Jan.
2022

Vegetable Crops Newsletter

University of California
Agriculture and Natural Resources
Cooperative Extension

UC CE

SAVE THE DATE: FEBRUARY 10, 2022!
VIRTUAL SACRAMENTO VALLEY PROCESSING TOMATO PRODUCTION MEETING

Due to the rapid spreading of the COVID-19 omicron variant and University of California guidelines, the annual tomato grower meeting for the Sacramento Valley will be virtual in 2022. **You will need to register in order to receive the Zoom link.** Please visit the following link to register and view the agenda:
https://surveys.ucanr.edu/survey.cfm?surveynumber=36488.

If you have any questions or issues registering, please do not hesitate to reach out to me or to ANR Program Support.
Program Content - Amber Vinchesi-Vahl, acvinchesi@ucanr.edu
Logistics and Registration - UC ANR Program Support, anrprogramsupport@ucanr.edu, phone 530-750-1361 (messages only)

In this issue:

Farm Calls 2021

Below is a summary table of the samples and farm calls from the 2021 season and the resulting diagnoses from the Swett and Gilbertson labs at UC Davis (with updated diagnoses since September 2021). Beet curly top virus (BCTV) was the biggest issue in the northern counties in 2021, followed by Fusarium diseases in tomato.

Unfortunately, we are also seeing the northward spread of the resistance breaking (RB) strain for TSWV so be on the lookout for outbreaks of spotted wilt in resistant (Sw5) varieties during the 2022 season. More information on both BCTV and resistance-breaking TSWV can be found in the July 2021 Vegetable Crops Newsletter.

Disease	Tomato	Cucurbits
Beet curly top virus	10	5
Tomato spotted wilt virus	2	
Resistance breaking TSWV	2	
Cucumber mosaic virus		1
Watermelon mosaic virus		1
Bacterial canker	2	
Fusarium falciforme	5	3
Fusarium crown and root rot	6	
Fusarium wilt	4	1
Southern blight	1	
Pythium rot		1
Charcoal rot		2
Root-knot nematode	3	

Fusarium falciforme symptoms on tomato.

Beet curly top virus on tomatoes (left), and squash (right).

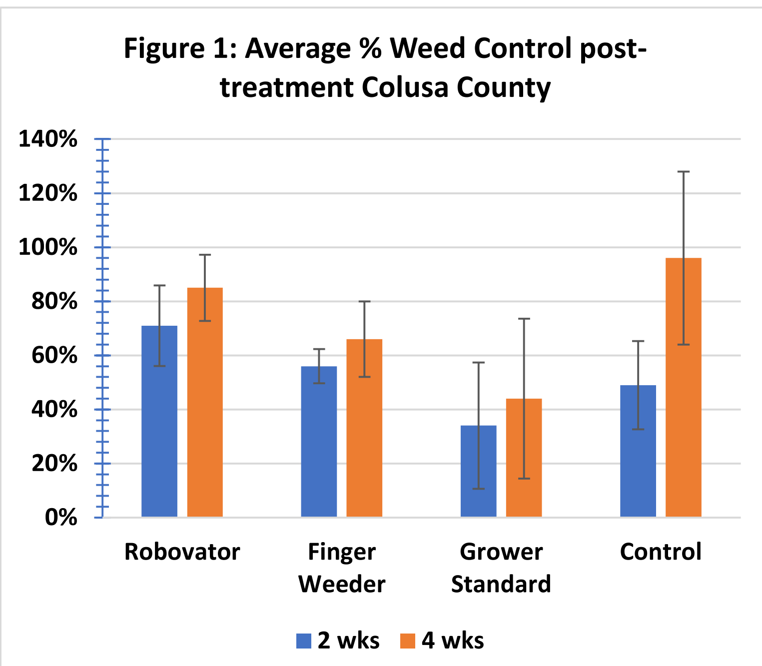
2021 Research Results

Weed control and cost-benefit analysis of automated cultivators to control within-row weeds in processing tomatoes

Key Takeaways:

