Fusarium wilt of strawberry

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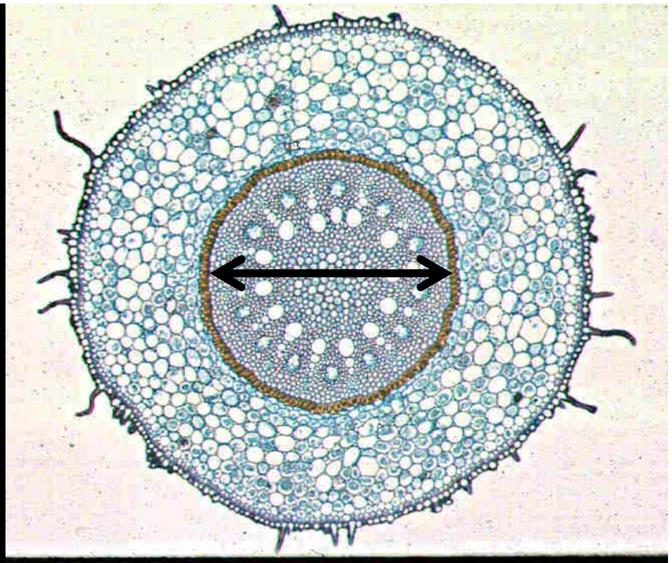
Fusarium wilt

Verticillium wilt

Macrophomina crown rot

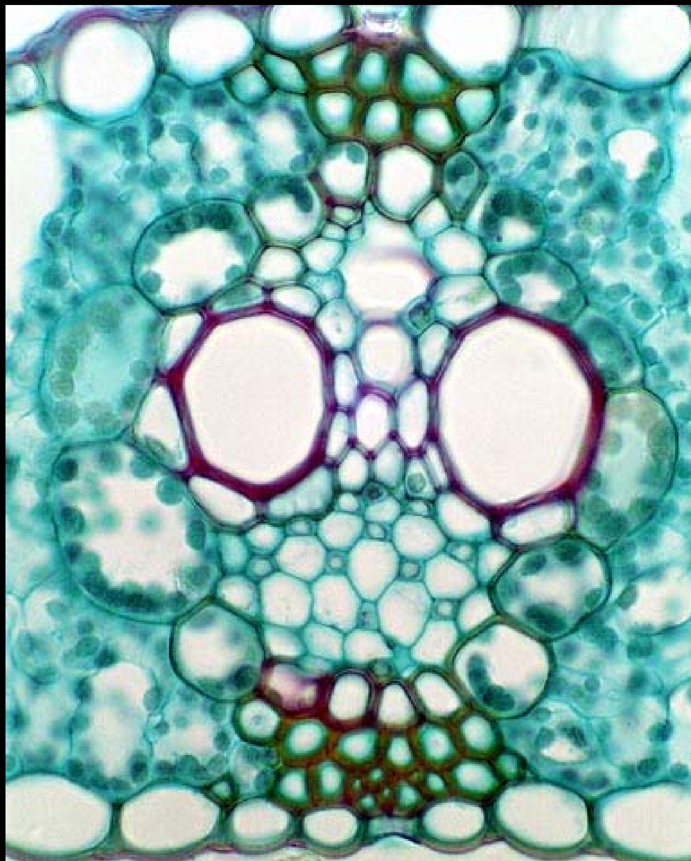


Damage results when the fungus enters the core of the root

Fusarium wilt

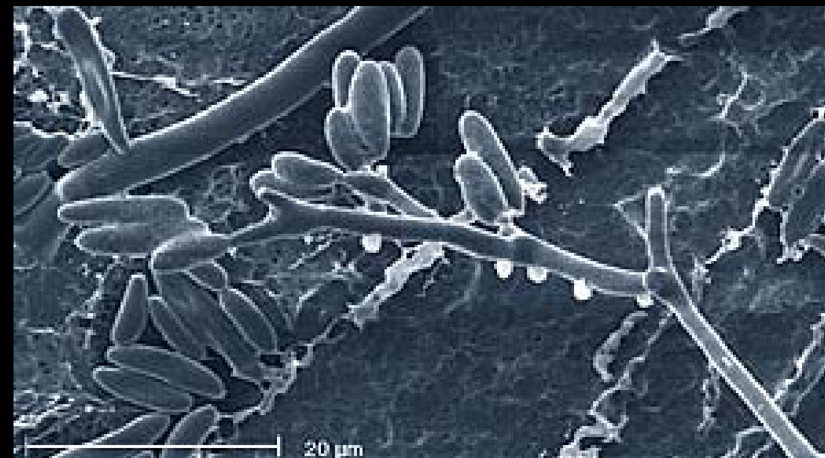
Caused by *Fusarium oxysporum* which survives in soil

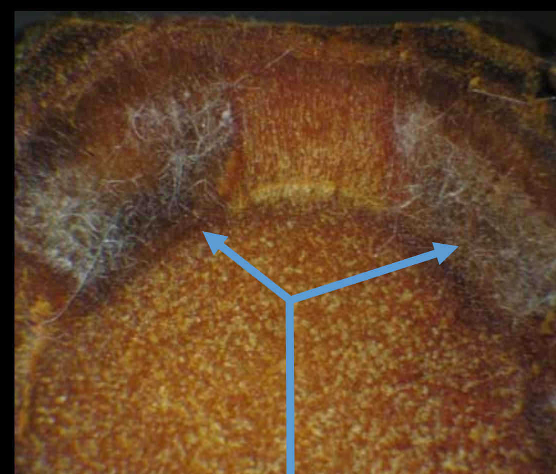
Infects plant roots



Within the root core the fungus invades xylem vessels, which transport water to the crown and leaves

Microconidia carried upward in xylem vessels





Section of crown from infected plant showing fungal growth from colonized vascular tissue

Reduced flow of water from roots results in collapse of the plant

Fusarium also rots the crown producing symptoms similar to those caused by Macrophomina

