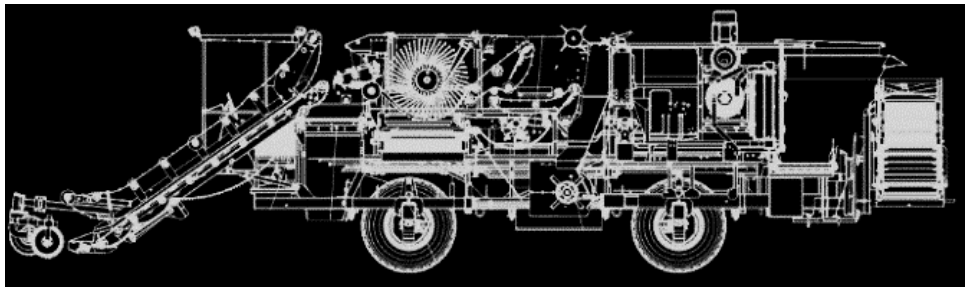


Developing data on best management practices for equipment sanitation to reduce spread of broomrape and other soil borne pests

Cassandra Swett, Megan Gastelum, Kacey Zimmerman, Kelley Paugh, Swett Lab et al., UCD Dept. of Plant Pathology

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

Zach Bagley, CTRI director

Carlos Zatarain and Tony Terranova, AnTerra Group

anterra

"We keep the promises they make"

California Food Producers

California Tomato Research Institute

AKA Team Clean Machine

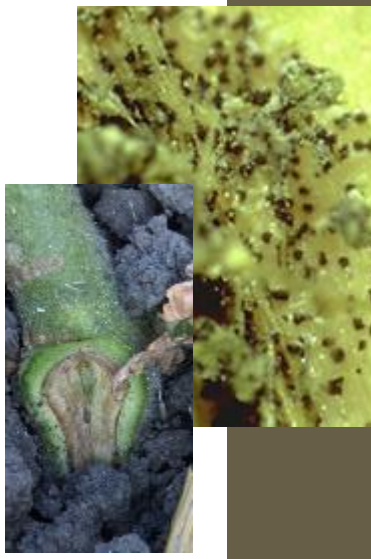
Soil-borne pests spread from field to field on agricultural equipment

Broomrape

G. Miyao

Southern blight

Verticillium



Fusarium wilt and rot diseases

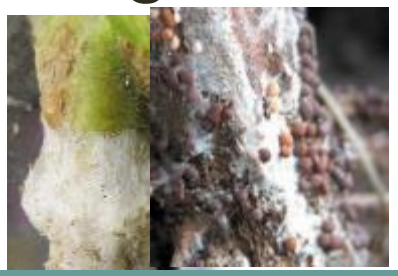
Clavibacter (bac canker)

Root knot nematode

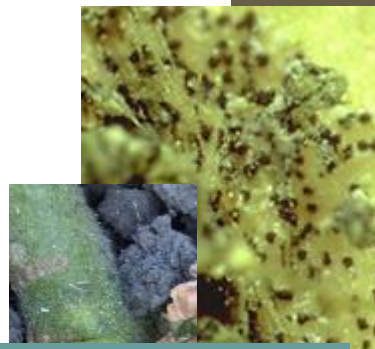
Soil-borne pathogens and other pests spread from field to field on agricultural equipment

Broomrape

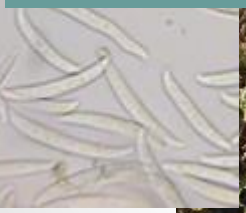
Southern blight

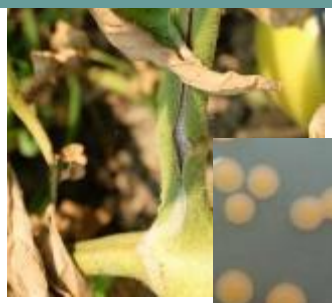


Verticillium



No Best Management Practices (BMPs) have been developed to mitigate pest spread on agricultural equipment

