Branched broomrape management research update

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- Cassandra Swett, Justine Beaulieu (UC Davis Plant Path)

University of California
Agriculture and Natural Resources

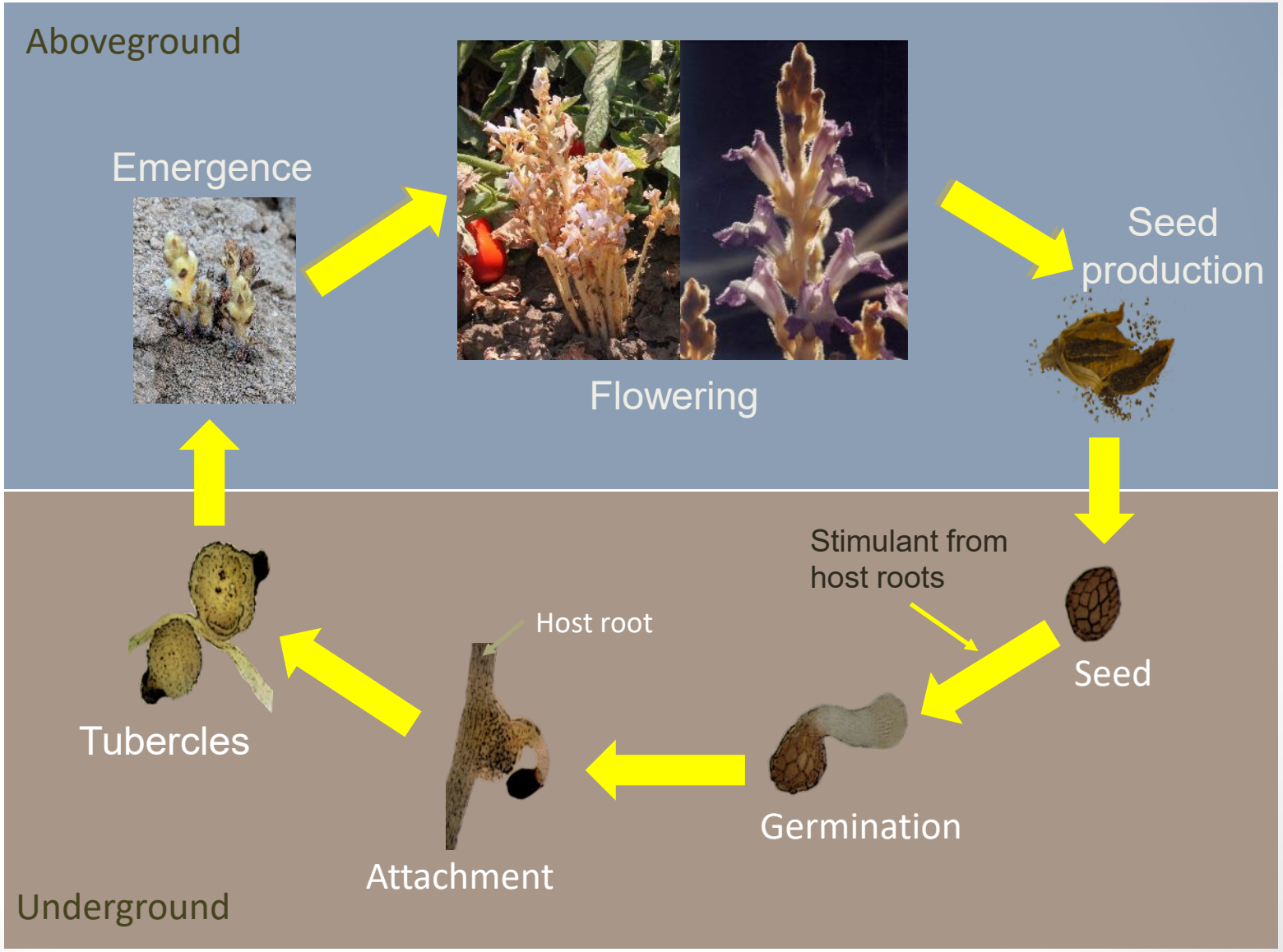
UCDAVIS
DEPARTMENT OF PLANT SCIENCES
College of Agricultural and Environmental Sciences

CA tomato conf
Napa, CA
11-13-23

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

Lifecycle


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

Current management plan in CA

- Scouting, reporting, quarantine, crop destruct…

- We do not currently have data on suppression/control of branched or Egyptian broomrape with CA-registered pesticides
  - Both species have been detected in conventional processing tomato fields; suggests little (or incomplete) efficacy of registered herbicide programs
  - Quarantine treatments are based on soil fumigation
- Minimizing spread will be key in the short-term
- Will need to develop mitigation approaches for our systems