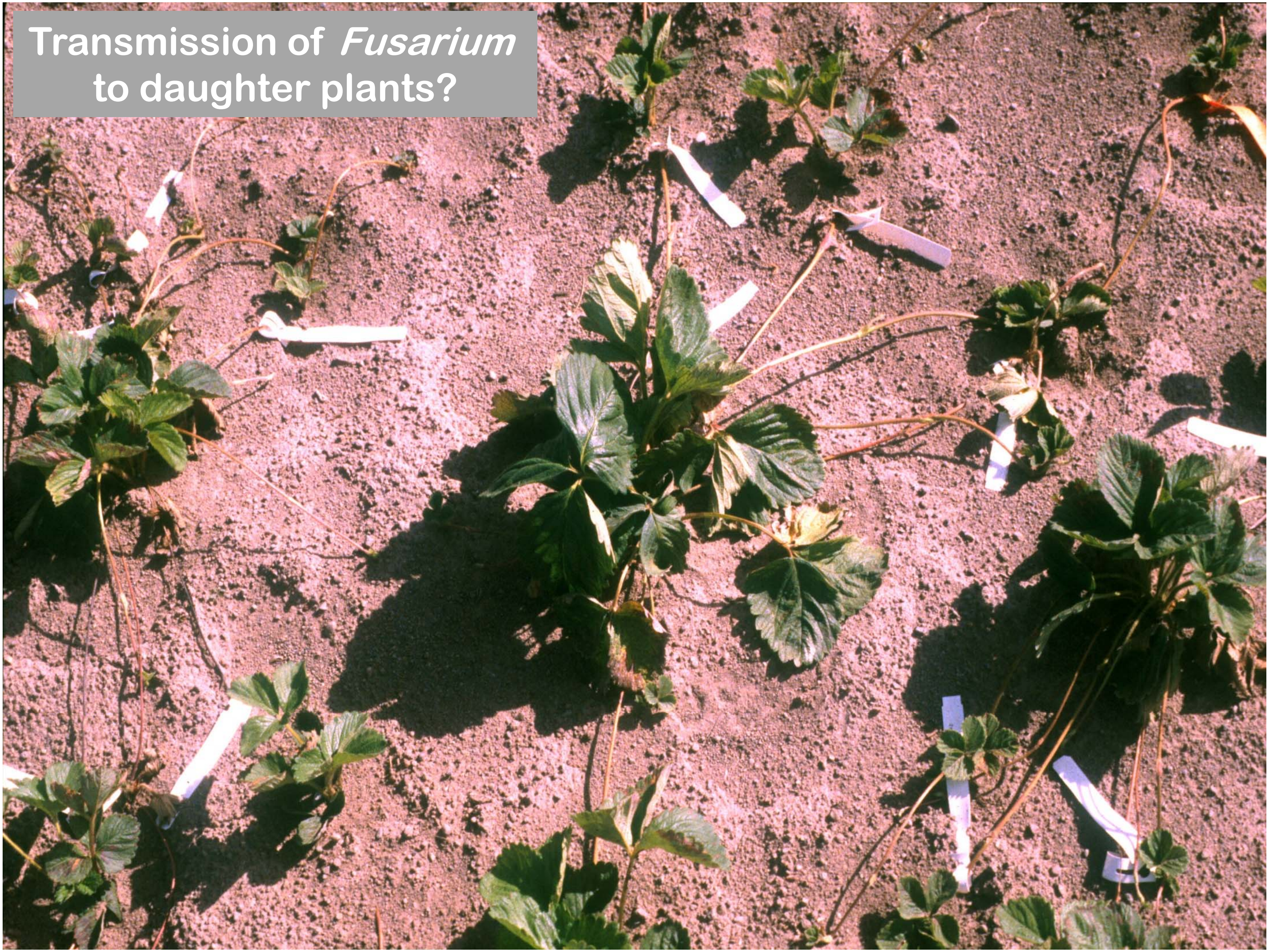
Management

Avoid introduction

Pathogen can be moved
with soil on equipment

Infected transplants

Transmission of *Fusarium* to daughter plants?



Experiments were conducted to test for transmission of *Fusarium* from infected mothers to daughter plants

Inoculation

Plants were infected

But vigorous enough to produce runners and daughter plans

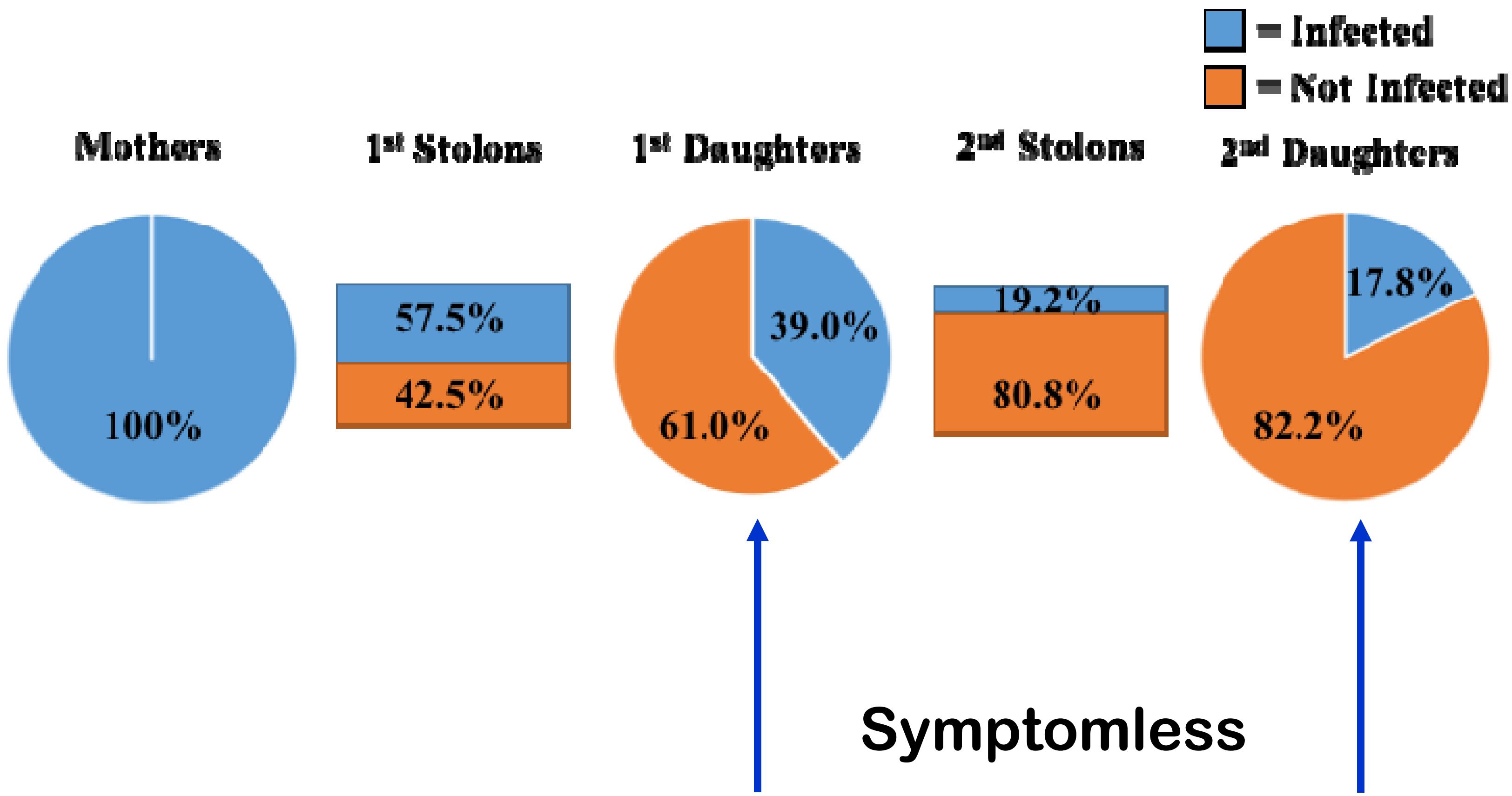
Transmission of *Fusarium* to daughter plants

