Branched broomrape: a parasitic weed threat to the tomato industry

- Brad Hanson, Matt Fatino, Pershang Hosseini (UC Davis)

University of California
Agriculture and Natural Resources

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DEPARTMENT OF PLANT SCIENCES
College of Agricultural and Environmental Sciences

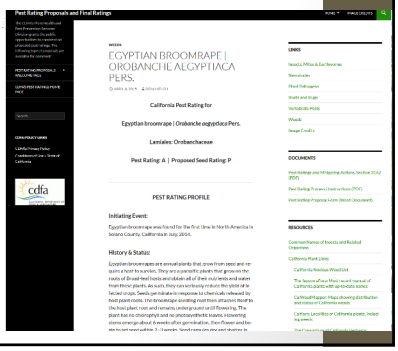
UC Ag Experts webinar
Zoom!
11-08-23

Broomrape

- A genus of >200 parasitic herbaceous plants
  - Orobanche spp (aka Phelipanche spp).
- Broomrapes are root parasites (attach below ground)
- Holoparasites = derives all carbon from a host plant
- Plants lack chlorophyll
  - Usually yellow- or straw-colored
- Some broomrapes have narrow host range, but others have a much wider host range
- At high density, can greatly reduce yield or even result in crop failure

Broomrape in California

- At least two species have been detected in CA tomato fields
  - Branched broomrape (*Orobanche ramosa*) - "A-listed"
  - Egyptian broomrape (*Orobanche aegyptiaca*) – "Q-listed"
    - First report in North America – Solano Co. in 2014
- Branched broomrape has been reported on-and-off for several decades in CA
- Egyptian broomrape has a wider host range (~23 crops grown in CA!) and may be an even more serious risk
  - Potential for non-crop risks too

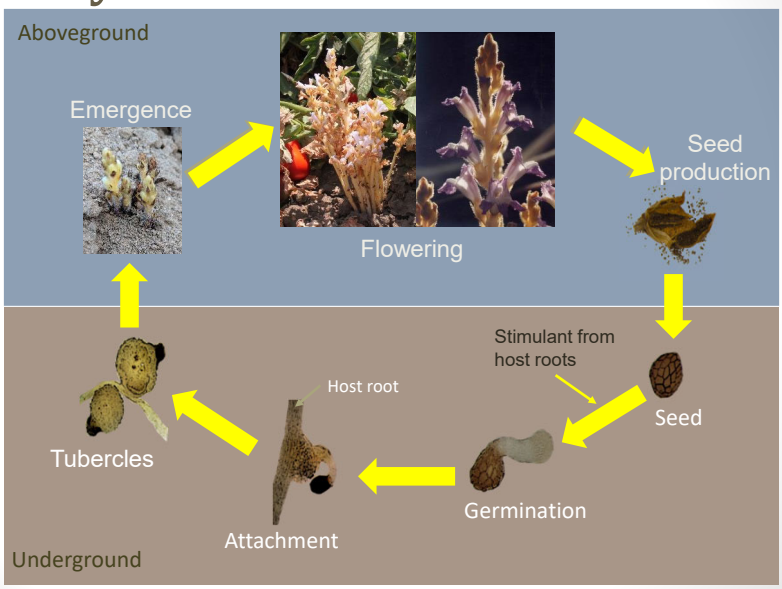


CDFA weed ratings reminder

- "A" listed
  - A pest of known economic or environmental detriment that is not known in CA or is present in limited distribution that allows for the possibility of eradication or successful containment
  - Subject to state enforced action involving eradication, quarantine, regulation, containment, rejection or other holding action
- "Q" listed
  - An organism or disorder suspected to be of economic or environmental detriment, but whose status is uncertain because of incomplete identification or inadequate information.
  -

https://www.cdfa.ca.gov/plant/ipc/encycloweedia/winfo_weedratings.html

Lifecycle


Aboveground
Emergence
Flowering
Seed production
Stimulant from host roots
Seed
Germination
Host root
Attachment
Tubercles
Underground