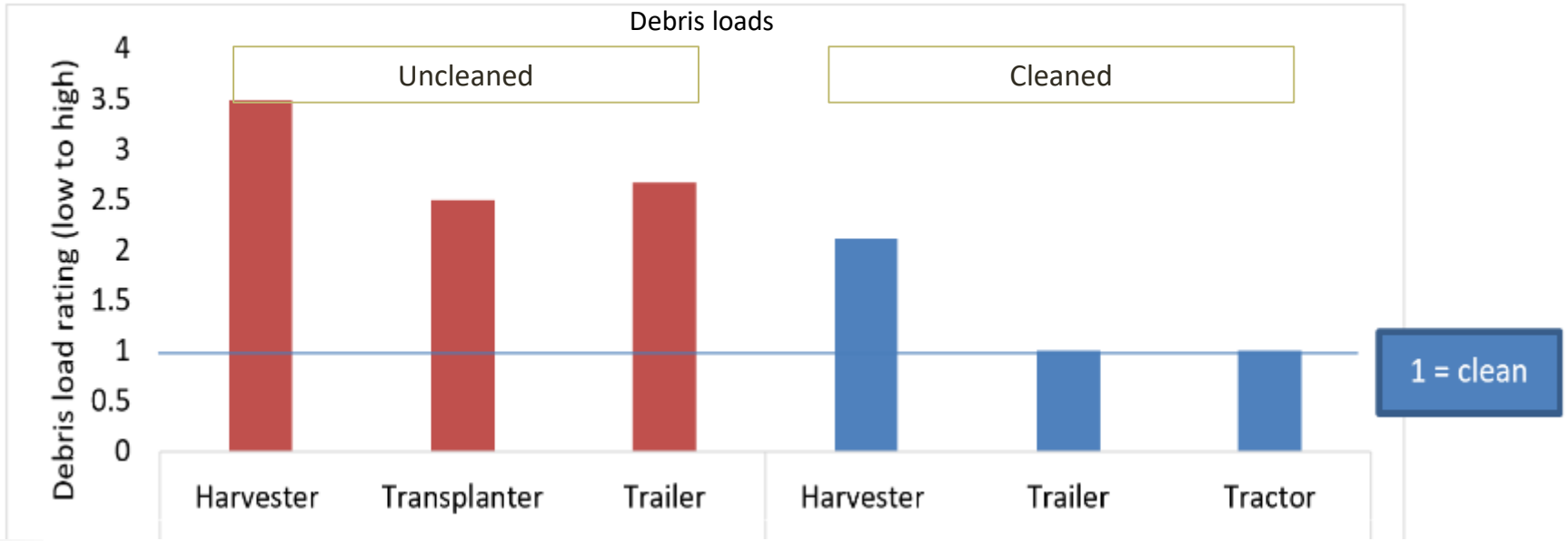


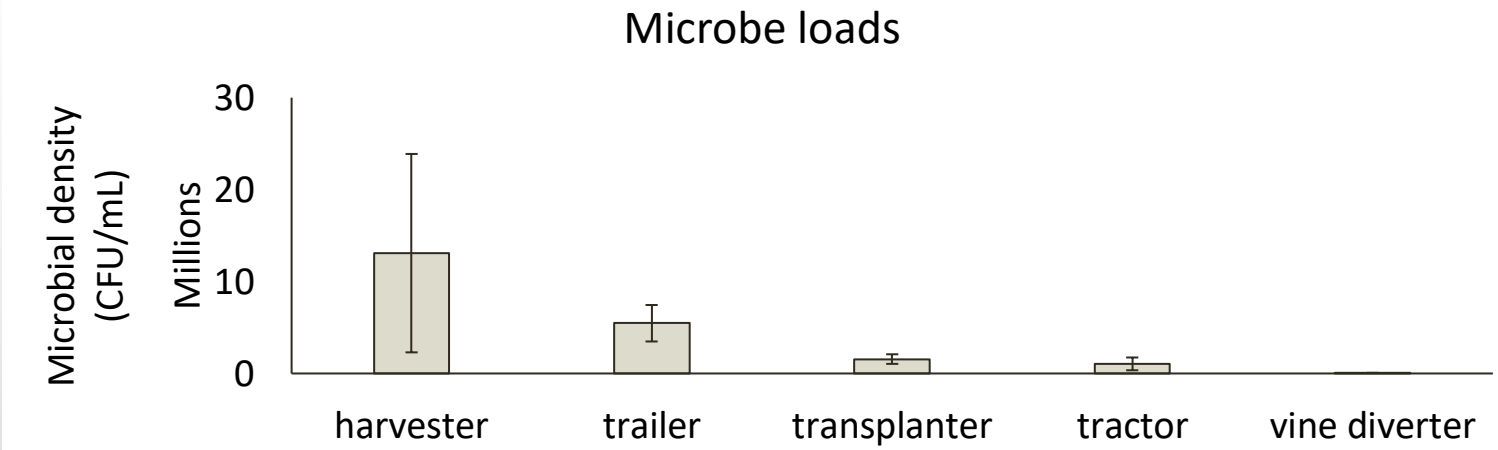


Research efforts aim to develop data on effective field equipment sanitation methods to mitigate pest spread

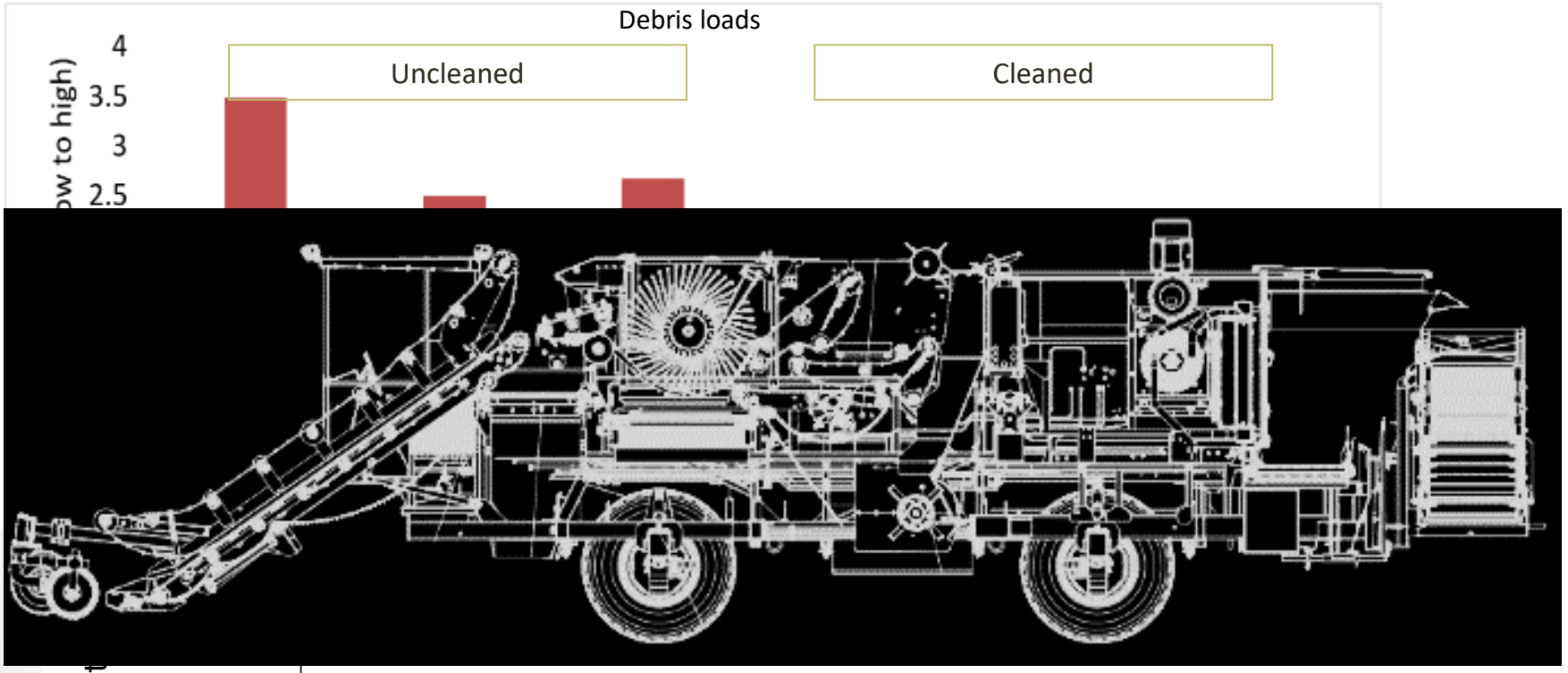
- Data on efficacy of sanitizers
  - Against broomrape
  - And also against other pests
- Data on efficacy of cleaning methods
  - Physical
  - Chemical
  - Identification of critical control points
- Work with CTRI to develop BMPs
  - As these are new practices, consult with your county ag commissioner on use of specific products
    - Brad and I are not a licensed PCAs and cannot make recommendations