Tag stolons and daughter plants

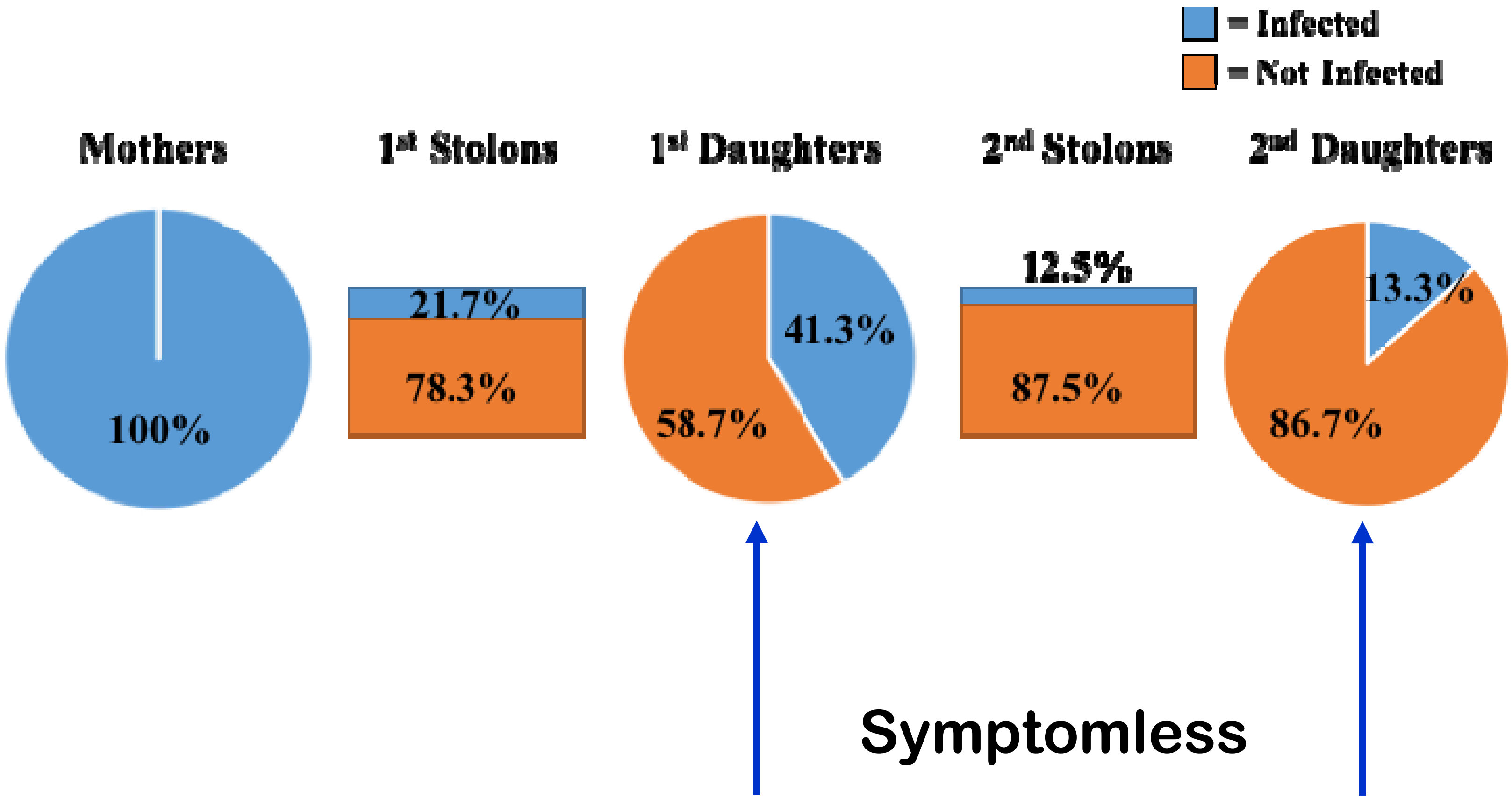
Transmission of *Fusarium* to daughter plants

Test for infection by the pathogen

Albion


= Infected
= Not Infected
Mothers
1st Stolons
1st Daughters
2nd Stolons
2nd Daughters
100%
57.5%
42.5%
39.0%
61.0%
19.2%
80.8%
17.8%
82.2%
Symptomless

