Tianna DuPont

WASHINGTON STATE UNIVERSITY

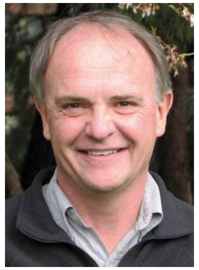
George Sundin

Nikki Rothwell

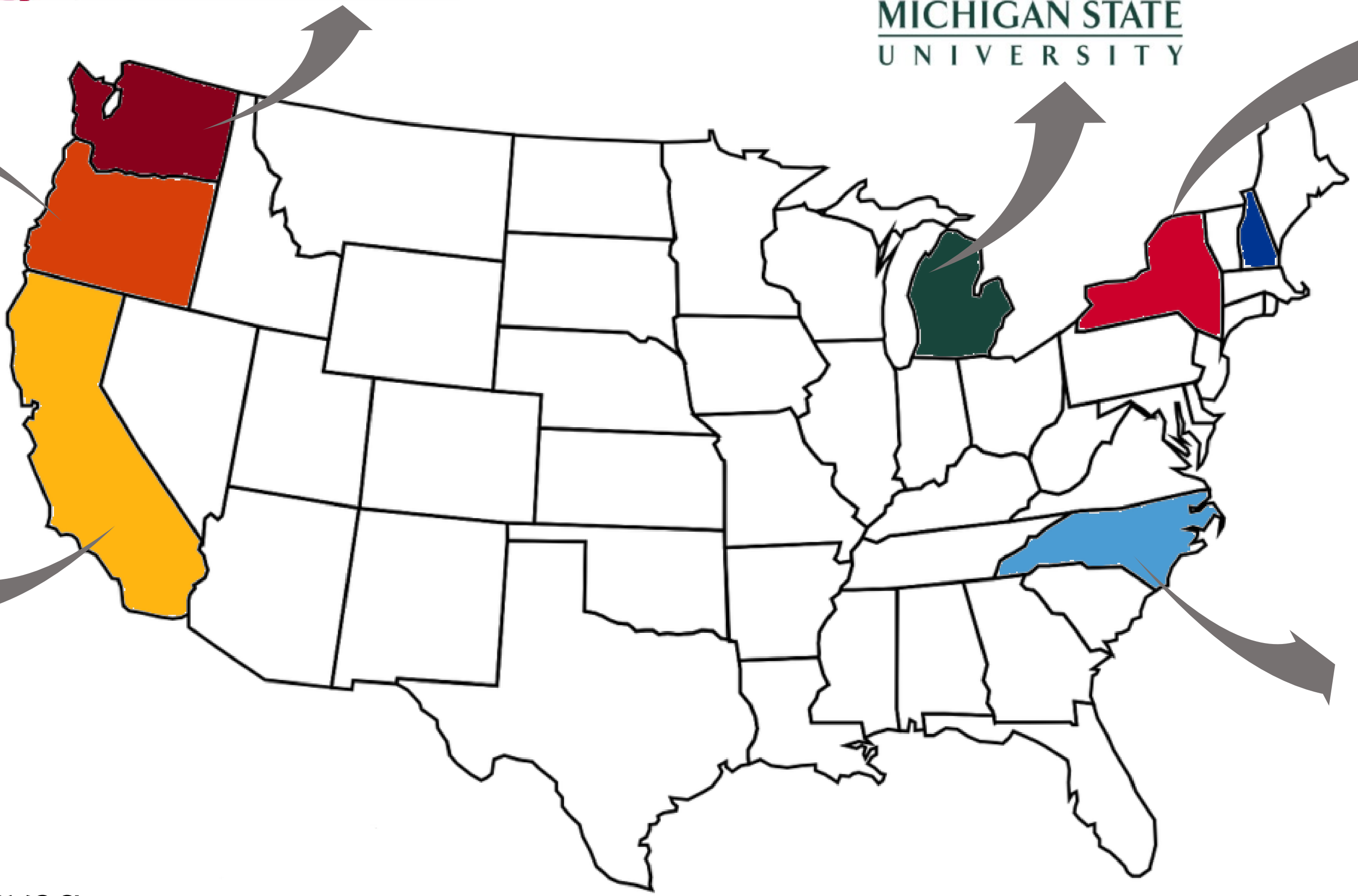
MICHIGAN STATE UNIVERSITY

Kerik Cox

Oregon State University



Ken Johnson



UC DAVIS

Jim Adaskaveg

Sara Villani

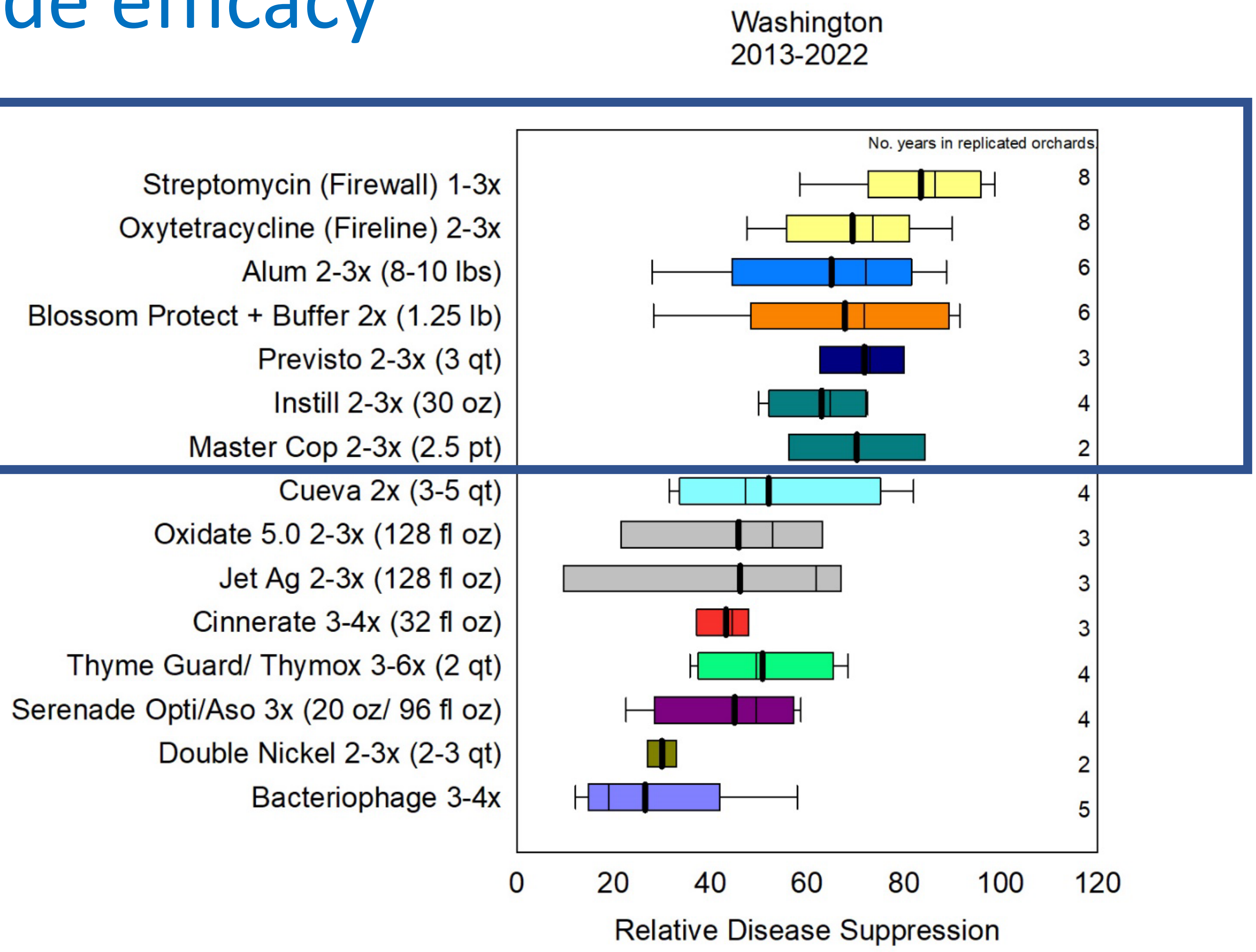
Peter Ojiambo

NC STATE UNIVERSITY

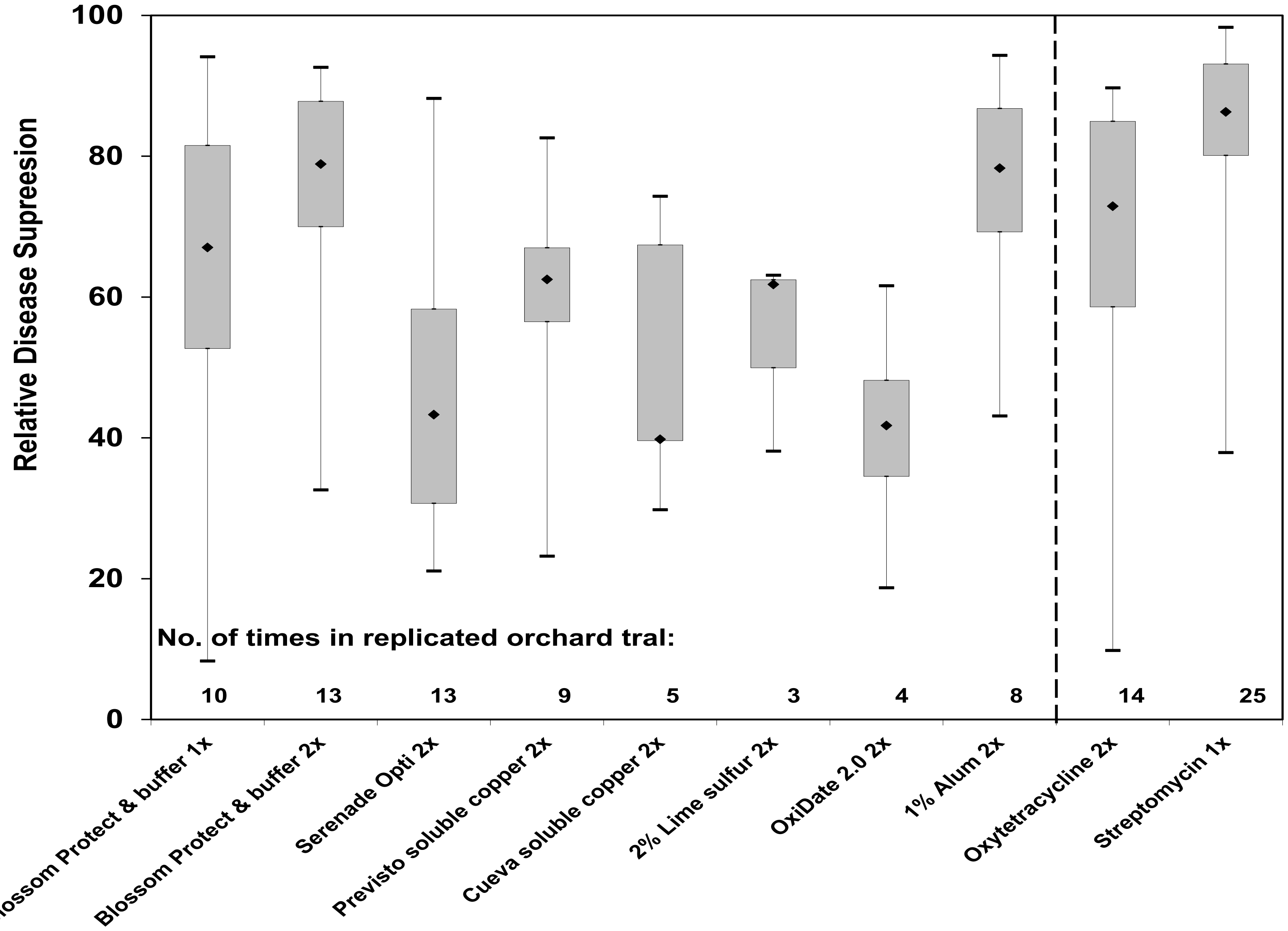
The challenge of selecting biopesticide materials for fire blight spray programs:

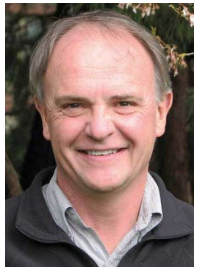