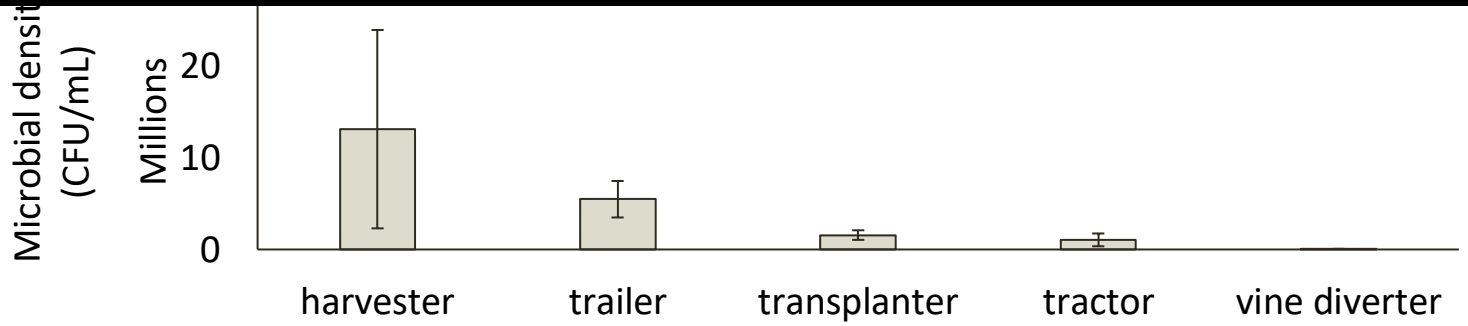
Harvesters represent the primary risk to spread





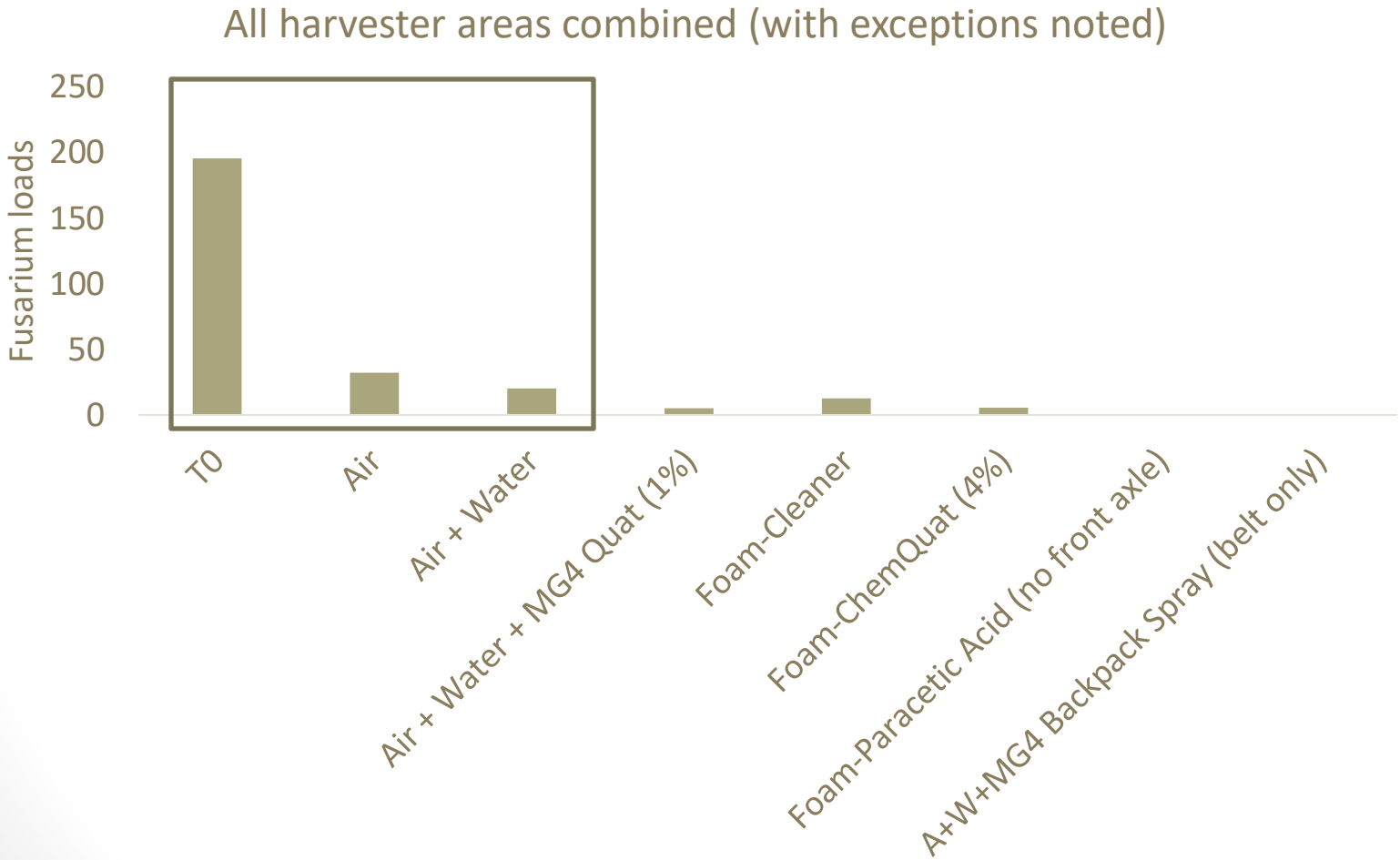
Harvesters represent the primary risk to spread





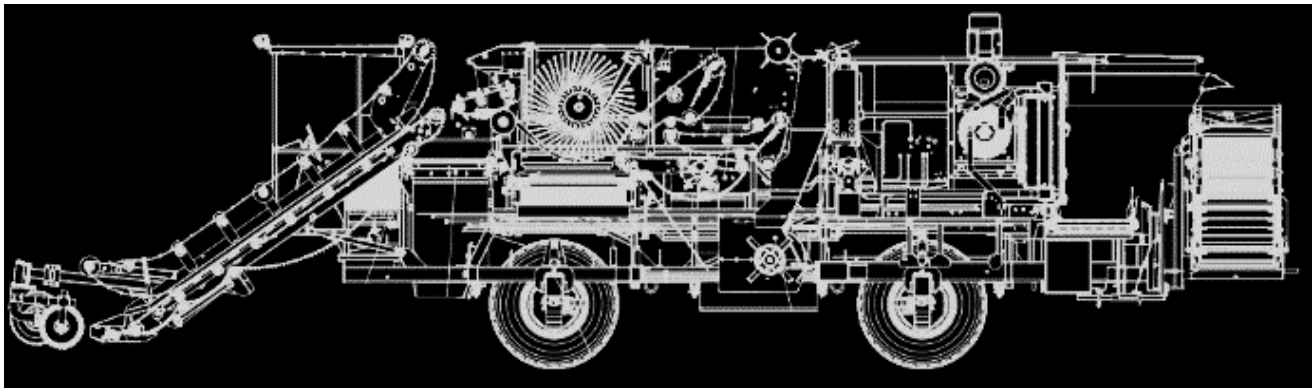
2022 project: develop data to improve harvester sanitation methods