Monterey



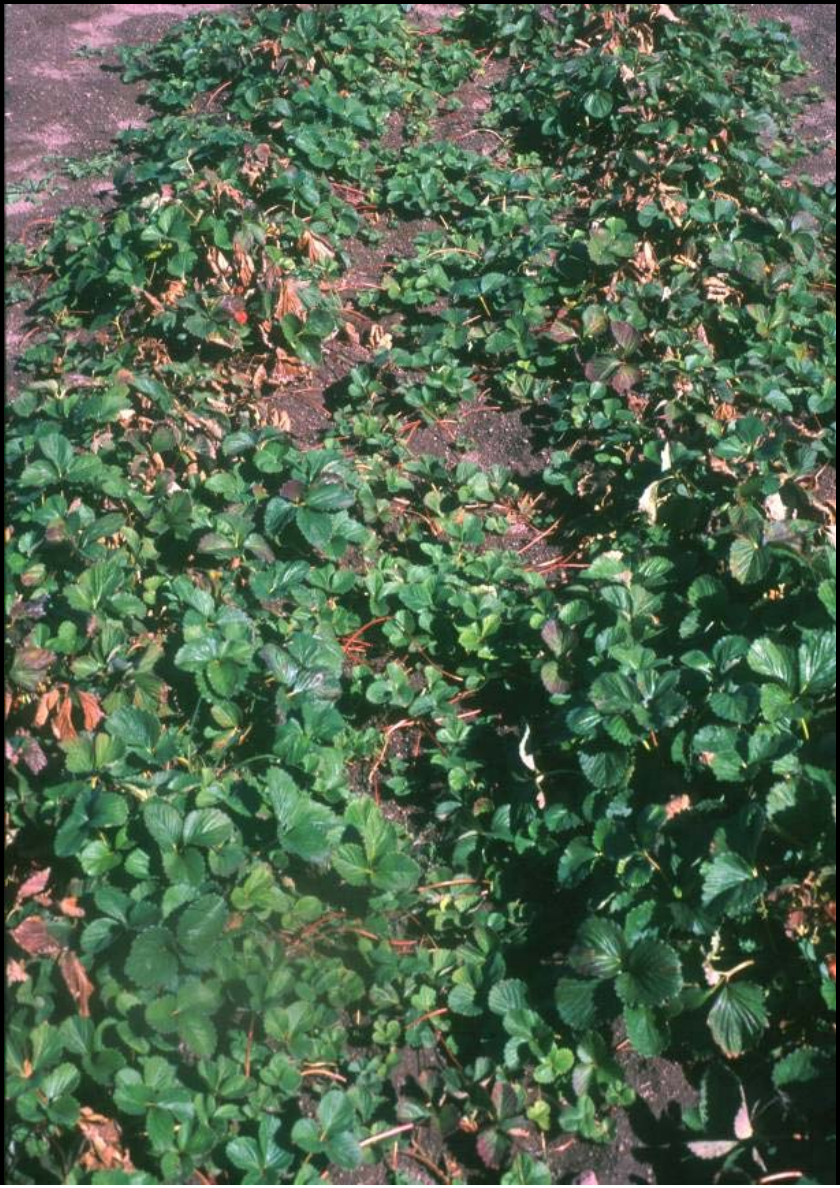
Symptomless

No transmission in resistant cultivars

Cultivar	Crown	Petiole	Runner	Daughter
Albion	+	+	+	+
San Andreas	+	-	-	-
Fronteras	+	-	-	-
Petaluma	+	+	+	+

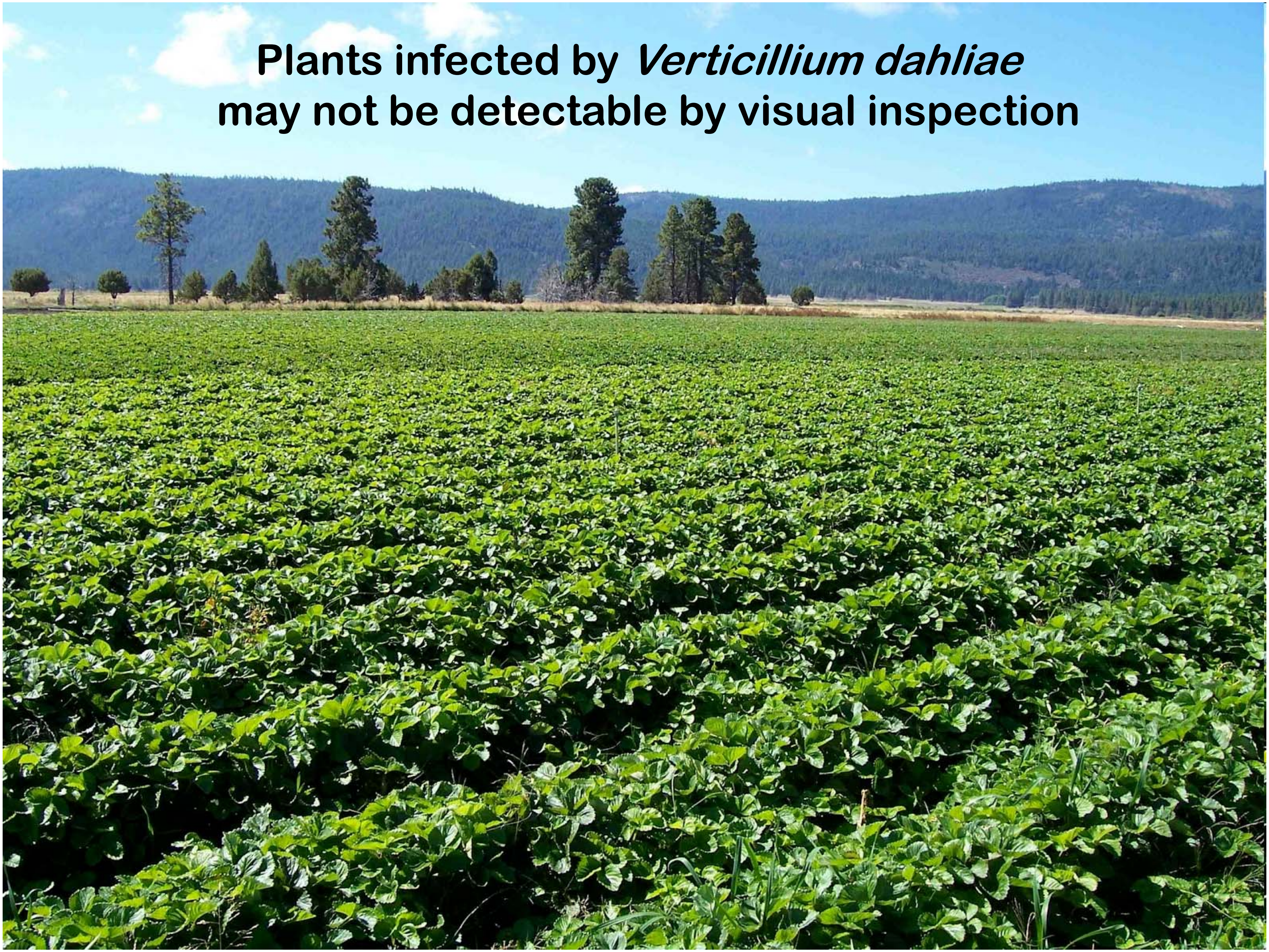
Transmission of *Verticillium dahliae* through stolons

