

What's new: best cleaning practices for managing broomrape spread on field equipment

With sneak peak on integration into CDFA broomrape board efforts



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Reducing the risk of broomrape spread on field equipment—where do we stand?

- Best management practices developed to reduce the risk of broomrape spread on farm equipment using:
 - In-field equipment sanitation methods—adaptive for a wide range of users
 - Wash station trailer sanitation methods
- Include sanitizer product information
 - Improving sanitation methods underway: products, volumes, concentrations



Field Equipment Sanitation BMPs (version 1.3 – May 2024)

WHY?

This short set of BMPs was created with the intent of sharing known best practices to slow down the spread of the parasitic weed, broomrape - between fields, operations, and production regions. The expectation is that lessons learned to date will allow operations that are currently implementing some level of sanitation to maximize the benefit from their program with science-backed tweaks AND to inform those operations who have not yet implemented sanitation programs but are interested in learning from others past lessons. Originally focused on tomato harvesters, this information is now being extended to field equipment generally. Although the particular target of this work is broomrape, the act of physical cleaning is also effective in reducing the risks of spread of other pests including weed seeds, fungal and bacterial pathogens, and root-knot nematode.

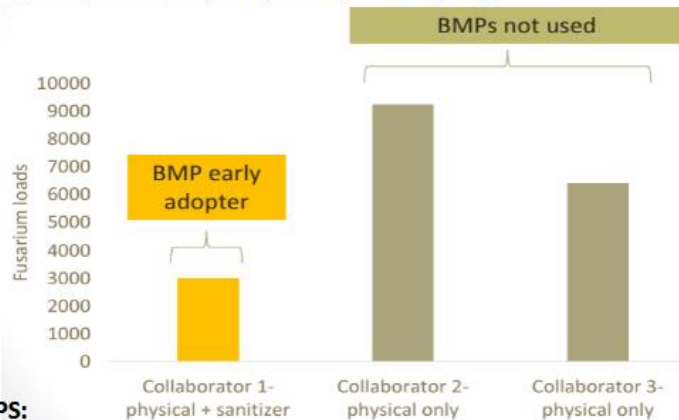


Figure 1. From left to right: Broomrape seeds the size of finely ground pepper, broomrape growing in a tomato field in California, broomrape debris on a harvester in Chile. Photo credits: Gene Miyao, Zoch Bagley, Brad Hanson.

WHERE TO CLEAN?

- A designated area for equipment cleaning, within the field perimeter, should be assigned and solely utilized.
- Monitor this area carefully in future crops as it will be an at-risk location for future broomrape emergence.

WHAT TO CLEAN? Any equipment or personnel that move in or out of fields, especially those that accumulate a lot of soil and plant debris, can spread broomrape and/or other pests and pathogens.



CLEANING STEPS:

1. **Remove loose debris – this is the most important step in the cleaning process. At 1%, on a clean surface, QAC sanitizers can effectively kill broomrape and significantly reduce microbial loads. HOWEVER, QAC efficacy is greatly reduced in the presence of soil and plant debris due to sanitizer deactivation.**
 - 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 and/or other weeds seeds or pathogens of concern.

No one size fits all:
Aim to have adaptable systems that can be tailored to different situations

Goals in 2025/26:
Adding embedded video-based training content

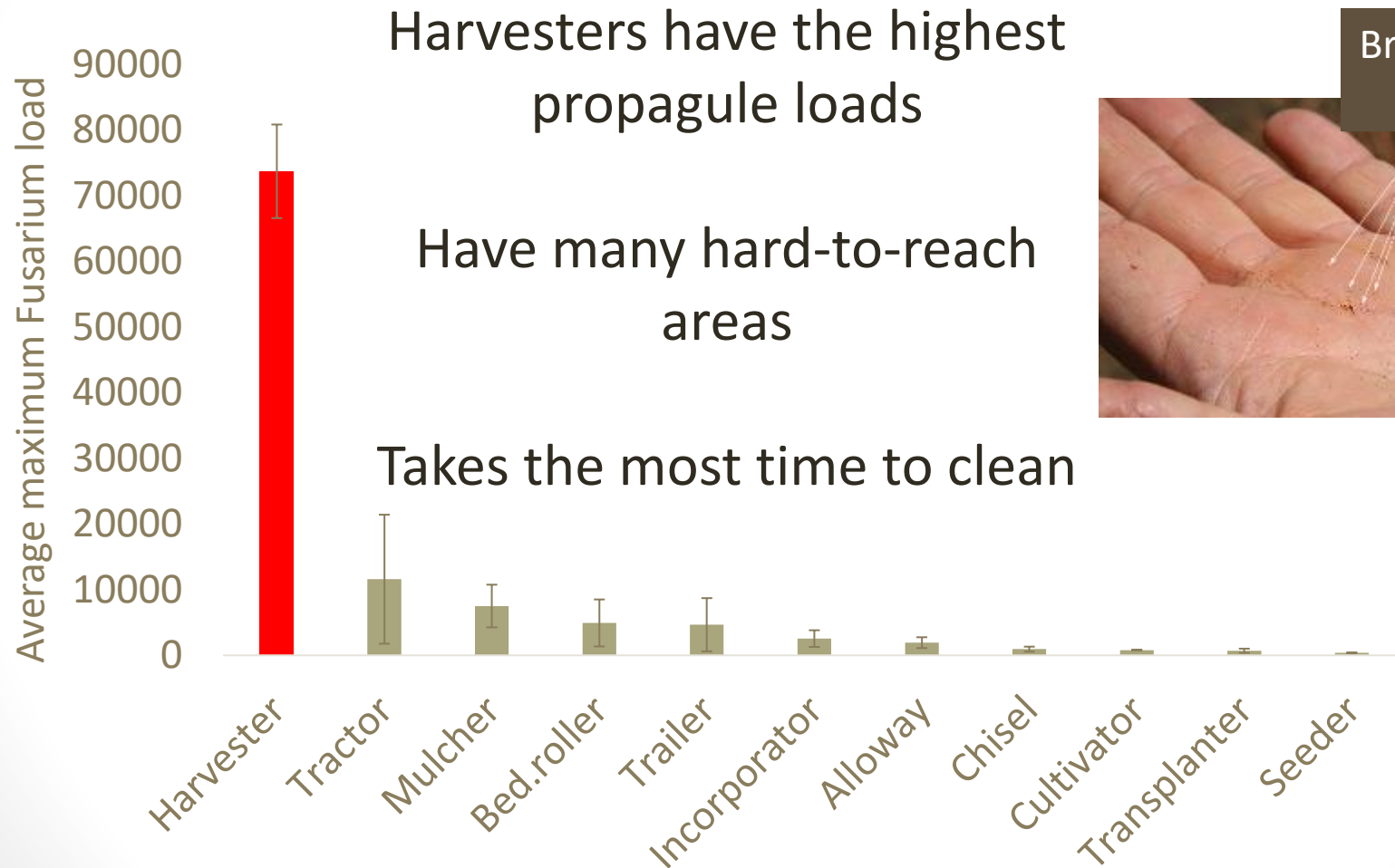
And preparing train-the-trainer materials for training officials and county advisors

Best management practices for equipment sanitation in the field

- Standing questions
 - How does dispersal risk and thus cleaning intensity varies by type of machine?
 - How we improve time to clean and improve access to hard-to-reach, high risk areas?
 - How can we overcome debris-inhibition of sanitizers?

