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—Scientific Note—

Pest Population Dynamics in Citrus under Protective Screen Production Enclosures: Experiences in Lake Alfred, Florida

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Citrus Under Protective Screen (CUPS) systems are used for the production of fresh citrus fruit varieties for the commercial market. The objective of CUPS growing systems is the exclusion of the Asian citrus psyllid, the vector of huanglongbing. The 1.33-acre CUPS structure in Lake Alfred, Florida uses 50 mesh screens and was built in 2014. This mesh size excludes larger insects but is less effective against organisms like mites and thrips that may damage leaves or fruit peels. To make the CUPS system profitable, high-quality fruit is imperative. Therefore, scouting is necessary to monitor pest populations and determine the right time for applying a pesticide to protect fruit quality. Weekly scouting involved inspecting two leaves and two fruit per tree with a 10× hand lens. Scouted trees were selected using a grid pattern, with 19 rows and 11 locations per row totaling 209 positions. When young flush was present, the tap-sampling method was used. A white sheet of laminated paper was placed underneath the young flush, which was then gently tapped, displacing thrips and other pests onto the sheet below. The number of pests that appear are recorded in a Microsoft Excel spreadsheet. Grapher 8 (Golden Software, Golden, CO), was used to create line graphs (Fig. 1), and GS+ (GammaDesign Software, Plainwell, MI), was used for the Kriging Interpolated population heat maps (Fig. 2) which were used to monitor development of hot spots as pest population densities increased.

Over the past two years of scouting, major pests found include spider mites (*Tetranychus urticae*), Citrus rust mites (*Phyllocoptruta oleivora*), thrips, (Thysanoptera, *Frankliniella bispinosa* and *Scirtothrips citri*), leaf miner (*Phyllocnistis citrella*), and mealy bugs (Pseudococcidae). Figure 1 shows spikes in spider mites (Fig. 1a), rust mites (Fig. 1b), and thrips (Fig. 1c) populations. Spider mite population peaks tended to coincide with leaf flushes (Spring and Summer), citrus rust mite population peaks tended to coincide with the maturation of fruit (August–January), and thrips population peaks coincided with the flowering period (February–April).

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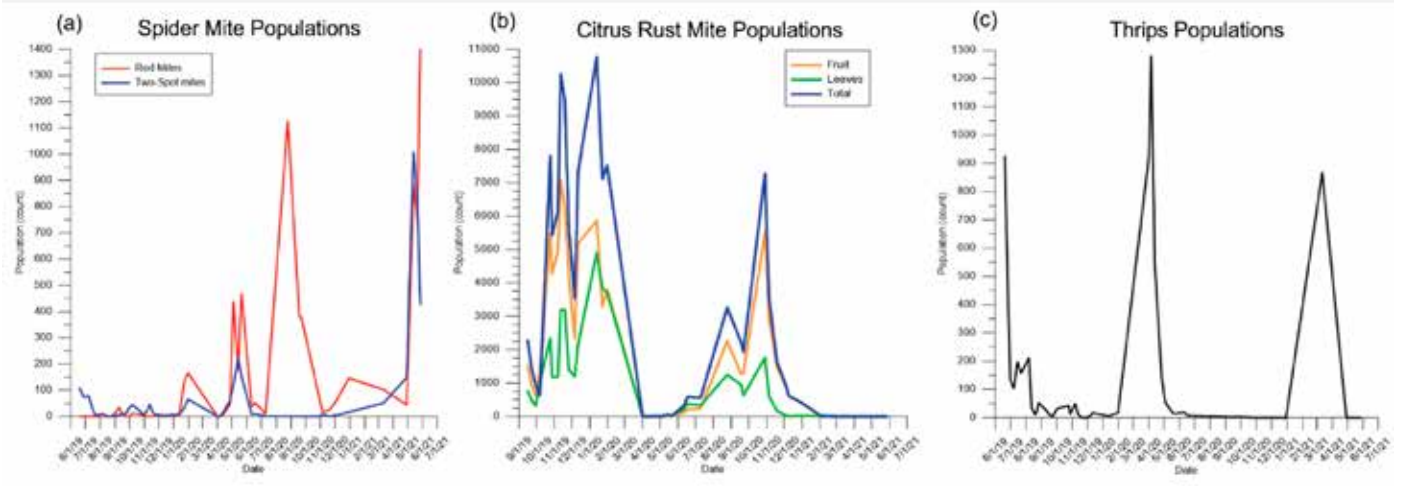

Fig. 1. (**a**) Spider mite (*Tetranychus urticae*), (**b**) citrus rust mite, (*Phyllocoptruta oleivora*) and (**c**) thrips (*Frankliniella bispinosa* and *Scirtothrips citri*) populations during a 2-year period in a citrus under protective screen system in Lake Alfred, FL.