Verticillium wilt in high elevation nurseries



Mother plants may show
show symptoms only
late in the season

Overgrown by
daughter plants


Plants infected by *Verticillium dahliae*
may not be detectable by visual inspection

Infected daughter plants

Show no symptoms

Disease may develop in fruit production field

Management

Avoid introduction

Reduce inoculum levels in soil

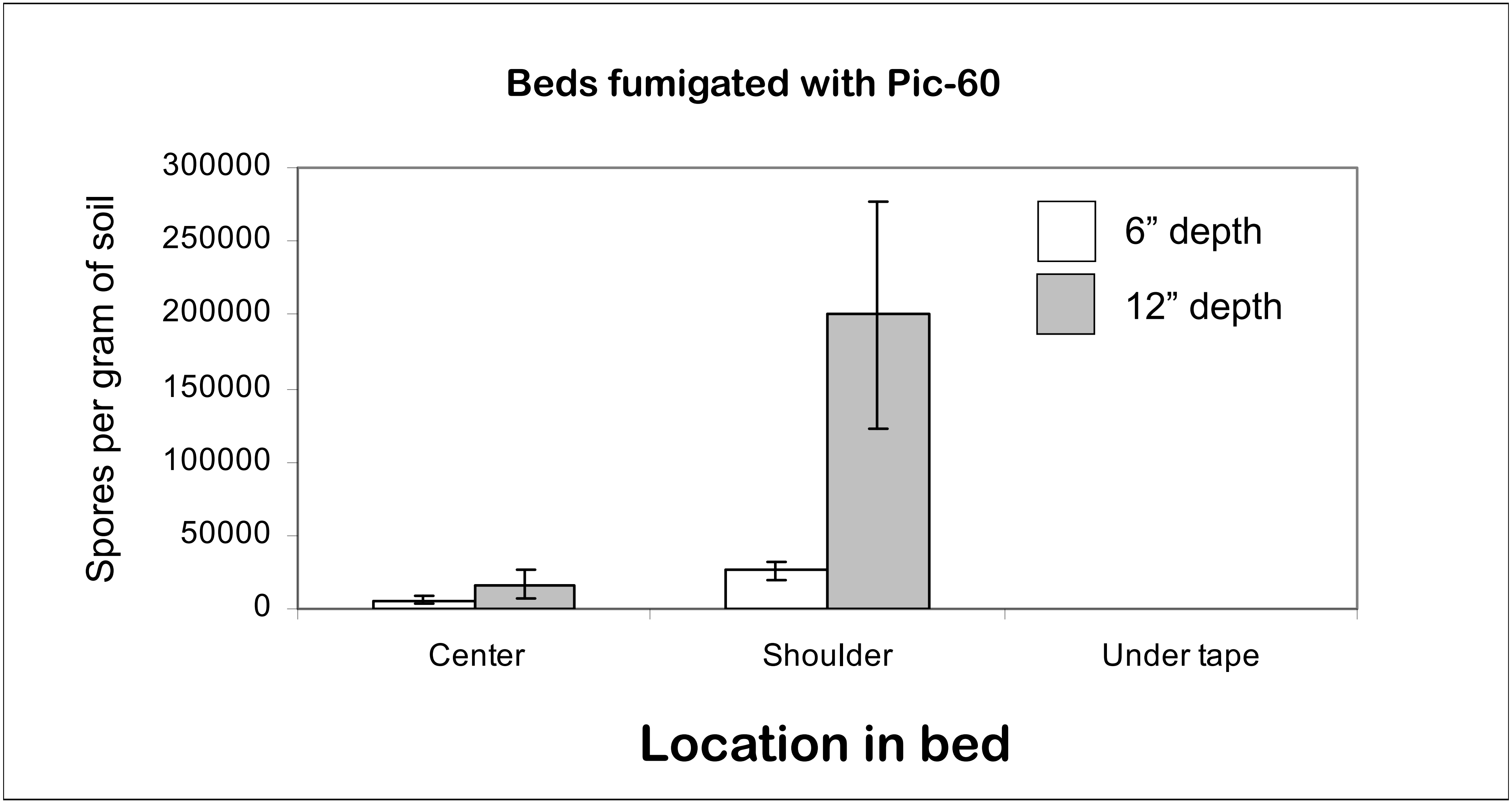
Pre-plant fumigation

Flat fumigation to treat the entire field

Mortality is not evenly distributed across beds

Incomplete treatment

Fumigation is fully effective only directly under drip tapes



Anaerobic soil disinfestation

Effect on survival of *Fusarium oxysporum*

Rice hulls at 9 tons per acre

cool conditions	warm conditions
Day/night = 77/64°F	Day/night = 82/68°F
+ 310%	+0.01%
Increase in pathogen population	No change

