USING THE ACP AS A WEAPON AGAINST ITSELF

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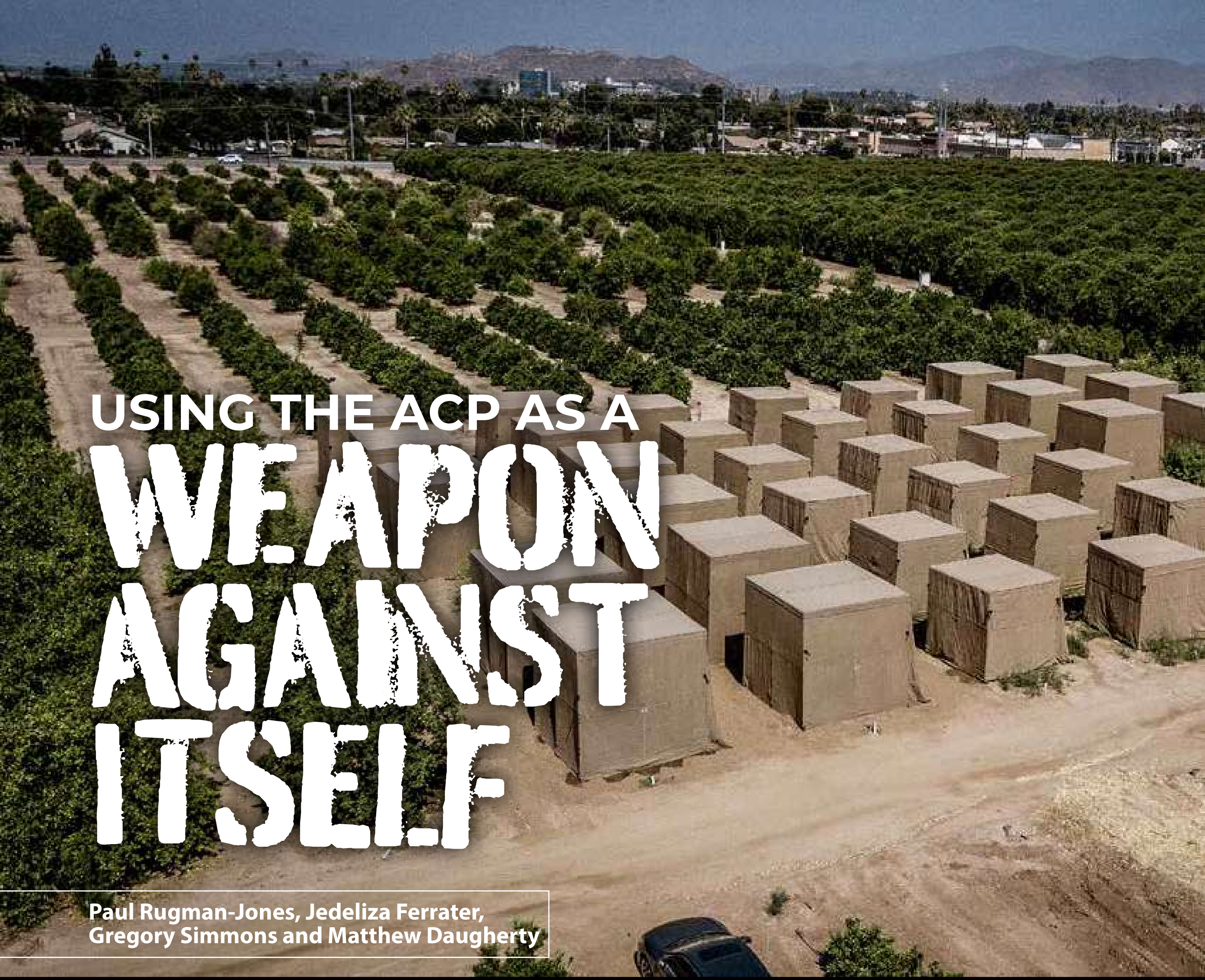

Caged lemon trees at the University of California, Riverside Agricultural Operations are being used to provide a realistic field-like environment to test the mating competitiveness and suppressive effect of sterile psyllid releases. *(Photo by Mike Lewis, UCR)*

The citrus industry in California is under siege by the Asian citrus psyllid (ACP; *Diaphorina citri*). This insect is a major vector for huanglongbing (HLB), a bacterial disease that already has decimated the citrus industries in Florida and Brazil. In California, the disease is restricted, thus far, to residential areas in the south. Keeping it that way requires preventing the spread of ACP. This currently involves the coordinated area-wide spraying of insecticides in commercial citrus groves and the release of an imported parasitoid, *Tamarixia radiata*, in urban areas. But a team of researchers from the University of California, Riverside (UCR) and the U.S. Department of Agriculture (USDA) are asking if releasing sterile psylllids could be the key to saving our citrus trees.