- High winds/non-upright plants affect precision of Robovator and lead to higher % crop injury
- Weed control reduced at Colusa site compared to high success in 2020
- Weed control treatments (cultivators, herbicides) reduce hand-weeding time and costs compared to control

The main objective was to evaluate crop safety, weed control, time, and costs associated with using mechanical cultivators as part of a conventional weed management program in processing tomatoes. While both robotic cultivators and finger weeders have been used and evaluated in many vegetable crops, there has been little research evaluating these tools in processing tomatoes and how well they may complement or replace a traditional herbicide program or reduce hand weeding costs. We conducted replicated trials at two sites (Colusa and Merced counties) in 2020 and 2021. Scott Stoddard, UCCE Vegetable Crops Advisor in Merced and Madera Counties worked with me on this project and led efforts at the Merced trial site. We compared the Robovator (automated weeder), finger weeder (mechanical), and Matrix application to control plots where there was no in-row cultivation and no Matrix application. Matrix was part of the grower standard herbicide program at the Colusa site both years. In 2020, both in-row cultivators provided long-term control, especially 4 weeks post cultivator pass. All treatments reduced hand weeding costs and time compared to the Control. Details on the 2021 trial are below.



Plant stands were assessed before and after cultivator passes. Weeds were counted before treatment, 2 weeks and 4 weeks after treatment in the center bed of each plot. Cultivators and hand-weeding crews were timed as they moved through the field. Hand weeding times were determined by measuring the time for three people to hand weed each plot. Plots were hand-harvested in Colusa.

In Colusa, the Robovator and finger weeder did a moderate job of weed control on all plots. On average, the Robovator provided up to 59% control two weeks and 13% four weeks after it was run. The finger weeder provided only 69% control on average 4 weeks post-treatment. It is worth noting that for the control plots, only one plot had a reduction in weeds, whereas weed numbers increased in the other two plots which affected the average % weed control. There was a lot of variation by plot for weed control for each treatment which can be seen from the error bars in Figure 1. There was no significant difference between the cultivator treatments and the grower standard (Matrix) for weed control.

Field variation and weed species influenced weed control and pressure, and weed pressure was higher in 2021 compared to 2020. High winds a few days before running the Robovator caused non-upright tomatoes which led to issues with the Robovator. Despite increasing the buffer zone and continuously working with the computer program and calibration, crop injury occurred at 11-19%. The Robovator visual technology recognized the top of the tomato plant, but the blades cut the stems since the tomato plants were not standing upright (Figure 2). The finger weeder was able to cover 5 beds and moved quickly through the field compared to the Robovator, but did not have the same weed control efficacy in 2021 compared to 2020.

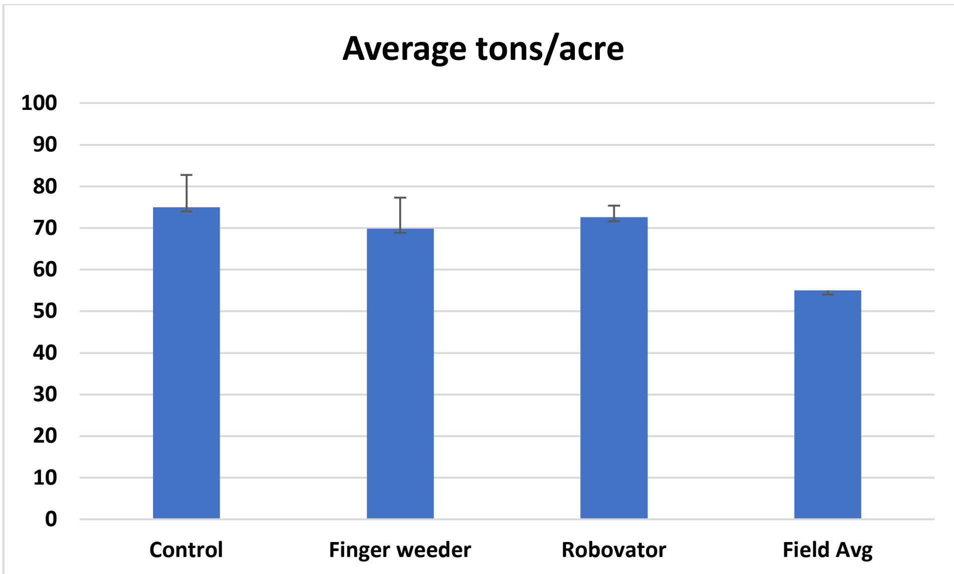
Figure 2. Robovator 2021, cutting plants at stem. In the photo on the right, the left-most blade is cutting the tomato stem.

