

Managing tomato brown rugose fruit virus using disinfectants and disease resistance

Kai-Shu Ling, Bidisha Chanda and Andrea Gilliard

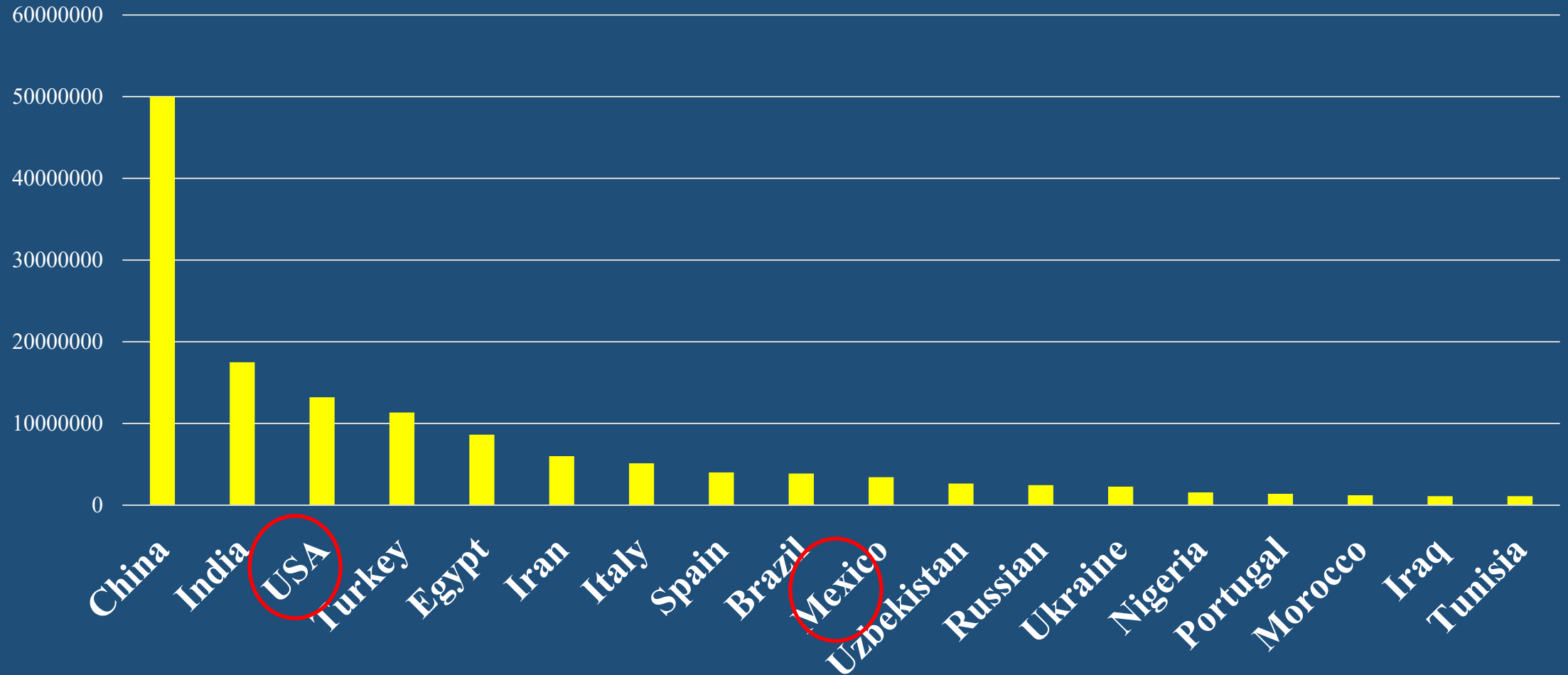
**USDA-Agriculture Research Service
U. S. Vegetable Laboratory
Charleston, SC**



(Procinorte-2020, September 29-30, 2020)

World Leading Tomato Producing Countries

(FAO statistics-2012, tonnes)