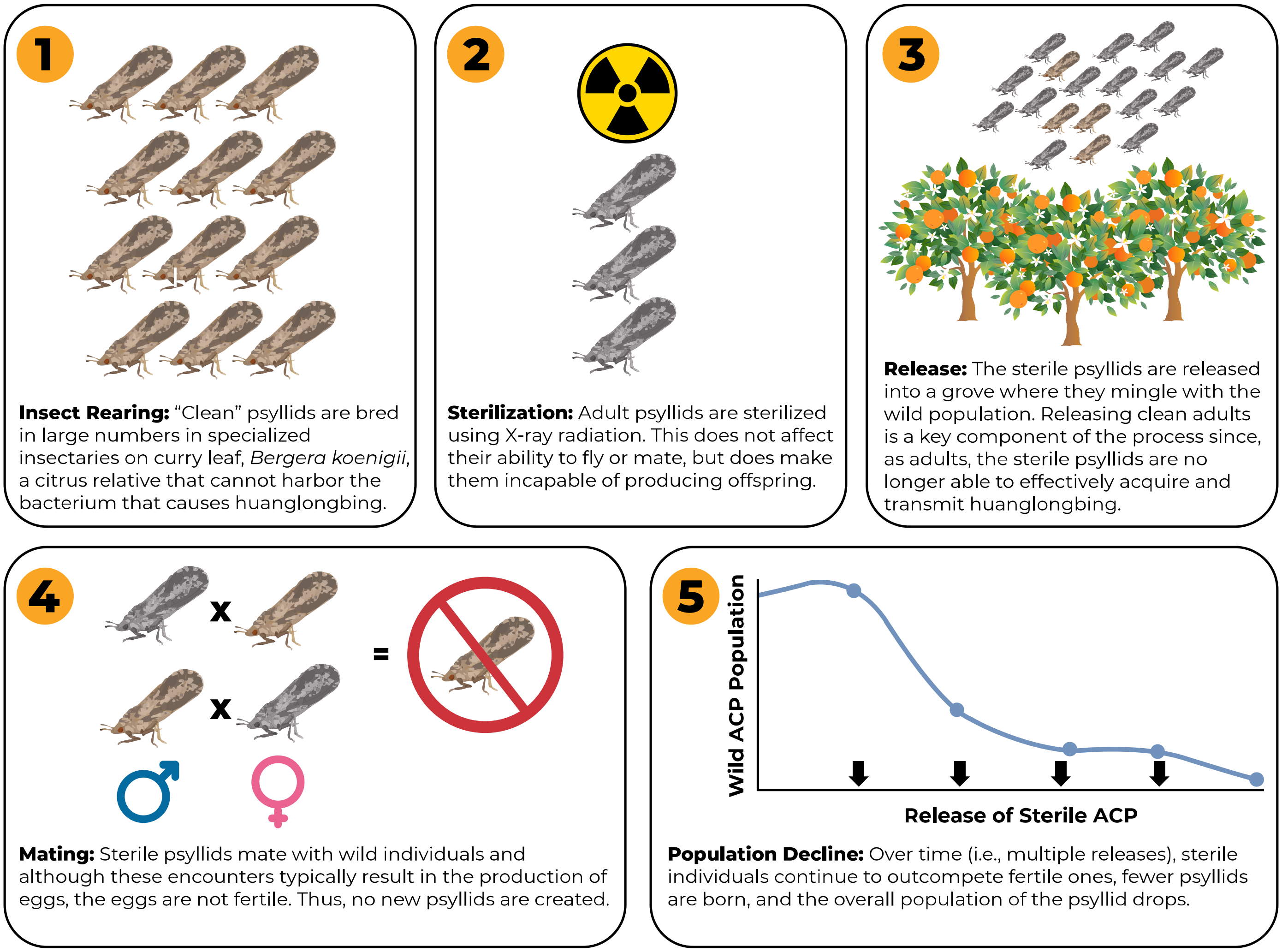

Figure 1. The sterile insect technique and how it might be applied to control Asian citrus psyllid populations.