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

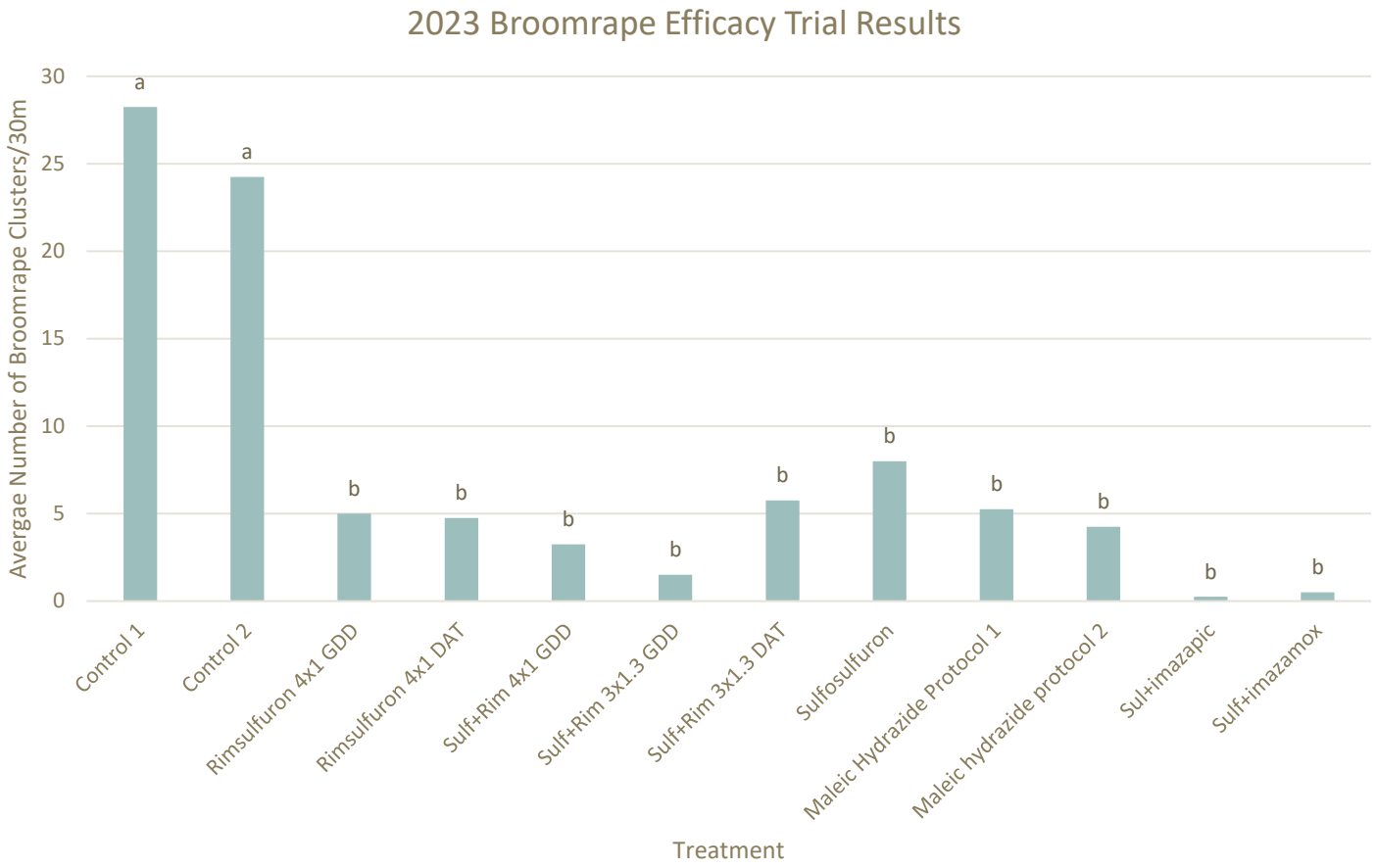
CA field trials 2022

Matt Fatino

Broomrape suppression (CA 2022)

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



- **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

AGRIAN by TELUS Agriculture

RESULTS | DETAILS

5 Results Found For: **matrix**

Matrix SG

General | Crop Specific | Documents | Safety | Registration | Mfg. Info

- Label - CD02-628-020
- MSDS/SDS - 04/01/2022 CD03-628-020

Supplemental Documents All States | All Commodities

- Section 24c - CA - For Management of Broomrape in Tomatoes
- Supplemental Label - FOR USE IN BLUEBERRIES, RASPBERRIES & BLACKBERRIES (Expires 2024-04-01)

CORTEVA™ agriscience

RIMSULFURON	GROUP	2	HERBICIDE

FIFRA Section 24(c) Special Local Need (SLN) Label

FOR DISTRIBUTION AND USE ONLY WITHIN THE STATE OF CALIFORNIA

For management of broomrape in tomatoes

Matrix SG

EPA Reg No. 352-768 **SLN # 303093**

ATTENTION

- It is a violation of Federal law to use this product in a manner inconsistent with its labeling.
- This labeling must be in the possession of the user at the time of application.
- Follow all applicable directions, restrictions, Worker Protection Standard requirements and precautions on the EPA registered label for Matrix SG (352-768).

Chemigation

UC WEED SCIENCE
Weed control, management, ecology, and minutia

UC ANR

UCANR: Safeguarding abundant and healthy food for all Californians

Rimsulfuron 24c registration for broomrape management in tomato

Author: Bradley Hanson

Published on: October 7, 2022

One of the largest weed issues affecting the California processing tomato industry is the parasitic plant, branched broomrape (Phelipanche ramosa; Orobanche ramosa)

- https://ucanr.edu/blogs/blogcore/postdetail.cfm?postnum=50241
- https://ucanr.edu/blogs/blogcore/postdetail.cfm?postnum=47701
- https://ucanr.edu/blogs/blogcore/postdetail.cfm?postnum=43342

Last week, CDPR issued a positive decision on a 24c "Special Local Needs" label request to allow application of rimsulfuron (Matrix SG) via chemigation through subsurface drip irrigation systems. This newly-allowed use pattern should be helpful for suppression of broomrape in tomato.

The CDPR decision was posted here: https://www.cdpr.ca.gov/docs/registration/nod/nodmenu.htm and is in Report 2022-39 for the Week of September 30, 2022. I've also attached it to the bottom of this blog post.

Rimsulfuron is widely used in tomato in California both as PRE and early POST herbicide for control of many weeds. The 24c label simply adds a new application method that is targeted specifically at the broomrapes which are parasites that attached to the root of tomatoes and other host plants. The new use pattern puts the herbicide right in the rootzone of the tomato plant at the time when broomrape seeds are germinating and the seedlings just attaching to the host.

The protocol for this specific use is three applications of rimsulfuron; one at early bloom and two more at 10-15 d intervals thereafter. Each of the three applications should be 1.33 oz product (25% WDG) which equates to the yearly max allowed on the Section 3 label.

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- August 2022

Feeds

September 20, 2022

FIFRA 24(c) Special Local Need Label (SLN)
For distribution and use only in the state of California

For use on Tomatoes for control of Broomrape (*Phelipanche ramosa* and *aegyptiaca*) through

Location: Statewide

Crop/Site/Commodity: Tomatoes

EPA

Targe

Manu

Dosag

Diluti

Restricted

Metho

Preharvest

Other Requ

Chemigat

- Appl
  prod

Frequency/Timing of Application: A total of 3 applications must be used for weed control. Make the first application at early bloom and repeat at 10 to 15 day intervals for a maximum of 3 applications.

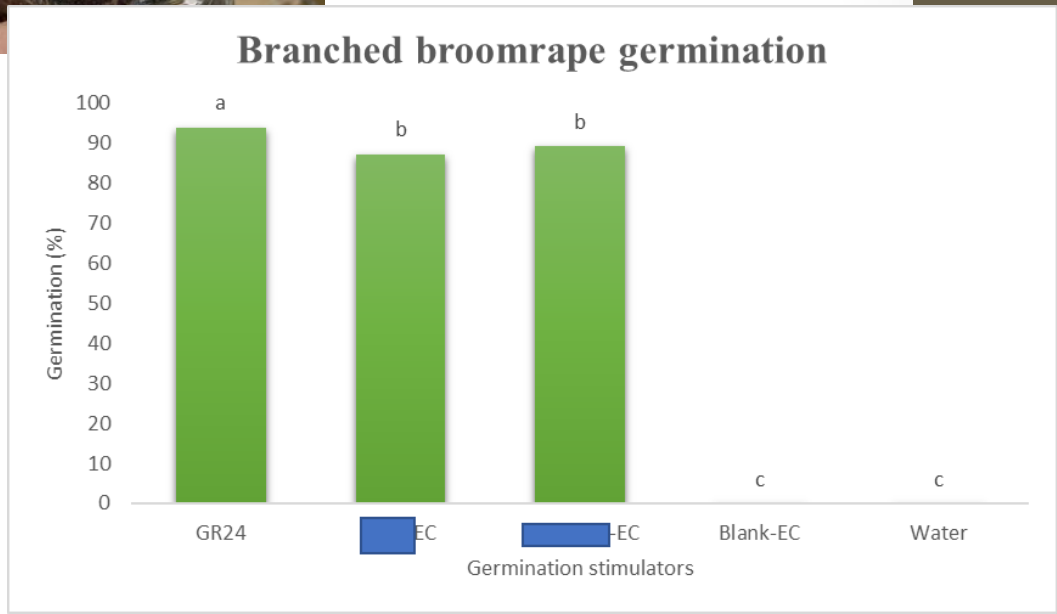
Specific Use Restrictions:

1. Do not make more than 3 applications per acre per year.
2. Do not apply more than 4.0 ounces of product per acre per year.
3. Tomatoes treated under this SLN cannot be combined with treatments allowed under the Section 3 product label for this product on tomatoes.
4. Do not apply to tomatoes grown in greenhouses.
5. This SLN can only be used for control of broomrape (*Phelipanche ramosa* and *aegyptiaca*).