Material class	Goal: Significantly reduce pathogen #s on flowers	Goal: Good infection suppression	Goal: low potential to mark fruit
Antibiotics			
Blossom Protect			
Soluble coppers			
Alum			
Bacillus-biorationals			
Botanicals (essential oils)			
Oxidizers (H_2O_2, lime sulfur)			
Phage			

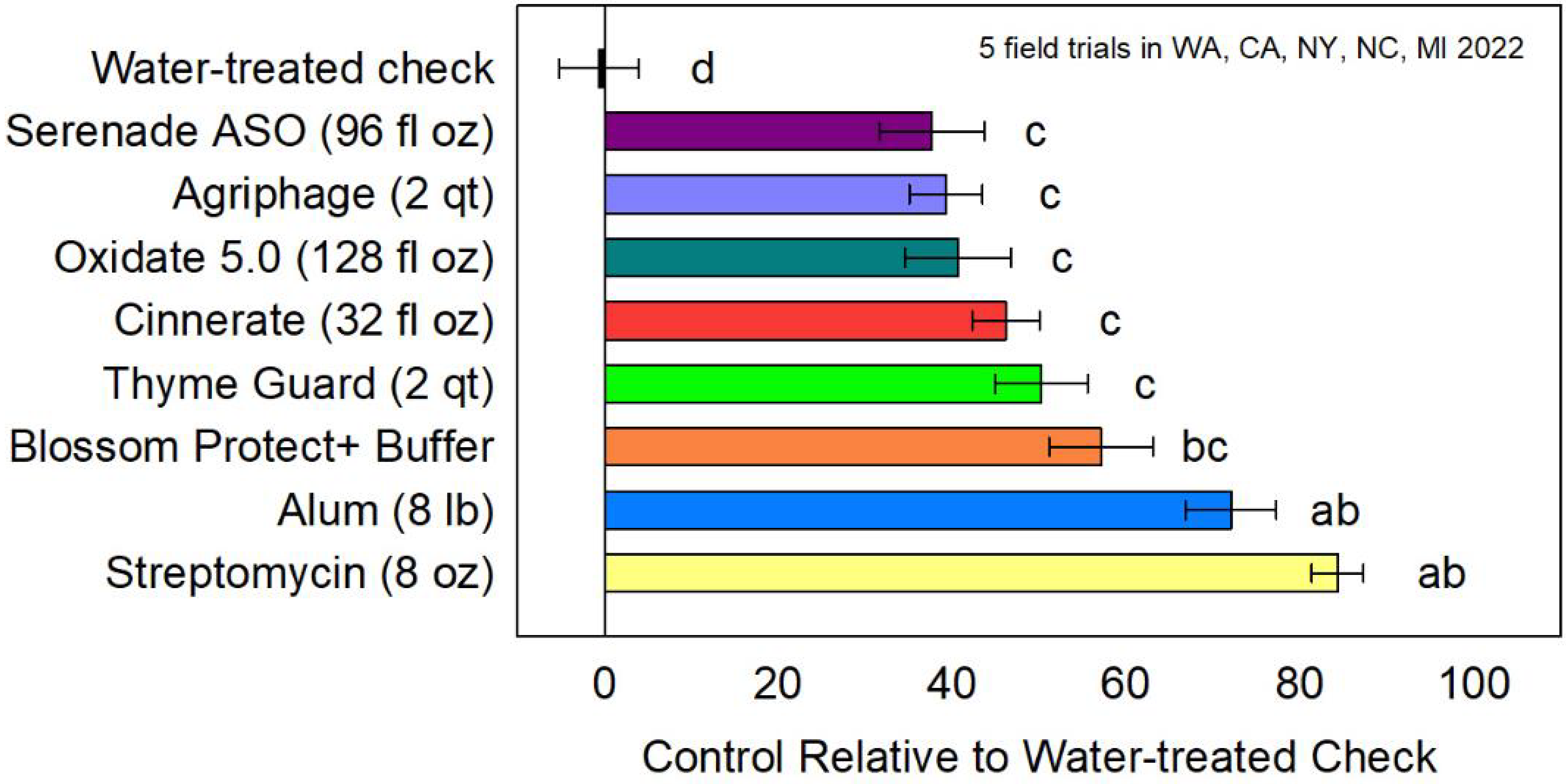
1) Biopesticide efficacy



Relative fire blight suppression from pathogen-inoculated pear and apple orchard trials conducted near Corvallis, Oregon from 2013 to 2021.