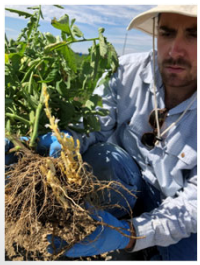
Success in Israel with PICKIT DSS

PICKIT decision support system developed in Israel

Overview of broomrape management trials

- 2019/2020 evaluated chemigated imazapic and preplant incorporated sulfosulfuron according to PICKIT protocols
- 2021 focus shifted to chemigated imazamox paired with PPI sulfosulfuron
- 2022 continued to evaluate chemigated imazamox as well as chemigated rimsulfuron alone and paired with PPI sulfosulfuron
- 2023 continued to evaluate chemigated rimsulfuron (24c SLN) alone and paired with PPI sulfosulfuron
  - Foliar applications of maleic hydrazide
  - Variety screening and field trials

CA field trials 2022



Matt Fatino

Broomrape suppression (CA 2022)

UC Davis Chile 2022

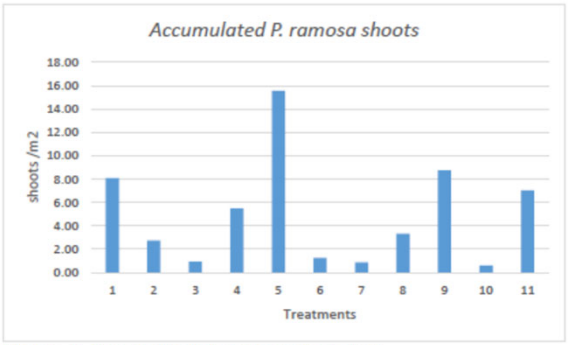


Figure 6. Accumulated *P. ramosa* shoots/m2

Figure 10. Broomrape shoots on 3 planting dates. (T1:Oct 11th,

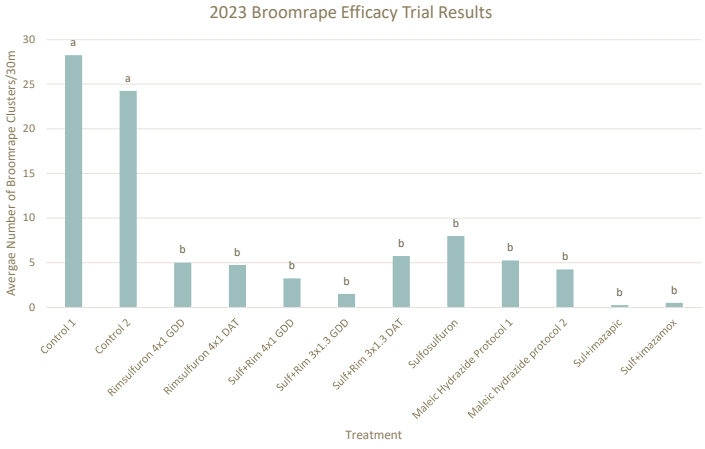
- #3, 6, 7 included imazamox at 9.6 or 19.2 g/ha
- # 4, 8 included chemigated rimsulfuron
- # 10 included imazapic

2023 Field Season Objectives

- Refine chemigated rimsulfuron application timing, evaluate efficacy of treatment alone and paired with PPI sulfosulfuron
- Evaluate foliar applications of PGR maleic hydrazide
- Screen 5 varieties for differences in branched broomrape attachment