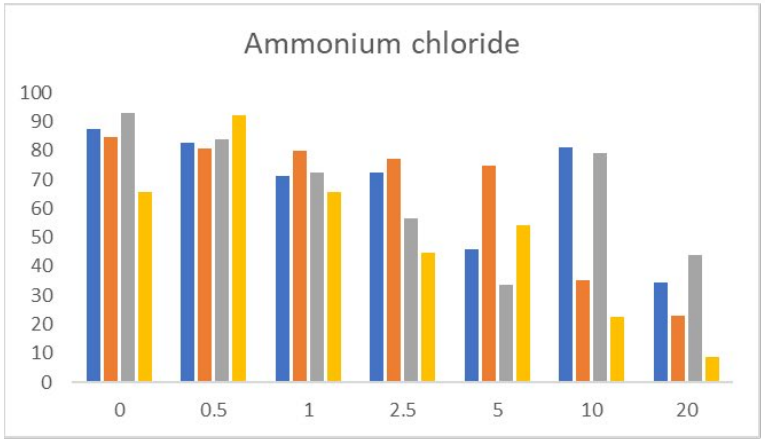
Phenology modeling

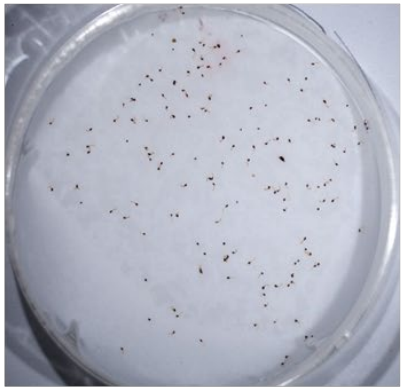
Glass-front rhizotrons for evaluating broomrape germination, attachment, turbucle formation, emergence.

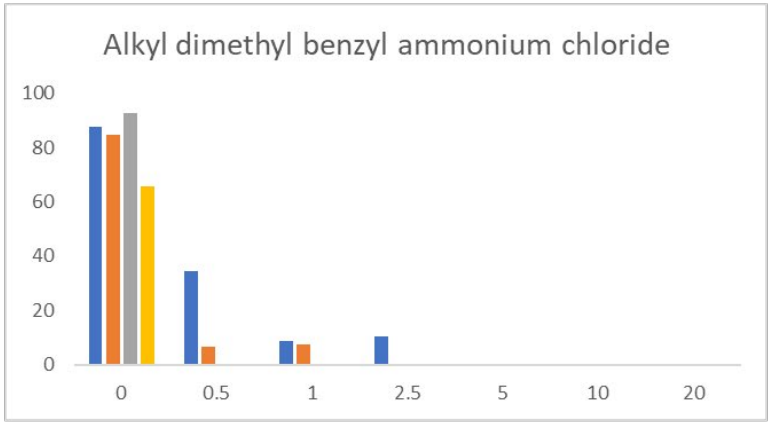
Germination stimulation studies



CRF projects

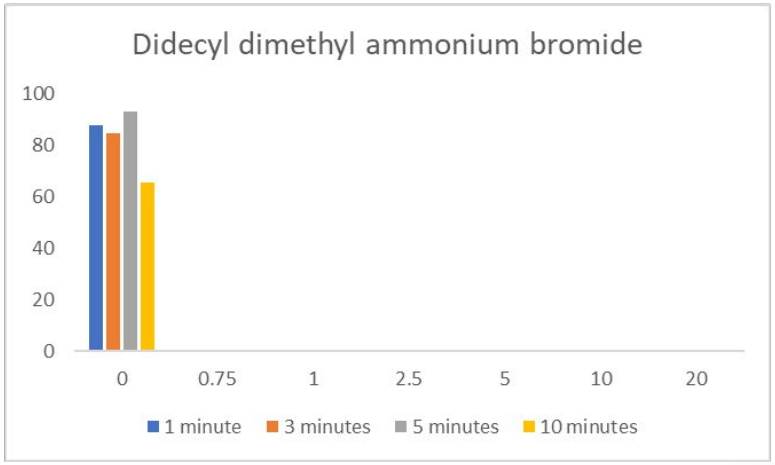






Check w local ag commissioner re quat use for this purpose

Pershang Hosseini



QAC activity studies

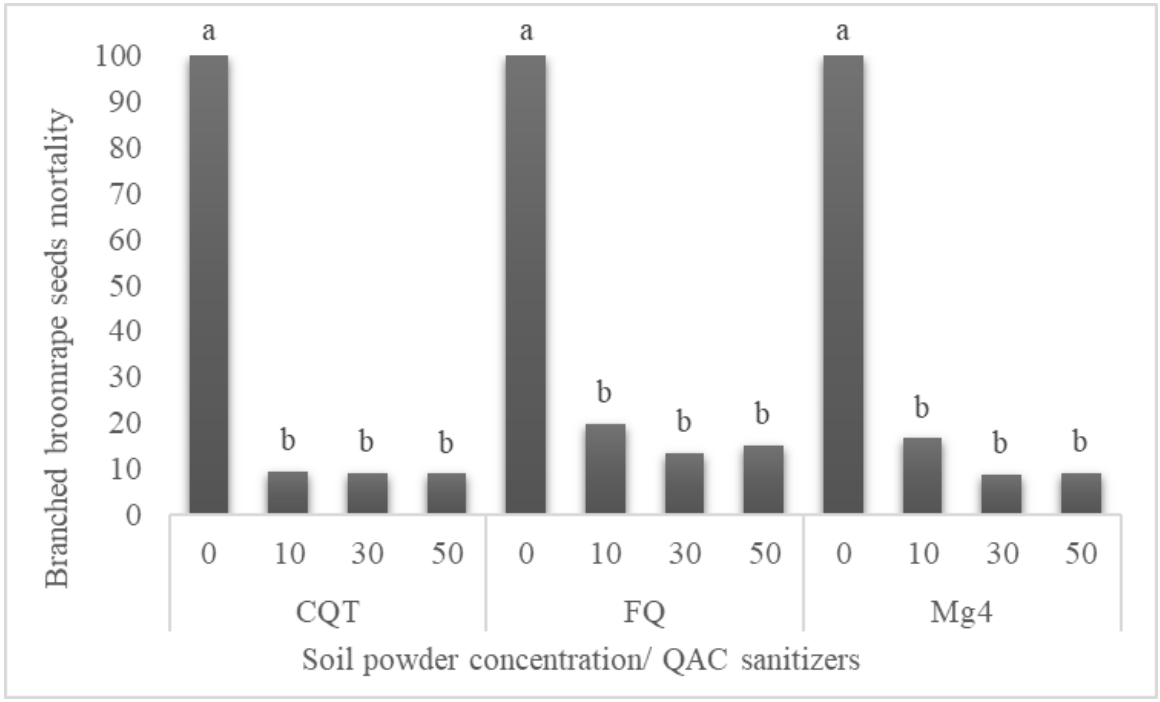


Figure 1. While commercial quaternary ammonium compounds kill 100% of broomrape seeds in the absence of debris, in the presence of even low amounts of soil these same sanitizers only kill 5-20% of seeds.