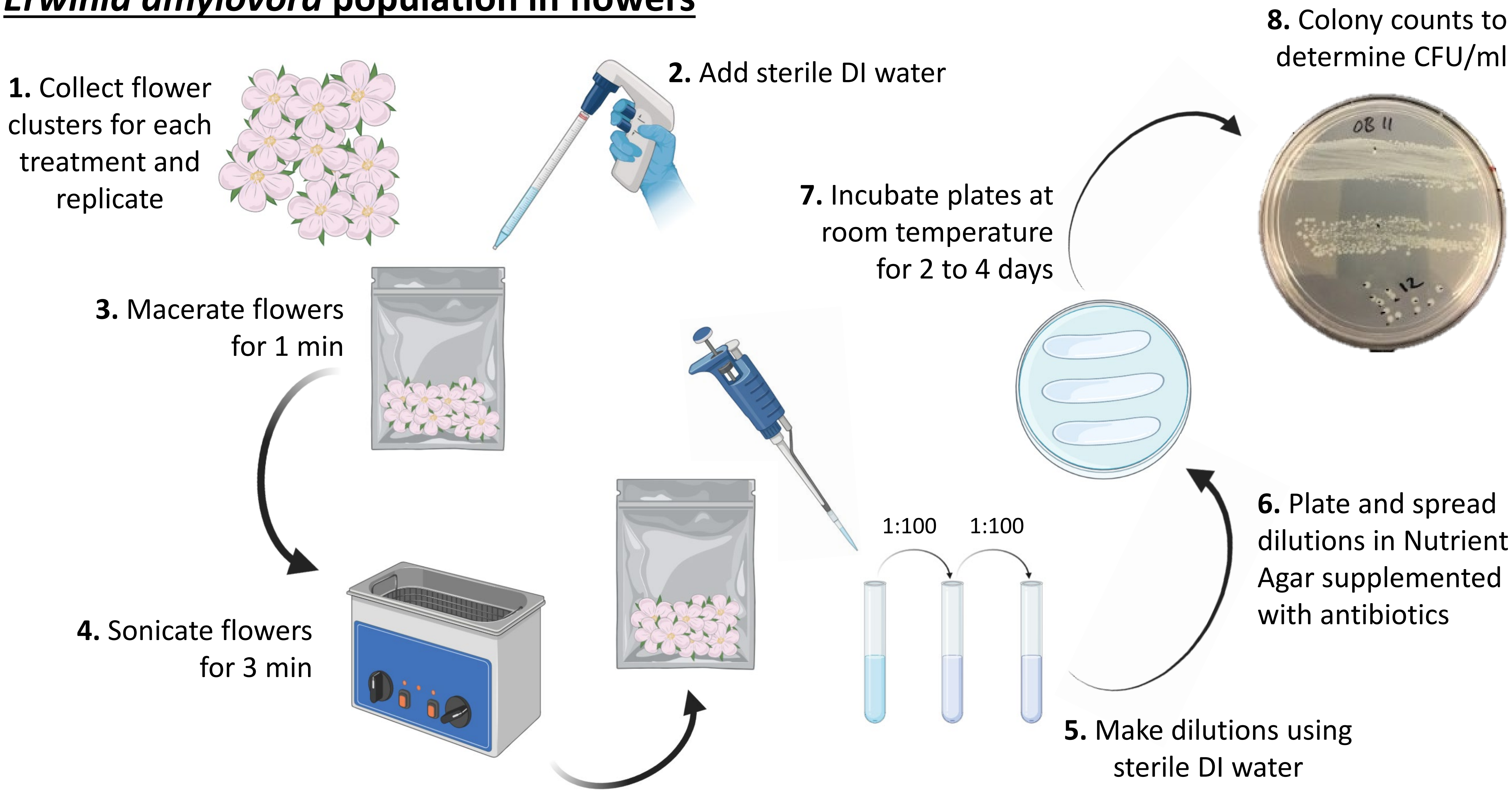




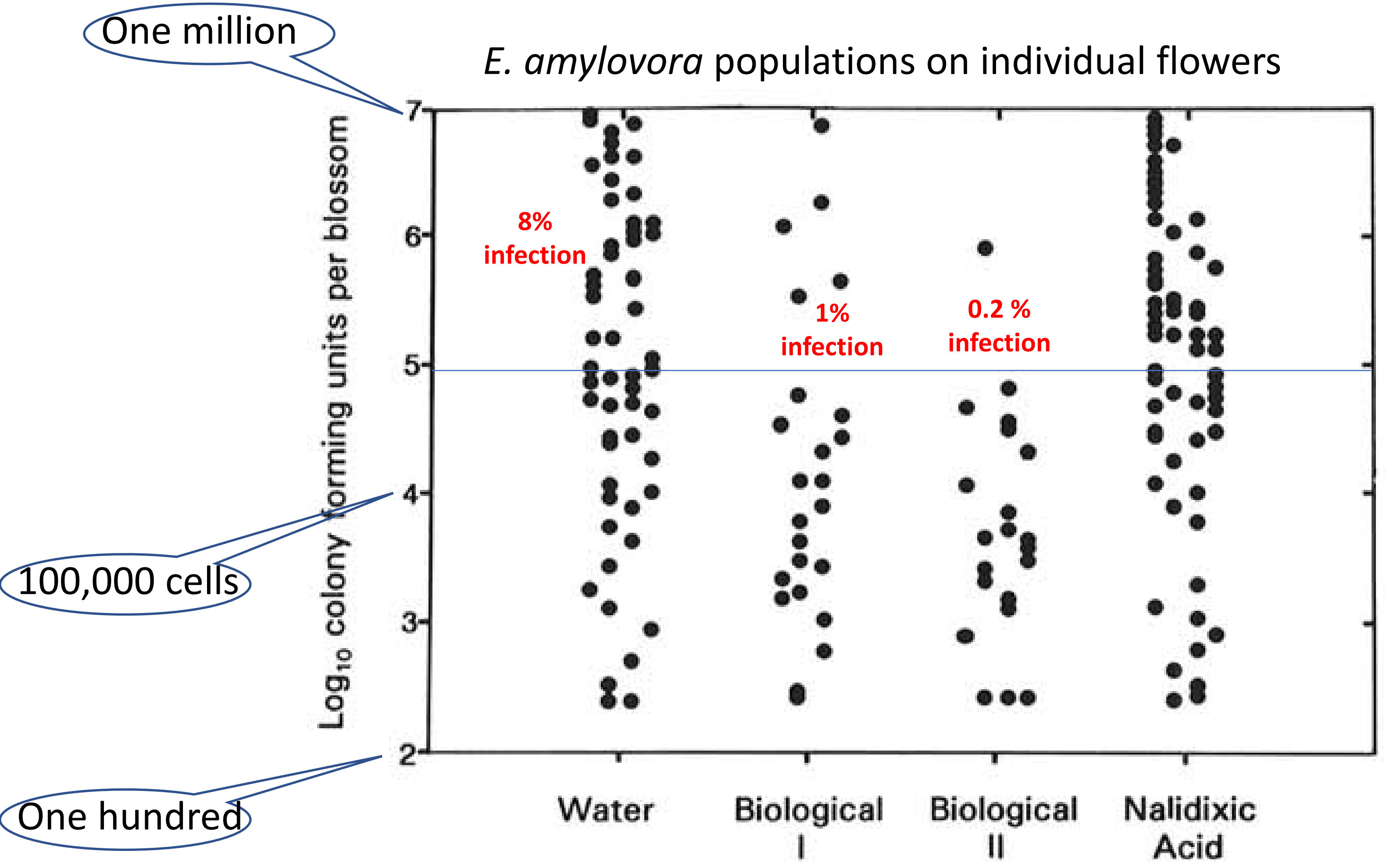
5 field trials in WA, CA, NY, NC, MI 2022
Water-treated check
Serenade ASO (96 fl oz)
Agriphage (2 qt)
Oxidate 5.0 (128 fl oz)
Cinnerate (32 fl oz)
Thyme Guard (2 qt)
Blossom Protect+ Buffer
Alum (8 lb)
Streptomycin (8 oz)
d
c
c
c
c
c
bc
ab
ab
0
20
40
60
80
100
Control Relative to Water-treated Check