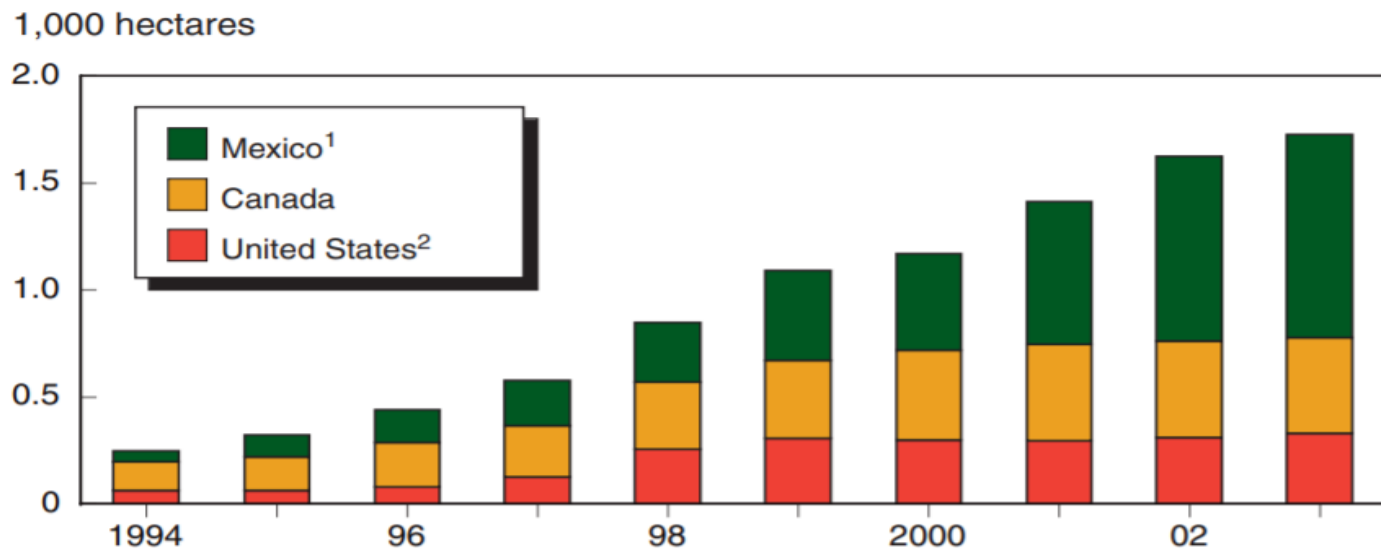




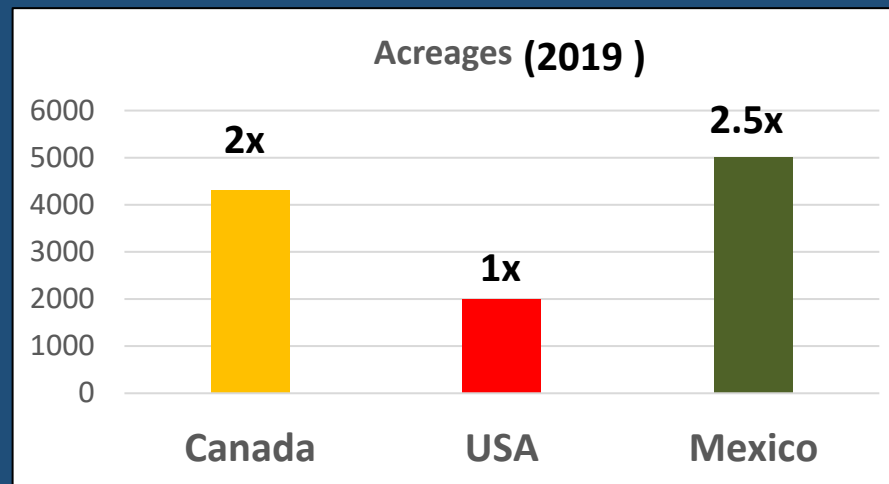
Greenhouse Tomatoes Change the Dynamics of the North American Fresh Tomato Industry

Roberta Cook and Linda Calvin

Figure 3
Estimated trends in North American greenhouse tomato area



A highly integrated North American
greenhouse tomato market



Three Distinct Tomato Production Systems in the U.S.

Field processing tomatoes
(California)



Fresh greenhouse tomato



Fresh field tomatoes
(Florida)



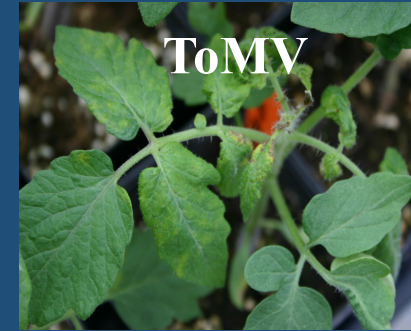
Fresh greenhouse tomato



Which Viruses and Viroids Are Prevalent in Greenhouse

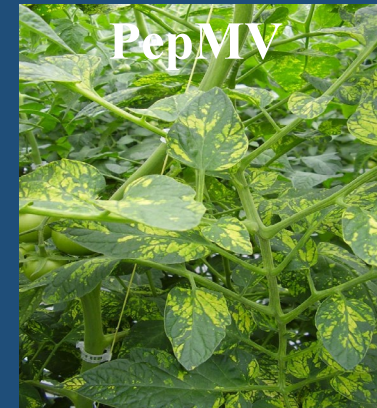
➤ **Tobamovirus complex** (4 species)

- Tobacco mosaic virus (TMV)
- Tomato mosaic virus (ToMV)
- Tomato mottle mosaic virus (ToMMV)
- Tomato brown rugose fruit virus (ToBRFV)



➤ **PepMV complex** (3 genotypes)

- Pepino mosaic virus (EU, CH2 and US1)



➤ **Pospiviroid complex** (8 species)

- Potato spindle tuber viroid
- Tomato chlorotic dwarf viroid
- Tomato planta macho viroid (Mexican papita viroid)
- Citrus exocortis viroid
- Tomato apical stunt viroid
- Columnea latent viroid
- Pepper chat fruit viroid
- Chrysanthemum stunt viroid

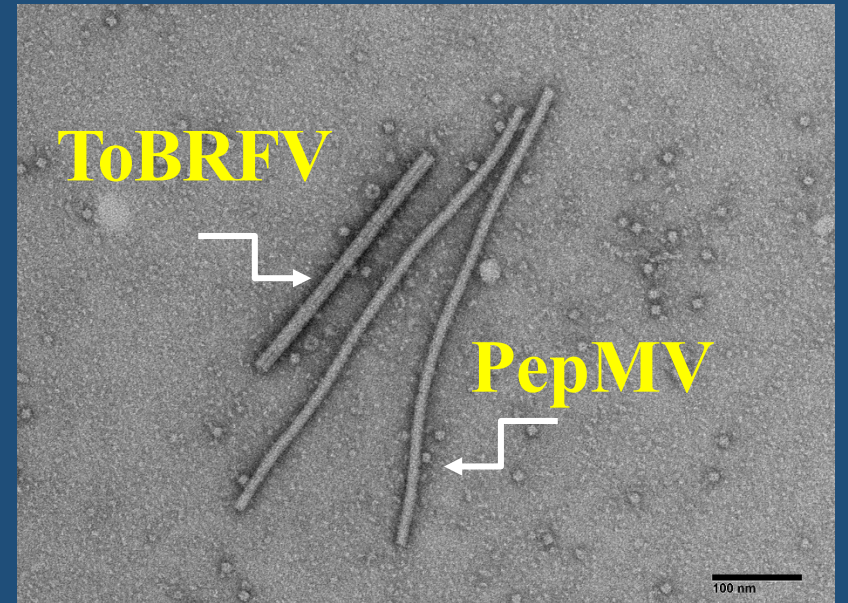


Why Virus and Viroid Epidemics in Greenhouse Tomatoes?

- Monogenic and intensive production practices.
- Hot and humid conditions.
- Grafting, de-leafing, and intercropping of tomato crops.
- Bumble bee pollination.
- Long production season, 9-10 months/year.