At its core, the sterile insect technique (SIT) is a biological pest control method that involves releasing large numbers of sterile insects into the wild to reduce target pest populations (**Figure 1**). The technique already is employed in California by a joint federal and state program to prevent the establishment of Medfly (CDFA 2024) and by vector control districts to battle invasive mosquitos (Seidman 2024).

In work supported by the USDA's Citrus Health Response Program, we began laying the foundations for developing an SIT program for ACP several years ago. The first challenge, the ability to rear "clean" (disease-free) psyllids in large numbers, was already met, thanks to the state's *T. radiata* biological control program. Clean psyllids are reared in the insectary at UCR on curry leaf, *Bergera koenigii* (also known as *Murraya koenigii*), a citrus relative that cannot harbor the HLB-associated bacterium (Beloti et al. 2018). Early work also identified the appropriate dose of radiation to render psyllids sterile without otherwise harming them. Adult psyllids were exposed to varying doses of X-ray radiation, paired with fertile partners and allowed to mate and lay eggs. By counting the number of viable offspring produced, we determined that 320 Gray (Gy) was an appropriate dose (Ferrater et al. 2024). We then turned our attention to release rates. For SIT to be successful, the technique demands the release of enough sterile insects to reduce the likelihood of wild females mating with wild males in the pest population. This is a numbers game, with the goal of creating a biased ratio of sterile insects to wild insects, referred to as the overflooding ratio. Utilizing a series of small, caged psyllid populations, we found that overflooding ratios of 10:1 and 15:1 could suppress the size of the subsequent generation by as much as 78 percent.

With this fundamental knowledge in hand, we currently are testing the sterile psyllids under more challenging and "spatially" realistic conditions by releasing them onto caged mature citrus trees. In experiments conducted in spring 2024, we measured the impact that a single release of psyllids sterilized with 240 or 320 Gy of radiation, at overflooding ratios of 10:1 or 15:1, can have on the establishment of wild psyllid populations contained within secure 10′ x 10′ x 10′

cages (**Figure 2**). A total of 150 wild psyllids were released into each cage alongside an appropriate number of sterile psyllids (1,500 or 2,250 for the 10:1 and 15:1 overflooding ratios, respectively). The size of the caged psyllid populations then were estimated on dates coinciding with the predicted peaks of the following two psyllid generations (beginning 40 days after initiation and repeating a further 32 days later) and compared with cages in which only wild psyllids were released. The sterile psyllid releases resulted in dramatic reductions in the numbers of psyllids (**Figure 3**). We currently are completing the second replicate of this experiment, which began at the end of July. This year, we will use the same cages to conduct two further rounds of experiments. This time, we will examine the impact of a series of weekly sterile releases, to align more with operational SIT programs for other pests.

These early results from our study, supported by the California Department of Pesticide Regulation, are very promising and suggest that SIT may be a good method for preventing psyllids from establishing in new areas. The technique also has several advantages over traditional control methods:

- the technique targets only ACP, leaving beneficial insects like natural enemies and pollinators unaffected;
- doesn't contribute to pesticide resistance; and
- reduces the psyllid population over time with repeated SIT introductions.

SIT is not without its challenges. The main limitation is the cost and complexity of producing large numbers of sterile psyllids. ACP must be reared in controlled environments, sterilized carefully and then released in large enough numbers to have a noticeable impact. This will require significant investment in resources and

Figure 2. Releasing sterilized Asian citrus psyllid (ACP) inside a field cage. ACP are collected from a "clean" colony at UCR, transported to Salinas, California, for sterilization and returned to UCR for releases. From collection to release, the psyllids remain in sealed vials.

infrastructure. However, with the right combination of research, technology and field application, SIT could offer a promising tool for controlling ACP populations, thereby helping to prevent the spread of HLB and protecting California citrus crops for generations to come.

