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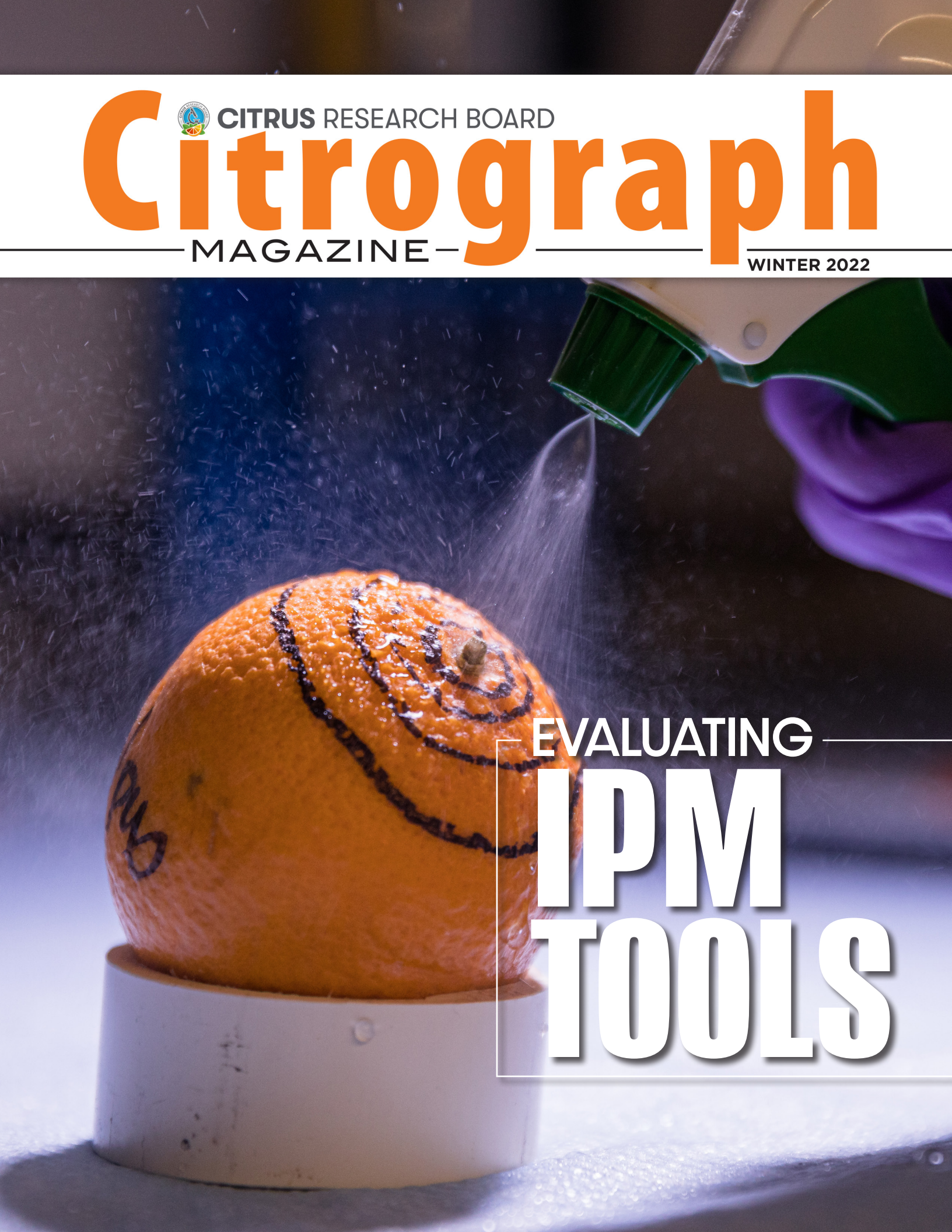

EVALUATING IPM TOOLS

MATING DISRUPTION EASES CALIFORNIA RED SCALE PROBLEMS

Joel Leonard, Beth Grafton-Cardwell, Matt Daugherty and David Headrick

Project Summary

CheckMate® CRS mating disruption[1] was evaluated in 12 commercial citrus orchards in 2016-19. Mating disruption of California red scale (CRS) significantly reduced the number of males that were attracted to trap cards, scale infestation of wood and the percentage of fruit with large numbers of scale. It worked best in large plots when applied before the first male flight and when initial scale populations were not high. Mating disruption will help San Joaquin Valley growers reduce, if not eliminate, insecticide treatments for CRS.

Background Information

There is a long history of integrated pest management for CRS, including parasitoid releases and selective insecticides (Grafton-Cardwell and Stewart 2012). Despite these efforts, the pest status of CRS has increased in the central San Joaquin Valley of California in recent years (Grafton-Cardwell and Douhan 2017). Factors that have contributed to scale problems include:

1. hotter summers and warmer winters increasing the number of CRS generations per season,
2. reduced populations of natural enemies because of increased pesticide use for invasive pests such as Asian citrus psyllid and pests of export importance such as Fuller Rose beetle and
3. loss of efficacy of the insecticide Esteem® because of resistance in CRS after more than 20 years of use.