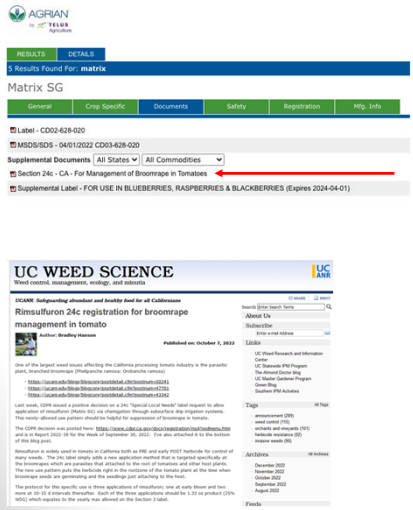
2023 Infested Field Efficacy Studies

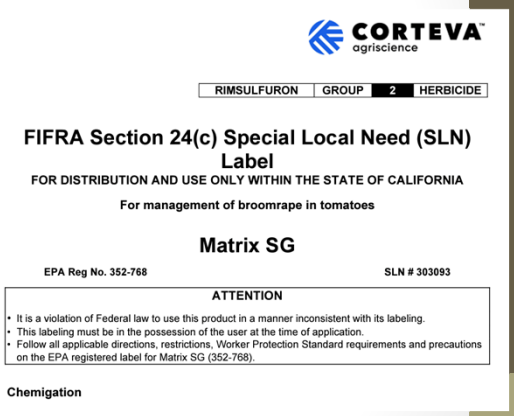
- HM 58841 transplanted single line for chemical trial
- May 21 planting date
- Phytotoxicity, broomrape emergence data recorded
- 9019, 9016, C8237, 58841, dodder resistant variety

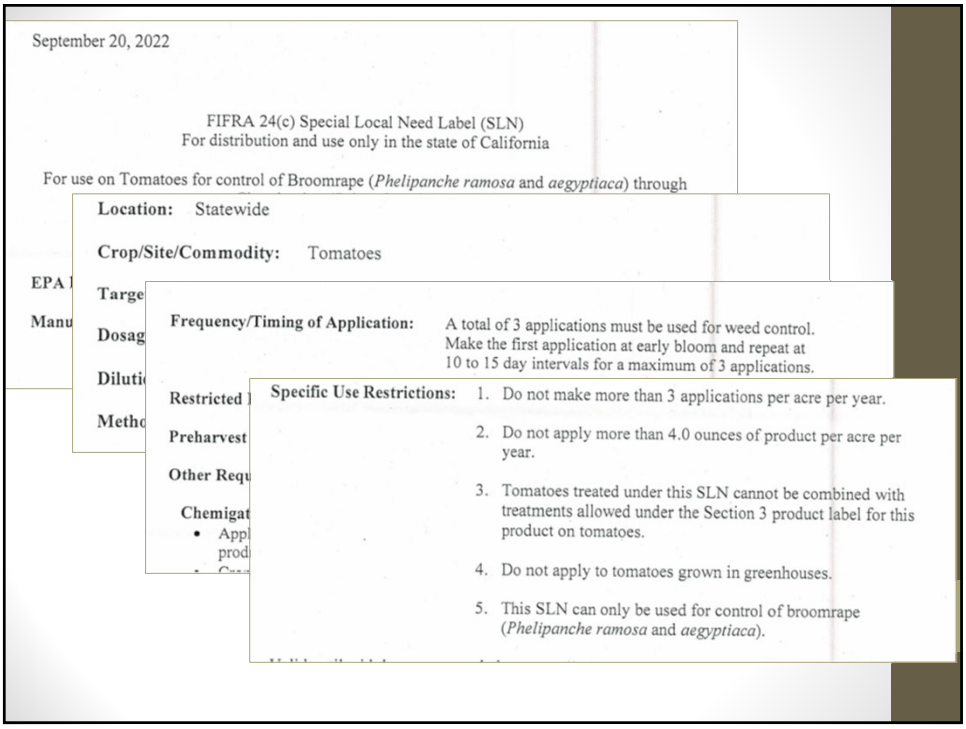


- **Figure 1.** Average number of branched broomrape clusters per 120-ft plot by treatment across four replications in an infested tomato field in Yolo County, CA.