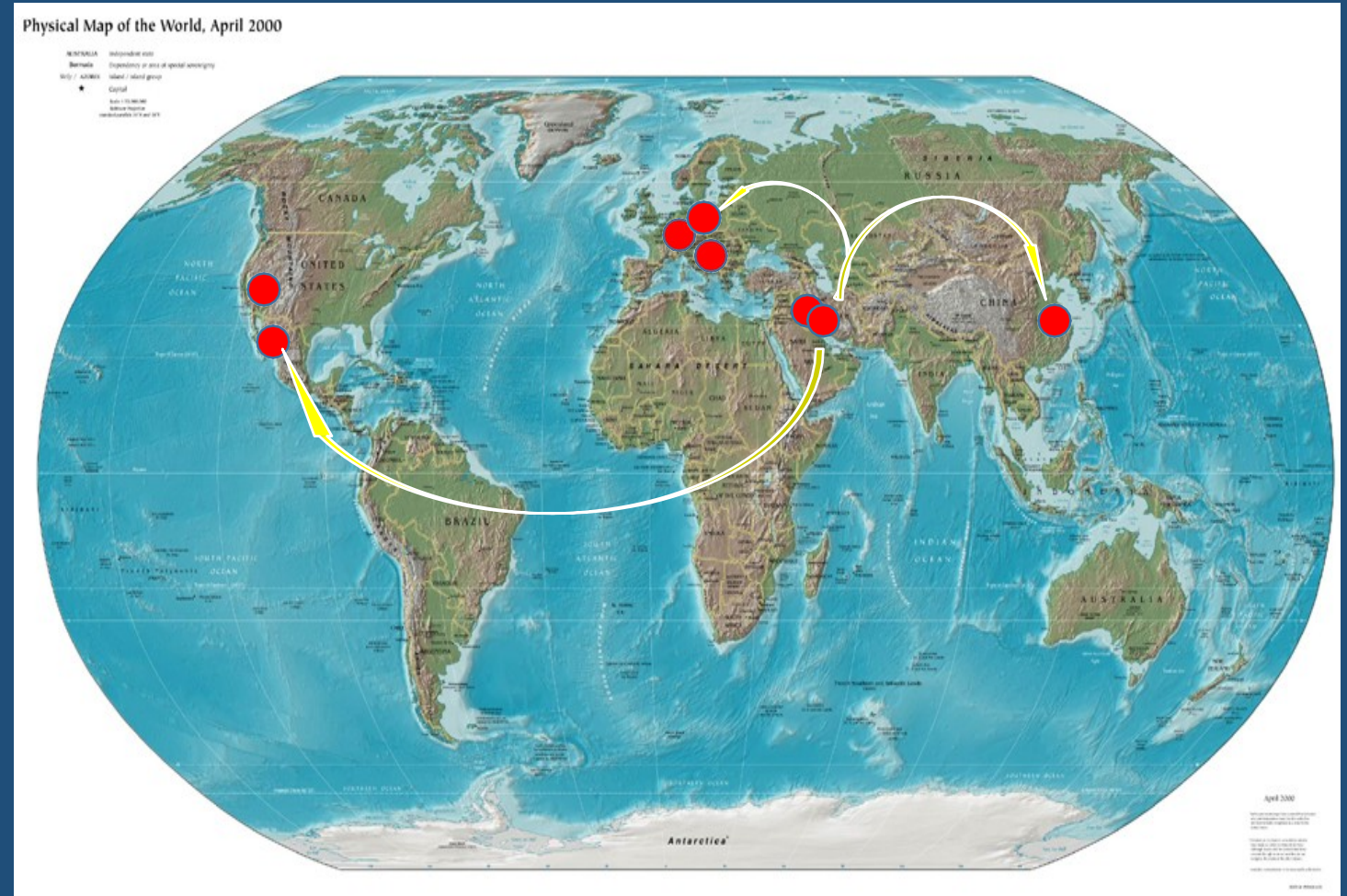


First Report of Tomato brown rugose fruit virus in the U.S.



Worldwide Emergence of ToBRFV

- **Middle East (2014-):**
 - **Jordan:** (Salem et al., 2016)
 - **Israel:** (Luria et al., 2017)
 - **Palestine** (Alkowni et al, 2019)
- **North America (2018-)**
 - **Mexico** (Cambron-Crisantos et al., 2019; Camacho-Beltran et al. 2019)
 - **USA (CA)** (Ling et al., 2019)
- **Europe (2018-):**
 - **Germany** (Menzel et al., 2019)
 - **Italy** (Panno et al., 2019)
 - **Turkey** (Fidan et al., 2019)
 - **UK** (Skelton et al., 2019)
 - **Greece, Netherlands, Spain** (EPPO)
- **East Asia (2019-):**
 - **China** (Yan et al., 2019)



Symptom expression on leaves in different tomato cultivars



Screening Tomato Germplasm for Resistance to ToBRFV

UC Davis, TGRC: 86

USDA-PGRU, Geneva, NY: 390

- *Solanum arcanum*
- *S. Chilense*
- *S. Corneliomulleri*
- *S. habrochaites*
- *S. huaylasense*
- *S. lycopersicum*
- *S. lycopersicum* var. *cerasiforme*
- *S. neorickii*
- *S. pennellii*
- *S. Peruvianum*
- *S. pimpinellifolium*
- *S. subsect. lycopersicon* hybr.