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

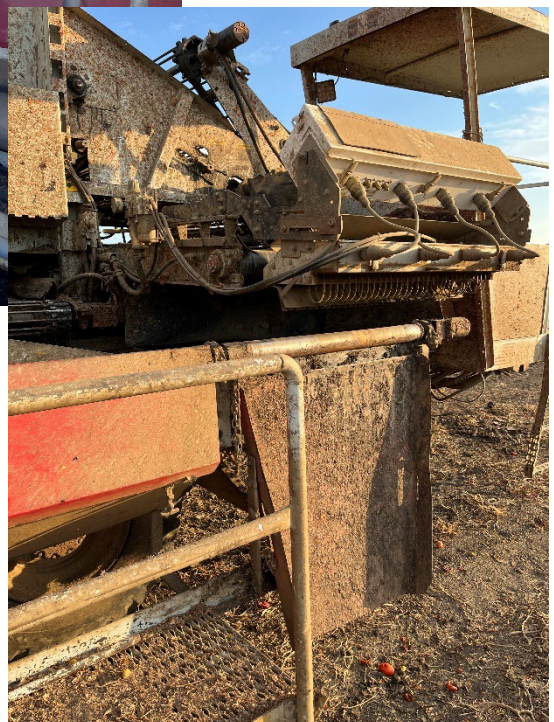
Fanterra

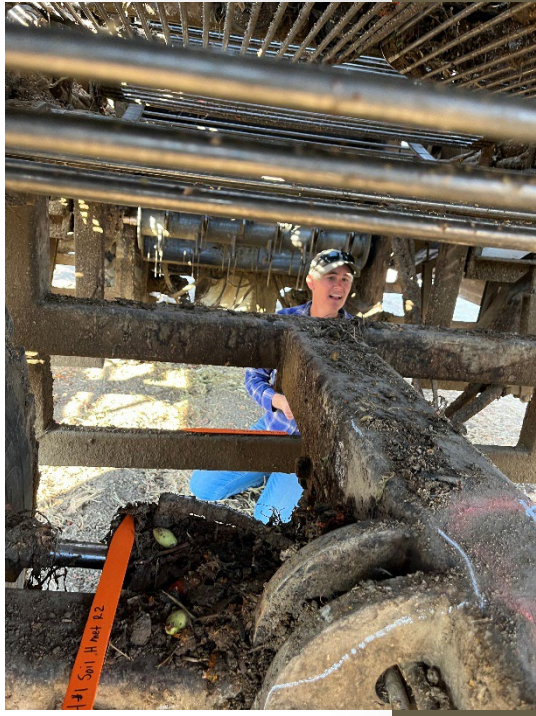
"We keep the promises they make"

BARRIOS FARMS INC.

California Tomato Research Institute

Equipment sanitation (AKA Project Clean Machine)



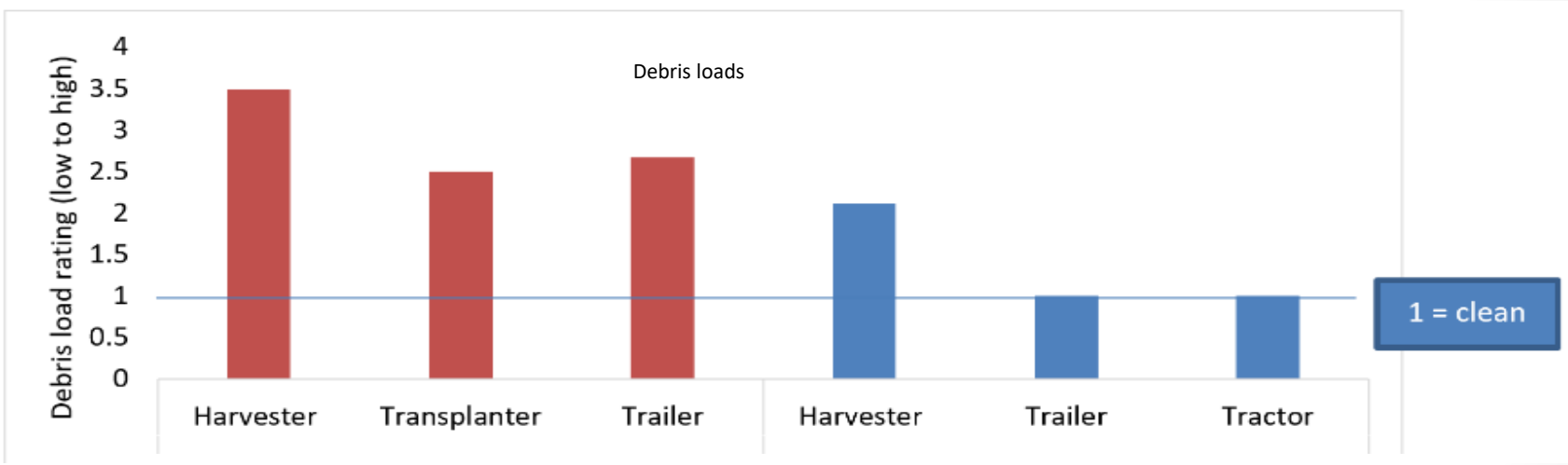


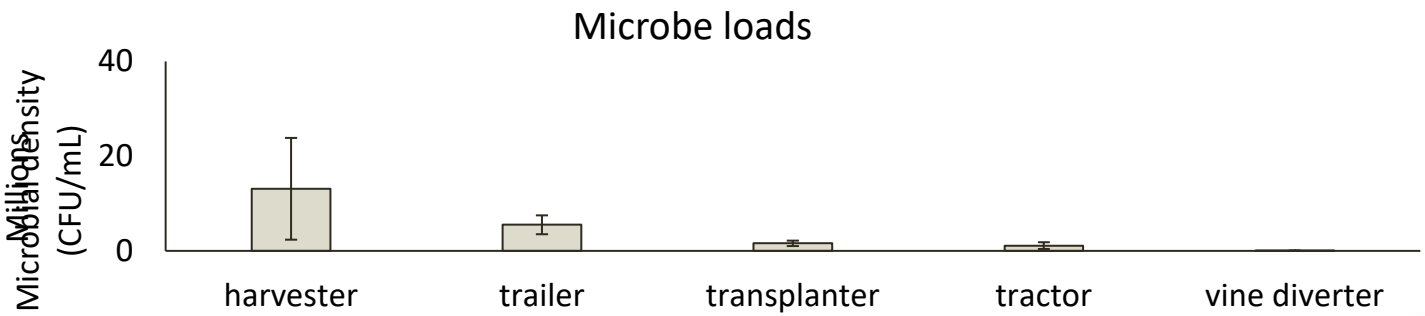
Research efforts to develop equipment sanitation methods to mitigate spread of soil borne pests