Mating disruption with synthetic pheromones[2] is commonly used for lepidopteran pest management but not for other types of insects such as scale pests. In Spain, slow-release mating disruption was effective in reducing CRS for three to four flights a year and reduced the amount of scale-infested fruit (Vacas et al. 2010). In California, there are four to five flights of CRS males per year depending on location and accumulation of heat units. There was uncertainty that a synthetic pheromone could be released in sufficient quantities and over enough generations to fully control CRS. The objective of this study was to evaluate the efficacy of mating disruption for CRS in central California commercial navel and Valencia citrus orchards using the Suterra CheckMate® CRS mesoporus dispenser[3] (**Photo 1**).

Photo 1. CheckMate CRS slow-release dispenser clipped on a branch inside the canopy of the citrus tree. *(Photographer: B. Grafton-Cardwell)*

What We Did

In all field trials, CheckMate CRS dispensers were deployed in trees at a rate of 180 per acre. In the first two trials, one conducted in 2016 and one in 2017, the plot sizes were 2.5-4 acres. Treated and untreated areas were replicated four times. Half received CheckMate CRS dispensers in May *after* the first male flight, and half received nothing. Ten additional trials were conducted, five in 2018 and five in 2019. In these trials, half of each 20- or 40-acre citrus orchard received CheckMate CRS dispensers in February or March *before* the first CRS male flight, and the other half received nothing. Nine of the ten 2018-19 sites were treated with Movento® in May in both the control and mating disruption treatment areas. Efficacy was determined in all locations by evaluating CRS male flight trap cards using Suterra CRS lures (**Photo 2**), counting CRS on leaf and twig samples and estimating the percentage of fruit that was infested with CRS in the central trees of each plot. In one navel orchard during one flight in 2018, virgin female CRS-infested lemons were hung in pheromone-treated and untreated areas, and the rate of successful scale mating was evaluated.

Photo 2. Male California red scales trapped on a monitoring card. The black squares represent 20 percent of the card. *(Photographer: J. Leonard)*

What We Found

Figure 1 shows that mating disruption provided good suppression of male CRS (**Photo 4**) throughout the season. However, in 2016-17 (**Figure 1A**), the population of males in the pheromone-treated area increased toward the end of the season, suggesting a loss of control. The 2018-19 sites (**Figure 1B**), with lower initial scale populations and larger plot sizes, showed excellent, season-long control of CRS.

When lemons infested with virgin female CRS were hung for two weeks in the treated and untreated areas of one block in 2018, the CheckMate CRS dispensers prevented mating of 95 percent of these CRS females. This has two benefits: (1) it reduces the number of crawlers the females can produce and (2) it holds CRS in the stage that is most preferred and most vulnerable to *Aphytis* parasitism, enhancing biological control (Vacas et al. 2012).

There was an average 93 percent reduction of CRS on twigs and leaves in the mating disruption areas. The percentage of heavily infested fruit (**Photo 3**, more than ten CRS per fruit) was significantly reduced by mating disruption both in 2016-17 and 2018-19 (**Figure 3**). The percentage reduction was greater in the 2018-19 sites where the treatment areas were larger and the initial CRS populations were generally lower. **Figure 4** further shows the relationship between male CRS trap card suppression and heavily infested fruit. When males were reduced by more than 95 percent, very few fruit had dense patches of scales. The five sites that did not show as much efficacy tended to be the sites with higher early season densities of CRS and/or the two sites where mating disruption was applied after the first male flight. The result was that in seven of the 12 sites there was less than 0.5 percent heavily infested fruit at the end of the season – a dramatic result considering this was just a single year of treatment with mating disruption. In contrast, there was an average of 5.6 percent (range 1-13 percent) heavily CRS-infested fruit in untreated areas.