Greenhouse inspection and disease diagnosis

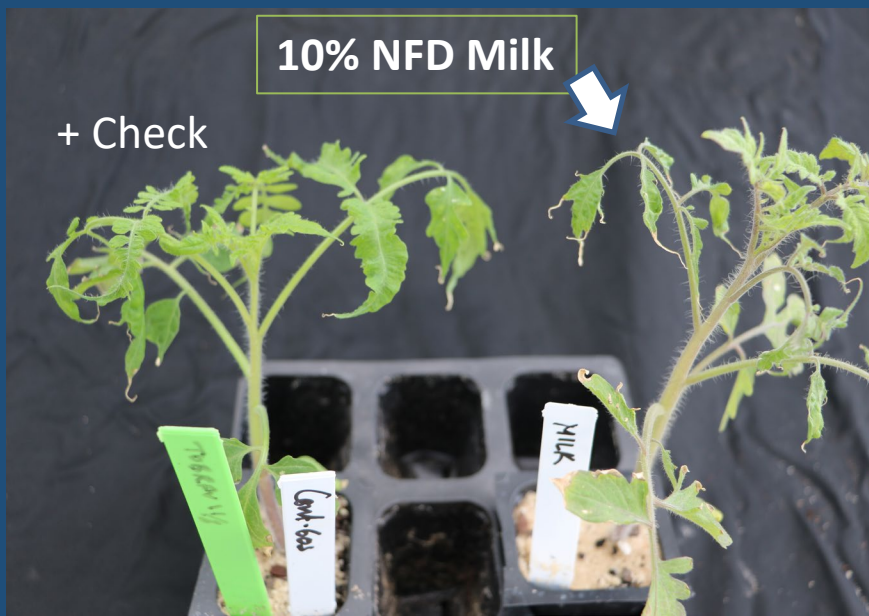
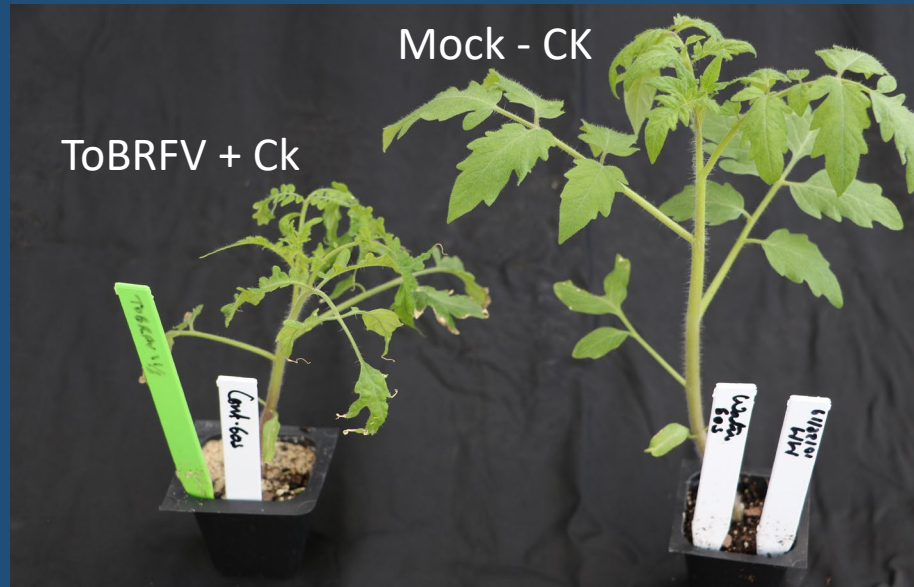