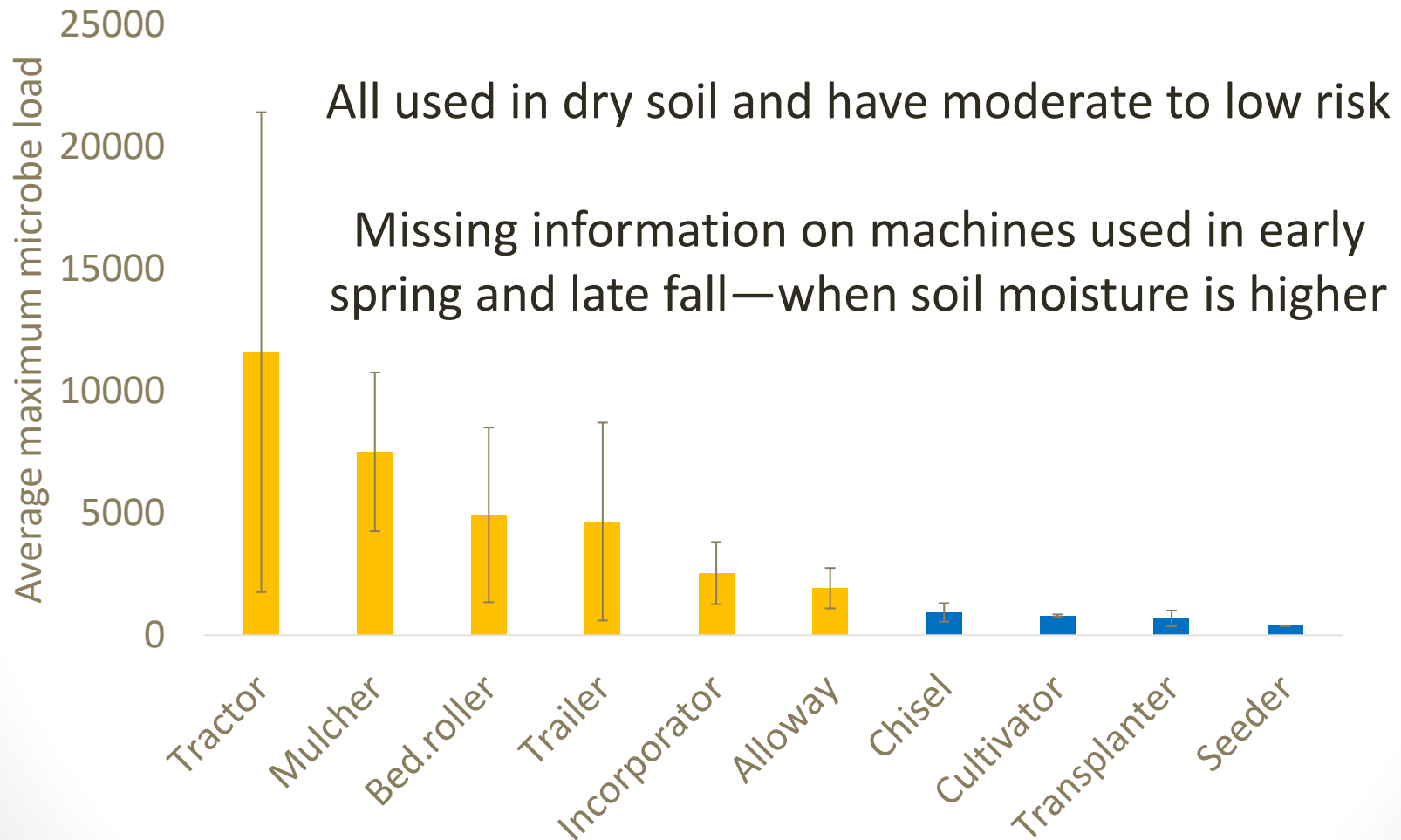


Propagule carrying loads, and thus transport risk, vary by machine type

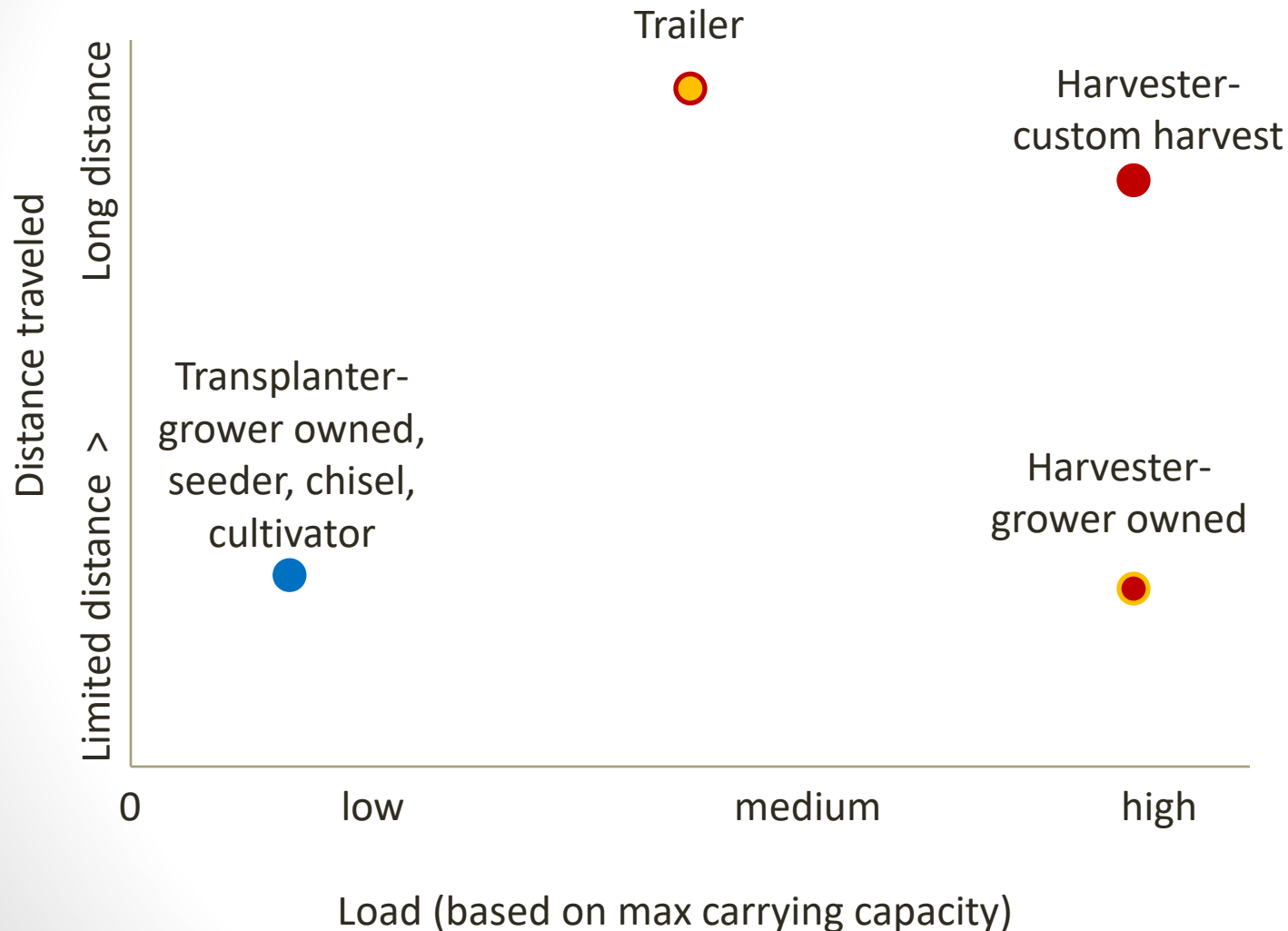


Propagule carrying loads, and thus transport risk, vary by machine type—beyond harvesters