Hand weeding times and costs between the control (no Matrix or in-row cultivation) and the Robovator were significantly different, with the control costing 2.3x more to hand hoe than the Robovator treatment. However, all treatments decreased time and costs compared to the control plots (Table 1).

Table 1. Estimated time for 6 people to hoe 1 acre in Colusa field. Costs calculated based on $13.50/hour. Significance noted by different letters in last column.

Treatment		**Hand hoe hours/A**	**cost $/A**	
1	Matrix and Dimetric (Grower standard)	1:29	$104.49	ab
2	Robovator	1:03	$83.43	b
3	Finger weeder	1:29	$104.49	ab
4	No Matrix/Dimetric or in-row cultivation (Control)	2:39	$193.59	a

There was no significant difference in yield between the control, Robovator and finger weeder plots, despite the early season crop injury from the Robovator (Figure 3). The lack of yield differences between treatments was likely due to hand weeding seven weeks before harvest and the lay-by application of herbicides earlier in the season. The differences between treatments and the grower field can be attributed to hand-harvesting of research plots versus machine-harvest of field.



Treatment	Tons/Acre ± StdErr
Control	74.97 ± 7.78
Finger Weeder	69.86 ± 7.43
Robovator	72.65 ± 2.73
Grower field	55.0

Figure 3. Yield ± standard error for treatments.

Acknowledgements: Many thanks to our grower cooperators in Colusa and Merced counties; Scott Stoddard for bringing the Robovator up to Colusa and helping to run the trial and troubleshoot; Steve Fennimore, Weed Management Specialist with UC ANR in Salinas for use of Robovator; and CTRI for their help and support.

2022 Research Projects

Evaluation of darkling beetle overwintering locations and movement into tomato fields

Darkling beetles girdle seedlings at or below soil line by chewing which can cause significant damage and plant death when beetles are in high numbers. Darkling beetles are not usually a problem once plants are big enough to withstand the chewing damage. They move in from field edges, including weedy areas or adjacent crops like grains or alfalfa. Conventional control includes insecticides, but organic growers have more limited options. Developing a forecasting tool or predictive monitoring method would be helpful to tomato producers (especially organic growers) that deal with darkling beetle damage.

In 2021, darkling beetle pressure was especially high in some areas, likely because the dry, hot spring weather dried down field edges early. Planting early is a cultural control method that is effective in managing darkling beetle migrations into tomato fields because field edges still retain moisture during the susceptible tomato growth stage, therefore reducing movement of beetles out of field edges in search of moisture in tomato fields. One of the key management tools for preventing infestations is allowing complete decomposition of crop residue and other organic matter before transplanting (PMSP 2021). Fallowing and/or cultivation can help with decreasing organic matter and crop debris. Keeping fields weed free can help eliminate potential shelter and overwintering sites (UC IPM). Another cultural control strategy involves maintaining water-filled ditches along field edges to reduce beetle migrations from surrounding areas. For conventional management, insecticides (primarily baits) are used for managing heavy infestations (PMSP 2021).

The main goal of this project is to gain understanding of darkling beetle movement into tomato fields (including how far they move) and develop a monitoring strategy to assist with control before beetles migrate into crop fields.