Managing ToBRFV using disinfectants

Disinfecting tools



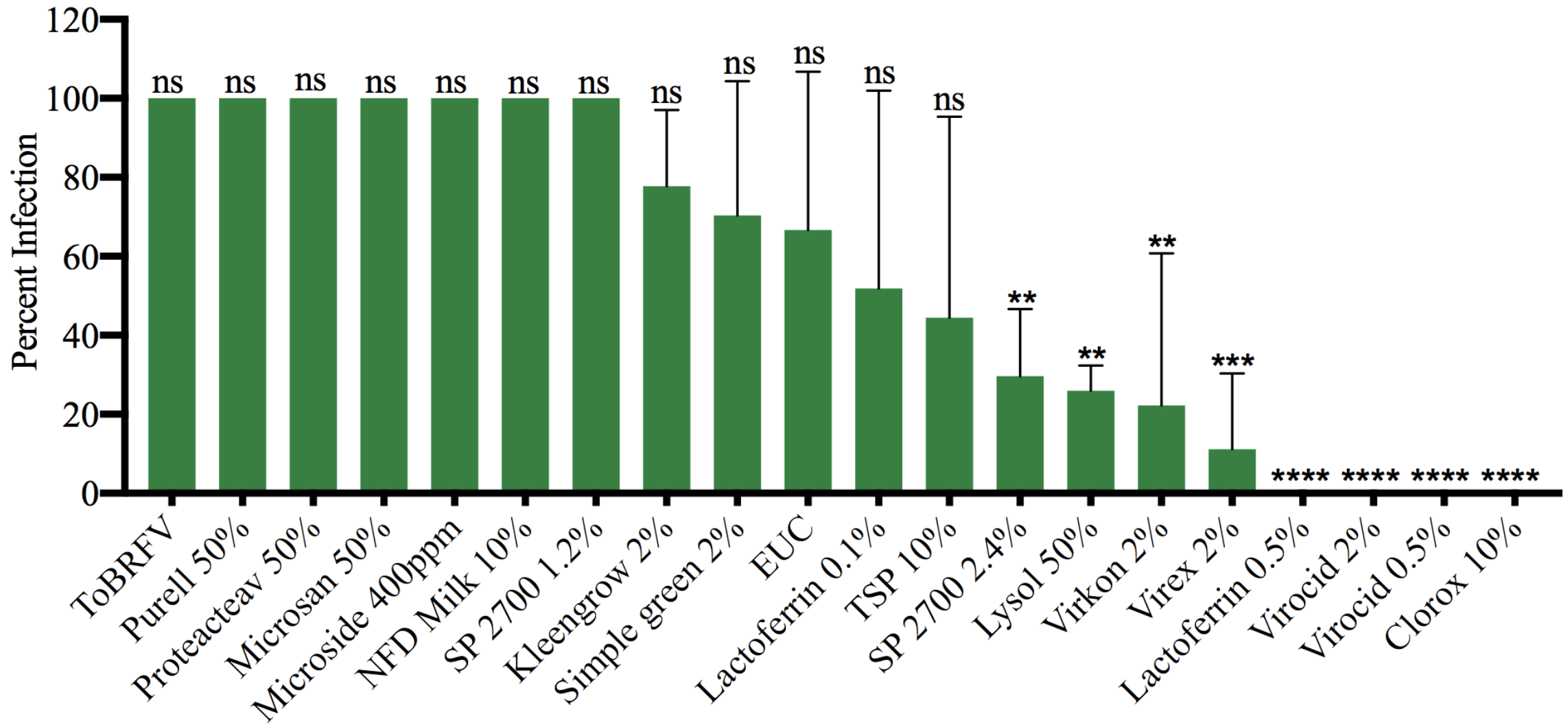
Evaluating disinfectants against ToBRFV



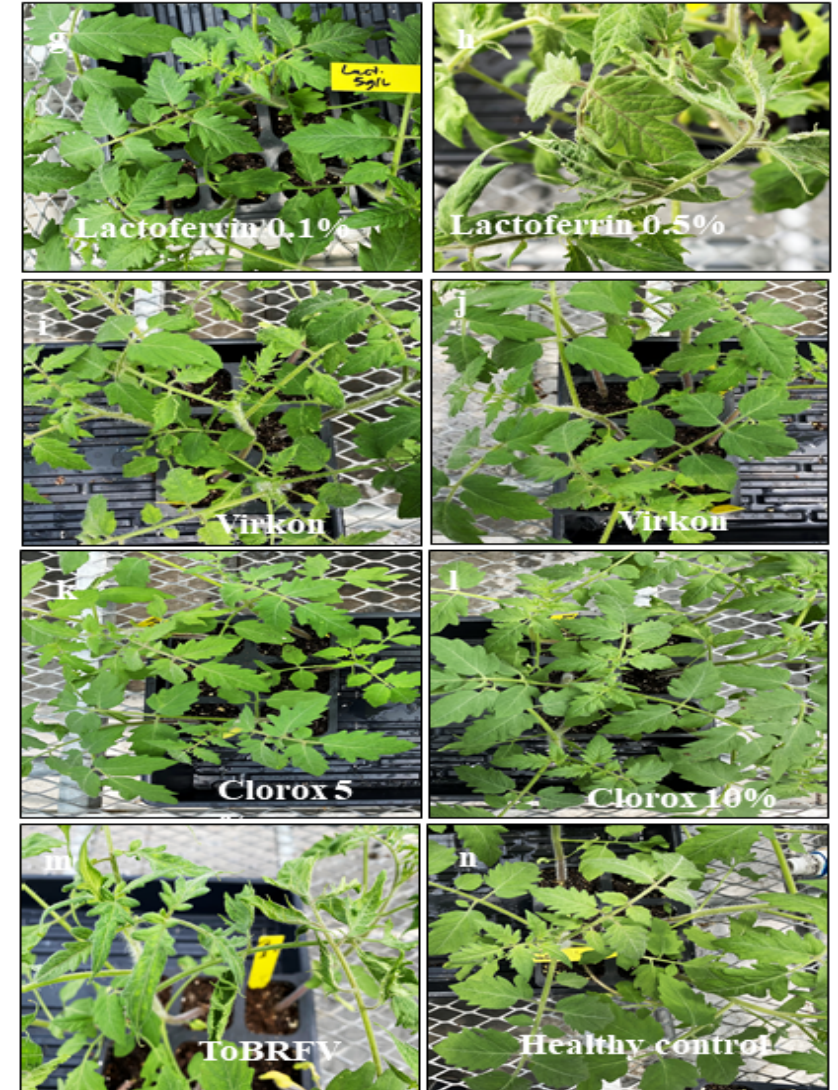
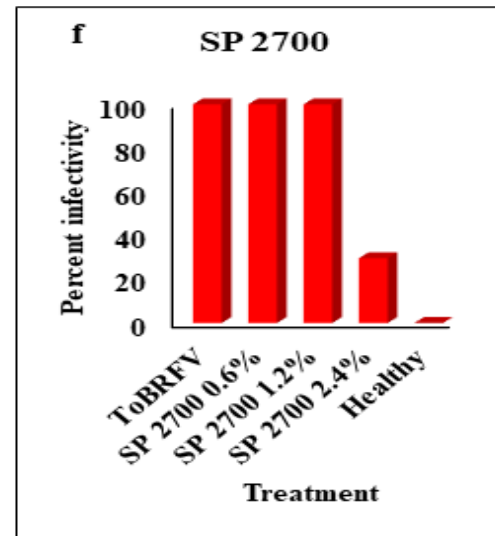
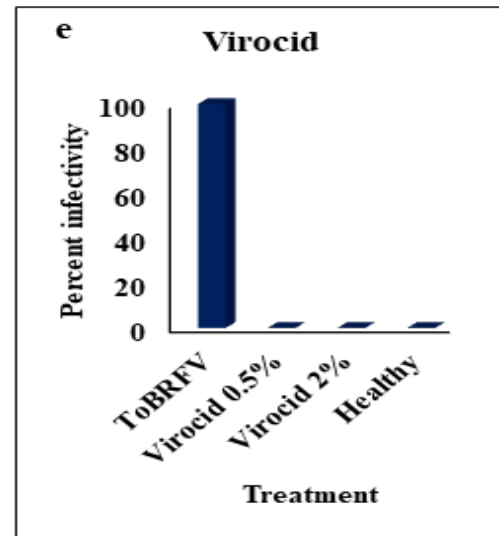
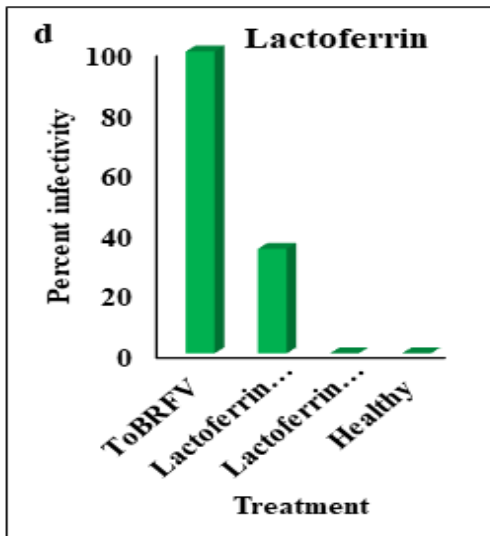
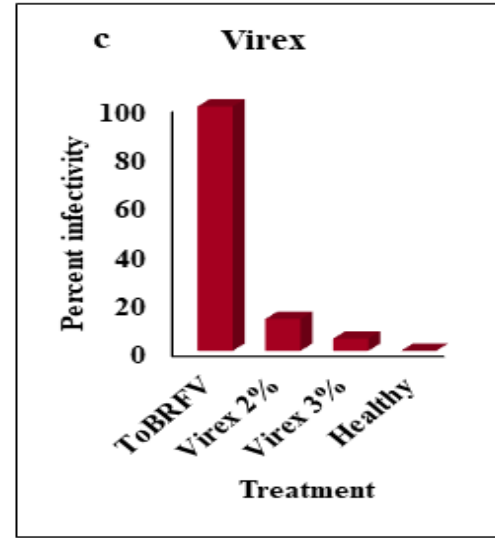
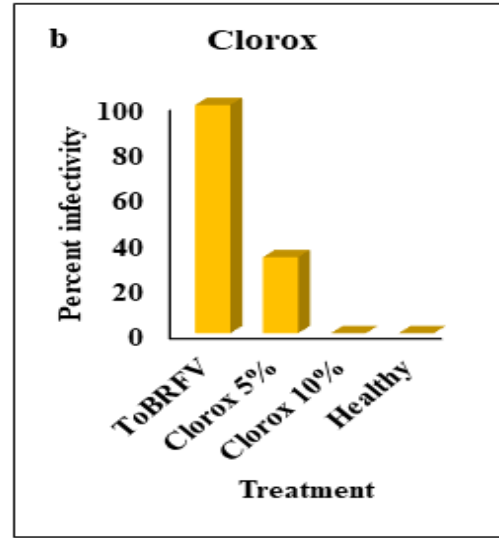
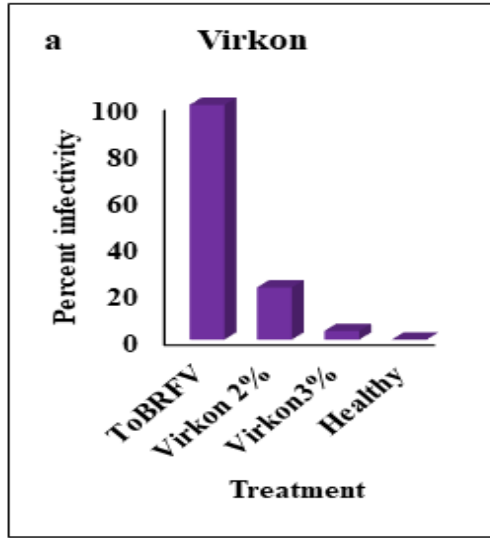
Example effects of disinfectants against ToBRFV