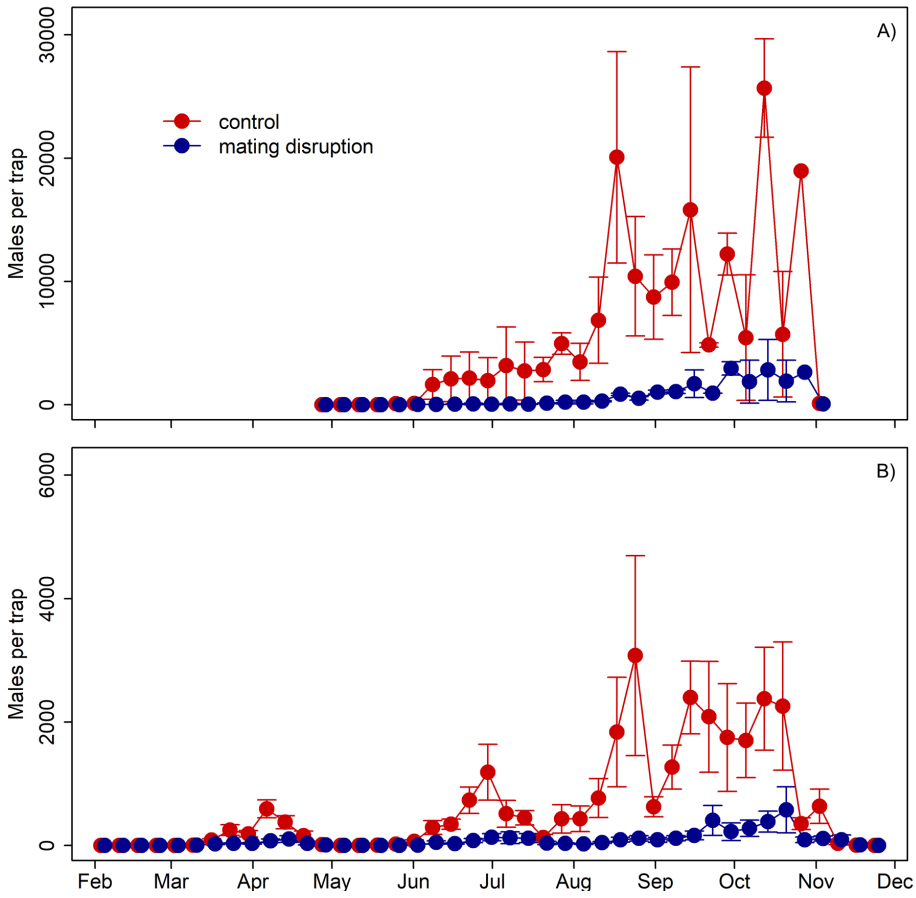

Figure 1. Good suppression of male California red scale was seen on monitoring traps in (A) two orchards in 2016-17 and (B) ten orchards in 2018-19. The CheckMate® CRS dispensers were deployed in the orchards after the first male flight in 2016-17 and before the first male flight in 2018-19.

Strategies to Maximize CheckMate CRS Mating Disruption Efficacy

Our study demonstrated that CheckMate CRS can be very effective in disrupting CRS mating by reducing scale populations on twigs, leaves and

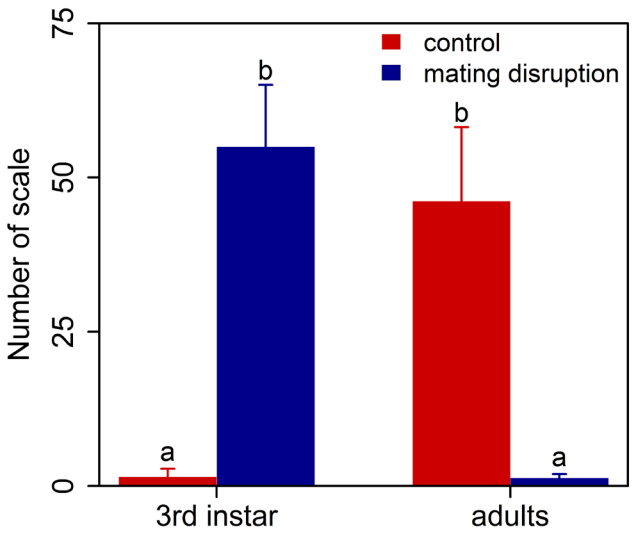

Figure 2. Lemons infested with virgin female California red scale (CRS) were hung in the treated and untreated areas of the orchard for two weeks. Less than three percent of female CRS were mated and became gravid in the mating disruption treated areas during that time period. For each pair of bars, the different letters indicate statistically significant differences.

Photo 3. Fruit with more than ten California red scales, such as this navel orange, are considered heavily infested. *(Photographer: B. Grafton-Cardwell)*

fruit. Based on this research, important strategies for how best to use the mating disruption to control CRS can be implemented. First, deploying the dispensers before the first flight helps to keep the spring population from developing, which is a more effective strategy than waiting until after the first flight. Second, the larger the area in which CheckMate CRS dispensers are deployed, the better. Third, heavy CRS populations are going to be harder to control because the males and females develop next to each other, and it will be harder for the synthetic pheromone to compete with the natural pheromone emitted by nearby CRS females. It is critical to reduce heavy populations of CRS with insecticides ahead of or in addition to the mating disruption to reduce the need for pesticides in subsequent years. Finally, pest control advisors experienced with the product say that it can take up to three years of use for mating disruption to work on its own, especially if the initial population is high. This study monitored only one year of mating disruption treatment in