Probable overwintering sites will be scouted in late winter/early spring for presence of darkling beetles. Overwintering sites include weedy vegetation, debris, hedgerows, field borders, and other locations in close proximity to crop fields. Location descriptions will be recorded, including time of dry down (for weeds/vegetation). These sites will be scouted from late winter through planting in late spring. To determine darkling beetle presence, pitfall traps and visual observations will be used.

This project is funded by the California Tomato Research Institute.

- Parreira, S., A. Vinchesi-Vahl, C. Swett and T. Martin. (2021). "Pest Management Strategi Plan for California Processing Tomato Production". Pest Management Strategic Plan. Western IPM Center.
- UC IPM Pest Management Guidelines for Cucurbits, Cole Crops, Cotton and Dry Beans.

<u>Continuing Projects 2022</u>

- Evaluating commercially available processing tomato varieties for their tolerance/susceptibility to the new soilborne pathogen, *Fusarium falciforme*
    - PI: Brenna Aegerter, UCCE San Joaquin, Co-PIs: Tom Turini, UCCE Fresno; Amber Vinchesi-Vahl, UCCE Colusa; Cassandra Swett, UC Davis Extension Pathology Specialist, Collaborators: AgSeeds
    - Funded by California Tomato Research Institute

- Evaluation of compost application to processing tomato fields in the Sacramento Valley
    - PI: Amber Vinchesi-Vahl, UCCE Colusa, Collaborator: Suellen Witham, Westside Spreading LLC
    - Funded by Healthy Soils Demonstration Program, CDFA

Characterizing the non-crop habitat for a pest of melons, the western striped cucumber beetle

Jasmin Ramirez Bonilla, Masters student in Grettenberger lab, Department of Entomology and Nematology, UC Davis

Do you ever wonder where the insects that feed on summer crops go during the winter season? In this case, the western striped cucumber beetle (CB), *Acalymma trivittatum*, a key pest of fresh-market melons in Northern CA, exits the fields when all vegetation has been removed. These beetles will aggregate under protective structures such as tree bark and dead foliage during the cold and rainy days of the year (Fig 1). Once the weather warms up, the beetles emerge from their overwintering locations. They can be found on wild weeds adjacent to agricultural fields.

Figure 1. Adult western striped CB overwintering underneath tree bark and wood debris.

We conducted a study to characterize the non-crop habitat and observe the feeding behavior of the western striped CB during the non-cucurbit season. Here, we will describe the work we did and discuss the benefits of identifying non-cucurbit hosts to improve monitoring and management of this pest. California's Mediterranean climate allows many insects to remain active even during the "cold-weather months", which is the case for the western striped CB. With multiple generations per year, this beetle overwinters as an adult. The first generation occurs in the fields when melons are planted in late spring/early summer, and overwintered adults move into the fields to lay eggs. The following generations occur in cucurbit fields throughout the crop season.

While we know that the western striped CB feeds exclusively on cucurbits throughout the crop season, we have learned it feeds on other plants during late winter/spring. Because of the timing of melon planting in the Sacramento Valley (May-July), the beetles require nourishment before their preferred host is available and must feed on something to survive. Technically, they could survive (and reproduce) on wild cucurbits, but these are not widespread in field margins in the Sacramento Valley, so they instead feed on weeds along field edges.

In March 2020 (late winter/early spring), we carried out an observational field study to characterize the non-crop habitat of the western striped CB. We deployed yellow-sticky cards on wooden stakes in weedy areas at two empty organic fields previously planted with cucurbits (Fig 2a). We identified weed species within 20 ft. to the right and left of each trap. We conducted four-minute visual counts around each trap. We recorded the number of beetles observed on various weed species to better understand the relationship between weed species and beetle abundance per trap (Fig 2b). In addition, we measured weed abundance using percent cover assessments to associate weed species with beetle abundance from the visual counts.

Figure 2. A) Yellow-sticky trap in unmanaged weeds at barren fields (previously cucurbits). B) Four-minute-counts in randomly selected plants adjacent to the traps.

Figure 3. Adult western striped CB images inhabiting wild weeds in the early spring.