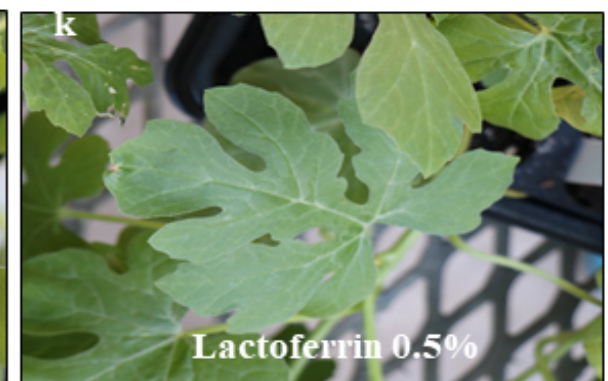
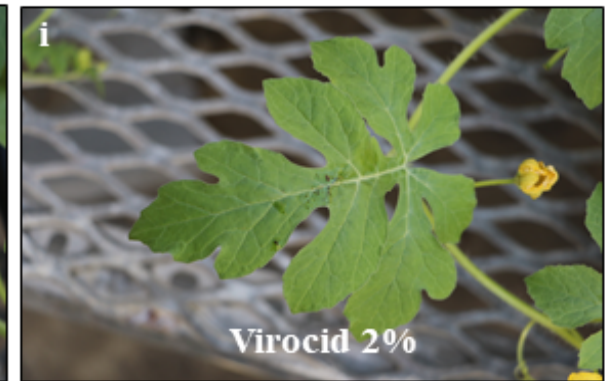
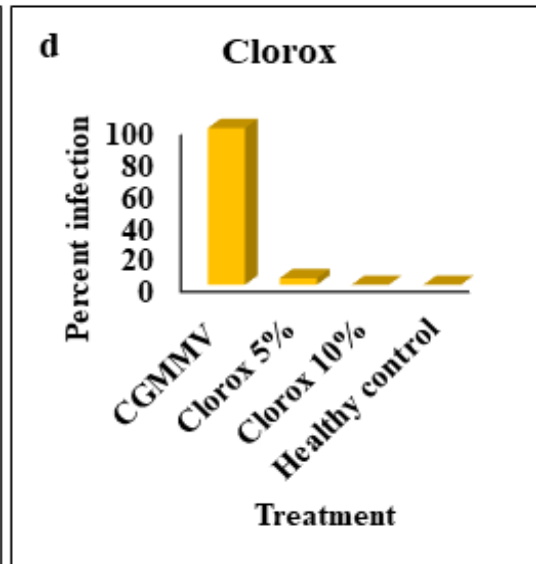
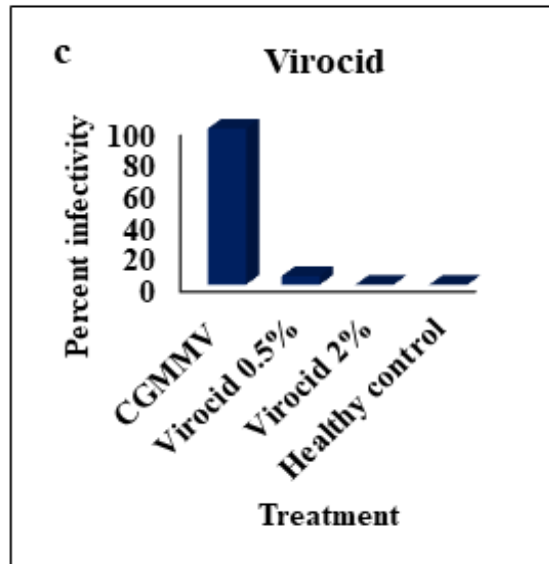
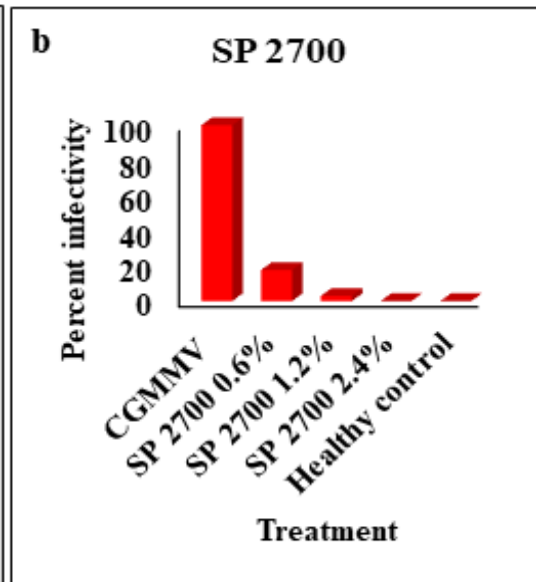
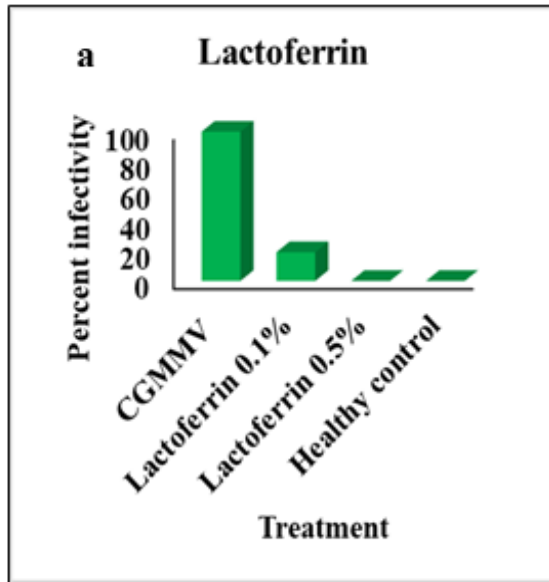
Efficacy of disinfectants against ToBRFV on tomato



