damage can be individual, superficial cuts (A), chewed areas of the fruit surface (B), or deeply chewed holes (C). As the damaged fruit mature, they have deep, scabby scars that are usually round (D). The deep, scabby scars persist to harvest (E). *Photos:* Bodil N. Cass.

Figure 4. Katydids feed on young clementine fruitlets. The feeding damage can be individual, superficial cuts (A), chewed areas of the fruit surface (B), or deeply chewed holes (C). As the katydid-damaged fruit matures, the scars may be jagged in appearance (D). Clementine damaged by fork-tailed bush katydids can split along the scar lines late in the season (E). Split fruit often shed. On mature clementine, katydid scars may be deep and irregular, with jagged or webbed edges (F). *Photos:* Bodil N. Cass.

Figure 5. Katydids cause minor, superficial damage to *C. reticulata* cv. Tango fruitlets (A). This damage remains superficial as the fruit matures (B). This damage does not result in significant visible scarring at harvest (C). *Photos:* Bodil N. Cass.

Figure 6. Early-instar earwig nymph (A). Third- or fourth-instar earwig nymph (B). Adult male earwig (C). Adult female earwig (D). *Photos:* Hanna M. Kahl.

Sweet orange

Earwig nymphs climb trees and chew deep holes into young, sweet orange fruit for about 4 weeks after petal fall (fig. 7). These holes develop into large, scabby scars that are visible on mature fruit. This damage can be mistaken for katydid damage but tends to be more rectangular and is often nearer the calyx. When earwigs become adults, they show less preference for feeding on fruit.

Clementine

Earwig damage on clementine is similar in depth and location to earwig damage on sweet orange, but it tends to be more irregular and webbed (fig. 8). Although earwigs cause damage less frequently on young clementine fruit than on sweet orange fruit, the damage at harvest can be very severe on clementine. Because the scarring is deep, and earwigs often go unnoticed because they are active at night, earwig damage is easily mistaken for katydid damage.

Other mandarin species

Earwigs are generally not damaging to *C. reticulata* mandarin ('Tango' and 'W. Murcott Afourer'). On young fruit, damage to these mandarin fruit appears as small bite marks (fig. 9). Likely, the small bite marks are the result of earwigs "tasting" these varieties and choosing not to continue feeding. By the time fruit is harvested, the small marks tend to disappear or get lost among other superficial damage (caused by wind, rubbing against vegetation, and so on).

Citrus thrips, Scirtothrips citri Moulton (Thysanoptera: Thripidae)

Adult citrus thrips are small, orange-yellow insects with fringed wings (fig. 10). First-instar larvae are very small, whereas second-instar larvae are about the size of adults, spindle shaped, and wingless. Third- and fourth-instar thrips (propupa and pupa) do not feed and complete their development on the ground or in the crevices of trees.

Calyx-end scarring

Citrus thrips feed on leaves, stems, and fruit and cause damage by puncturing epidermal cells (fig. 11), leaving scabby scars—grayish or silvery—on the rind. Because they are thigmotactic (fond of hiding in small spaces), thrips nymphs spend much of their time under the sepals of the fruit and cause most of the damage in that region. As the fruit grows, damaged rind tissue moves outward from beneath the sepals and presents as a conspicuous ring of scarred tissue on the calyx end of the fruit. Second-instar larvae cause the most damage because they feed mainly under the sepals of

Figure 7. Earwig damage on young sweet orange fruit (A). Earwig damage on mature sweet orange fruit, similar to katydid damage (B). Earwig damage on mature sweet orange fruit, with a ruler to show damage size (C). *Photos:* Hanna M. Kahl.

Figure 8. Earwig damage on young clementine fruit (A). Earwig damage on mature clementine fruit is similar to katydid damage in other mandarin species and can be quite large (B). *Photos:* Hanna M. Kahl.