- 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

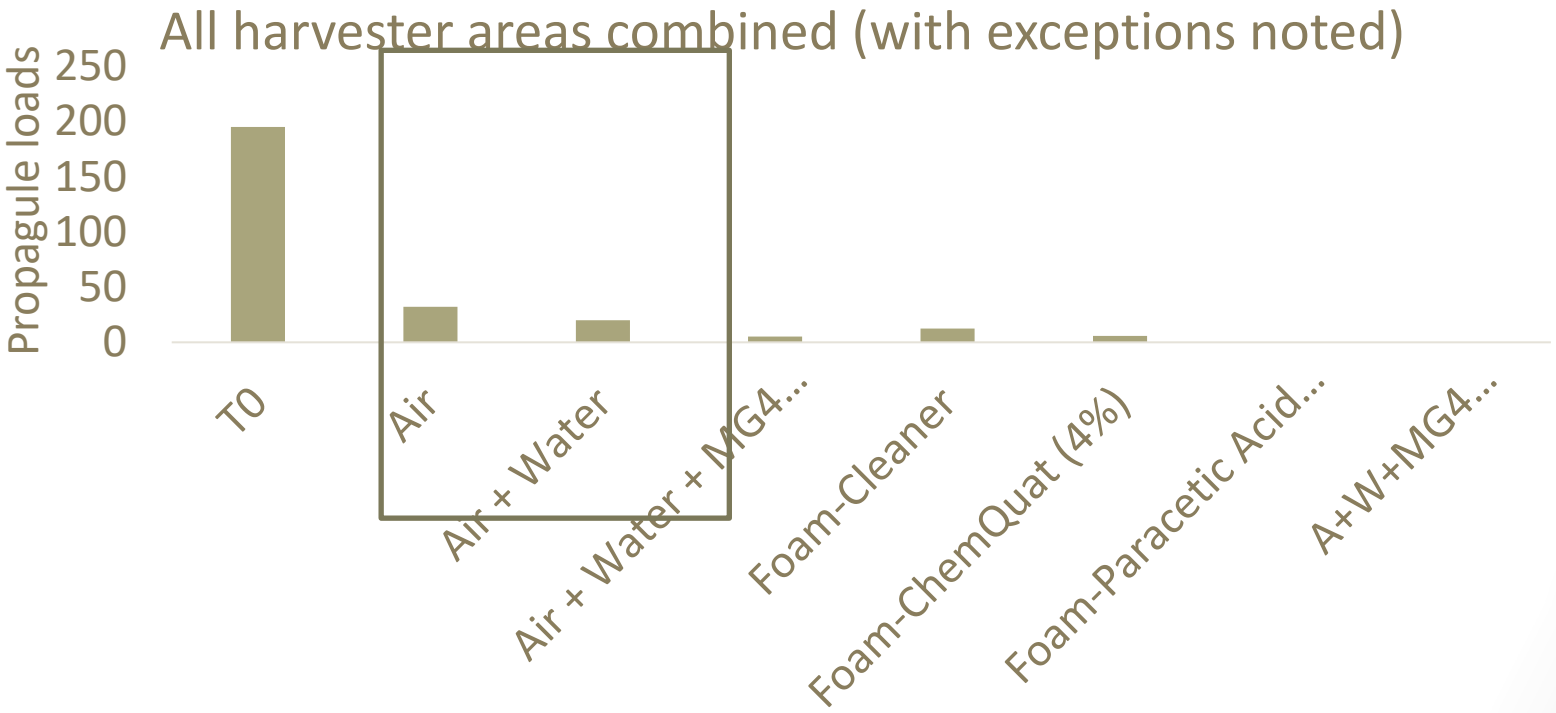
Harvesters represent a primary risk to spread





Swett lab data

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

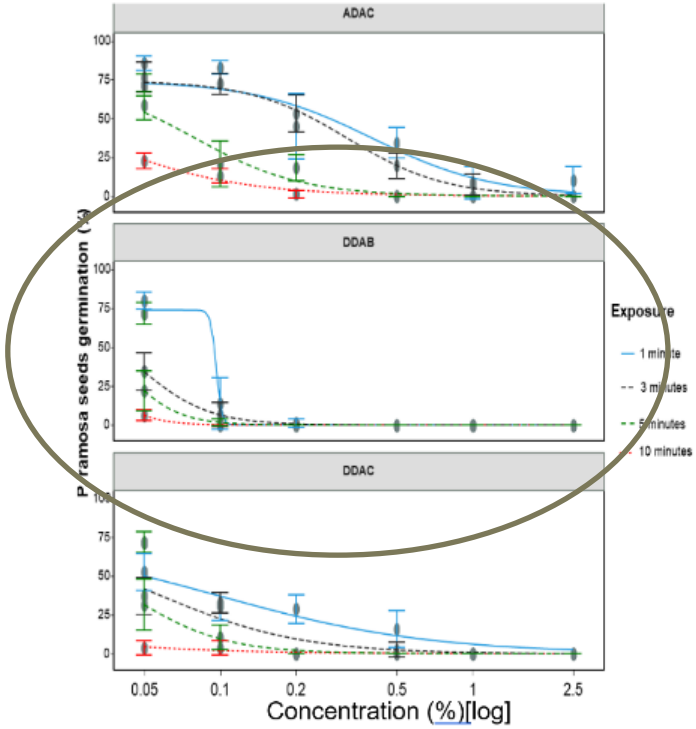


Swett lab data

Quaternary ammonium compounds

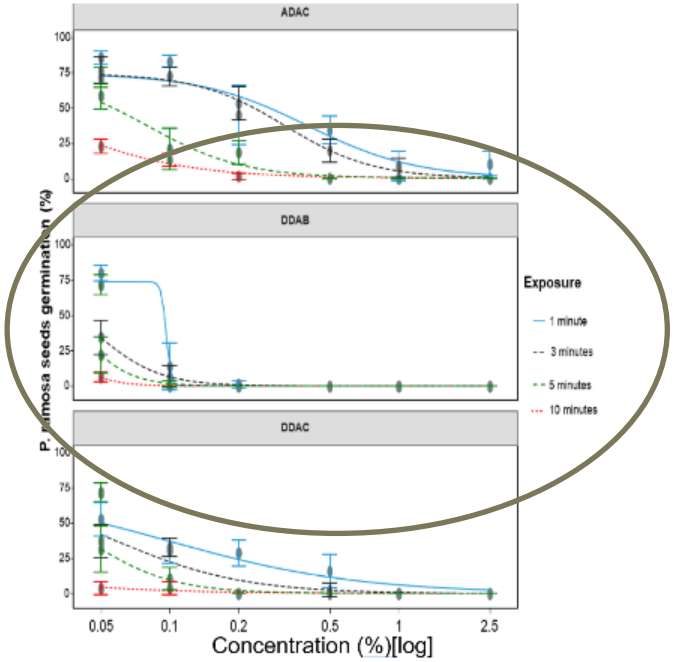
- Used in other countries
- Various products available for use in other aspects of food production-processing houses, etc
  - FloQuat, ChemQuat, Mg4 Quat
- Working to add equipment use and target pests to labels

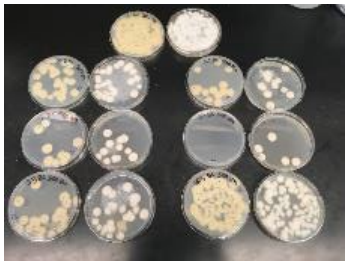
Quaternary ammonium compounds are effective against broomrape

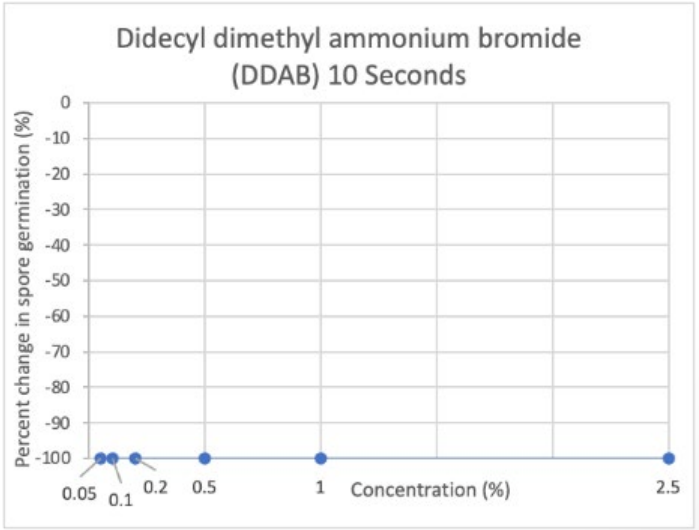


- QACs vary in efficacy
- Optimal compound: DDAB
  - effective with 1 min exposure
  - effective at 0.1% AI