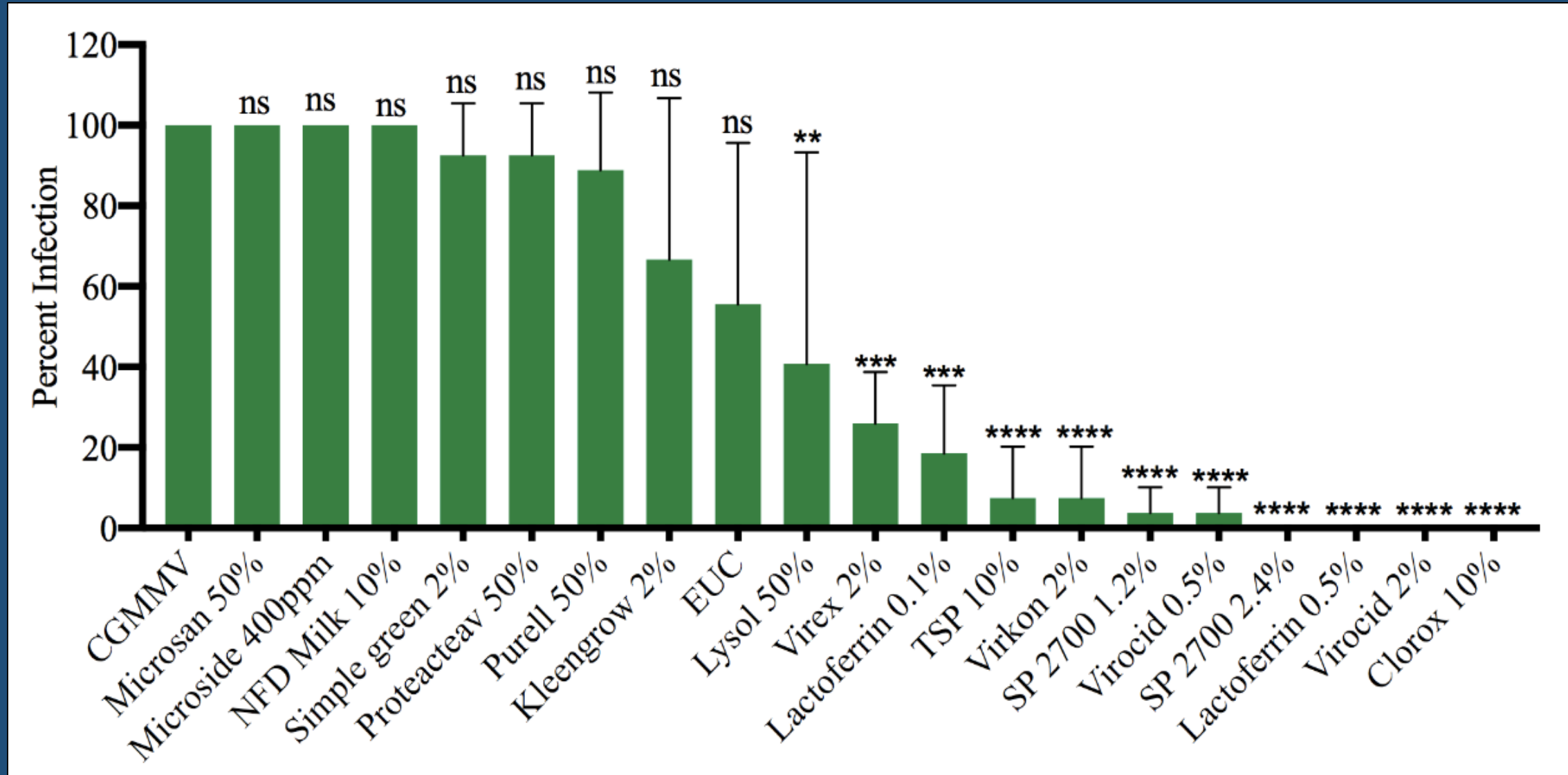
Optimizing disinfectant concentrations against ToBRFV