Rimsulfuron 24c Special Local Need Label







Directions for Use

- For use on processing tomato for management of broomrape (Phelipanche ramosa, aka *Orobanche ramosa*) and Egyptian broomrape (*Phelipanche aegyptiaca*). For management of broomrape, apply Matrix SG **through buried- or surface-drip irrigation tubing** to transplanted tomato. **Apply at an application rate of 1.33 oz/A for up to 3 applications per season at approximately 30, 50 and 70 days after transplanting.**
- Refer to product label for Matrix SG for Use Precautions, Mixing and Application directions.
- Surface or buried drip irrigation applications simulate banded applications.
- The amount of water and injection time may vary depending on soil type and irrigation system used. Introduce Matrix SG into the irrigation system at approximately the midpoint of the irrigation set to limit movement of the herbicide beyond the tomato root zone, where broomrape germination and attachment occurs, which may improve broomrape control. Factors such as soil type, irrigation system, injection timing and length, drip tape placement, etc. may affect weed control when Matrix SG is used through the drip irrigation system.
- After Matrix SG has been evenly applied across the field, flush the irrigation system prior to ending the irrigation.
- **Do not apply more than a total of 4.0 oz/A Matrix SG (0.0625 lb ai/A rimsulfuron) on tomato during the same year.**
- Do not make more than 3 applications of Matrix SG per year.
- Preharvest Interval: **Do not apply within 45 days of harvest.**
- This label must be in the possession of the user at the time of application. Follow all recommendations and restrictions on the Matrix SG Section 3 labeling.

Quarantine greenhouse

Seed production and emergence biology

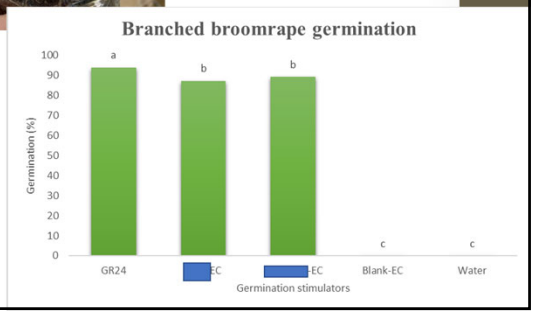
Branched vs Egyptian broomrape

Cultivar and chemical evaluations

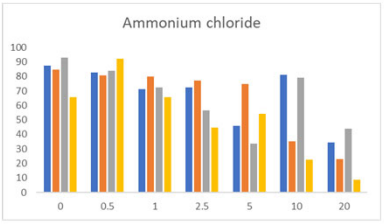
Phenology modeling

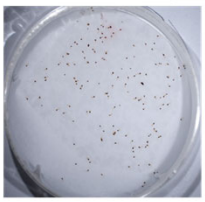
Glass-front rhizotrons for evaluating broomrape germination, attachment, turbucle formation, emergence.

Germination stimulation studies

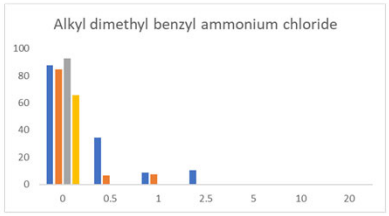


CRF projects

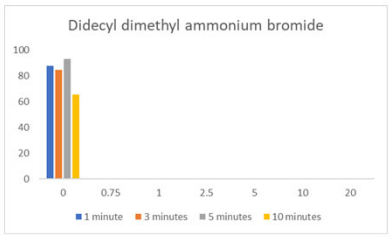


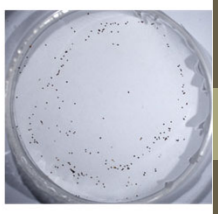


Check w local ag commissioner re quat use for this purpose



Pershang Hosseini





QAC activity studies

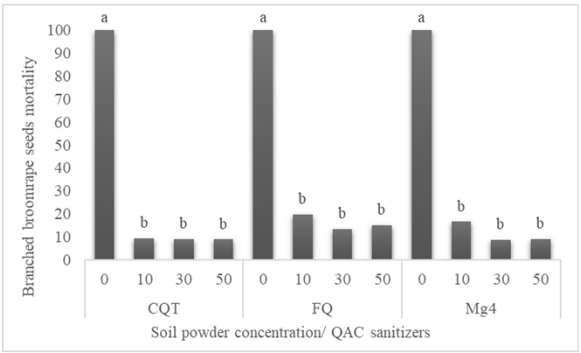


Figure 1. While commercial quaternary ammonium compounds kill 100% of broomrape seeds in the absence of debris, in the presence of even low amounts of soil these same sanitizers only kill 5-20% of seeds.