2) Biopesticide efficacy effects on pathogen populations in flowers

***Erwinia amylovora* population in flowers**



Important result: the number of cells required to cause an infection

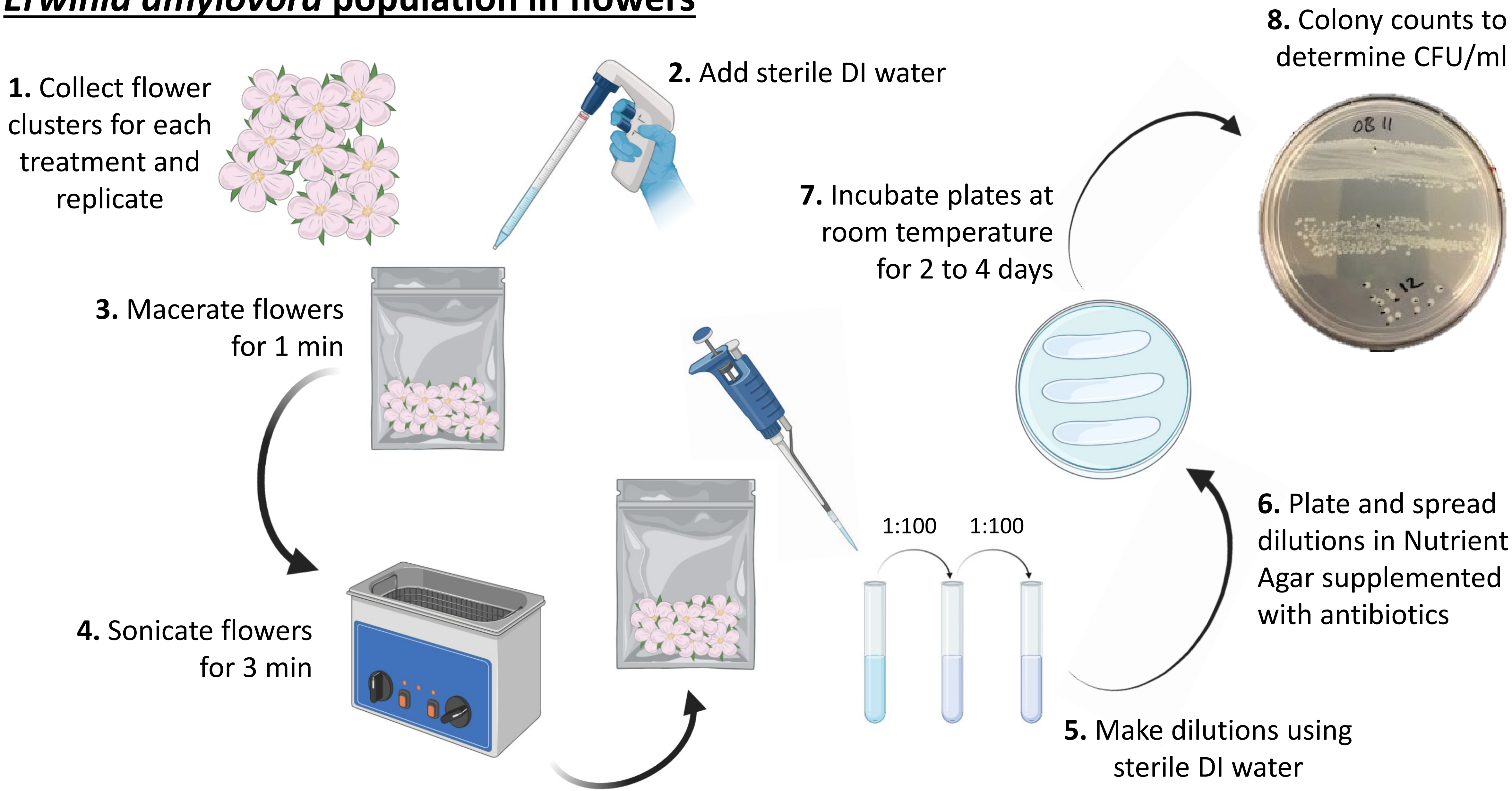


Many flowers developed an *E. a.* population

But, E. a. populations > 100,000 cells/flower (10^5) showed the best correlation with infection

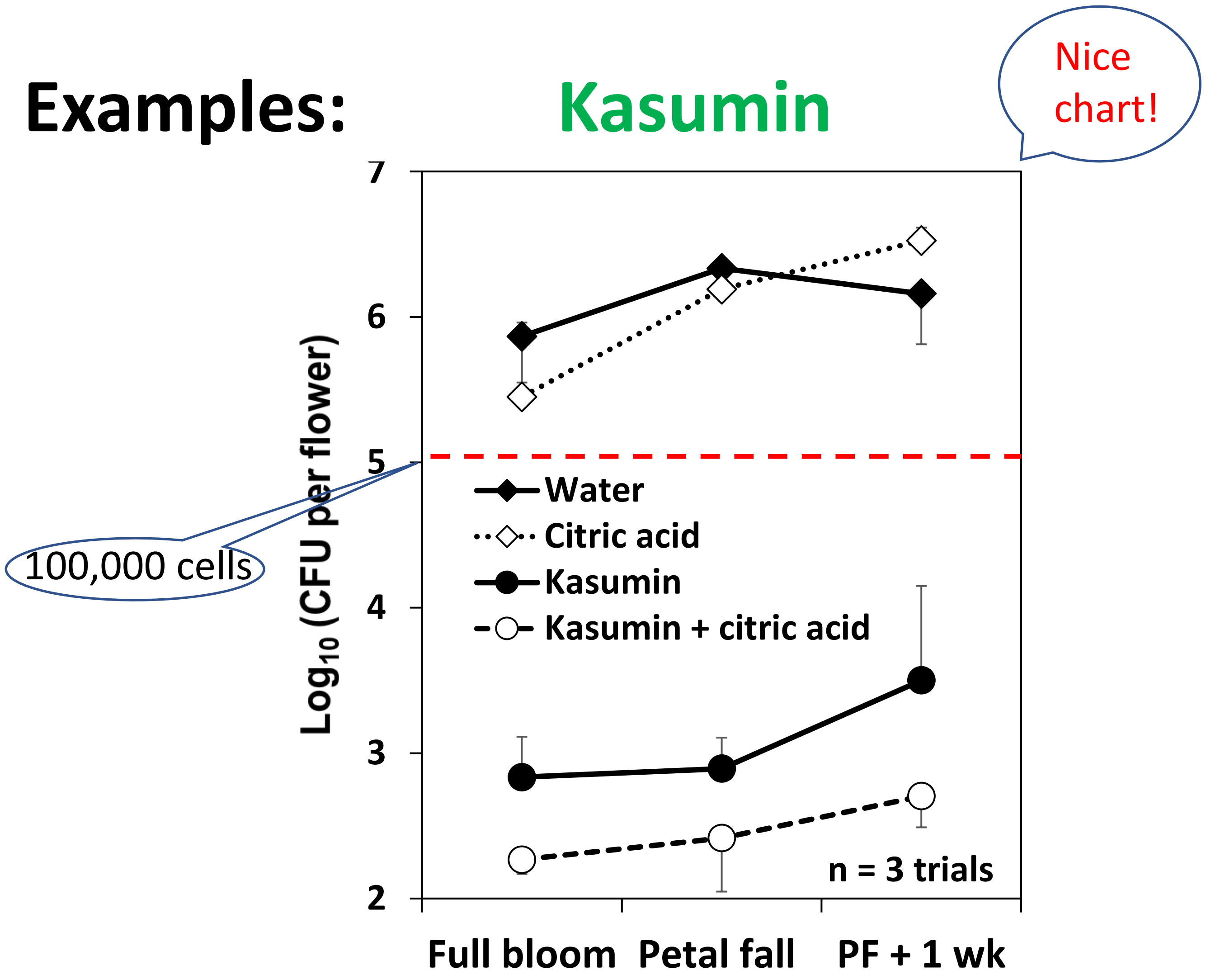
Johnson et al., Phytopathology 83:995, 1993