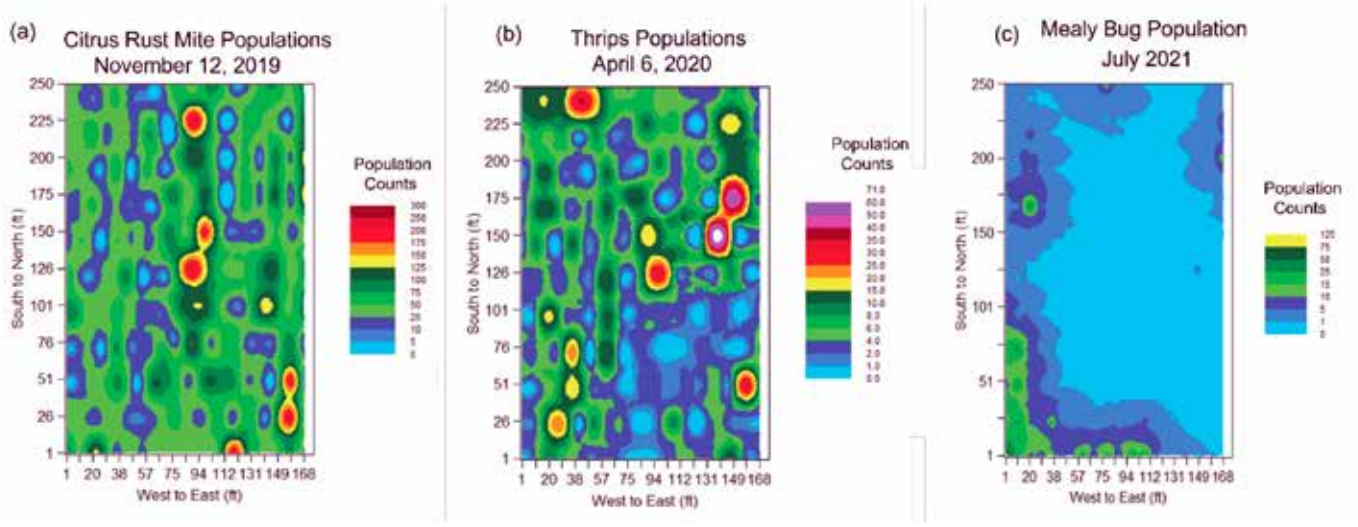

Fig. 2. Heat maps of (**a**) citrus rust mites (*Phyllocoptruta oleivora*), (**b**) thrips (*Frankliniella bispinosa* and *Scirtothrips citri*), and (**c**) mealybug populations (Pseudococcidae) in a citrus under protective screen system in Lake Alfred, FL.

Figure 2 shows the population intensities over space, with axis tick marks representing rows (x axis) and scouting locations (y axis). Citrus rust mite population hotspots in Nov. 2019 (Fig. 2a) were found where fruit density was high. Thrips hotspots in Apr. 2020 (Fig. 2b) coincided with the locations of the late flower blooming varieties. Population dynamics of mealybugs in July 2021 (Fig. 2c) showed the highest populations are concentrated nearest personnel and equipment (tractor, sprayer, etc.) entrances with populations radiating outward.

The screen was replaced in Feb. 2020 and psyllids entered and established a population that was detected in Sept. 2020. A rotation of chemical controls was used to remove the psyllids shortly after detection. The minor pests detected were leaf rollers, snow scale, Florida wax scale, Glover scale, ants, grasshoppers, whiteflies, and fruit flies. As part of the pest control strategy the following biocontrol agents were released: minute pirate bug (*Orius insidiosus*), ladybugs (Coccinellidae, convergent and mealybug destroyers), and predatory mites (*Galendromus occidentalis* and *Amblyseius andersoni*). Of these, only the predatory mites are routinely found during scouting and the minute pirate bugs have been found rarely. The CUPS environment provides an opportunity for a diverse population of pests and beneficial organisms. Furthermore, with scouting, pest populations can be controlled to reduce economic damage and maintain high quality fruit standards.