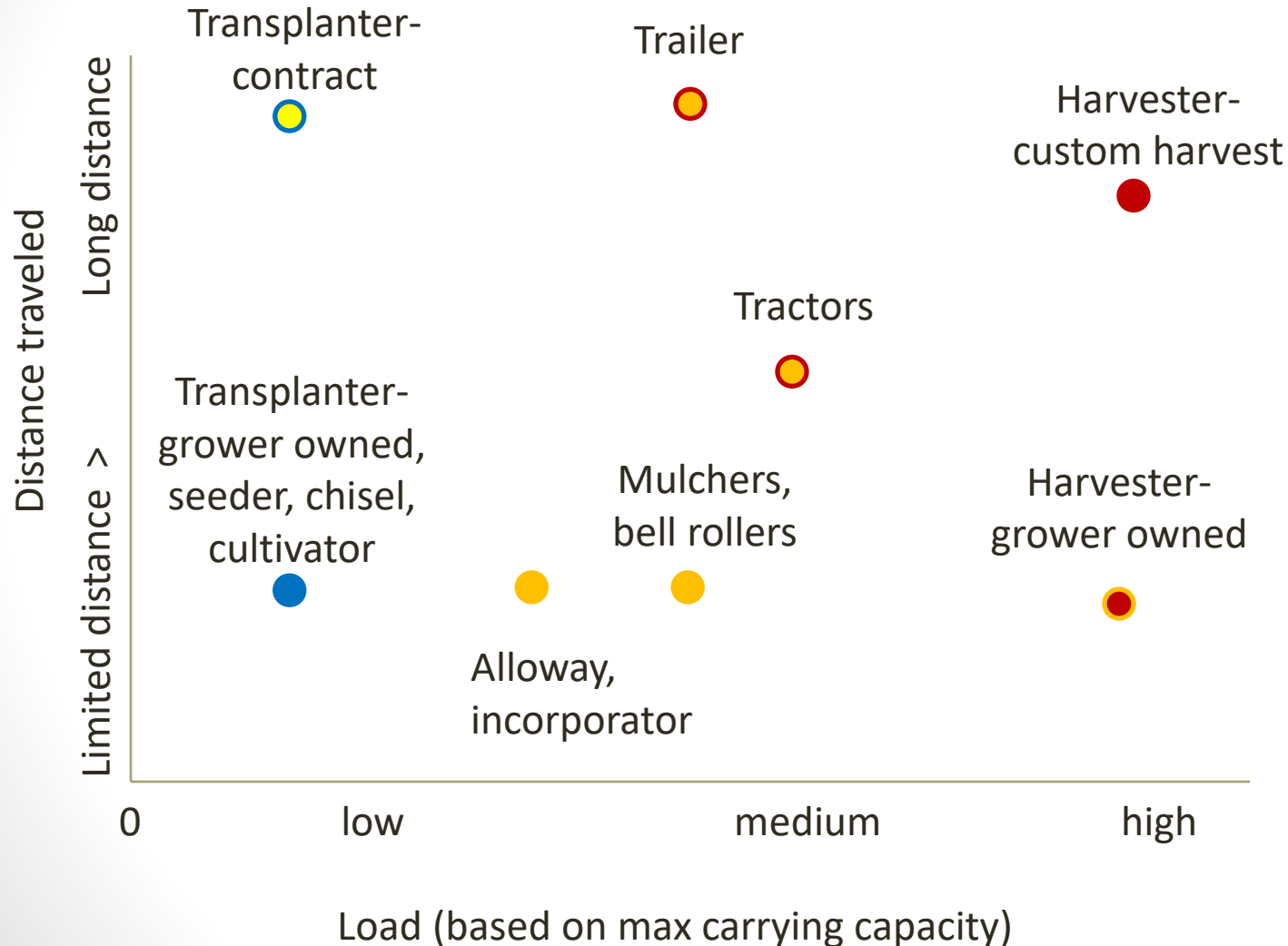
Spring and fall field prep equipment



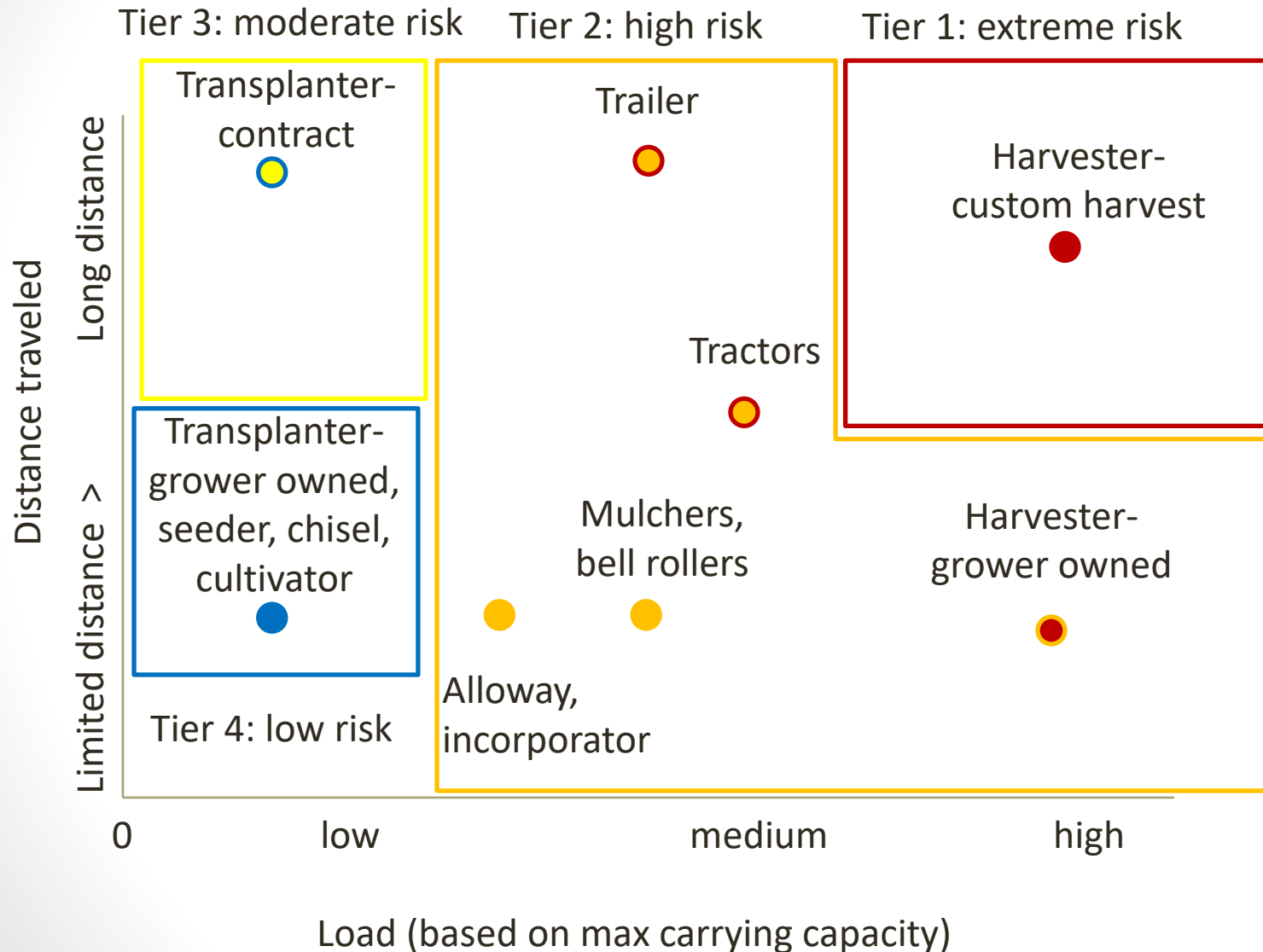
Propagule loads are not the only factor influencing risk of spread—considering machine movement