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

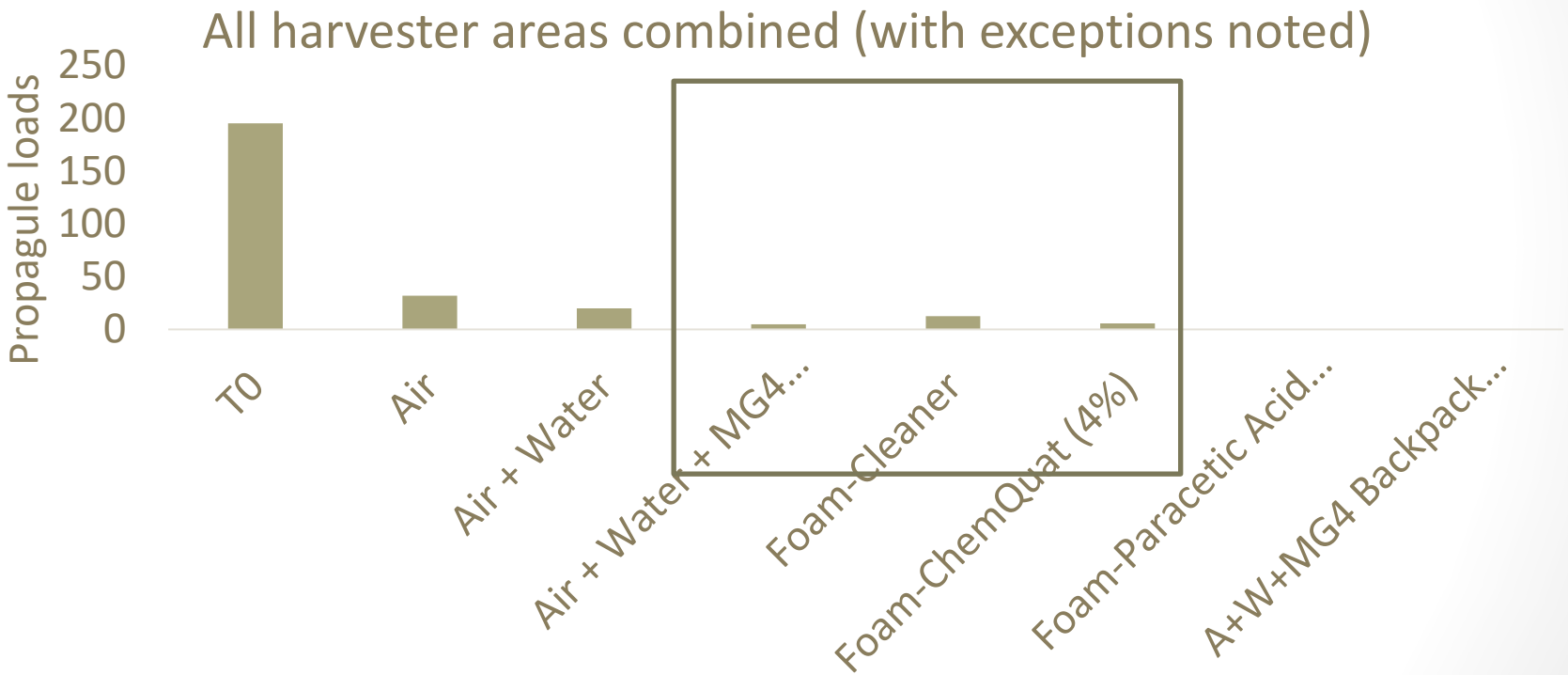






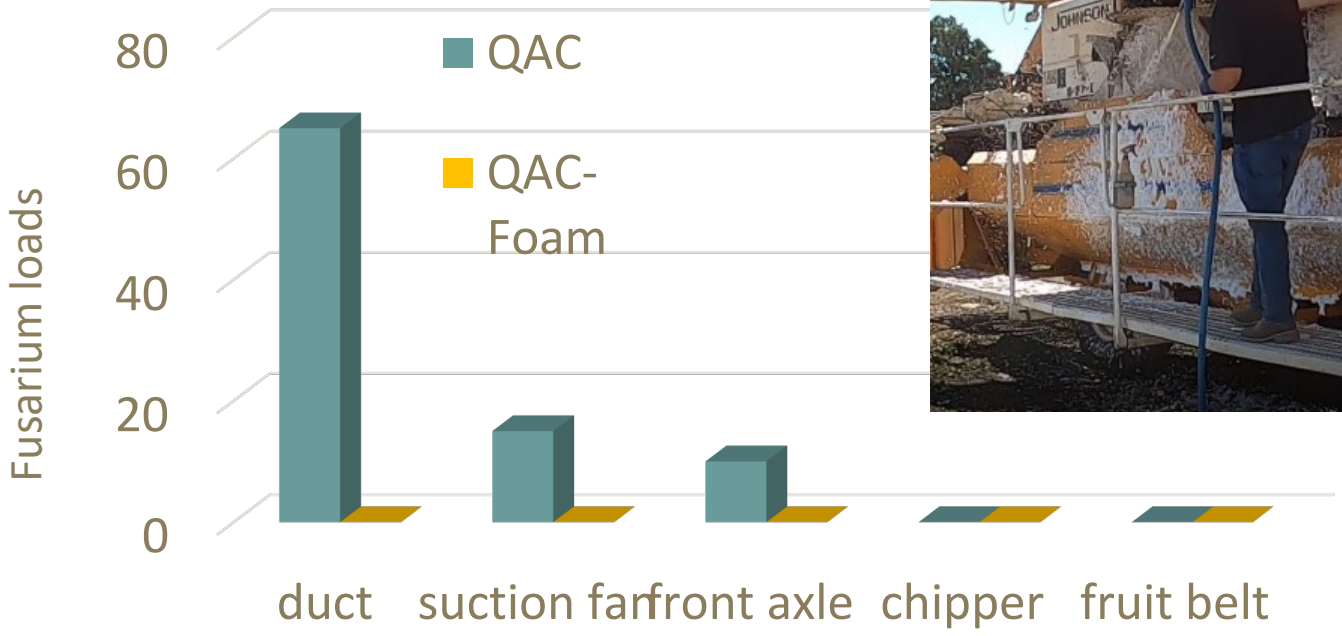
Swett lab data

QAC compounds reduced loads by 97% in controlled studies



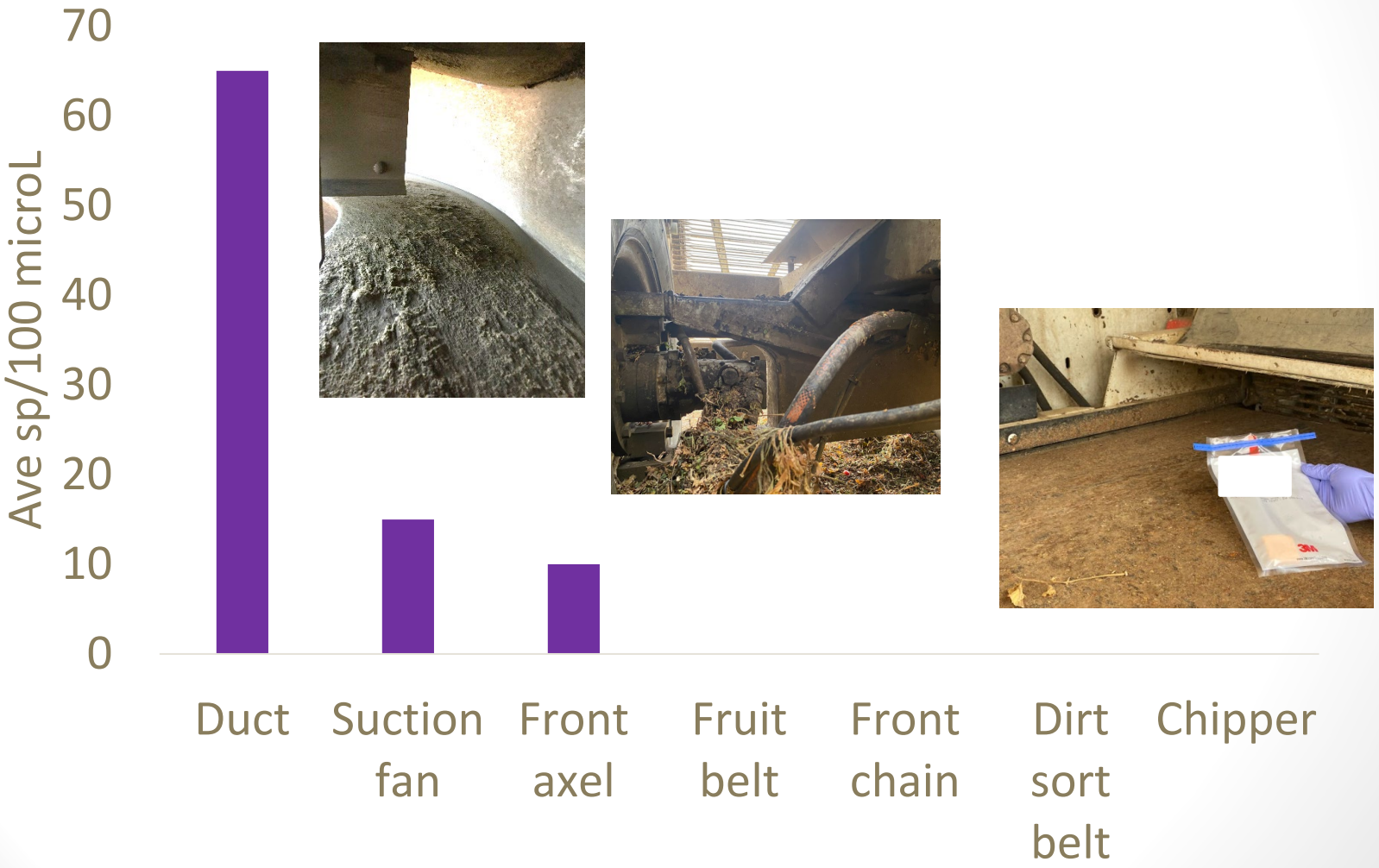
Swett lab data

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



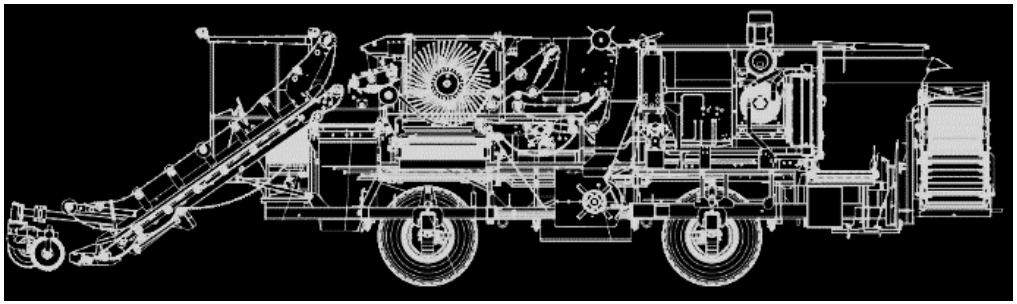
Swett lab data