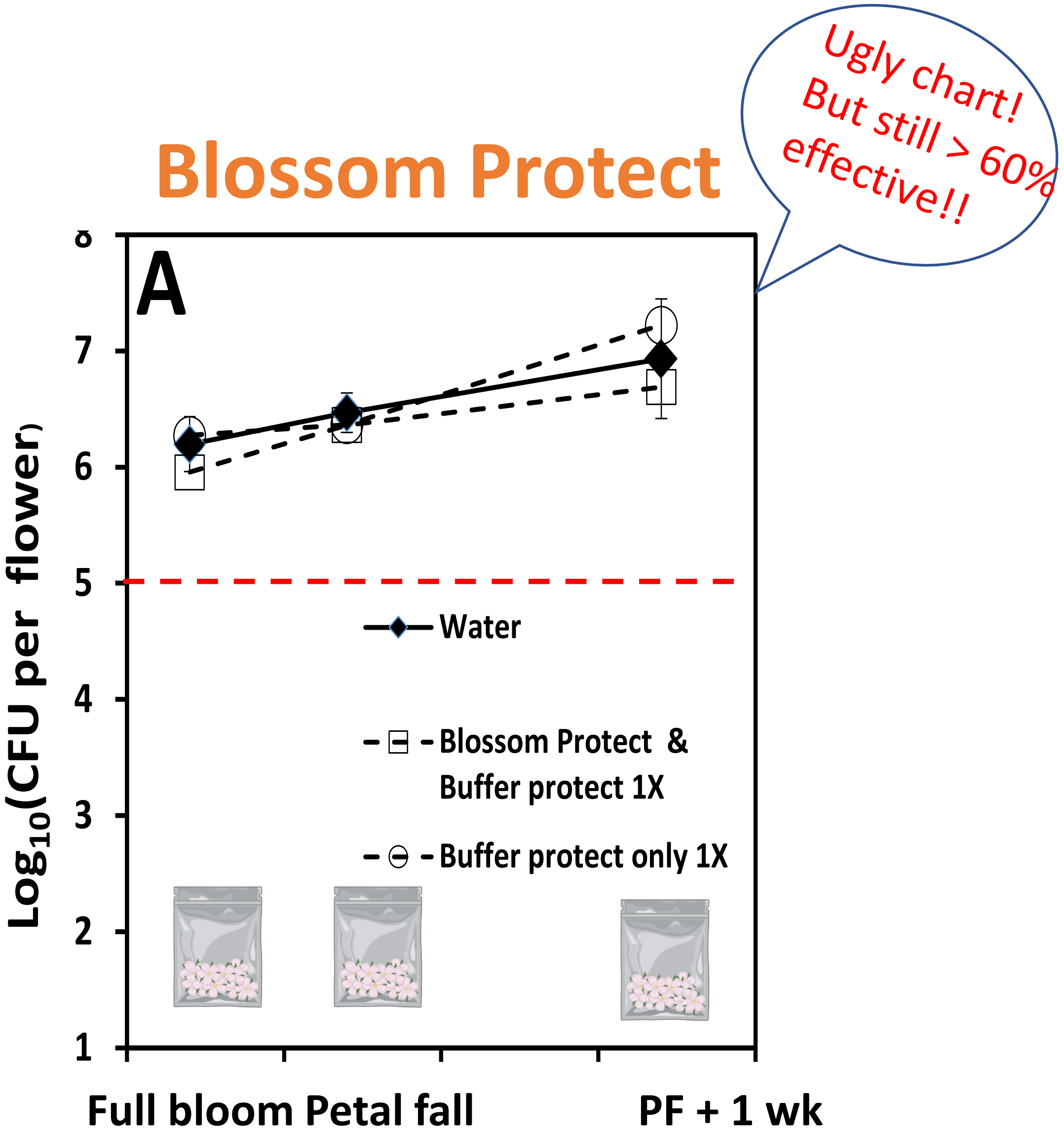
Erwinia amylovora population in flowers

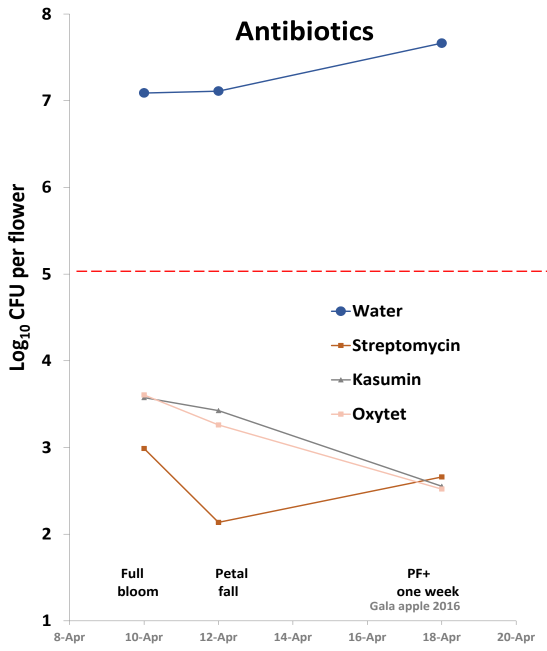


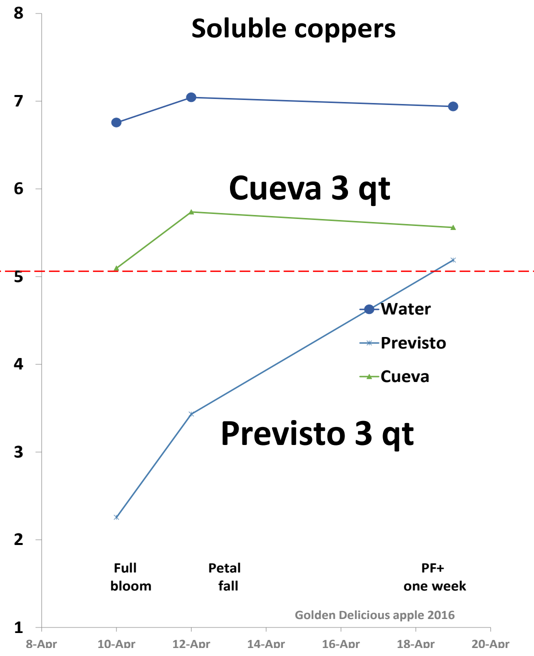
2) Biopesticide efficacy effects on pathogen populations in flowers

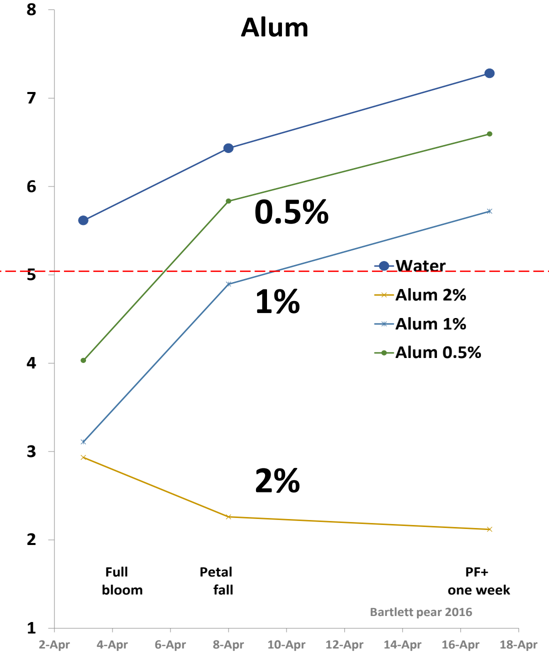
Examples:

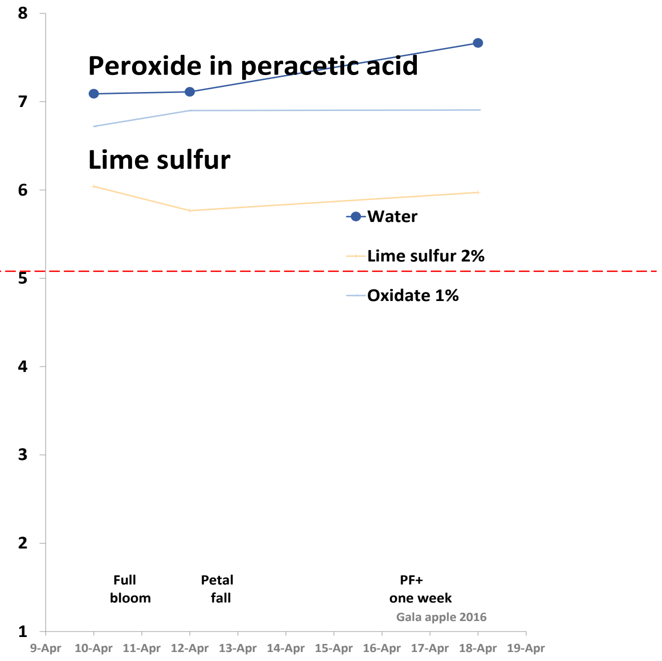


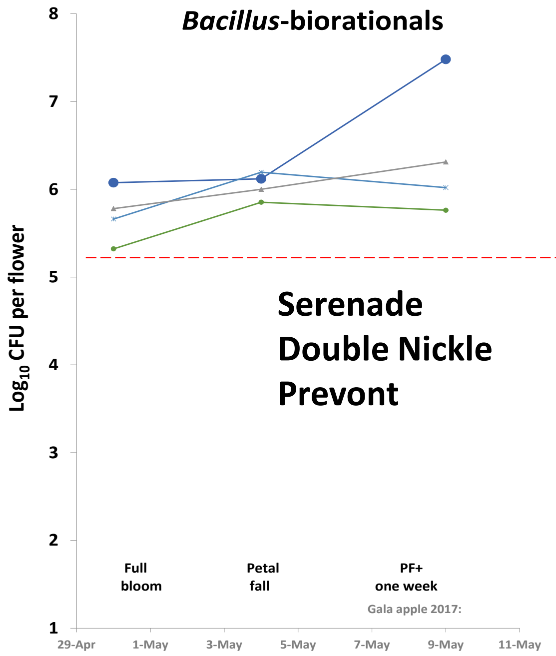


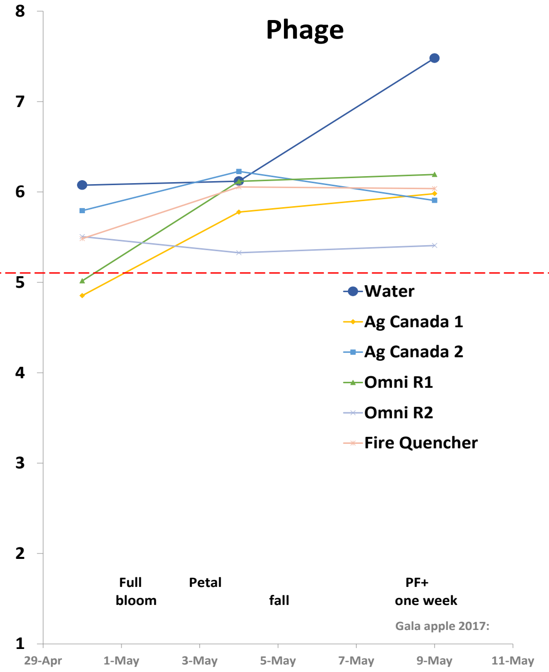


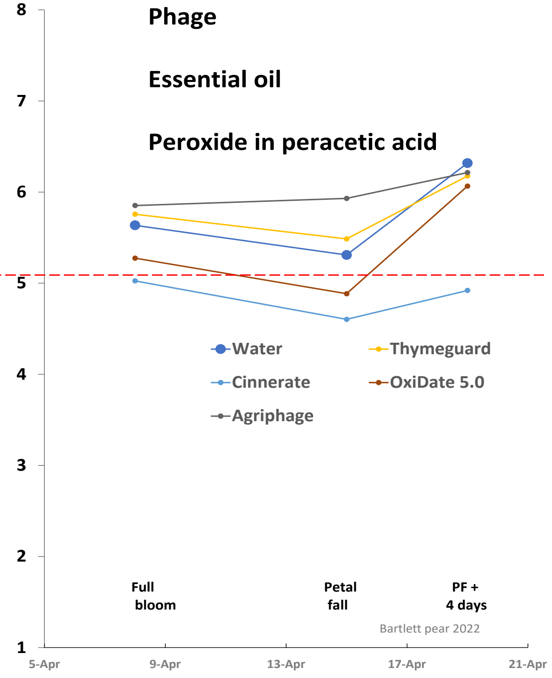






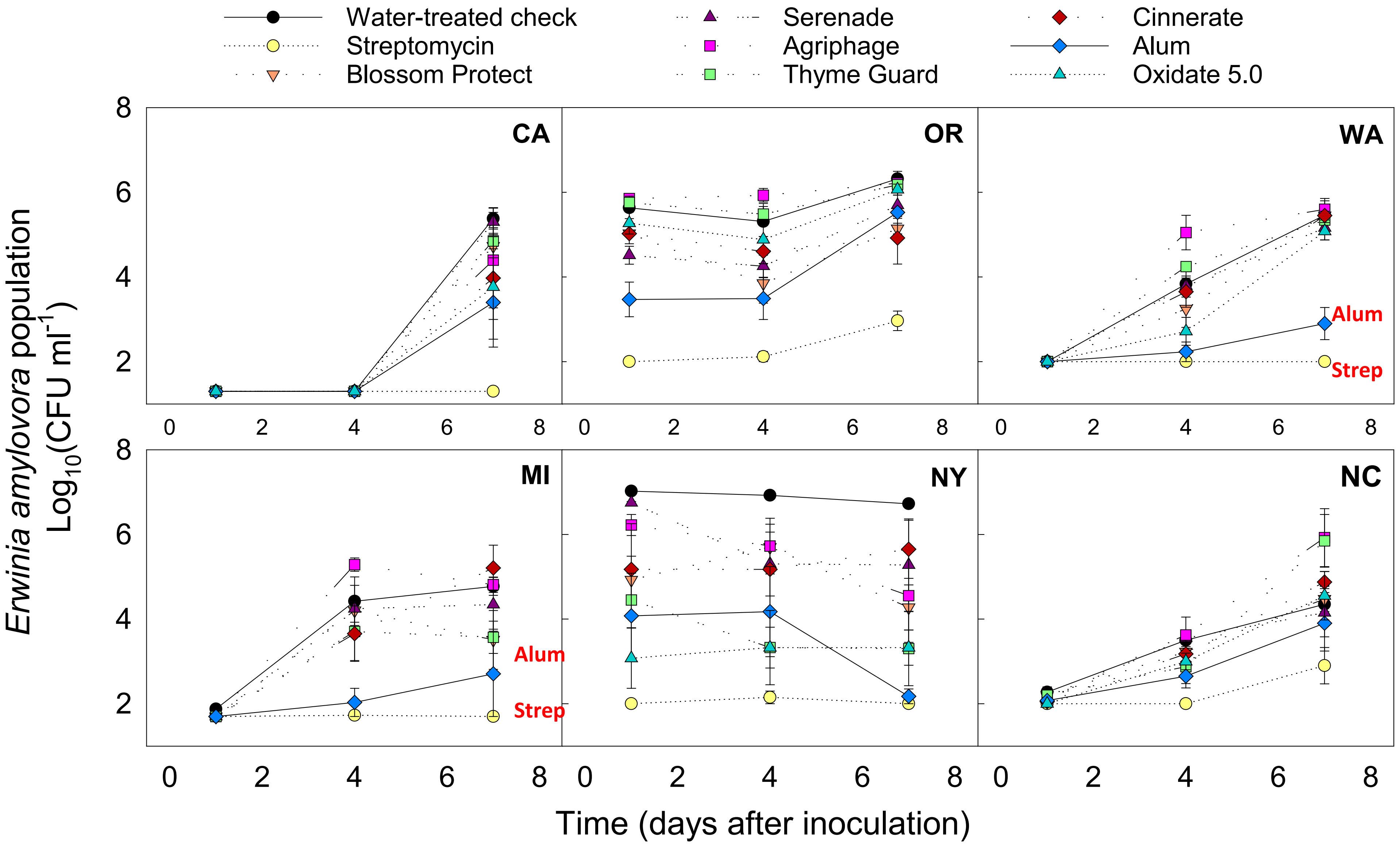






Effect of materials (marketed or in development) on epiphytic populations of *Erwinia amylovora*

Erwinia amylovora population in flowers



The challenge of selecting biopesticide materials for fire blight spray programs:

Material class	Goal: Significantly reduce pathogen #s on flowers	Goal: Good infection suppression	Goal: low potential to mark fruit
Antibiotics	✓	✓	✓
Blossom Protect		✓	
Soluble coppers	✓	✓	
Alum	✓	✓	
Bacillus-biorationals			✓
Botanicals (essential oils)			
Oxidizers (H_2O_2, lime sulfur)			
Phage			✓

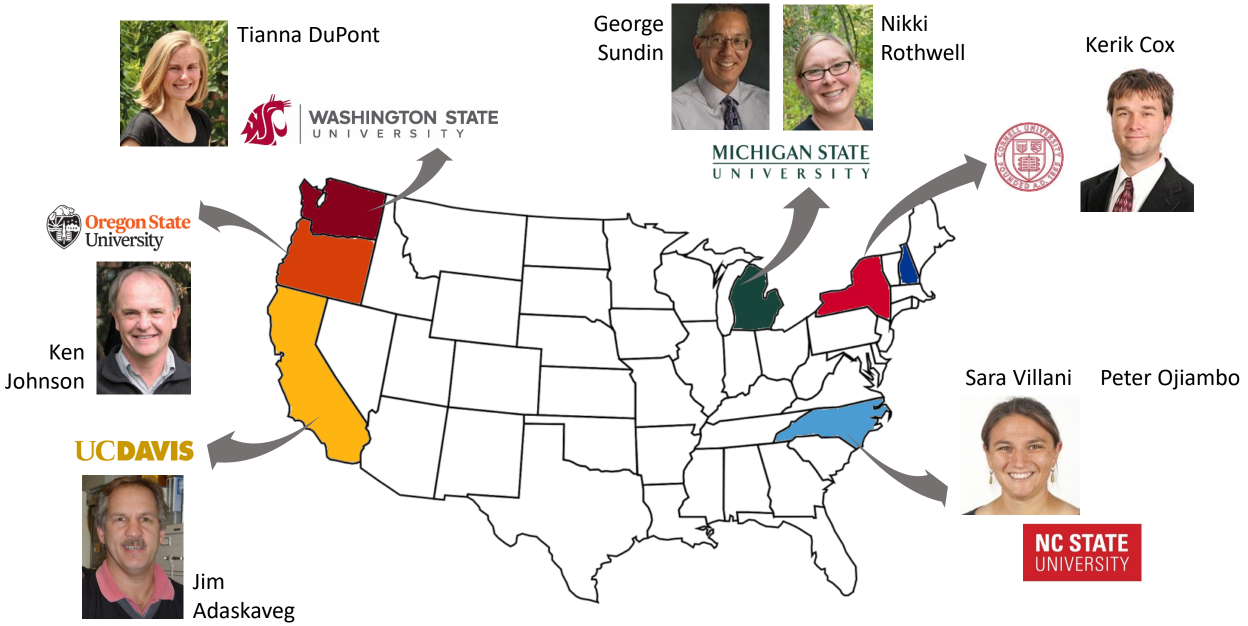
3) Understanding and Optimizing Biopesticides