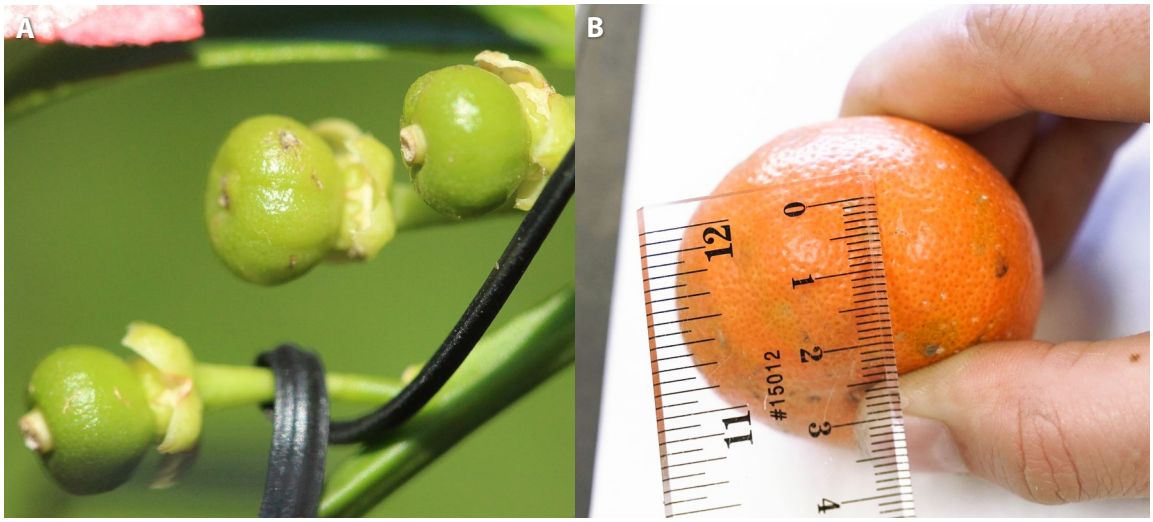

Figure 9. On young mandarin fruit, earwig damage appears as very small superficial bite marks (A). Earwigs very rarely chew deep holes into the fruit. Earwig damage on mandarin is hardly noticeable on mature mandarin (B). If scars occur, they are generally very small. *Photos:* Hanna M. Kahl.

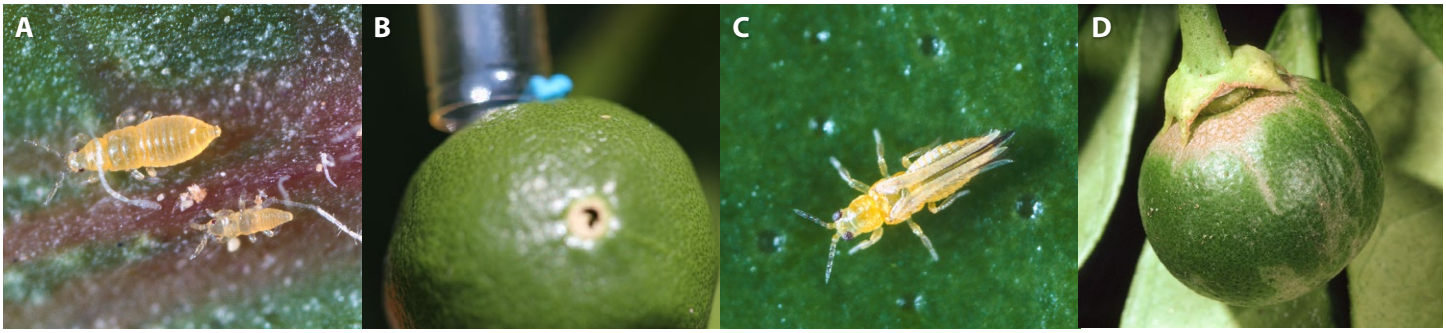

Figure 10. Citrus thrips first-instar larva (below) and second-instar larva (above) (A). Immature thrips on a young navel orange fruit (B). Adult citrus thrips (C). Thrips damage on young fruit (D). *Photos, 10A, 10C, and 10D:* Jack Kelly Clark. *Photo 10B:* Bodil N. Cass.