Developing best equipment sanitation practices for eradication of branched broomrape and other high-profile soil borne pathogens to mitigate field-to-field spread

Cassandra Swett, Justine Beaulieu, UCD Dept. of Plant Pathology

Brad Hanson, Pershang Hosseini, UCD Dept. of Plant Sciences

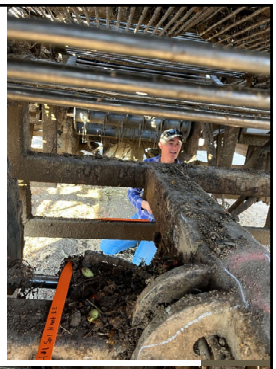
Zach Bagley, CTRI director

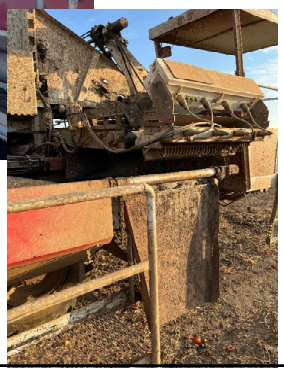
Fanterra
"We keep the promises they make"

BARRIOS FARMS INC

California Tomato Research Institute

Equipment sanitation (AKA Project Clean Machine)



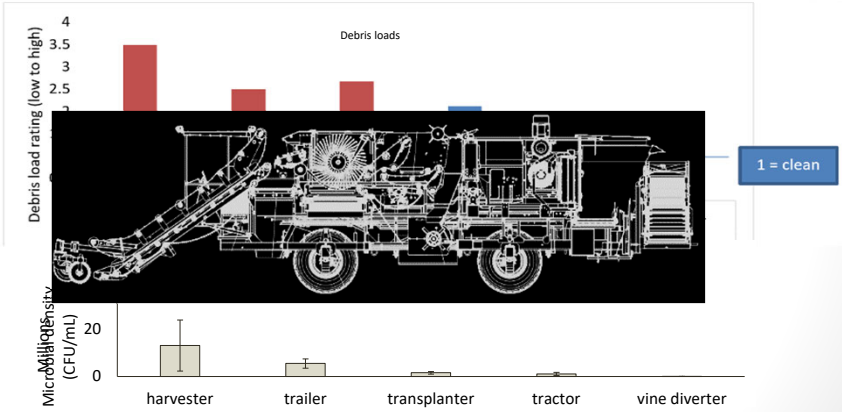


Research efforts to develop equipment sanitation methods to mitigate spread of soil borne pests

- Critical needs
  - Develop best management practices-none exist
  - Get equipment use added to sanitizer labels
- Needed for
  - Rapid response in cases of new resistance breaking strains
  - Preventing spread of emerging pests, including quarantine pests
    - Broomrape is primary industry concern
    - Known distribution currently limited to Yolo region
    - Concern that widespread use of harvesters and other equipment across county lines will facilitate expansion

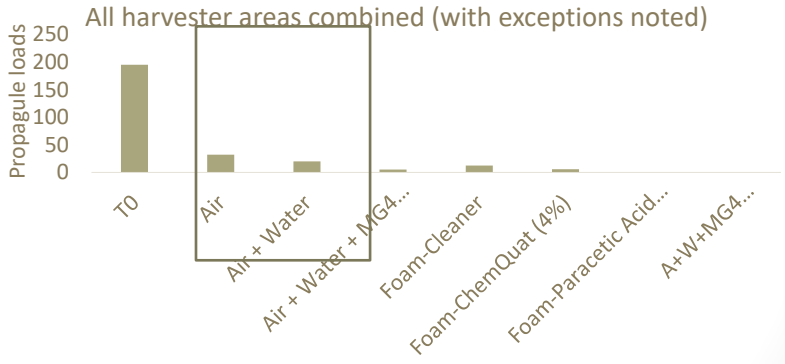
Swett lab data

Harvesters represent a primary risk to spread



Swett lab data

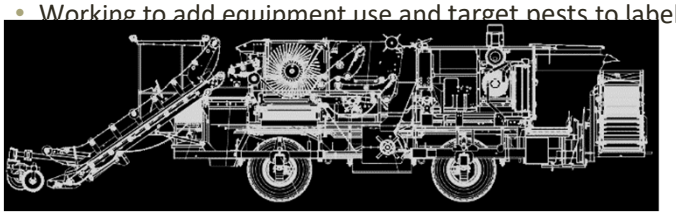
Controlled studies-Air alone reduces microbe propagule loads by ~83%; Pressure wash increased to 90%