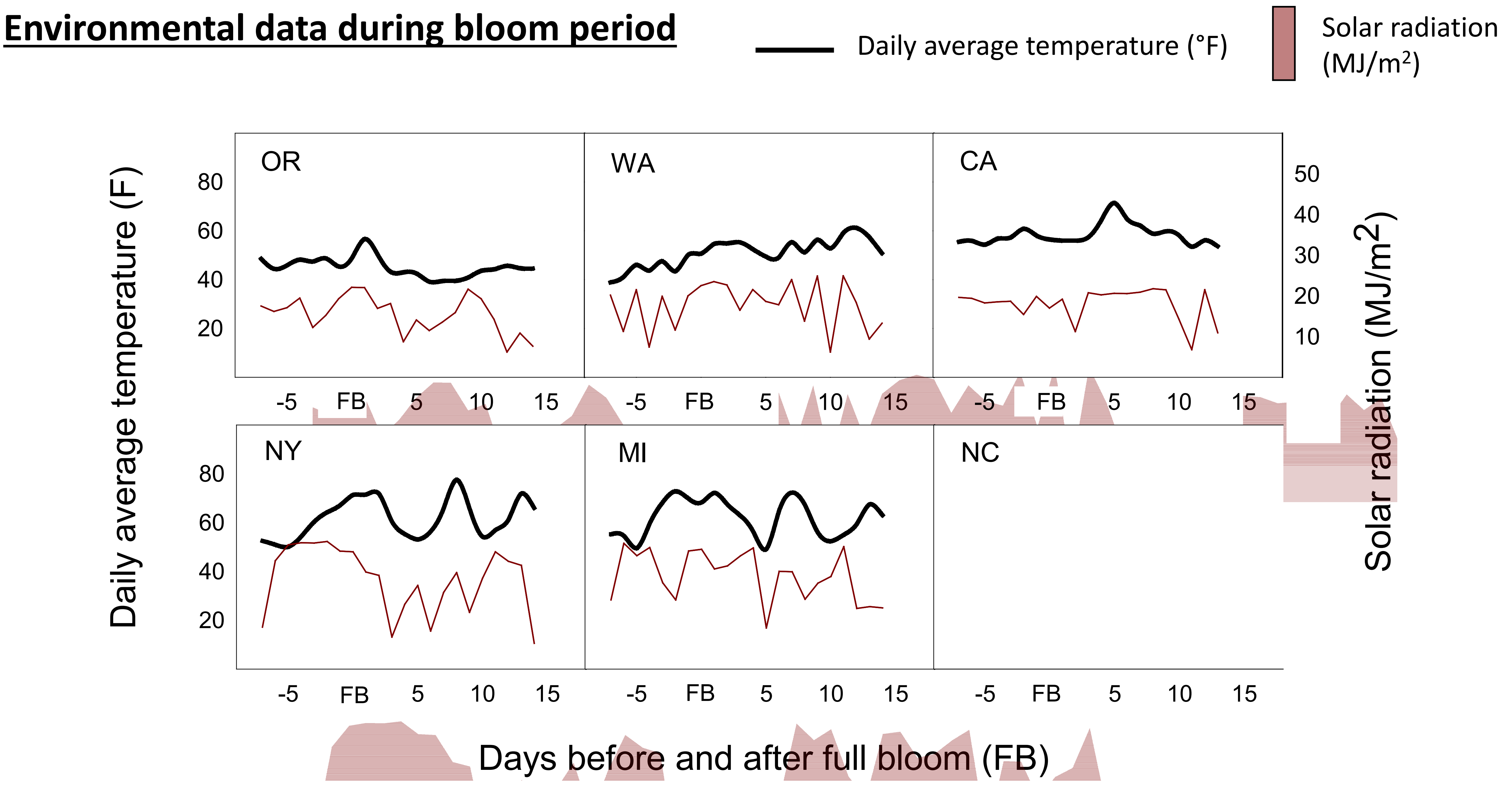
Solitary

Biopesticides

Understanding how *environmental variability* affects the goals of Ea pop reduction, infection suppression, and minimal fruit russeting

Utilize specific properties of biopestides in sequences programs that *optimize* the goals of Ea pop reduction, infection suppression, and minimal fruit russeting



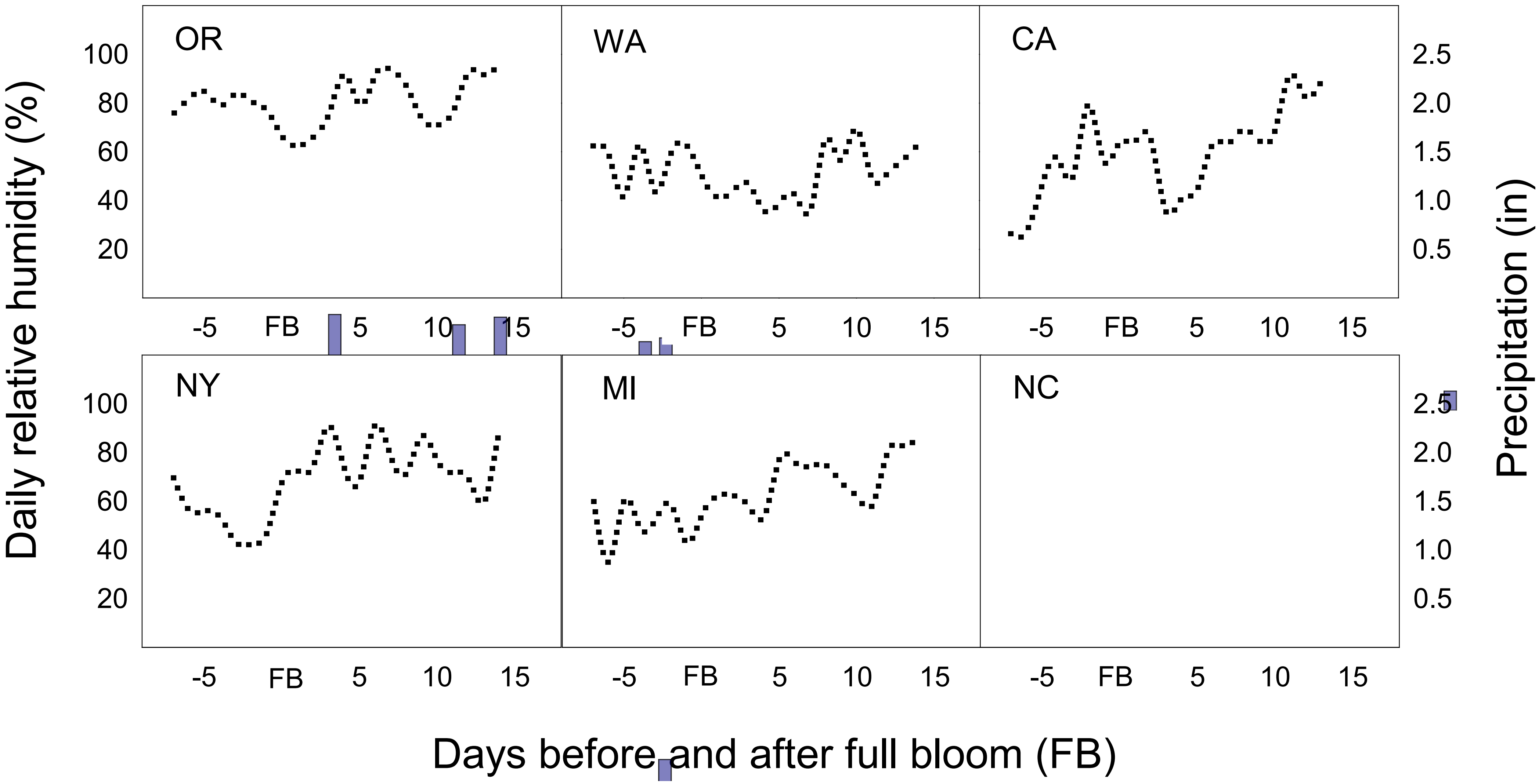


Environmental data during bloom period
Daily average temperature (°F)
Solar radiation (MJ/m2)
OR
WA
CA
NY
MI
NC
Daily average temperature (F)
Solar radiation (MJ/m2)
80
60
40
20
50
40
30
20
10
-5
FB
5
10
15
Days before and after full bloom (FB)

Environmental data during bloom period

Daily relative humidity (%)

Precipitation (inches)



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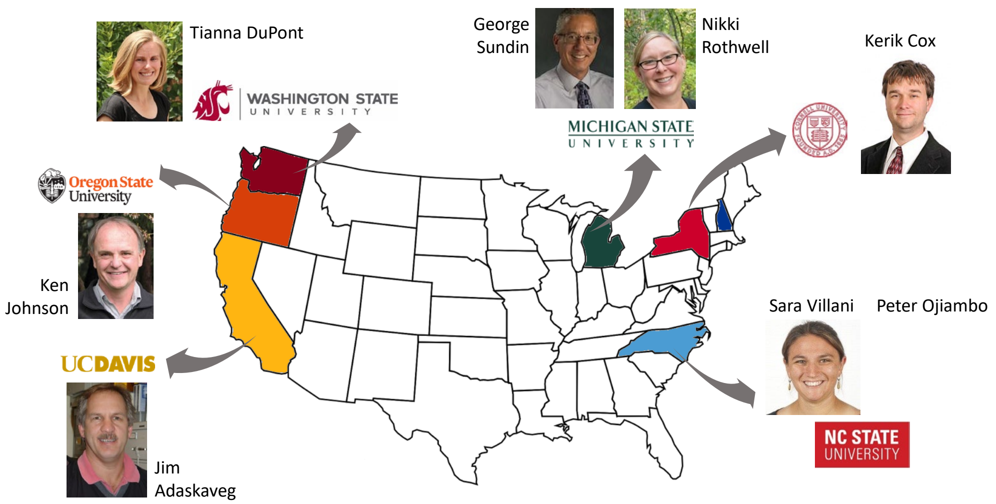


Integrated, non-antibiotic fire blight control in PNW organic orchards:

Example PNW spray program with considerations for fruit safety:

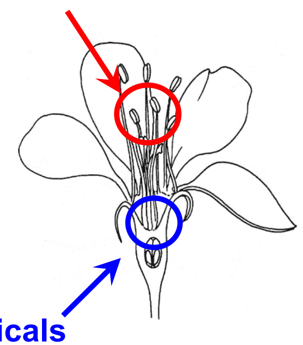
1) Prebloom (just prior to green tip):
   Fixed copper sanitation if fire blight was in orchard last year (5 to 6 lb/A)