Anaerobic soil disinfestation

Effect on survival of *Fusarium oxysporum*

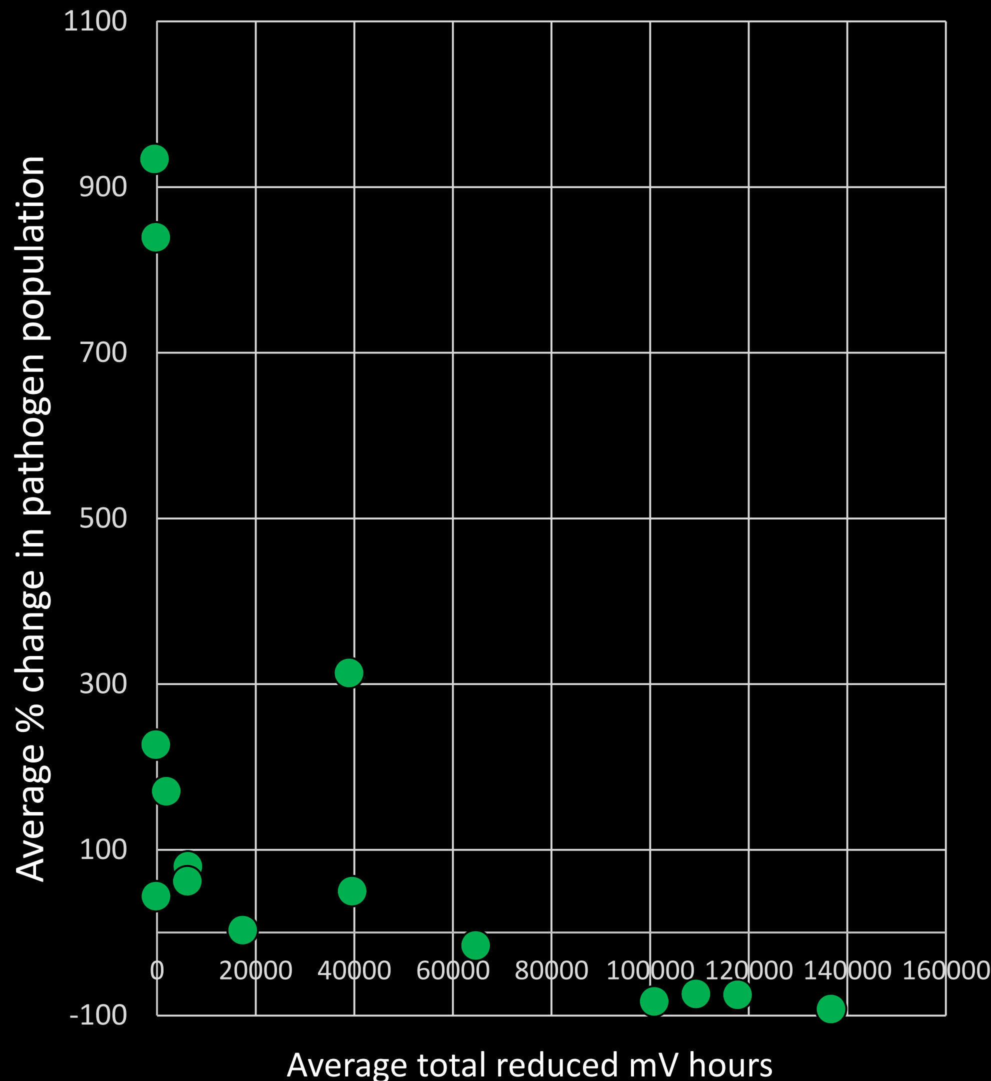
Rice hulls at 9 tons per acre

Cool conditions
Day/night = 77/64°F

Mustard seed meal

None	3 tons/acre
+ 310%	- 74%

Duration of anaerobic conditions



Crop rotation

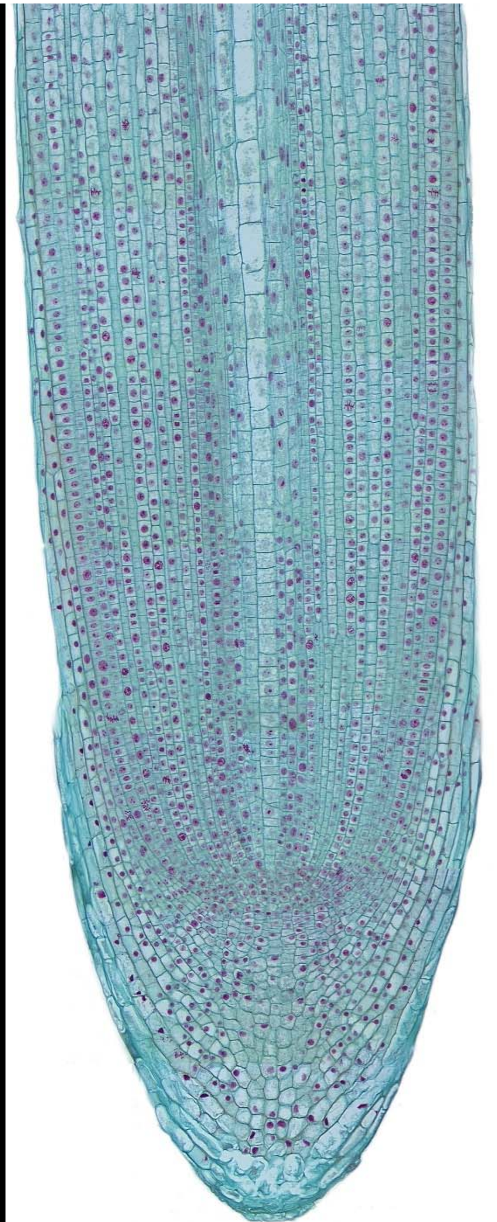
Inoculum levels decline when other crops are grown