Propagule loads are not the only factor influencing risk of spread—considering machine movement

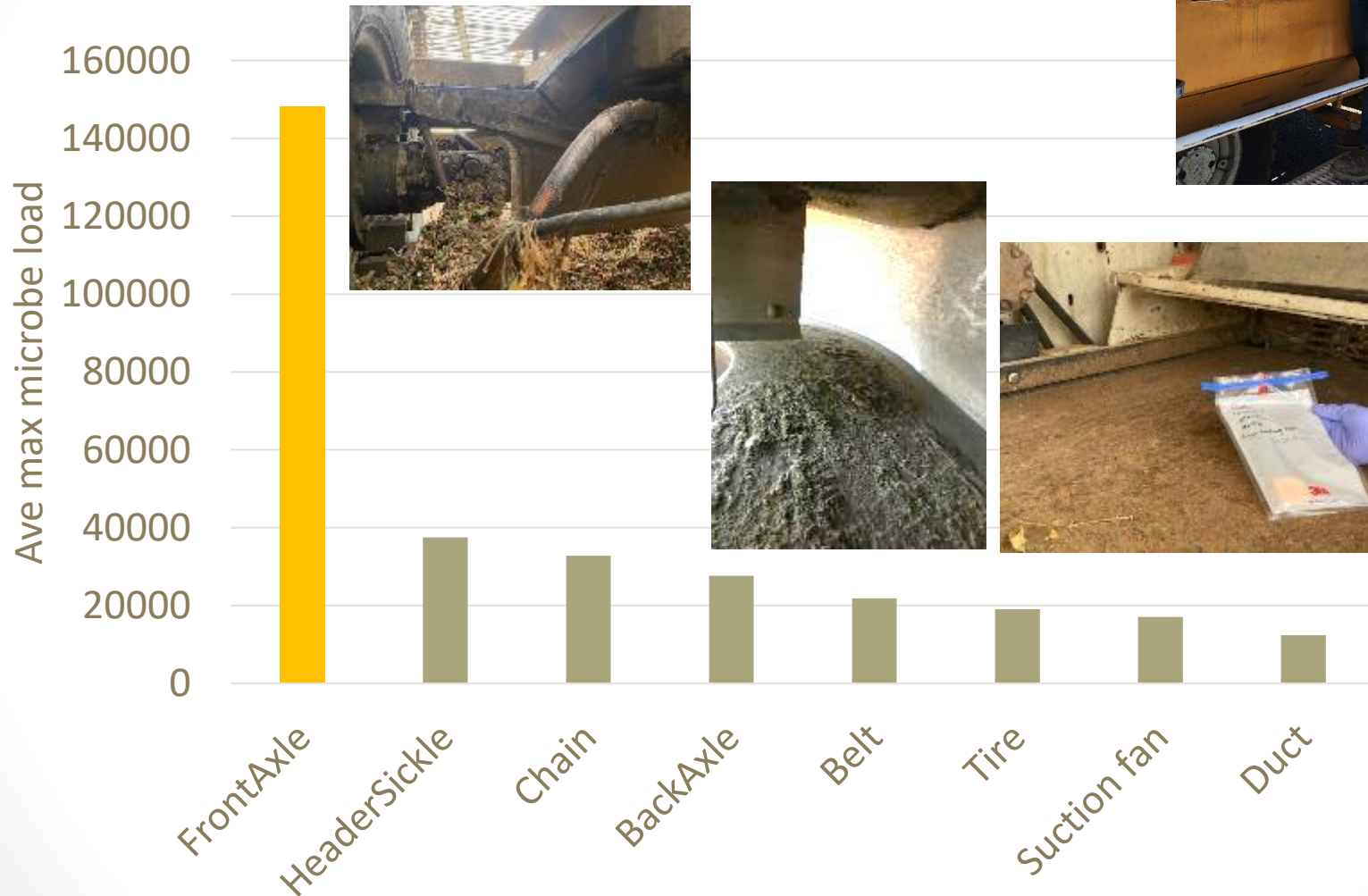


Propagule loads are not the only factor influencing risk of spread—considering machine movement



What parts to clean? Harvesters

Hard to reach = less clean



Prototype development: on-board wash systems to access hard to reach areas and reduce cleaning time