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

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http://ucanr.org/blogs/UCDWeedScience/

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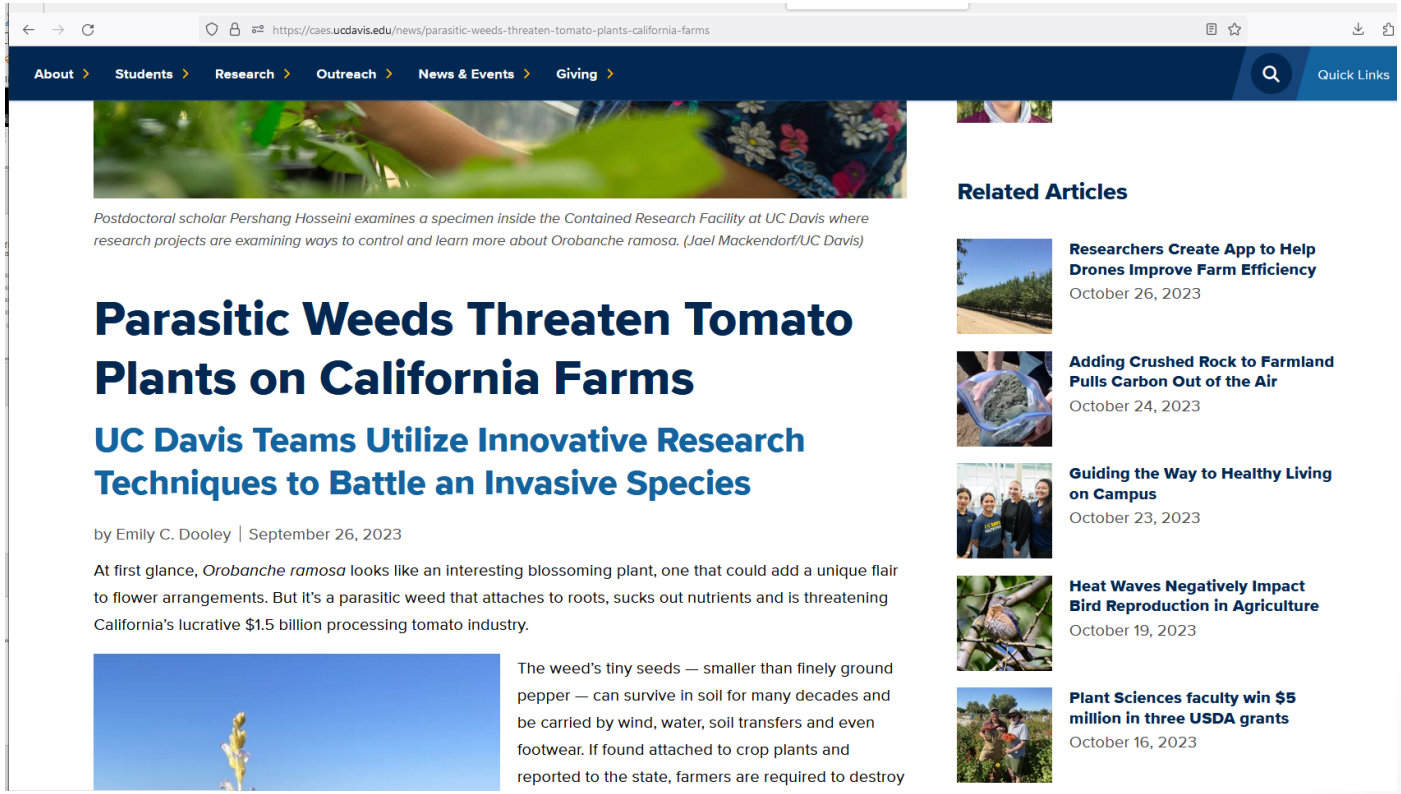
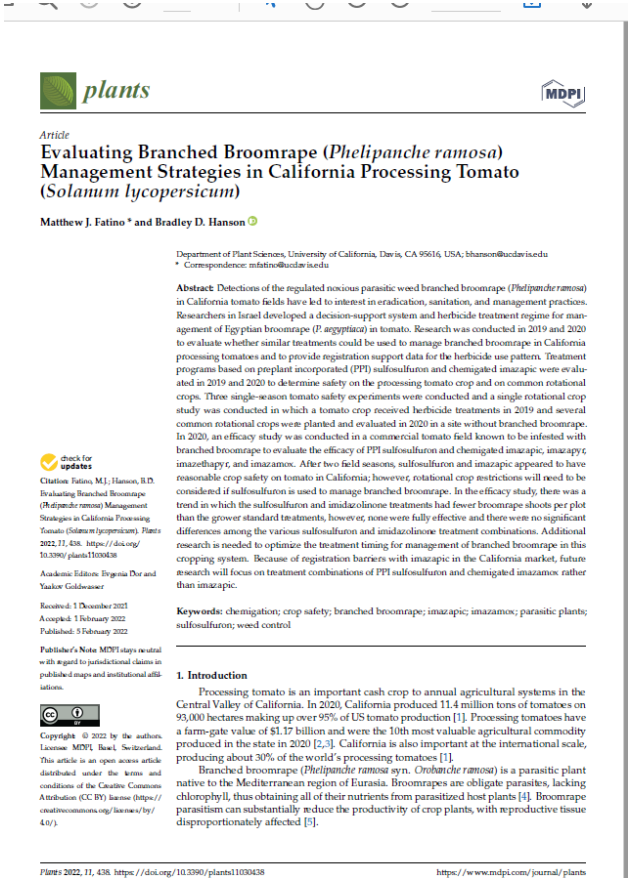
- https://caes.ucdavis.edu/news/parasitic-weeds-threaten-tomato-plants-california-farms
- Online September 26, 2023