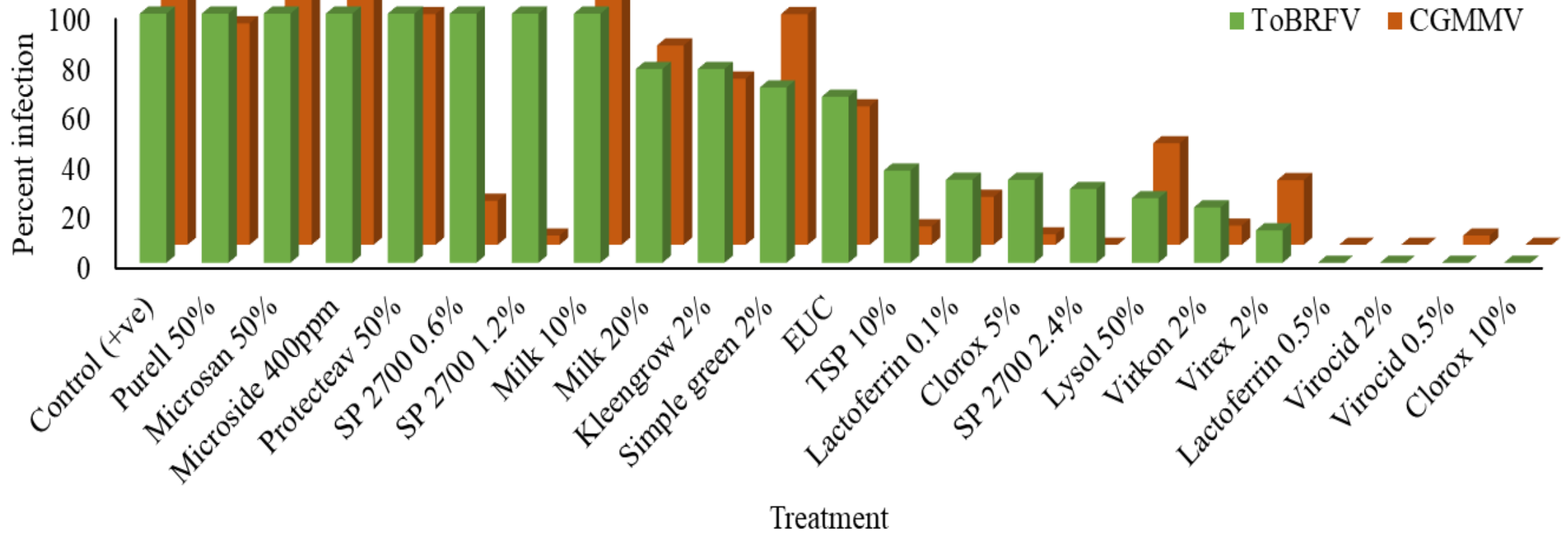
Optimizing disinfectant concentrations against CGMMV



Efficacy of disinfectants against CGMMV on tomato



Comparing disinfectants between ToBRFV and CGMMV





RESEARCH

Open Access

Evaluation of disinfectants to prevent mechanical transmission of viruses and a viroid in greenhouse tomato production

Rugang Li¹, Fulya Baysal-Gurel², Zaid Abdo³, Sally A Miller² and Kai-Shu Ling^{1*}

Most effective disinfectants against tomato viruses/viroids

Disinfectants	PepMV	ToMV	TMV	PSTVd	ToBRFV
Clorox (10%)	✓	✓	✓	✓	✓
Virkon S (2%, 3%)	✓	✓	✓	✓	✓
Lysol (50%)	✓	✓	✓	Partial	Partial
Virocid (0.5%, 2.0%)	-	-	-	-	✓
Virex (3%)	-	-	-	-	✓
Lactoferrin (0.5%)	-	-	-	-	✓

Summary

- **With no resistance tomato cultivars available for ToBRFV, the best disease management strategy is through prevention, which is similar to Covid-19.**
 - **Social distancing (avoid touching plants)**
 - **Washing your hands with soap for 2 min**
 - **Stepping on foot bath with disinfectant**
 - **Using effective disinfectants on tools, hands, and equipment.**
 - **Planting certified ToBRFV-free seeds and seedlings**
- **Waiting for “vaccine”: Breeding for disease resistance.**

Acknowledgments

USDA-ARS, Charleston

-Bidisha Chanda
-Andrea Gilliard
-Md Shamimuzzanman



USDA-APHIS-PPQ:

Yazmín Rivera, Schyler Nunziata, Marco Galvez

The Ohio State University:

Sally Miller

University of Florida:

Gary Vallad

California Dept. Food and Agriculture

T. Tian

Sakata Seed America

S. Gurung

Eurofins BioDiagnostics

R. Salati

HM Clause

C. Kurowski

The U.S. Greenhouse tomato growers:

Mike Bledsoe

Karin Tift

Funding:

-USDA-ARS NPDRS
-USDA-NIFA SCRI
-ASTA