Efficacy of current best cleaning practices varies across machines

→ Tied to how dirty the machine gets and accessibility of parts

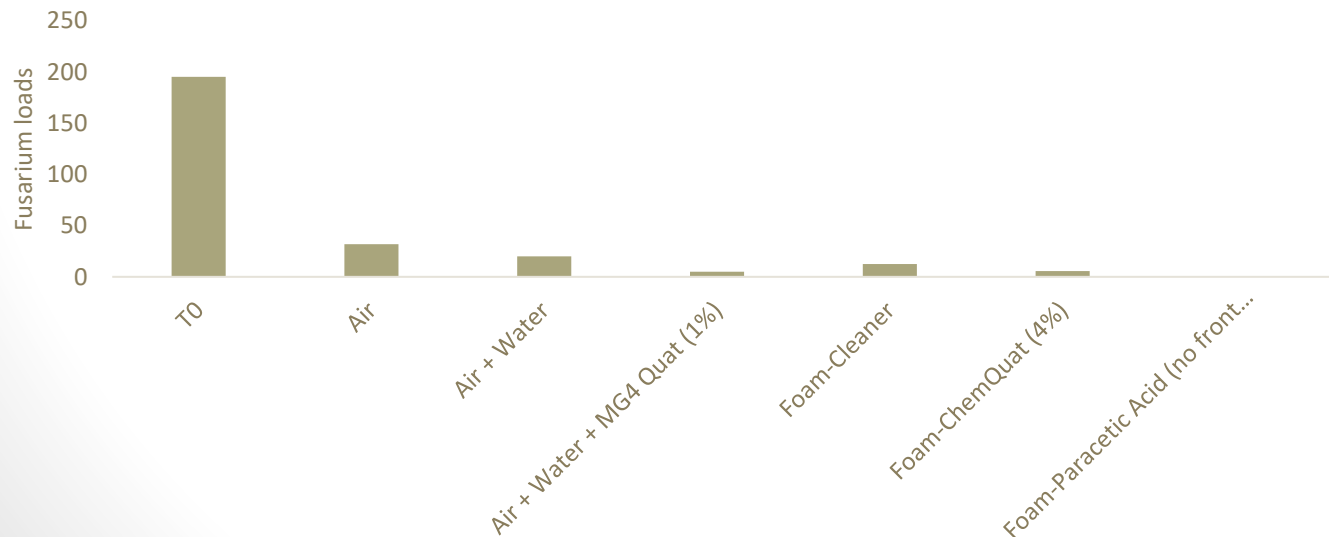
	% Change post cleaning		Risk after cleaning		Risk post cleaning
	Microbial	Debris	Microbial	Debris	
Tractor	-47.0%	-3.6%	0.5	2.3	Very low
Lister	-67.2%	-27.5%	0.8	2.4	Low
Alloway	-37.4%	-16.0%	0.7	1.9	Mod
Chisel	-38.0%	-28.8%	1.0	1.7	Mod-High
Mulcher	-86.0%	-46.2%	0.3	1.2	High
Agriplanter	-100.0%	-50.0%	0.6	1.1	
Harvester*	-80.7%	NA	3	NA	
Trailer*	-15.7%	-13.8%	3	3.1	

*Averaged across several operations

Best management practices for equipment sanitation

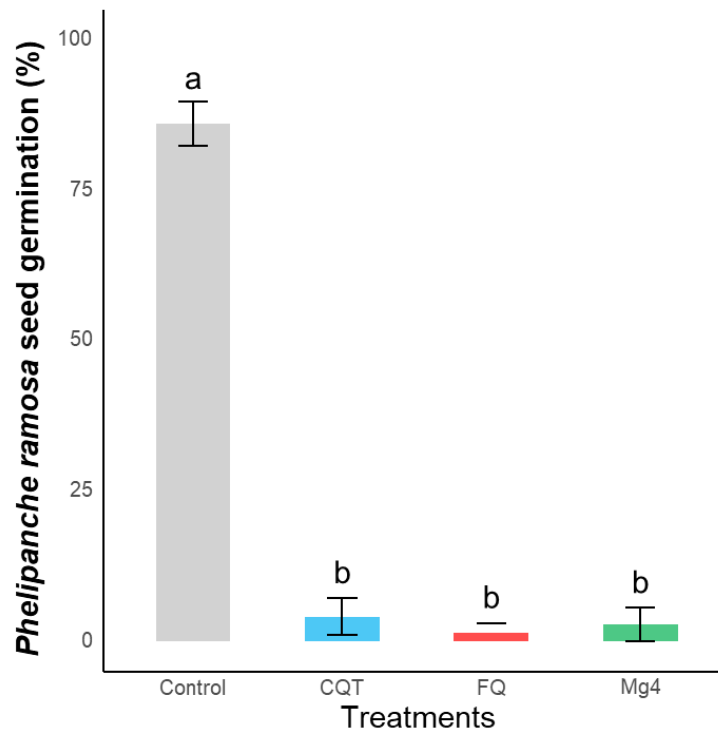
Even if the surface looks clean it can still have propagules

- Physical cleaning—reduces propagule (seed, spore) loads by up to ~87%
 - Air, pressure wash
- Only additional chemical sanitation can completely eliminate propagules
 - Most effective sanitizer: Quaternary ammonium compounds



Sanitizers: products, application rate and volume?

- Quaternary ammonium compound-based sanitizers
 - High efficacy on clean surfaces



Commercial 4-chain quat products:

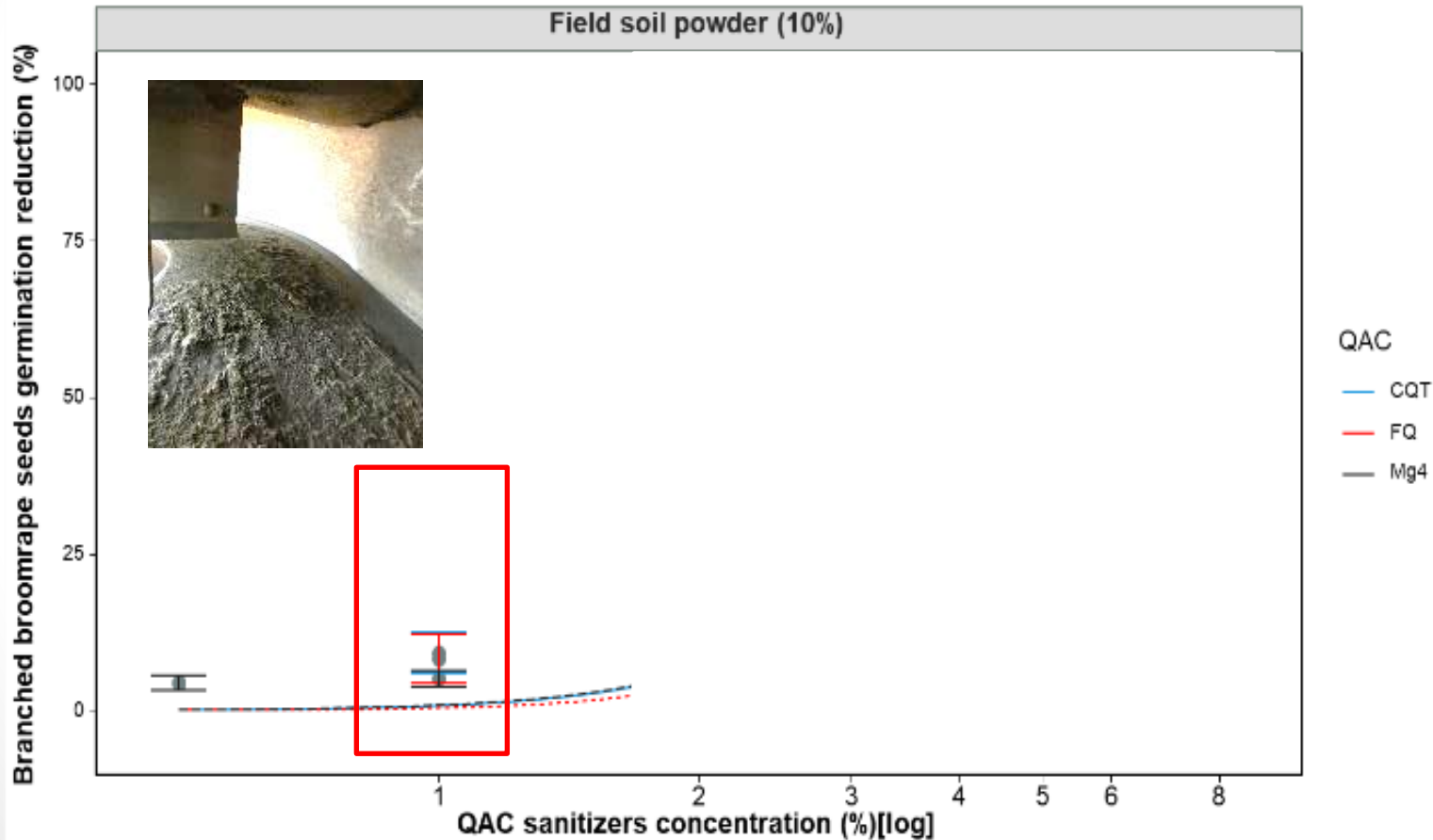
Cleaner QT

Flow-Quat

Mg4-Quat

Problem: Debris affects QAC efficacy

At label rate of 1%, QAC sanitizers no longer work when soil is present

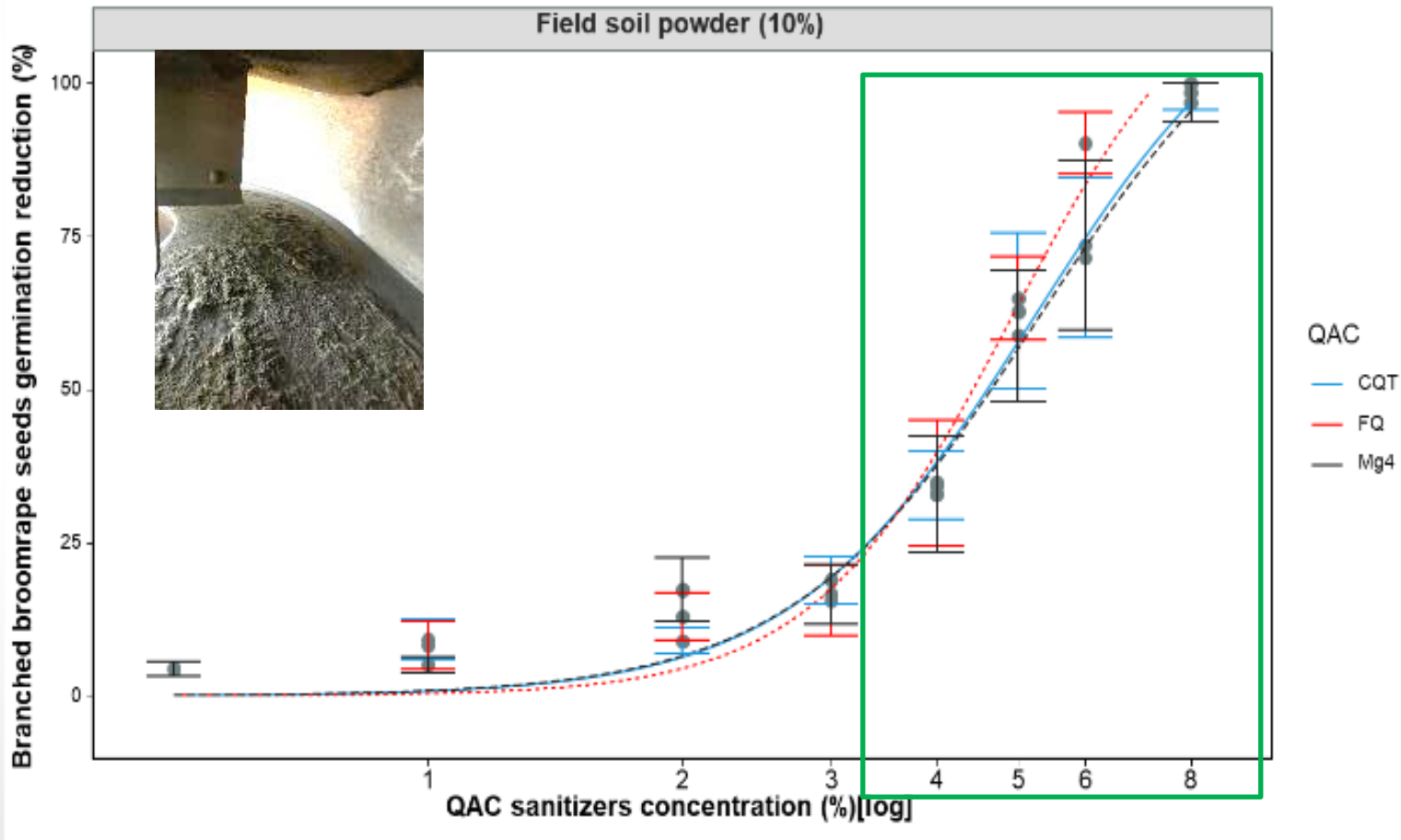


Solutions: Increase QAC concentration?