Air alone reduce loads by ~83%; Pressure wash increased to 90%

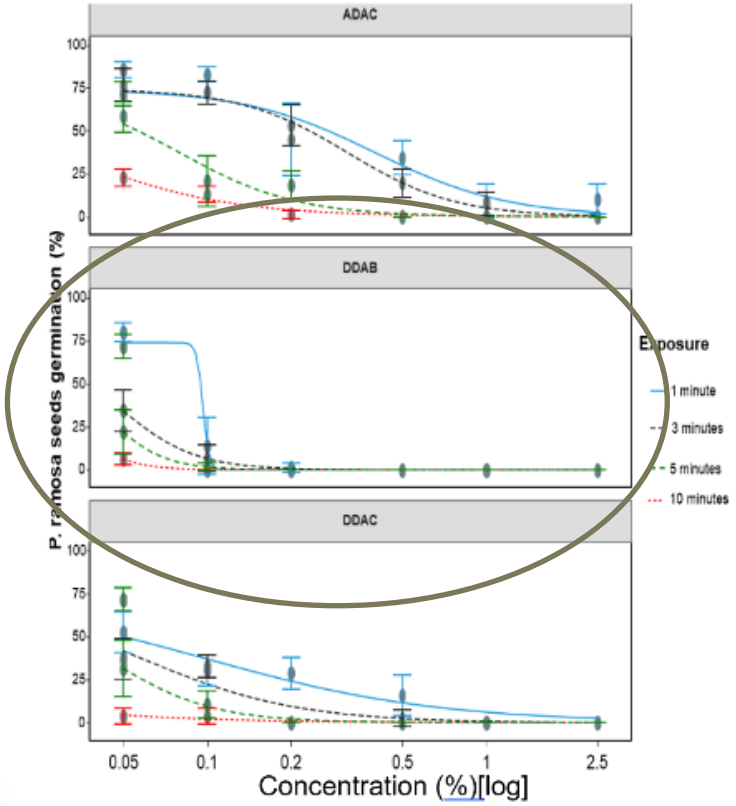


Sanitizing: Quaternary ammonium compounds (QACs)

- Used in other countries for broomrape control
- Note that there are likely other sanitizers that could also be effective

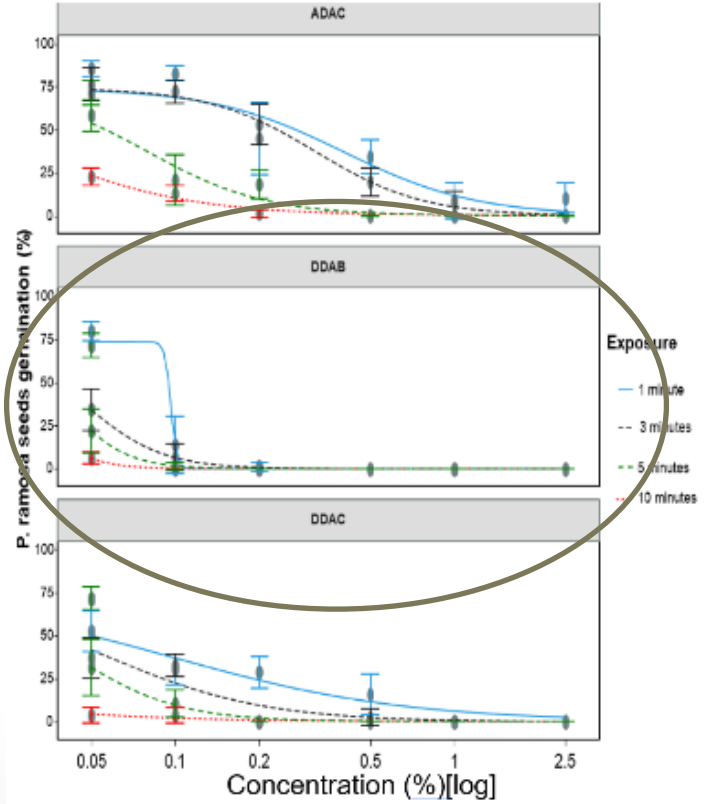


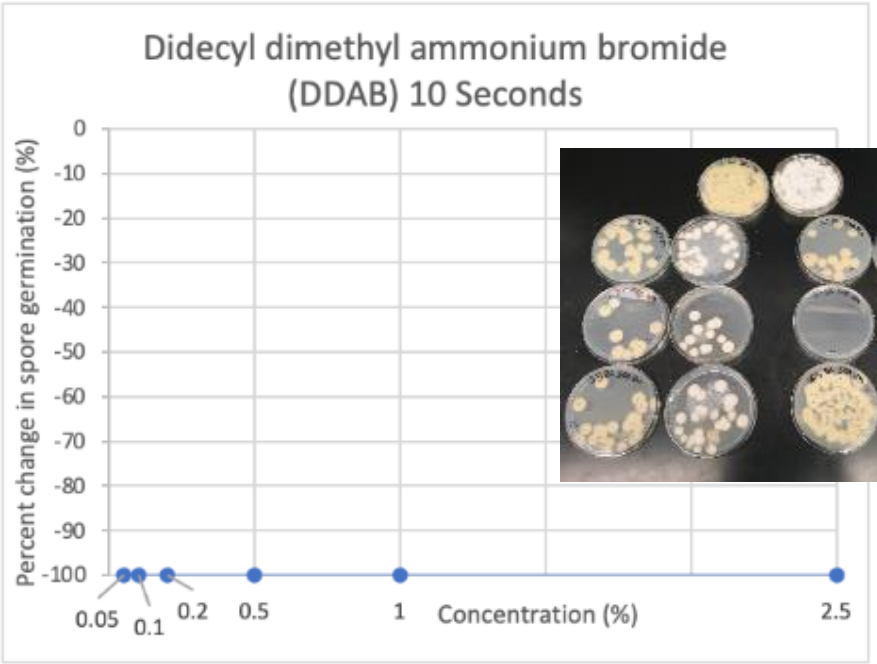
Only some quaternary ammonium compounds are effective against broomrape