Acknowledgements

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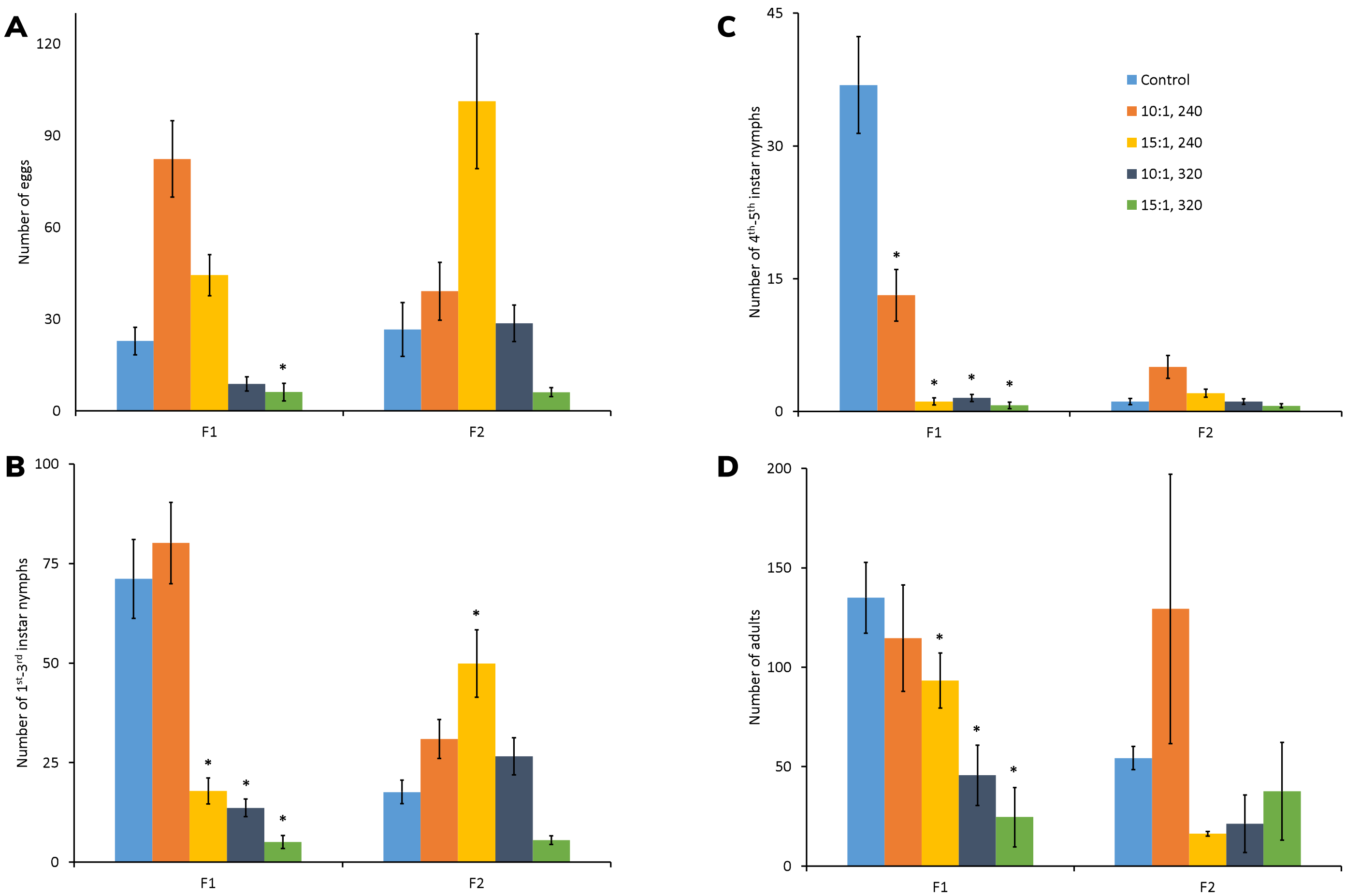

Figure 3. The impact of releasing sterile psyllids on the establishment of a wild psyllid population on individual citrus trees contained within secure field cages. Psyllids were sterilized with either 240 or 320 Gy of X-ray radiation and released at overflooding ratios of 10:1 and 15:1. The size of the caged populations was estimated over the subsequent two generations (F1 and F2) by counting immature psyllids on shoot samples and adults intercepted by yellow sticky traps. Estimates (mean ± SE) of: A) eggs per shoot, B) 1st-3rd instar nymphs per shoot, C) 4th-5th instar nymphs per shoot and D) adults per trap. Asterisks denote significant differences in counts between treatment groups and untreated controls within a given generation census.

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