- 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

Department of Plant Sciences, University of California, Davis, CA 95616, USA; bhanson@ucdavis.edu
* Correspondence: mfatino@ucdavis.edu

Abstract: Detections of the regulated noxious parasitic weed branched broomrape (*Phelipanche ramosa*) in California tomato fields have led to interest in eradication, sanitation, and management practices. Researchers in Israel developed a decision-support system and herbicide treatment regime for management of Egyptian broomrape (*P. aegyptiaca*) in tomato. Research was conducted in 2019 and 2020 to evaluate whether similar treatments could be used to manage branched broomrape in California processing tomatoes and to provide registration support data for the herbicide use pattern. Treatment programs based on preplant incorporated (PPI) sulfosulfuron and chemigated imazapic were evaluated in 2019 and 2020 to determine safety on the processing tomato crop and on common rotational crops. Three single-season tomato safety experiments were conducted and a single rotational crop study was conducted in which a tomato crop received herbicide treatments in 2019 and several common rotational crops were planted and evaluated in 2020 in a site without branched broomrape. In 2020, an efficacy study was conducted in a commercial tomato field known to be infested with branched broomrape to evaluate the efficacy of PPI sulfosulfuron and chemigated imazapic, imazapyr, imazethapyr, and imazamox. After two field seasons, sulfosulfuron and imazapic appeared to have reasonable crop safety on tomato in California; however, rotational crop restrictions will need to be considered if sulfosulfuron is used to manage branched broomrape. In the efficacy study, there was a trend in which the sulfosulfuron and imidazolinone treatments had fewer broomrape shoots per plot than the grower standard treatments, however, none were fully effective and there were no significant differences among the various sulfosulfuron and imidazolinone treatment combinations. Additional research is needed to optimize the treatment timing for management of branched broomrape in this cropping system. Because of registration barriers with imazapic in the California market, future research will focus on treatment combinations of PPI sulfosulfuron and chemigated imazamox rather than imazapic.

Keywords: chemigation; crop safety; branched broomrape; imazapic; imazamox; parasitic plants; sulfosulfuron; weed control

check for updates

Citation: Fatino, M.J.; Hanson, B.D. Evaluating Branched Broomrape (*Phelipanche ramosa*) Management Strategies in California Processing Tomato (*Solanum lycopersicum*). *Plants* **2022**, *11*, 438. https://doi.org/10.3390/plants11030438

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1. Introduction

Processing tomato is an important cash crop to annual agricultural systems in the Central Valley of California. In 2020, California produced 11.4 million tons of tomatoes on 93,000 hectares making up over 95% of US tomato production [1]. Processing tomatoes have a farm-gate value of $1.17 billion and were the 10th most valuable agricultural commodity produced in the state in 2020 [2,3]. California is also important at the international scale, producing about 30% of the world's processing tomatoes [1].

Branched broomrape (*Phelipanche ramosa* syn. *Orobanche ramosa*) is a parasitic plant native to the Mediterranean region of Eurasia. Broomrapes are obligate parasites, lacking chlorophyll, thus obtaining all of their nutrients from parasitized host plants [4]. Broomrape parasitism can substantially reduce the productivity of crop plants, with reproductive tissue disproportionately affected [5].

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.

by O. Adewale Osipitan, Bradley D. Hanson, Yaakov Goldwasser, Matthew Fatino and Mohsen B. Mesgaran

Online: https://doi.org/10.3733/ca.2021a0012

Abstract

Branched broomrape (*Phelipanche ramosa*), a parasitic weed that was the focus of a $1.5 million eradication effort four decades ago in California, has recently re-emerged in tomato fields in several Central Valley counties. Processing tomatoes are important to the California agricultural economy; the state produced over 90% of the 12 million tons of tomatoes grown in the United States in 2018. Branched broomrape is listed as an "A" noxious weed by the California Department of Food and Agriculture (CDFA); discovery of broomrape in California tomato fields leads to quarantine and crop destruction without harvest, resulting in significant economic loss to growers. In countries where broomrape is common, yield reductions caused by this parasitic weed can range from moderate to 80%, depending upon the infestation level, host and environmental conditions. Developing a detailed understanding of the biology of this weed under local conditions is an important step towards developing effective management plans for California. In this review, we discuss branched broomrape in the context of California production systems, particularly of tomato. We also discuss the potential management practices that could help to prevent or reduce the impacts of branched broomrape in tomatoes and other host crops.

Processing tomatoes are important to the California agricultural economy; in 2018, California accounted for over 90% of the 12 million tons of tomatoes grown in the United States (USDA NASS 2019). Some of the most potentially damaging pests of tomato include the weedy broomrapes (*Orobanche* and *Phelipanche* spp.), which have recently made an appearance in several California tomato fields after a 40-year hiatus. While broomrape is not currently at levels that can impact yield, presence in a field causes a large economic loss to growers because of the weed's status as a quarantine pest. The establishment and spread of broomrape in California tomato production regions could cause severe consequences for individual growers and the entire tomato industry.

Broomrapes are obligate root parasitic plants that can cause devastating damage to tomatoes and many other economically important broadleaf crops. These weeds use a modified root, called a haustorium, to fuse into a host plant root and extract nutrients and water. This greatly reduces productivity and sometimes kills the host. Globally, seven broomrape species have been identified that can cause damage to crops. Of

UC Davis graduate student researcher Matthew Fatino and Emeritus UC Cooperative Extension Farm Advisor Gene Miyao conduct early season scouting for branched broomrape in a field trial at a commercial processing tomato field site. *Photo:* Bradley Hanson.