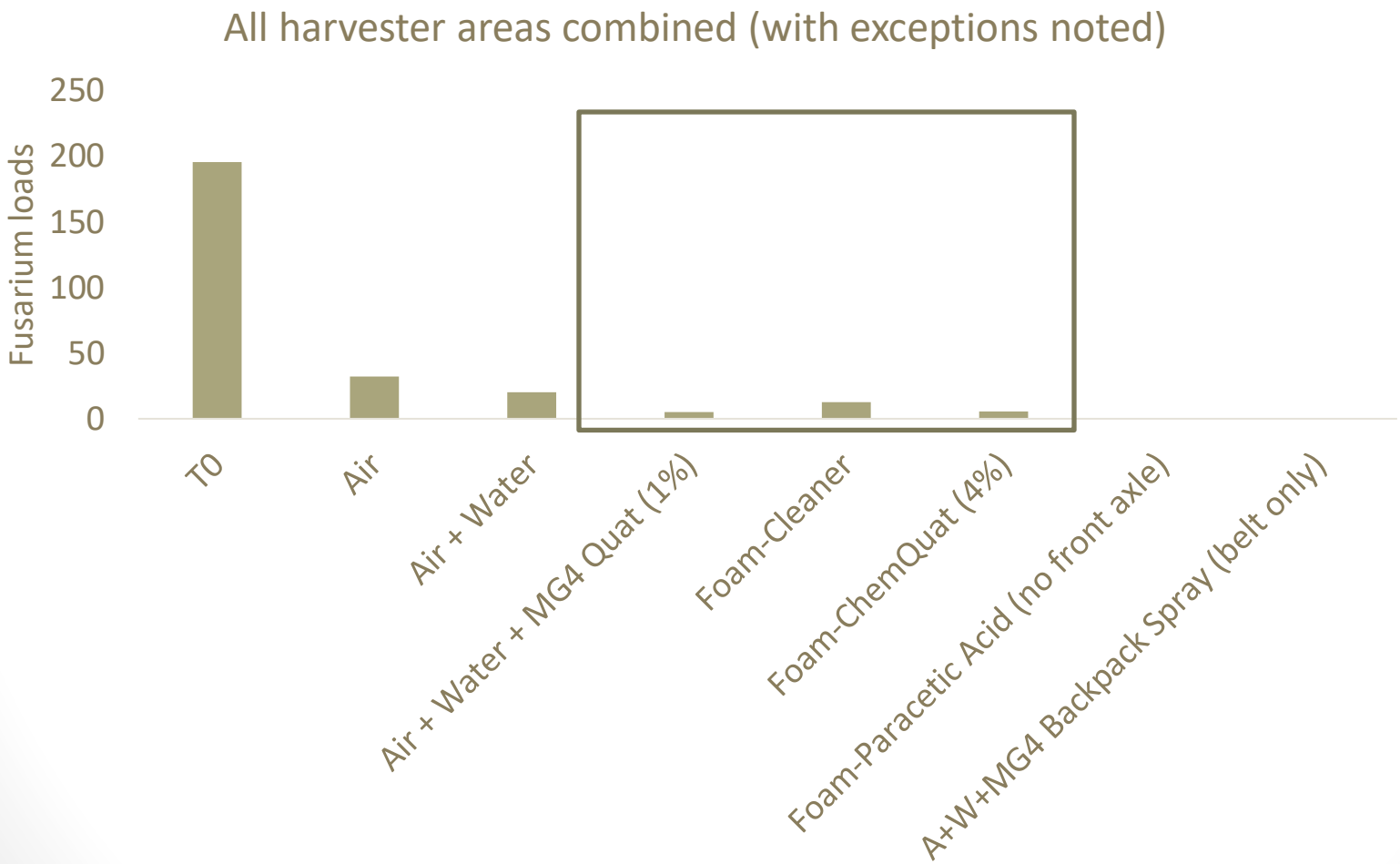
- QACs vary in efficacy
- Best active ingredients: ADAC, DDAB, DDAC
- Optimal compound: DDAB
  - effective with 1 min exposure
  - effective at 0.1% AI