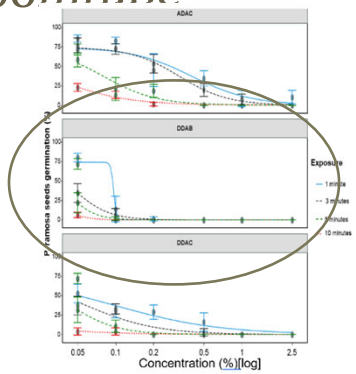
Swett lab data

Quaternary ammonium compounds

- Used in other countries
- Various products available for use in other aspects of food production-processing houses, etc
  - FloQuat, ChemQuat, Mg4 Quat
- Working to add equipment use and target pests to labels

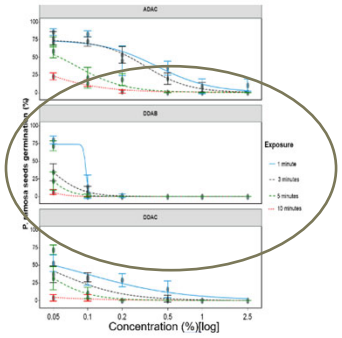


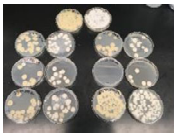
Quaternary ammonium compounds are effective against broomrape

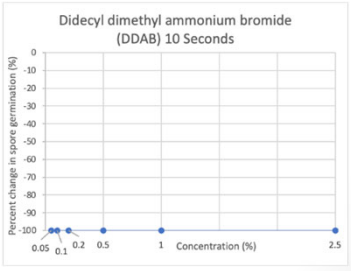


- QACs vary in efficacy
- Optimal compound: DDAB
  - effective with 1 min exposure
  - effective at 0.1% AI

The most effective QACs against broomrape was also the most effective for Fusarium