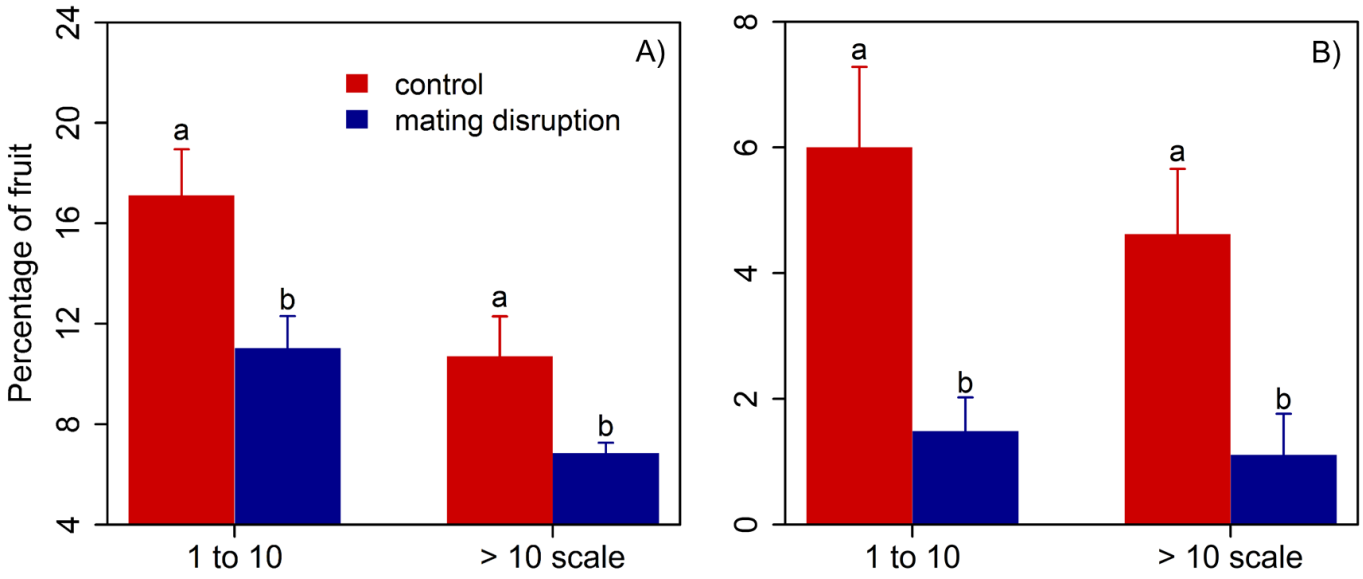

Figure 3. Mating disruption successfully reduced the percentage of fruit with a few California red scale (CRS) (1-10) and many CRS (greater than 10) in (A) two sites in 2016-17 and (B) 10 sites in 2018-19. In 2018-19, the percentage of heavy CRS was reduced below one percent. For each pair of bars, the different letters indicate statistically significant differences.

combination with a Movento treatment. Yet, CRS in seven of 12 sites was very successfully managed. Based on these results, mating disruption has great potential to reduce, if not eliminate, the need for pesticides for CRS populations in the San Joaquin Valley.

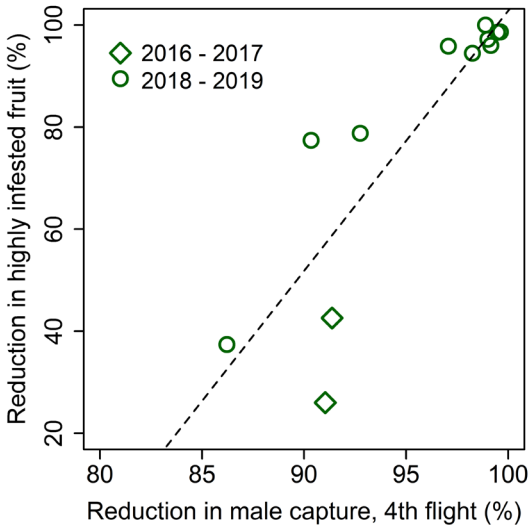

Figure 4. Very few California red scale (CRS)-infested fruit in this study were found when CRS males on trap cards in the fourth flight were reduced by 95 percent. This level of reduction for heavy CRS infestation on fruit occurred in seven of the twelve orchards tested.

Photo 4: The male California red scale (CRS) shown here is attracted to the flightless CRS female scale by the pheromones she emits.
(Photographer: J. K. Clark, UC IPM)

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Glossary

[1]Mating disruption: A pest management technique involving the release of a synthetic pheromone to confuse males so that they cannot find females and mate with them.

[2]Pheromones: Chemicals produced by female insects to attract males for mating.

[3]Mesoporous dispenser: A packet holding liquid pheromone with a very fine porous membrane opening (pore diameter between 2-50 nanometers) to allow for the slow release of the pheromone over many months.

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