The most effective QACs against broomrape were also most effective for Fusarium



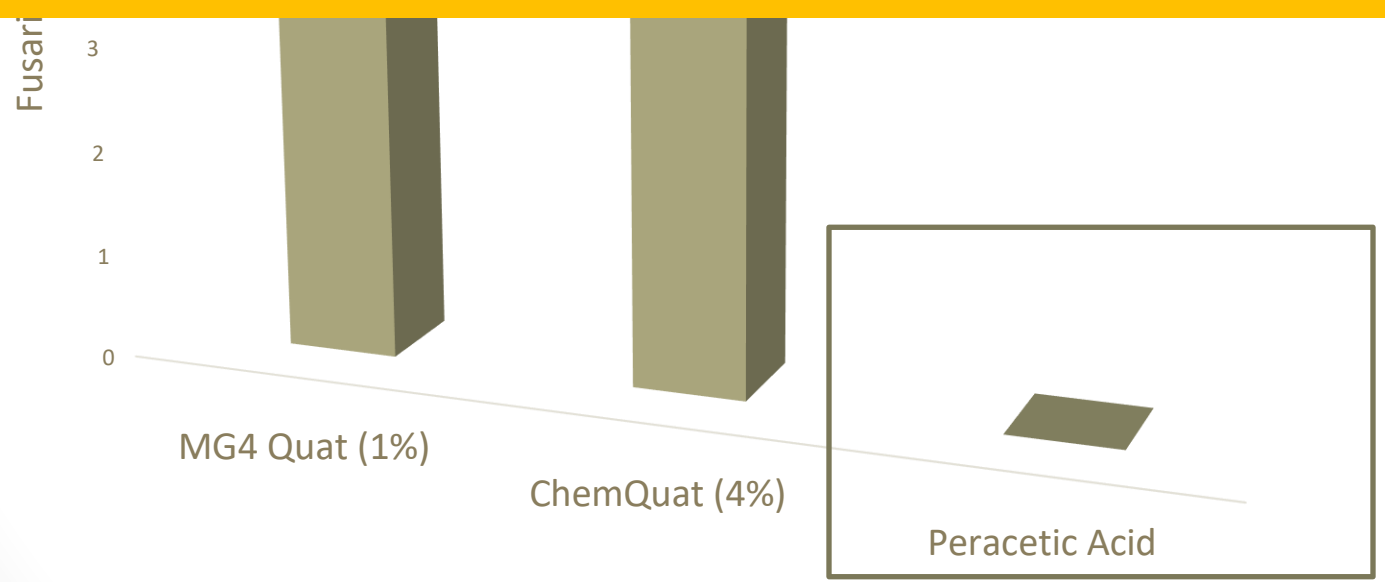


QACs reduced loads by 97%

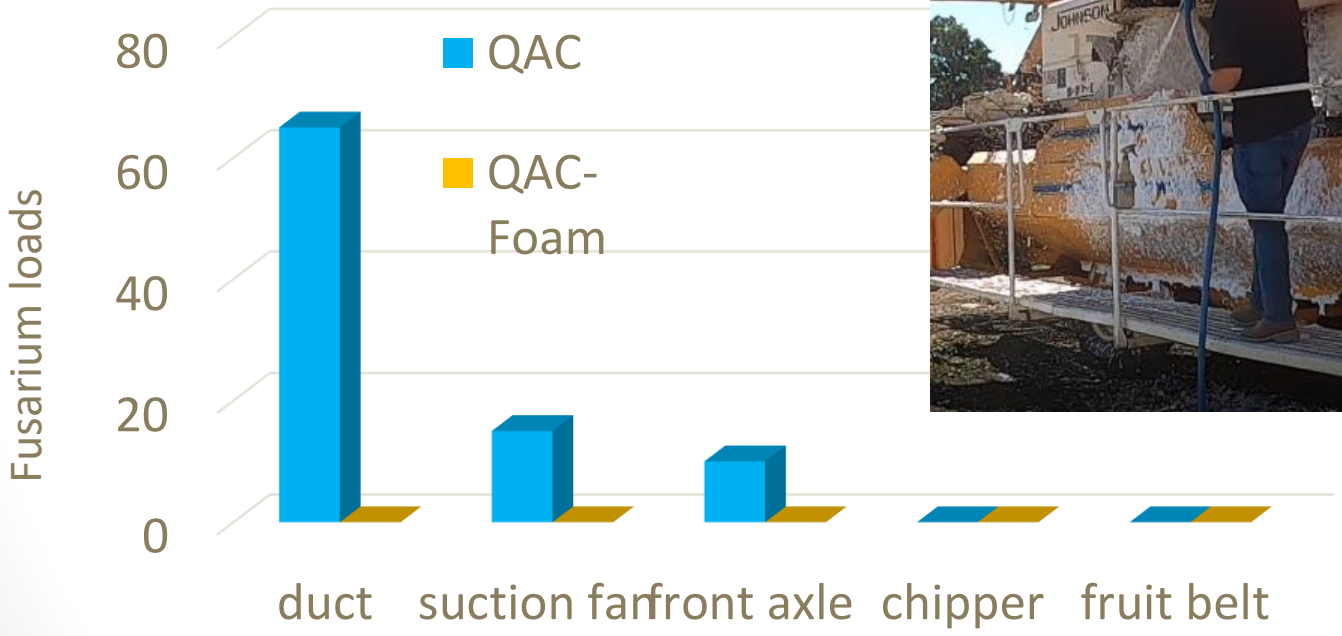


Only the non-QAC sanitizer peracetic acid killed all propagules

Peracetic acid efficacy against broomrape is unknown



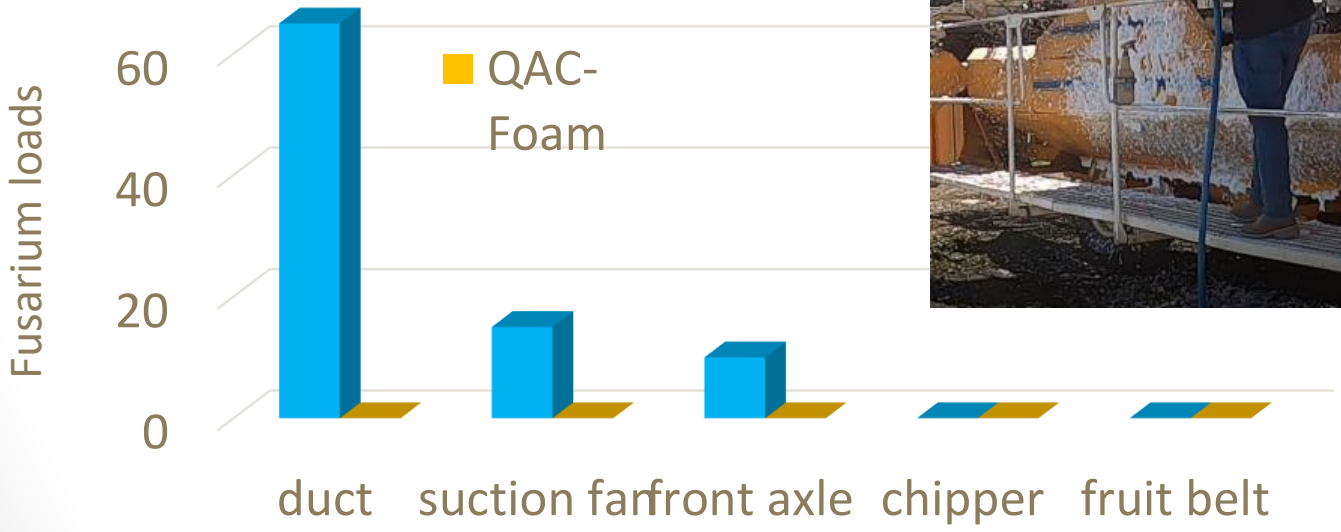
Use of foamer agents: Across comparable locations, sanitizer in foam was more effective in controlled studies



Sanitizer efficacy varies by location-less effective in hard-to-access areas with higher debris loads
Debris can deactivate QACs and is a barrier to surface contact