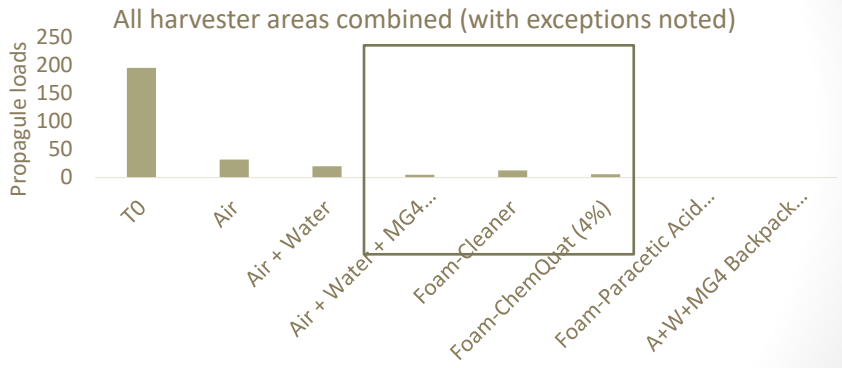






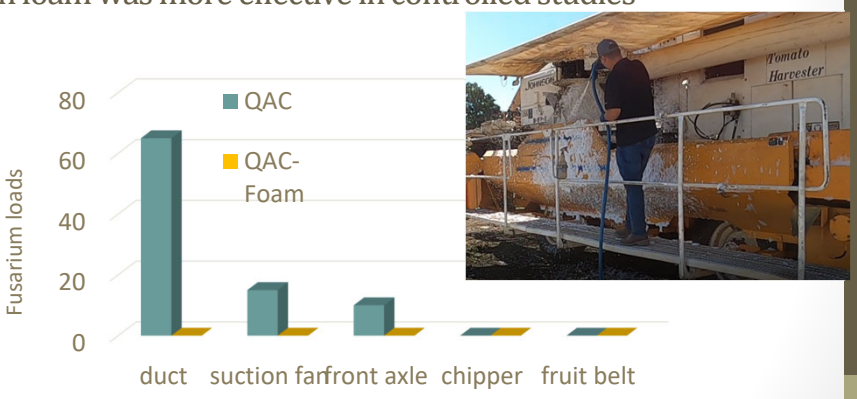
Swett lab data

QAC compounds reduced loads by 97% in controlled studies



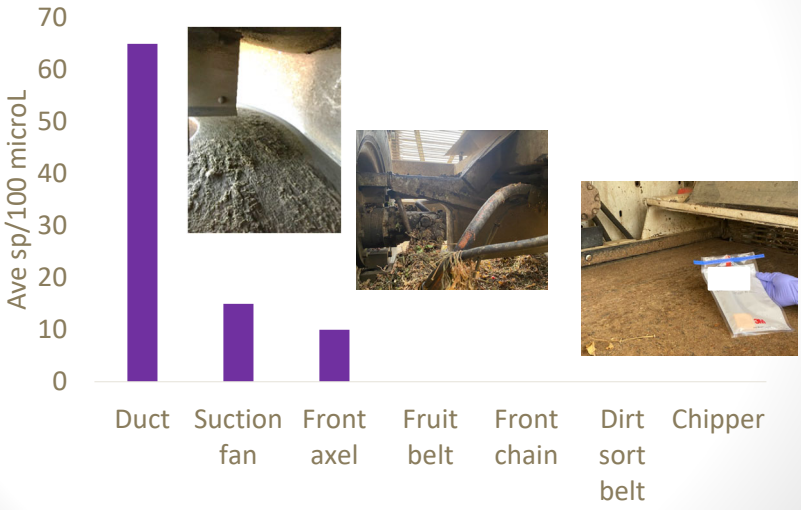
Swett lab data

Use of foamer agents: Across comparable locations, sanitizer in foam was more effective in controlled studies



Swett lab data

Take home #5: sanitizer efficacy varied by location



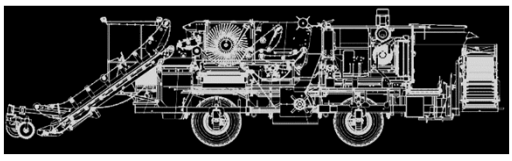
Swett lab data

Time is a critical barrier to effective cleaning

How can we overcome this barrier?
Surveys indicate increased labor will not help

Innovation in wash method to streamline debris removal and sanitizer application

More information on debris load thresholds (how clean it needs to be) may reduce time needed for cleaning



Swett lab data

Harvester Sanitation Best Management Guidelines (version 1.2)

WHERE TO CLEAN?

- A designated area for equipment cleaning, within the field perimeter, should be assigned and solely utilized.
- This area will be an at-risk location for future broomrape emergence if there was seed in the debris removed from the equipment and should be monitored carefully in future crops.

TIME TO CLEAN?

- The time needed for effective cleaning may require restructuring of harvest schedules.
  - Effective cleaning requires removing ALL debris and THEN applying a sanitizer—a process which typically takes 3-4 hours with a standard crew.
  - 1-2 hours of cleaning, no matter how efficient your crew is, is not likely to effectively reduce your risk of pest spread.

CLEANING STEPS:

1. **Remove loose debris –**
   a. Soil and plant debris should be removed from all equipment using compressed air, scrapers, and pressure washers. Any visible plant or soil debris has some risk of containing broomrape seed or fungal spores.
   b. Pay particular attention to the areas that accumulate a lot of debris or are difficult to access.
      - Axles and frame members, suction fan, fan duct, and chipper are all areas that accumulate a lot of debris, are hard to clean, and are of high risk of moving seed or pathogens.
      - In high-risk fields, it may be necessary to remove the fan duct for thorough cleaning.
2. **Pressure wash –**
   a. Remove fine debris, caked-on plant and soil materials, and greasy areas that can harbor seed and pathogens and also inactivate chemical sanitizers.
   b. This is the most important step in the cleaning process. Areas that contain debris when the sanitizer is applied will not be sanitized, since debris deactivates the sanitizer.
3. **Sanitize –**
   a. AFTER CLEANING, apply chemical sanitizers which can kill broomrape seed and fungal or bacterial pathogens.
   b. Quaternary ammonium, NOT BLEACH, is the sanitizing agent which is proven to kill broomrape seed.
      - Locally this can be bought under the labels: Clorox Pro Quaternary, Chem quat, Flo San or MG 4-Quat.
      - A solution of at least 1% is necessary for efficacy and should be used to spray down the equipment after soil and plant debris has been knocked off and pressure washing is completed.
   c. Apply sanitizers to surfaces still wet from pressure washing, or rewet the surfaces before sanitizing to increase contact time and improve efficacy.
4. **Do not rinse –** To provide maximum activity on seed or pathogens, washed and sanitized equipment should be left to dry, not rinsed with water or other cleaning agents.

REMEMBER:

- If seed is underneath or within soil or plant material no cleaning agent, including quaternary ammonium, will be completely effective in killing seed or pathogens.
- No amount, or % of active ingredient, will make up for poorly-cleaned equipment with significant amounts of plant debris and soil. Debris you can see is debris which can and will harbor pests and deactivate your sanitizer.

Sanitation BMP
https://files.constantcontact.com/11ae1167201/df663530-f4cd-4bf4-ae35-f81afa462151.pdf?rdr=true

- April-June 2021 issue of “California Agriculture”
  - Online: https://doi.org/10.3733/ca.2021a0012
- Plants (2022 special issue on parasitic weeds)
  - https://www.mdpi.com/2223-7747/11/3/438


plants

MDPI

Article

Evaluating Branched Broomrape (*Phelipanche ramosa*) Management Strategies in California Processing Tomato (*Solanum lycopersicum*)

Matthew J. Fatino * and Bradley D. Hanson

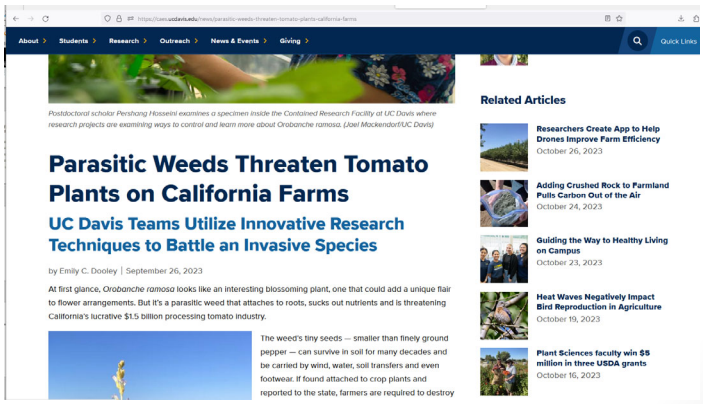

REVIEW

The potential threat of branched broomrape for California processing tomato: A review

After a 40-year absence, branched broomrape has reappeared in commercial California tomato fields, raising concern and prompting the search for Integrated approaches to management.

Abstract

- https://caes.ucdavis.edu/news/parasitic-weeds-threaten-tomato-plants-california-farms
- Online September 26, 2023



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Postdoctoral scholar Pershang Hosseini examines a specimen inside the Contained Research Facility at UC Davis where research projects are examining ways to control and learn more about Orobanche ramosa. (Joel Mackendorf/UC Davis)

Parasitic Weeds Threaten Tomato Plants on California Farms

UC Davis Teams Utilize Innovative Research Techniques to Battle an Invasive Species

by Emily C. Dooley | September 26, 2023

At first glance, *Orobanche ramosa* looks like an interesting blossoming plant, one that could add a unique flair to flower arrangements. But it's a parasitic weed that attaches to roots, sucks out nutrients and is threatening California's lucrative $1.5 billion processing tomato industry.

The weed's tiny seeds — smaller than finely ground pepper — can survive in soil for many decades and be carried by wind, water, soil transfers and even footwear. If found attached to crop plants and reported to the state, farmers are required to destroy

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