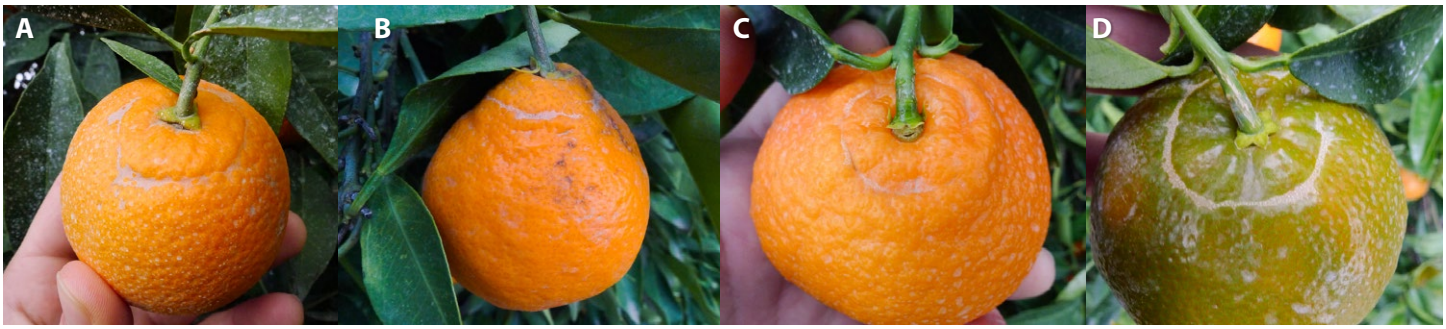

Figure 11. Calyx-end ring scarring caused by citrus thrips affects all citrus types, including navel orange (A), satsuma (B), clementine (C), and "true" mandarin (D). *Photos:* Tobias G. Mueller.

Figure 12. Citrus thrips scarring on the stylar end of a young navel orange fruit (A), mature clementine (B), and mature *C. reticulata* cv. Tango mandarin (C). *Photo 12A:* Bodil N. Cass. *Photos 12B and 12C:* Tobias G. Mueller.

young fruit and their mouthparts are larger than those of the first instars.

Although all varieties of citrus can be affected, citrus thrips is of greatest economic importance to San Joaquin navel orange and satsuma mandarin, coastal lemon, and all types of desert citrus. Citrus thrips scarring on *C. reticulata* ('Tango' and 'W. Murcott Afourer') mandarin looks similar to citrus thrips scarring on navel orange. However, scar densities tend to be lower, and thrips scarring is found less frequently on *C. reticulata* ('Tango' and 'W. Murcott Afourer') mandarin than on other varieties, so treatments are often not needed.

Stylar-end scarring

Citrus thrips feeding may also cause a ring of scarred tissue around the stylar end, or base, of the fruit, which may be light or quite extensive (fig. 12). Stylar-end scarring often occurs in combination with calyx-end scarring and is a more common type of damage for mandarin ("true" mandarin species and their hybrids, satsuma and clementine species) than for sweet orange.

Fruit deformity

Thrips scarring may be severe enough to restrict fruit growth asymmetrically, causing a deformity in fruit shape (fig. 13). This seems to be more common or appear more severe in mandarin than in orange.

Figure 13. Citrus thrips scarring can restrict the growth of the fruit and cause fruit deformity, as seen in this *C. reticulata* cv. W. Murcott mandarin. *Photo:* Tobias G. Mueller.

Reference

Grafton-Cardwell, E. E., N. V. O'Connell, C. E. Kallsen, and J. G. Morse. 2003. Photographic guide to citrus fruit scarring. Oakland: UC Agriculture and Natural Resources Publication 8090. https://anrcatalog.ucanr.edu/Details.aspx?itemNo=8090

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