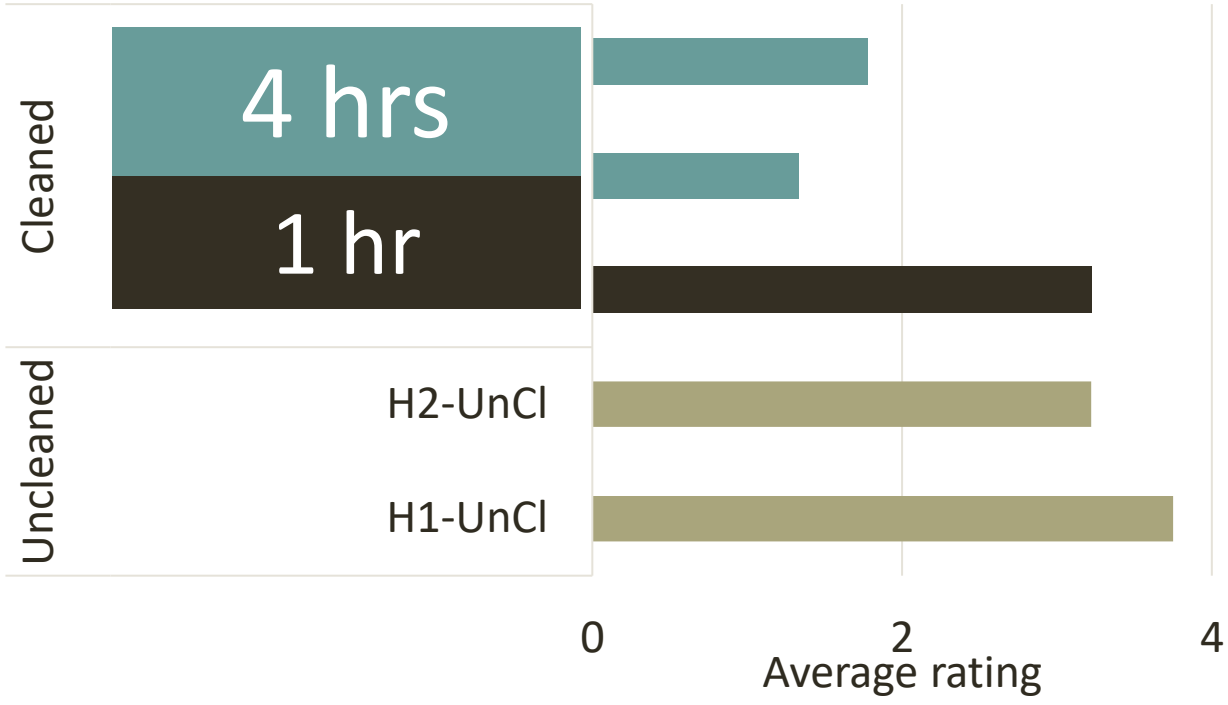
Use of foamer agents: Across comparable locations, sanitizer in foam was more effective in controlled studies

Foaming agents may help improve QAC efficacy in the presence of debris-more data is needed



Time is a critical barrier to effective cleaning

- Most operations were unable to spend more than 1-2 hrs cleaning their machines
- The most exhaustive cleaning took 4 hrs

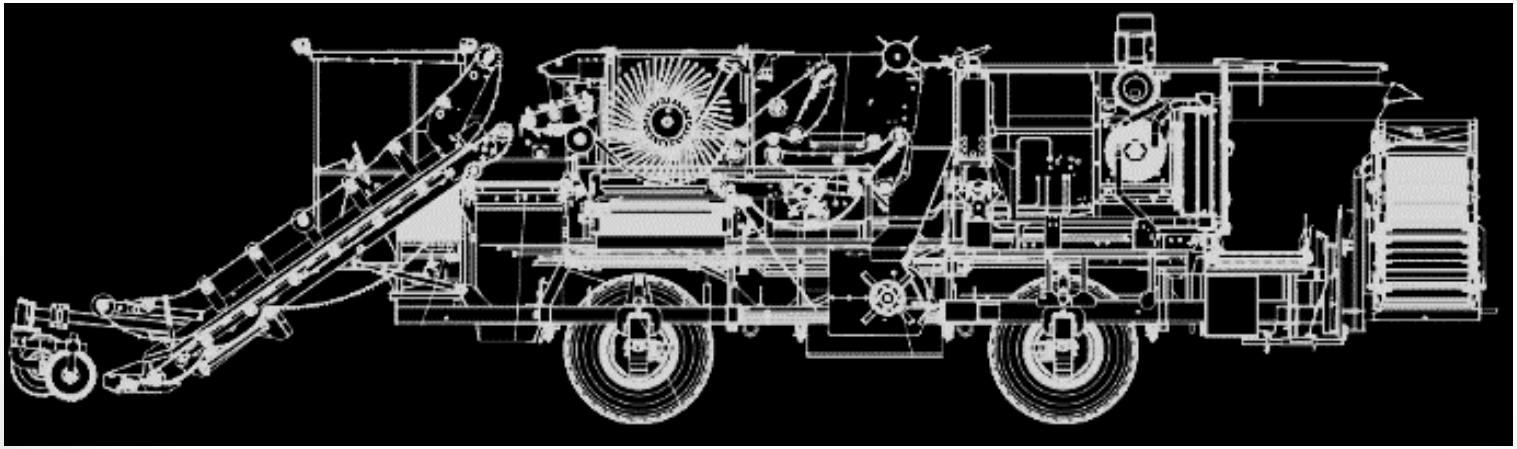


Time is a critical barrier to effective cleaning

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



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.

California Tomato Research Institute

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:

Review labels prior to use
Consult with local Ag Commissioner if you have questions

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.

California Tomato Research Institute

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:

Produced version 1.1 and revised 1.2 in 2022
https://swettlab.faculty.ucdavis.edu/extension/
Continuously update as more information comes in from studies

Swett Lab

Fungal Pathogen Ecology in Vegetable and Field Crops

Lab members
Research
Extension
Join the lab!