From these studies, we learned that the western striped CB was associated with broadleaf weeds, specifically milk thistle (*Silybum marianum*), little mallow (*Malva parviflora*), white clover, and some mustard species on field edges (Fig 3). Overall, we had substantially higher beetle counts at site one than at site two (Fig 4). We observed most beetles on milk thistle and little mallow (Fig 4b). According to the percent cover assessment, milk thistle accounted for 19% of vegetative cover at site one and 17% at site two. As for little mallow, percent cover was drastically different for each farm. Site one had vegetation coverage of 27.4 %, and site two had a total of only 8%. That said, percent cover for wall barley was abundant across both sites (>20%); however, there were no beetle sightings on this grass (Table 1).

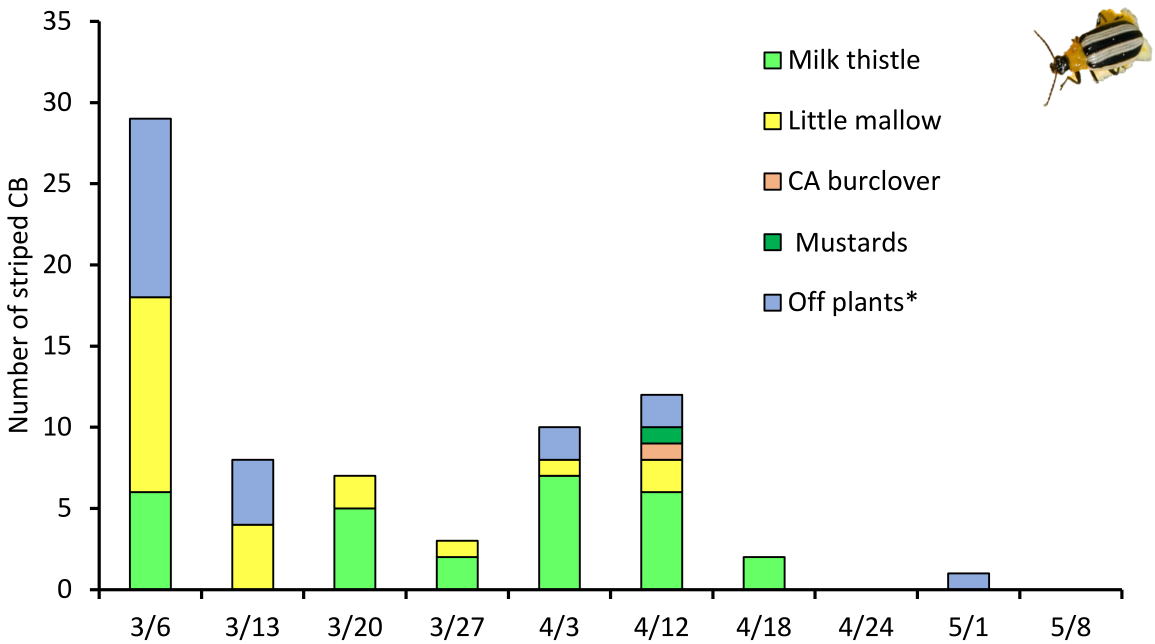


Figure 4. Adult western striped CB visual counts at site two.

	Site 1	Site 2
Common name of weeds found in surveys	***% Cover***	***% Cover***
Wall barley (grass)	20	28
Milk thistle (broadleaf)	19	17
Little mallow (broadleaf)	27.4	8
Brassicas (broadleaf)	5	4.2
CA burclover (broadleaf)	0.2	4.6
Bare ground + leaf litter	**12**	**18.1**

Table 1. Percent weed cover for different weed species observed in non-crop survey at site one and two.

Although these were exciting findings, we were not confident that the western striped CB truly preferred these weeds. The beetles might have been inhabiting these weeds because they were selected food sources or simply because they were abundant at each site and offered a place for beetles to rest. Even if the beetles did not actively feed on these species, they could still serve as habitat. That said, for milk thistle, we conducted a quick test where we placed a few beetles into a plastic container containing a milk thistle leaf and observed western striped CB feeding on this species. This observation suggested that milk thistle was a food item and warranted further testing.