Potentially also increase volume of QAC-flood out inhibitors

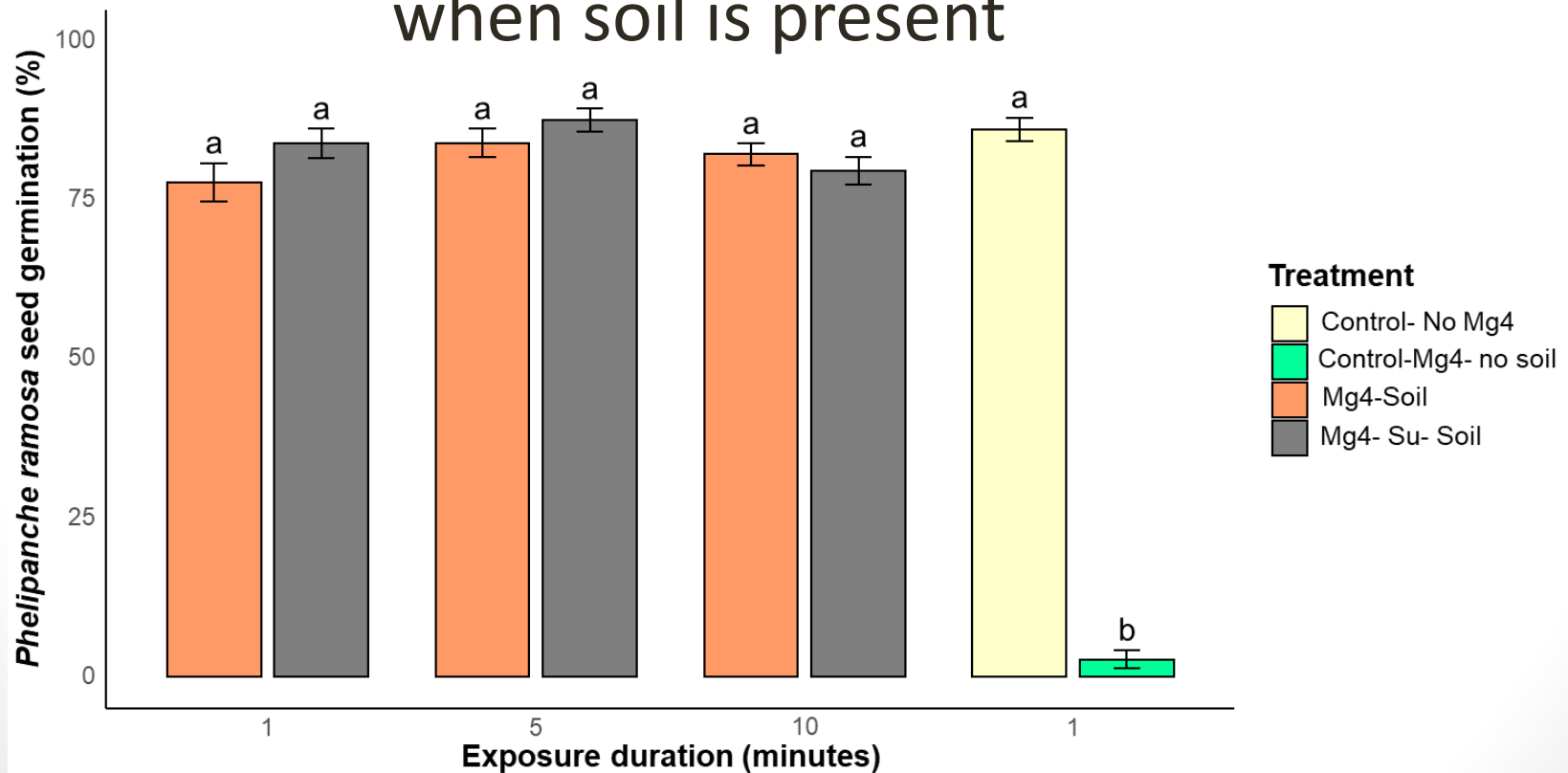
This is not a recommendation

We are currently investigating whether higher QAC rates are allowable



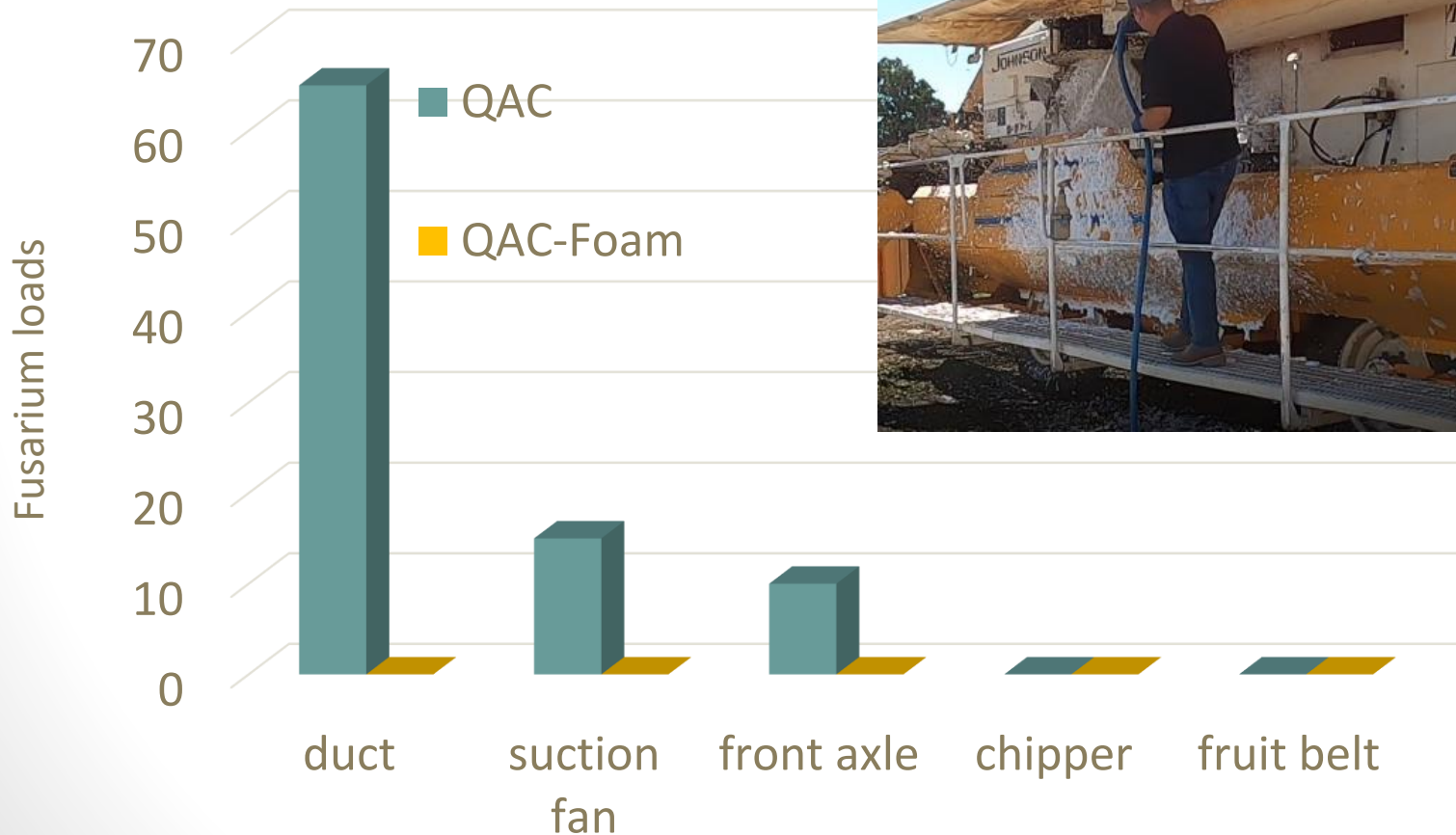
Solution: Use of surfactants or foam to increase residency time?

Based on studies of one surfactant (Lansurf), this approach has no effect when soil is present



Solution: Use of surfactants or foam to increase residency time?