2) Early bloom apple: (crop load thinning)
   Lime sulfur (plus oil) early bloom at 20 and 70% bloom
   Reapply biological if lime sulfur goes on after biological

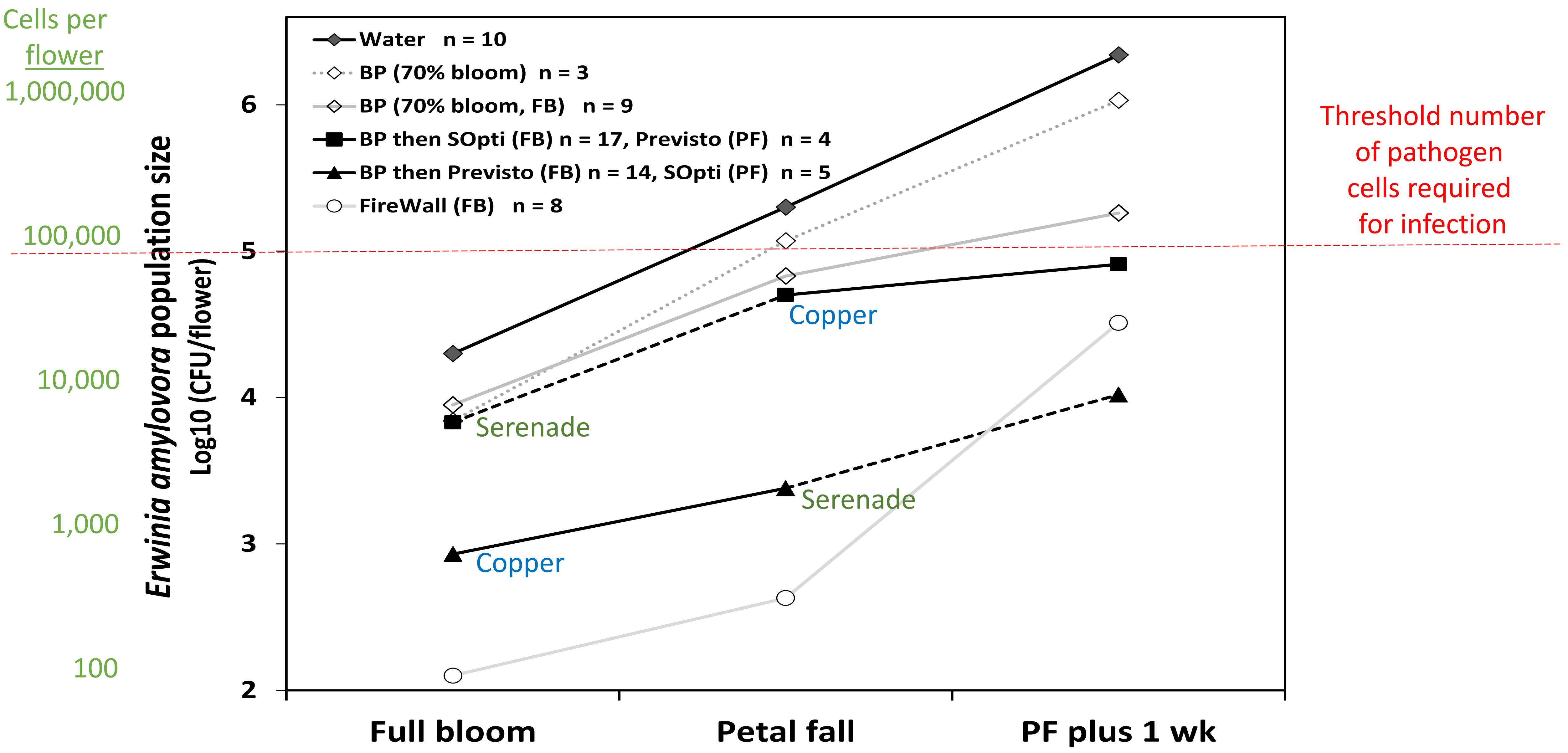
3) Early bloom apple and pear: Blossom Protect
   One full, or two half apps, (or two full apps if blight last year) – cover every row once
   80% bloom is ideal timing. In apple, o.k. to apply immediately after 2nd lime sulfur.
   In smooth-skinned pears in wetter areas, russet risk might be unacceptably high

4) Full bloom: depending on cultivar russet risk/CougarBlight model risk:
   Previsto (3 qts/A) (best for suppressing inoculum buildup)
   Serenade Opti (or ASO) with Cueva (3 qts/A)
   Serenade Opti (or ASO) every 2 to 4 days (most fruit safe)

5) Petal fall: Serenade Opti (or ASO) every 2 to 4 days (most fruit safe)
   Red apples: lime sulfur (2 to 4%) (also to clean up bacteria, yeast, mildew and rot fungi)



Effect of integrated non-antibiotic programs on epiphytic pathogen populations



OSU 'Integrated control' trials 2016-2020

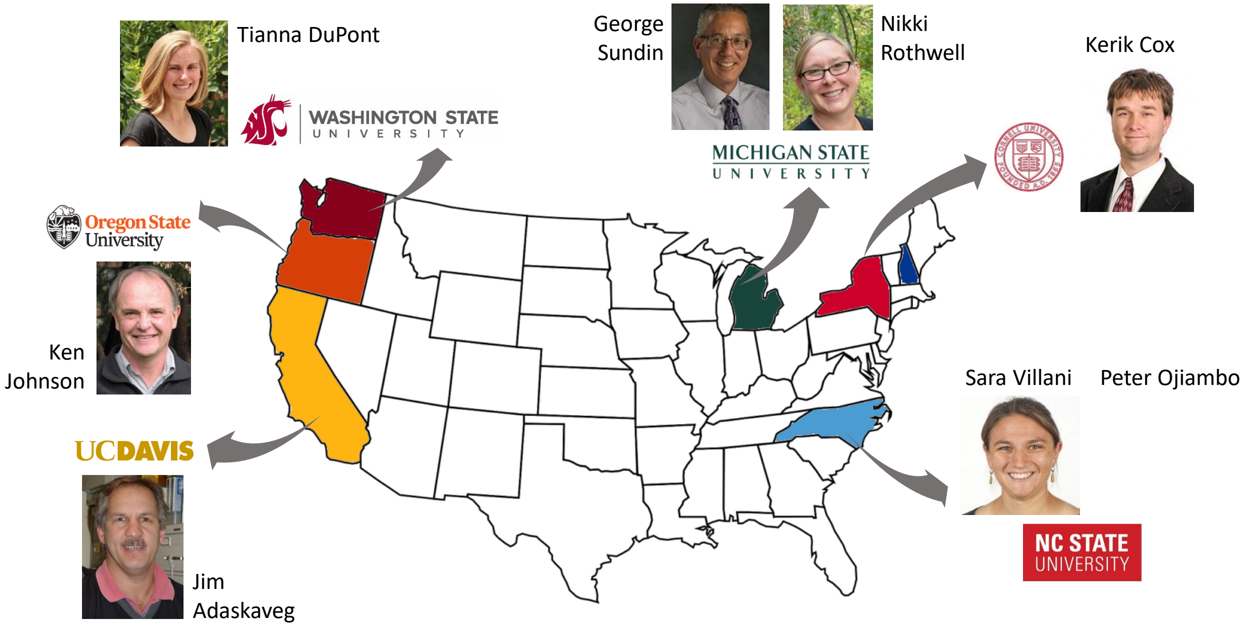
No. of trials	80% bloom treatment	Full bloom treatment	Petal fall treatment	Relative infection suppression (%)	
18	---	Water	Water	0.0	
10	Blossom Protect & Buffer	Blos. Prot. & Buffer	---	79.6 (4.1)	
4	Blossom Protect & Buffer	---	---	58.5 (12.7)	
13	Blossom Protect & Buffer	Serenade Opti	***then*** ↓		**70.3 (6.5)**
1	"	"	Serenade Opti	75.4 (14.2)	
2	"	"	Previsto	76.6 (9.9)	
7	"	"	Lime sulfur 4%	64.3 (12.7)	
3	"	"	Jet Ag	73.9 (17.7)	
10	Blossom Protect & Buffer	Previsto FB	***then*** ↓		**85.7 (3.3)**
4	"	"	Previsto	88.3 (3.6)	
3	"	"	Sernade Opti	82.5 (7.9)	
3	"	"	Lime Slufur 4%	85.4 (6.2)	
5	Blossom Protect & Buffer	Alum 1%	Alum 1%	86.9 (8.5)	
9	---	FireLine	FireLine	77.7 (2.8)	
15	---	FireWall	---	90.6 (1.4)	

Integrated programs with Previsto at full bloom are comparable to control achieved with antibiotics

No surprise, but the more effective non-antibiotic materials for infection suppression show a higher potential to mark fruit :/

Questions?

- Solitary Biopesticide efficacy
- Suppression of pathogen populations in flowers
- Integrated biopesticide programs control
- Fruit russeting concerns



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Organic program effects on fruit russeting

Medford, OR 2018-19

Pear

Apple