In 2021, we assessed the feeding preference of western striped cucumber beetles for four weed species in laboratory bioassays to test the association between broadleaf weeds and beetles that we observed in the 2020 field study. We evaluated the following weed species: milk thistle, little mallow, wild radish, and shortpod mustard. We selected these species based on previous research and our findings from the field surveys. We used multiple-choice and no-choice tests to determine whether the western striped CB strongly prefers a specific weed. In multiple-choice assays, insects are given two or more feeding choices. With no-choice assays, only one species is given to the insect. We recorded the feeding damage by adult cucumber beetles on leaf circles (3-cm diameter) placed inside plastic containers for ten days (12 reps per weed; Fig 5).

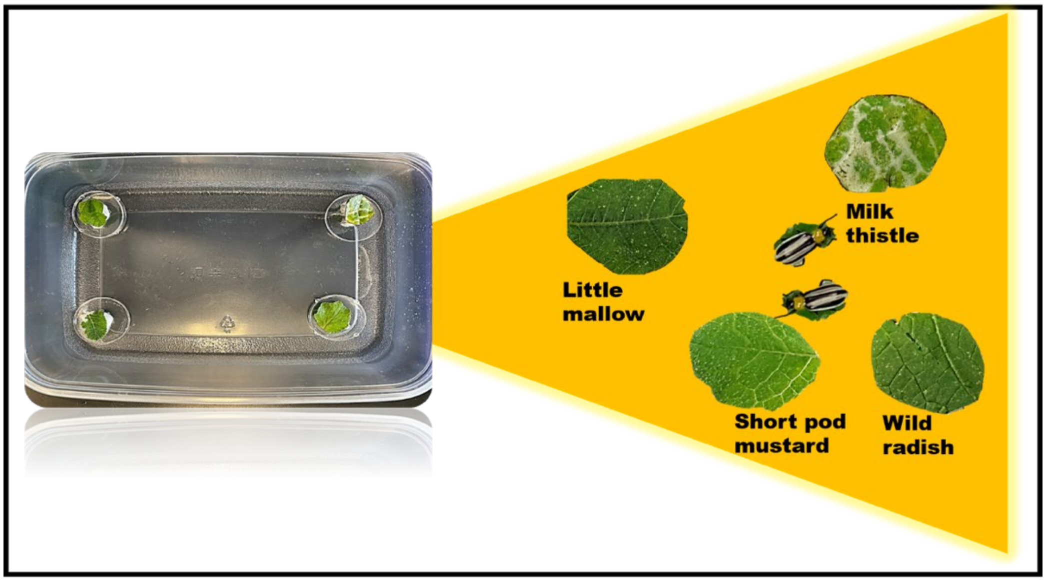


Figure 5. Schematic design of choice assay chamber with leaf discs, and inset image of each weed species with names and adult striped CB.

Feeding preference by the western striped CB varied across weed species. Milk thistle was the most consumed species, although the feeding level was not significantly different compared to either wild radish or shortpod mustard. We likely saw no significant differences between shortpod mustard and wild radish because both species belong to the mustard family. No beetles fed on little mallow; these leaf discs were untouched (Fig 6).