Foam may help



Solutions: increase physical cleaning efforts



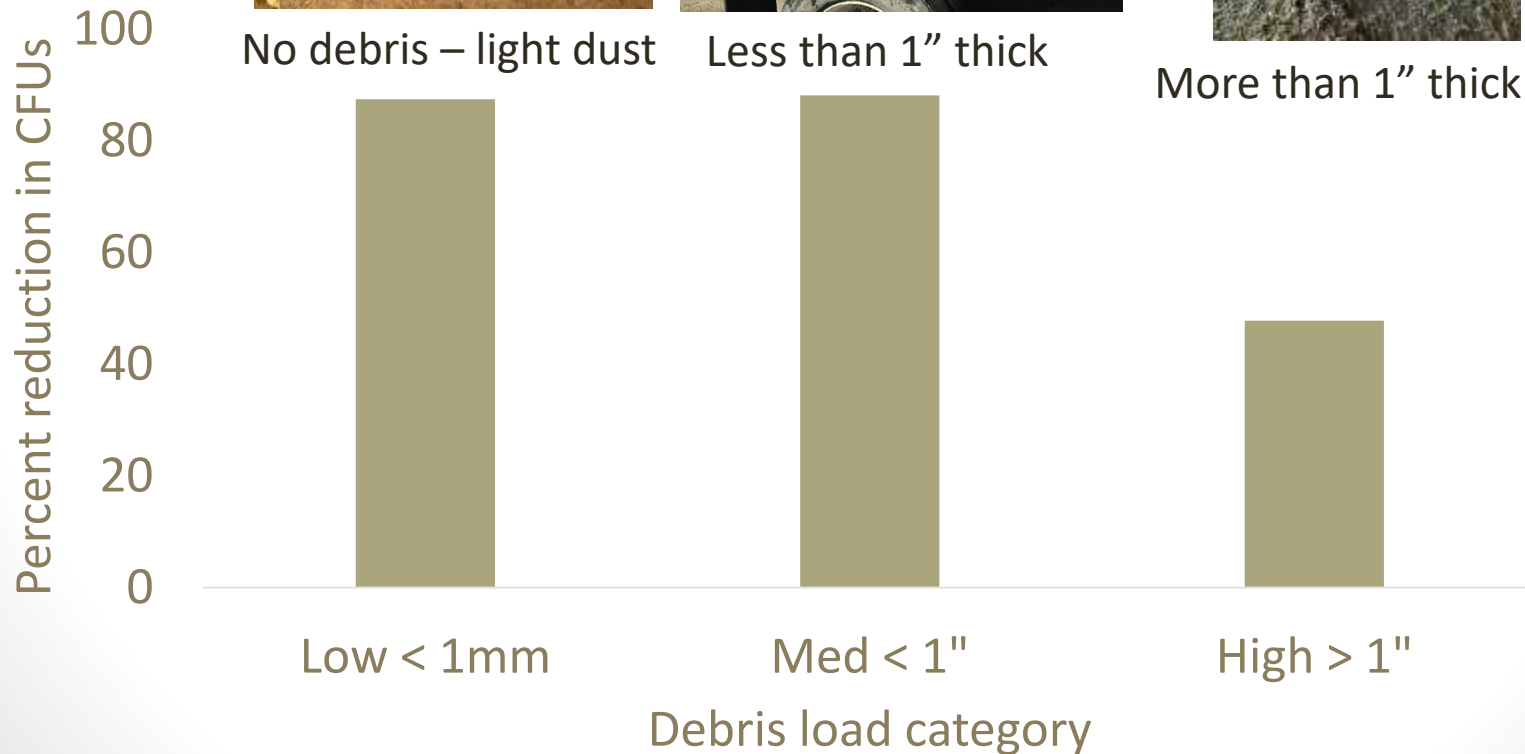
No debris – light dust



Less than 1" thick



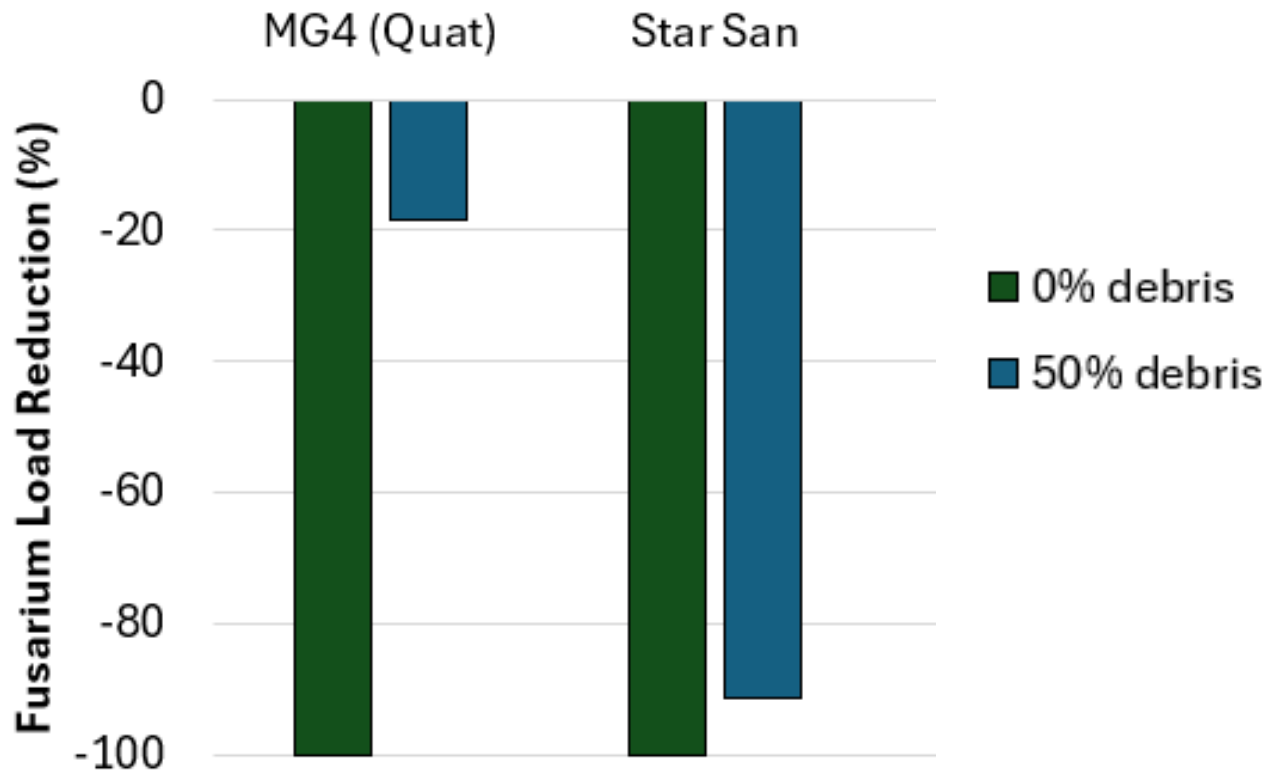
More than 1" thick



Solutions : less debris sensitive sanitizers

So far, no debris-tolerant products have had efficacy against broomrape

Additional product screening is underway



Sanitizer resources-in development

Trade Name	Tested Conc.	Sanitizer type	Corrosive on metal	Managed Pathogens	Efficacy in presence of soil debris
Peracetic acid/Peroxyacetic acid (94865-2)	0.01% (100 ppm)	Oxidizer	Yes	None	TBD
MG 4-Quat (10324-117-9152)	1% (10,000 ppm)	Quaternary Ammonia	No	Branched broomrape, Fusarium wilt, bacterial canker	Low
Star San Acid Sanitizer (65001-1)	0.03% (300 ppm)	Organic Acid	Corrosive on soft metals	Fusarium wilt, bacterial canker	Moderate-low
Virkon S (71654-6)	1% (10,000 ppm)	Oxidizer	Corrosive on soft metals	Fusarium wilt, bacterial canker	Moderate-high
Jet-Ag	0.2-0.3% (2,000-3,000 ppm)	Oxidizer	Yes	TBD	TBD
Bleach (67619-32)		Oxidizer	Yes	TBD	Low

Connection of this work to the CDFA broomrape board

- Consult with board on development of:
 - Cleaning procedures for equipment sanitation in-field and at wash stations
 - For growers and canneries
 - Training resources provided for using these protocols
 - Including train-the-trainer resources



Resources

- Swett lab extension website:
<https://swetlab.faculty.ucdavis.edu/extension/>
- Current BMP for field equipment sanitation:
https://swetlab.faculty.ucdavis.edu/wp-content/uploads/sites/434/2024/11/Field-Equipment-Sanitation-Best-Management-Guidelines_Updated-May-2024.pdf
- Forthcoming
 - BMPs on wash station use and field scouting

Outreach efforts aim to identify additional barriers and provide training

- Equipment sanitation training-spring, early summer 2025
 - Includes overview of on-board wash system prototype



Questions?

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