Equipment Sanitation working BMPs

UCD_Harvester Sanitation Best Management GuidelinesV1

Power point presentations

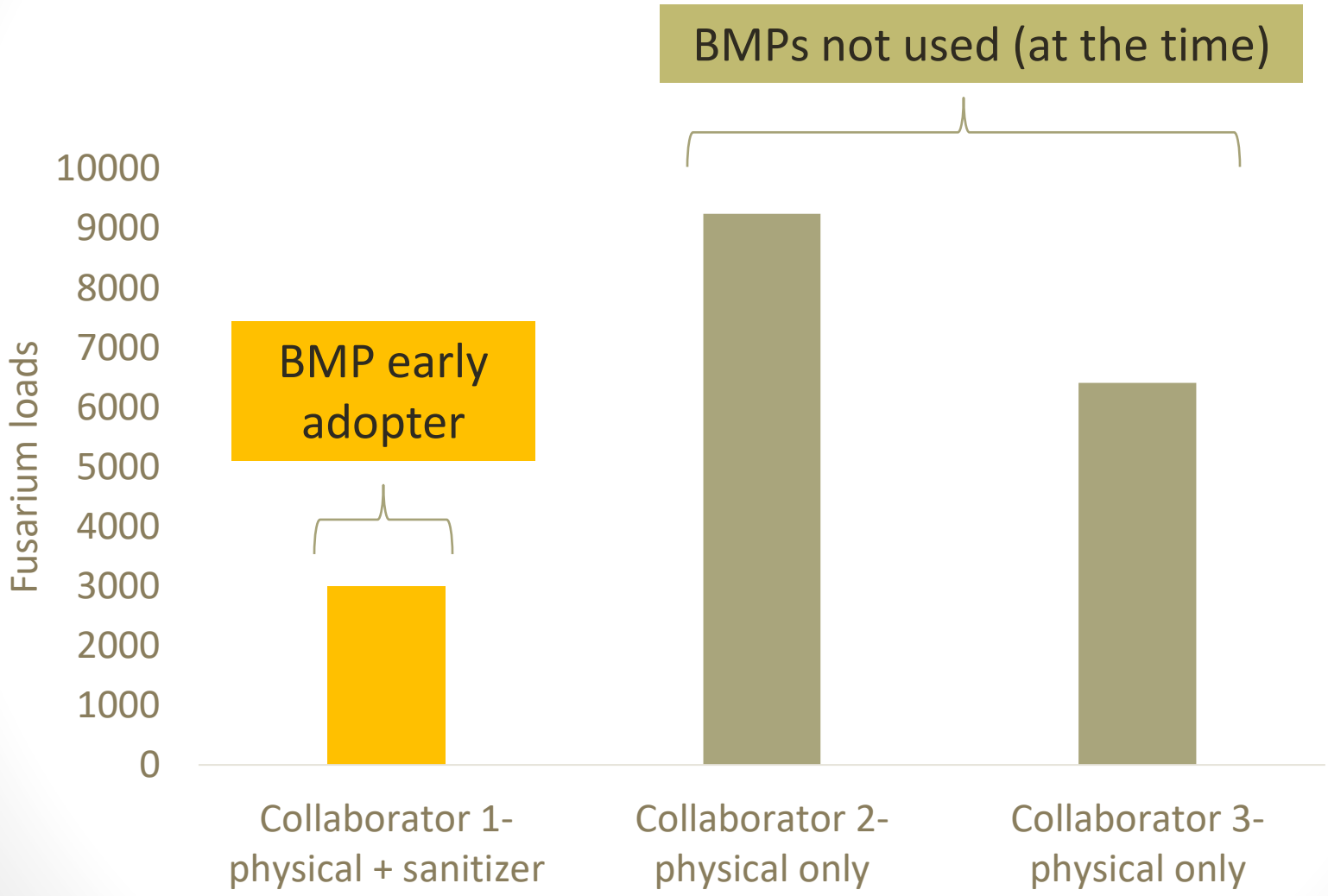
Fusarium wilt race 3 in California processing tomatoes

Diagnosing wilt and crown rot diseases of tomato

Newsletter Articles

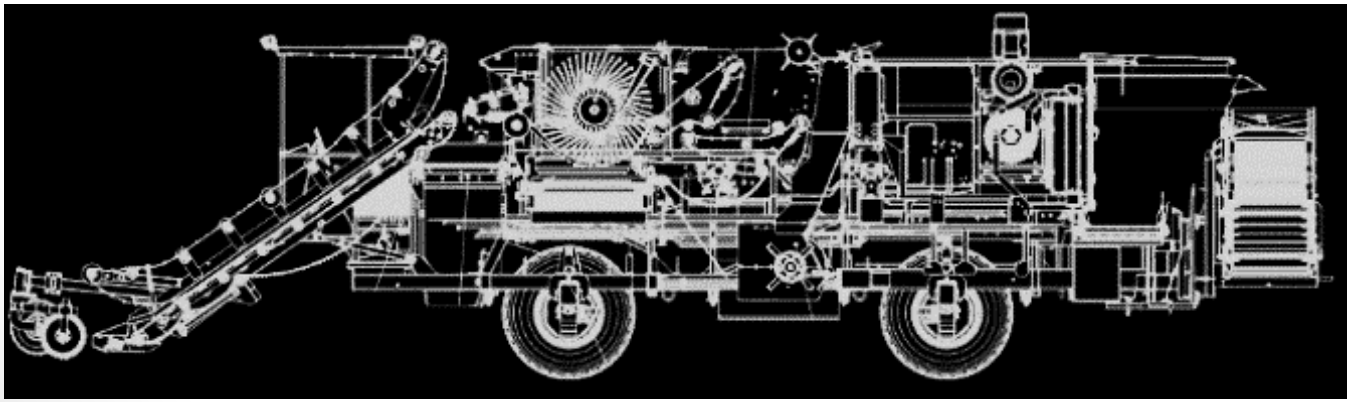
Southern Blight Cliff Notes 2017

Use of BMPs is improving harvester sanitation efficacy



Ongoing work to adapt BMPs to off-season harvester cleaning and trailer sanitation

- Needs for improved for post season harvester cleaning
  - Highlighted by September rain event in Yolo county—Many operations outside the county loaned their harvesters
- Adapting BMPs to trailer sanitation
  - Low hanging fruit to mitigate spread—returns to processing house between fields
  - Looking at various on-site cleaning strategies



Ongoing work to adapt BMPs to off-season harvester cleaning and trailer sanitation

- Needs for improved for post season harvester cleaning
  - Highlighted by September rain event in Yolo county—Many operations outside the county loaned their harvesters
- Adapting BMPs to trailer sanitation
  - Low hanging fruit to mitigate spread—returns to processing house between fields
  - Looking at various on-site cleaning strategies

Contact us if you would like us to consult with you and/or evaluate efficacy existing practices

Cass: clswett@ucdavis.edu
Zach: zach@tomatonet.org

Look out for outreach events in the spring/early summer

- Planning to do a harvester sanitation field day
  - English session
  - Spanish session (training and needs assesment-focused)

Questions?

Cassandra Swett
clswett@ucdavis.edu
BMPs: https://swettlab.faculty.ucdavis.edu/extension/