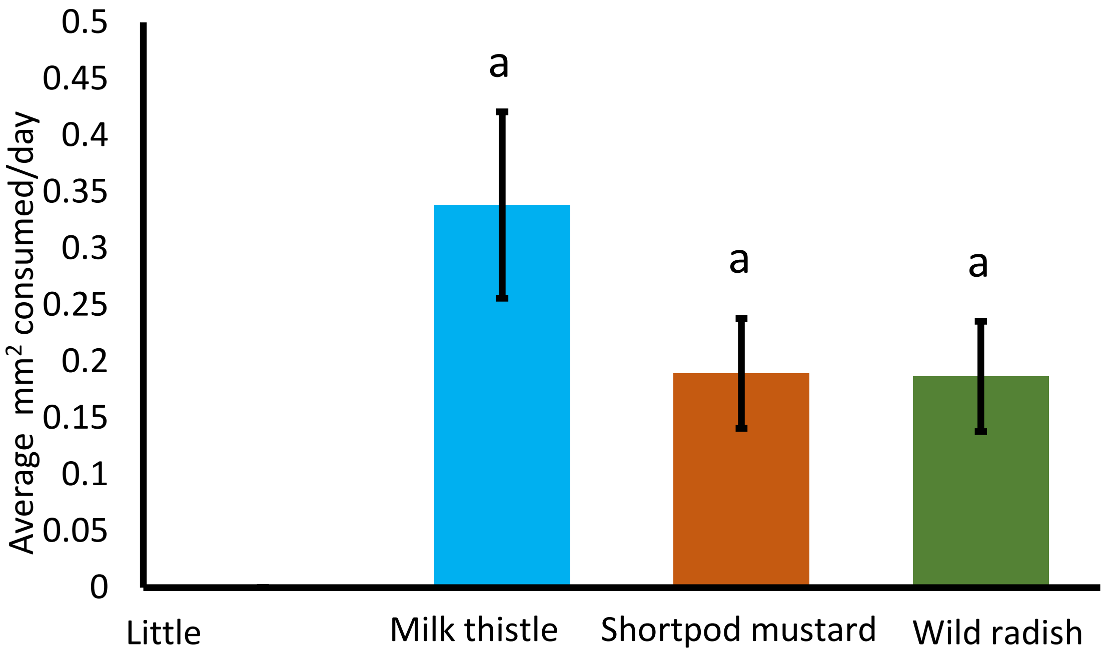


Figure 6. Feeding averages (±SE) for each wild weed species. Letters indicate lack of significant differences in between treatments. Note that little mallow was not fed on at all.

For the no-choice assay, results were somewhat inconclusive but still interesting. We believe that beetles were beginning to reserve energy for overwintering season, so most did not feed after the first two days of the planned 10 day experiment. Interestingly, in the no-choice assay, we did observe 2 of the 12 beetles feeding on little mallow. These observations indicate that some individuals will feed on little mallow when nothing else is available, although the number remained low. In addition, we observed 10 of the 12 beetles feeding on milk thistle in the no-choice trial.

The results from the choice bioassay confirmed our speculation about western striped CB preference for specific weeds. Nonetheless, the results with little mallow were surprising since we observed them inhabiting little mallow in the 2020 field studies. These outcomes help clarify the association between beetles and weed species. It is likely not driven by only weed abundance but also by preference for specific food sources. These results, coupled with those from our 2020 observational study, indicate that the western striped CB prefers feeding on broadleaf weeds (preferably milk thistle) to survive the non-cucurbit season.

How does this information contribute to the IPM of the western striped CB?

The outcomes from these studies can inform IPM decisions for western striped CB. For example, our results could help address the specifics of "where" to scout and monitor for these beetles before they move into cucurbit and melon fields. Pest control advisers or growers could scout semi-natural areas surrounding fields, where milk thistle and/or mustards are abundant, and estimate population density before planting for western striped CB. Depending on how important of a host milk thistle is, it could even be a target for weed management. Moreover, managers can use these non-crop hosts as areas to target with attract-and-kill (ATK) traps, which are management strategies that use an attractant to lure pests paired with a killing agent. The lure could include a pheromone, floral scent, or feeding source and the killing agent could be a sticky substance or liquid the pest is trapped in, or an insecticide. ATK traps could be deployed where broadleaf weeds are present (milk thistle patches appear to be good candidates), to better target western striped CB populations. We still have a lot to learn about how this pest uses non-crop areas to survive when cucurbits are not present, but identifying potential hosts is a crucial first step.

Please feel free to contact me with any vegetable crop issues in the field, questions or comments, or to subscribe to this newsletter electronically.

Amber can be contacted at the Colusa UCCE office at 530-458-0575, by cell phone at 508-254-4490, or at acvinchesi@ucanr.edu.