Rotation crops do not support pathogen development

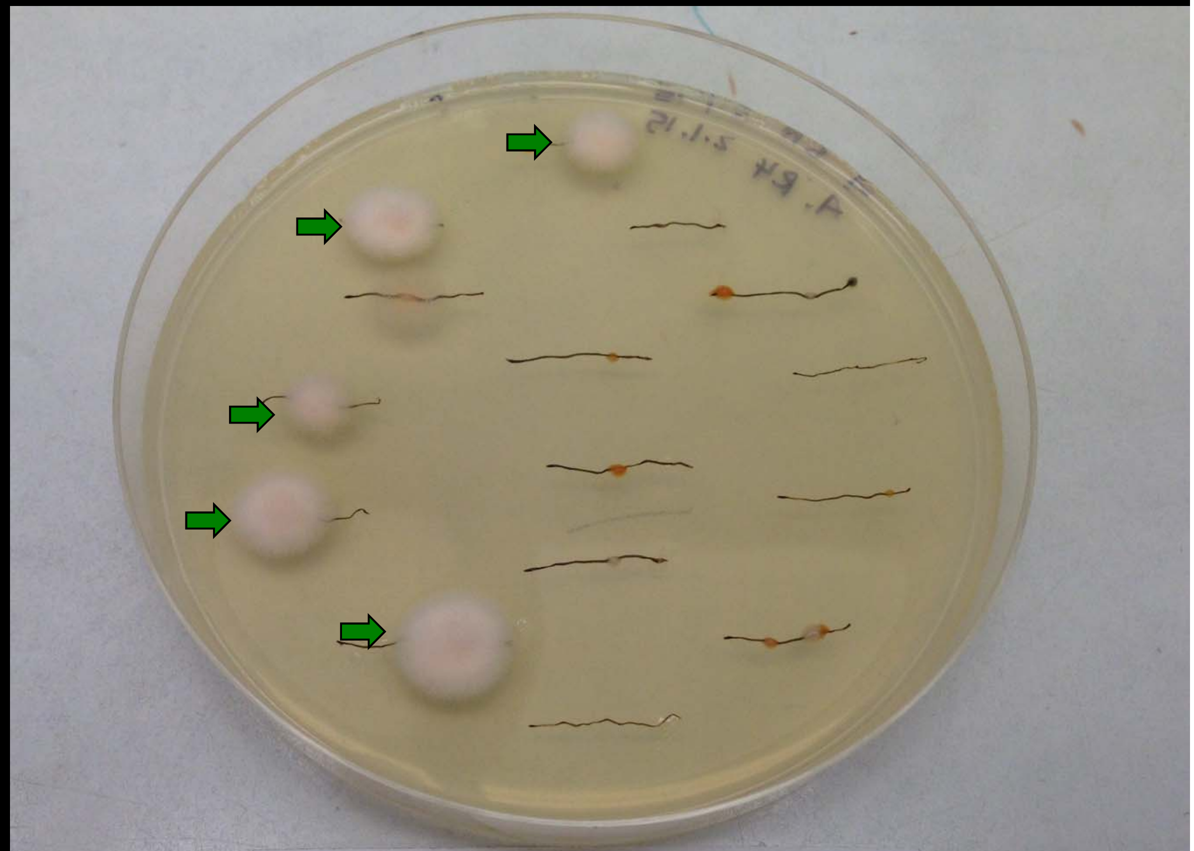
Colonization of rotation crops

Colonization of rotation crops

Broccoli
Lettuce
Spinach
Cilantro
Wheat
Raspberry

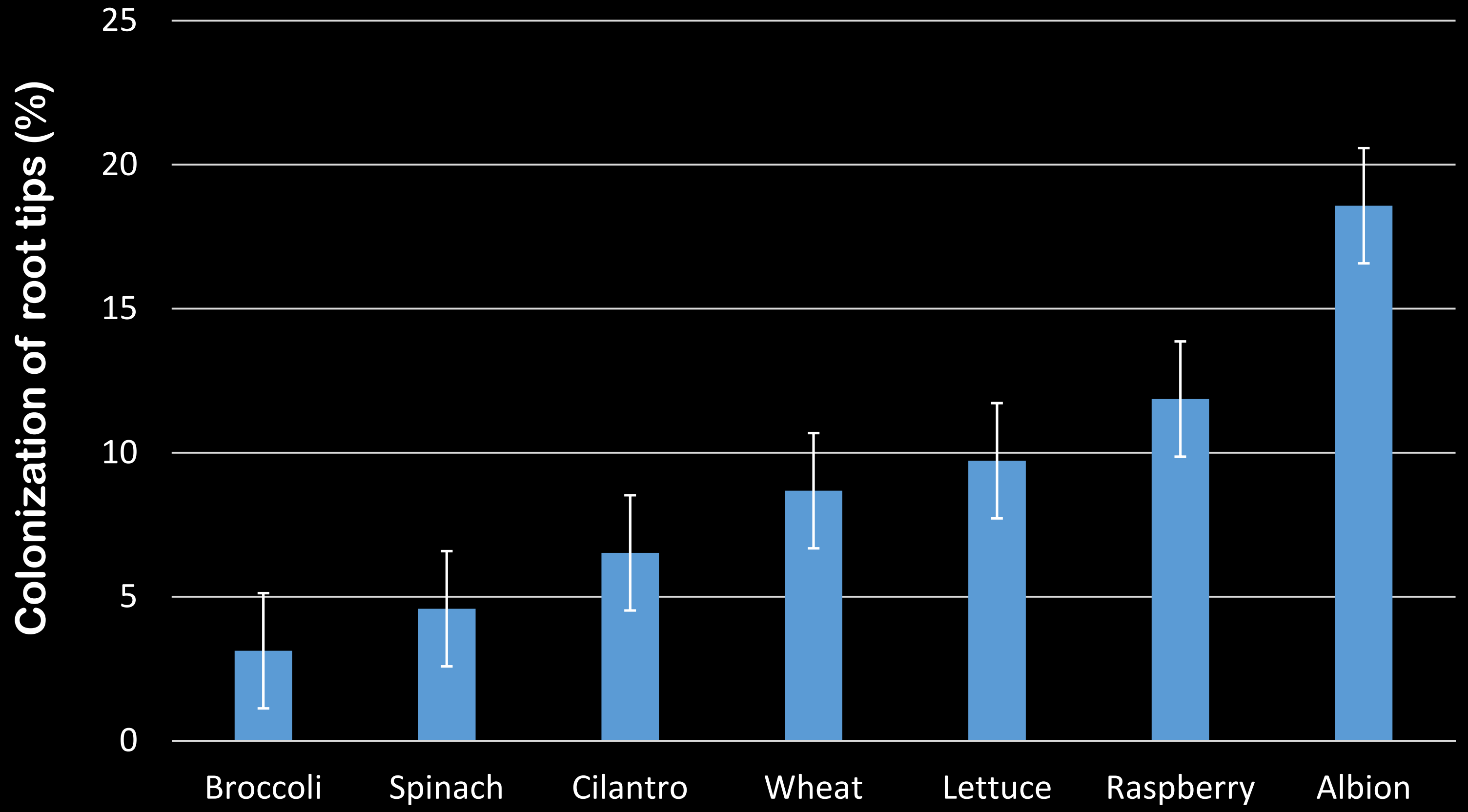


Root tip



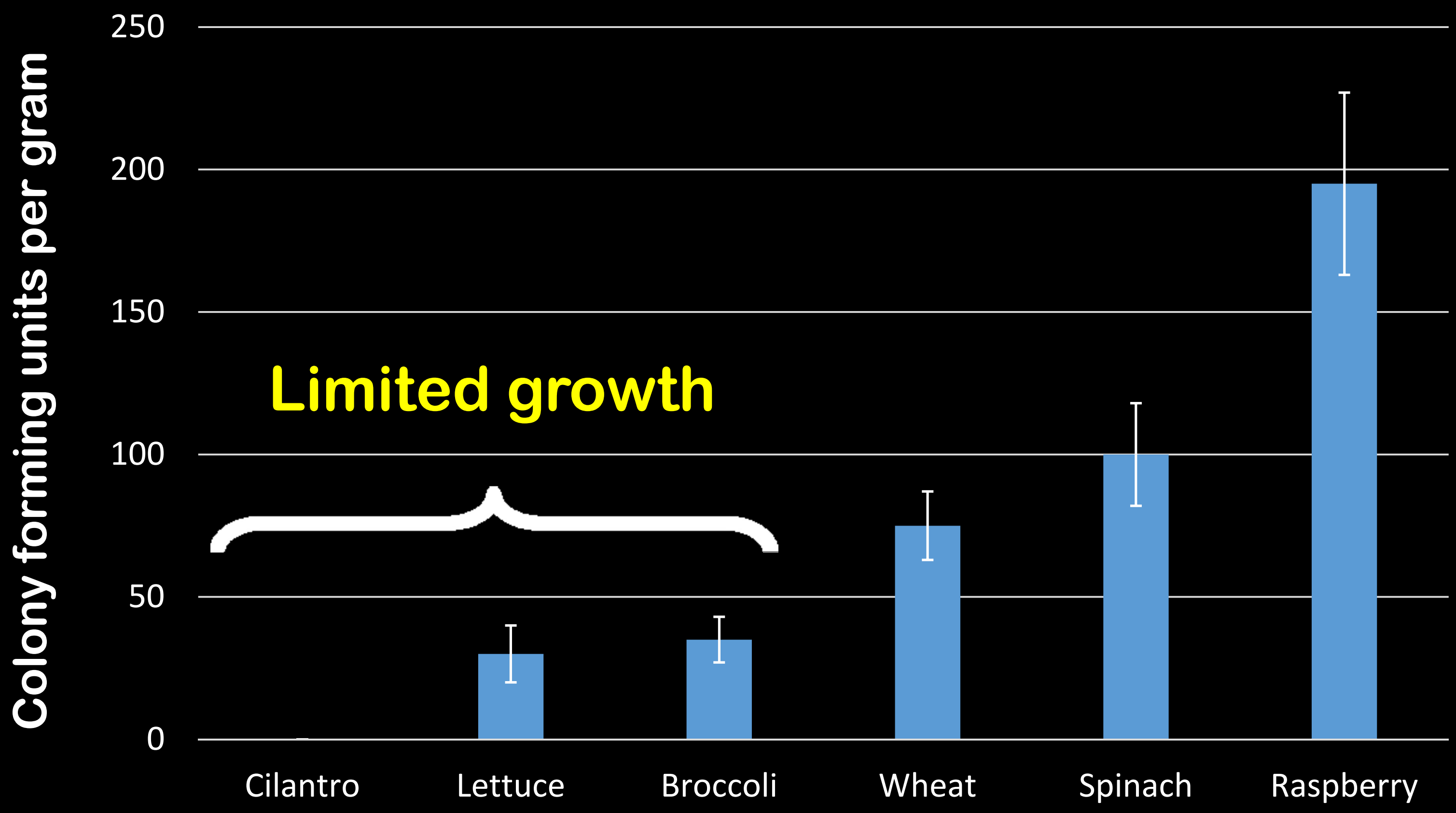
Percentage of root tips infected

Percentage of root tips infected



Extent of colonization?

Pathogen biomass in root cortex



Blackberry

Fusarium wilt

Fusarium oxysporum

Effect of blackberry pathogen on strawberry

Albion
Monterey
San Andreas
Portola
Petaluma

Susceptibility of strawberry to blackberry pathogen

Inoculated plants were rated on a 1 – 5 scale

Susceptibility of strawberry to blackberry pathogen

Plants were rated on a 1 – 5 scale

Healthy plant = 1

Dead plant = 5

Stunting and yellowing of leaves = 3

Susceptibility of strawberry to blackberry pathogen

1 – 5 scale

Cultivar	*F. o. mori*	*F. o. fragariae*
Albion	3.0	5.0
Monterey	2.1	5.0

F. o. mori = blackberry pathogen


Some plants were killed
by the blackberry pathogen
C Monterey Plant 4
MONTEREY
AM_S1
2

Susceptibility of strawberry to blackberry pathogen

1 – 5 scale

Cultivar	*F. o. mori*	*F. o. fragariae*
Albion	3.0	5.0
Monterey	2.1	5.0
San Andreas	1.0	1.0
Portola	1.0	1.0
Petaluma	1.0	5.0

Management

Disease resistance

The Population of *Fusarium oxysporum* f. sp. *fragariae*, Cause of Fusarium Wilt of Strawberry, in California

P. M. Henry, S. C. Kirkpatrick, C. M. Islas, A. M. Pastrana, and **J. A. Yoshisato,** Department of Plant Pathology, University of California, Davis 95616; **S. T. Koike,** University of California Cooperative Extension, Salinas 93901; **O. Daugovish,** University of California Cooperative Extension, Ventura 93003; and **T. R. Gordon,** Department of Plant Pathology, University of California, Davis

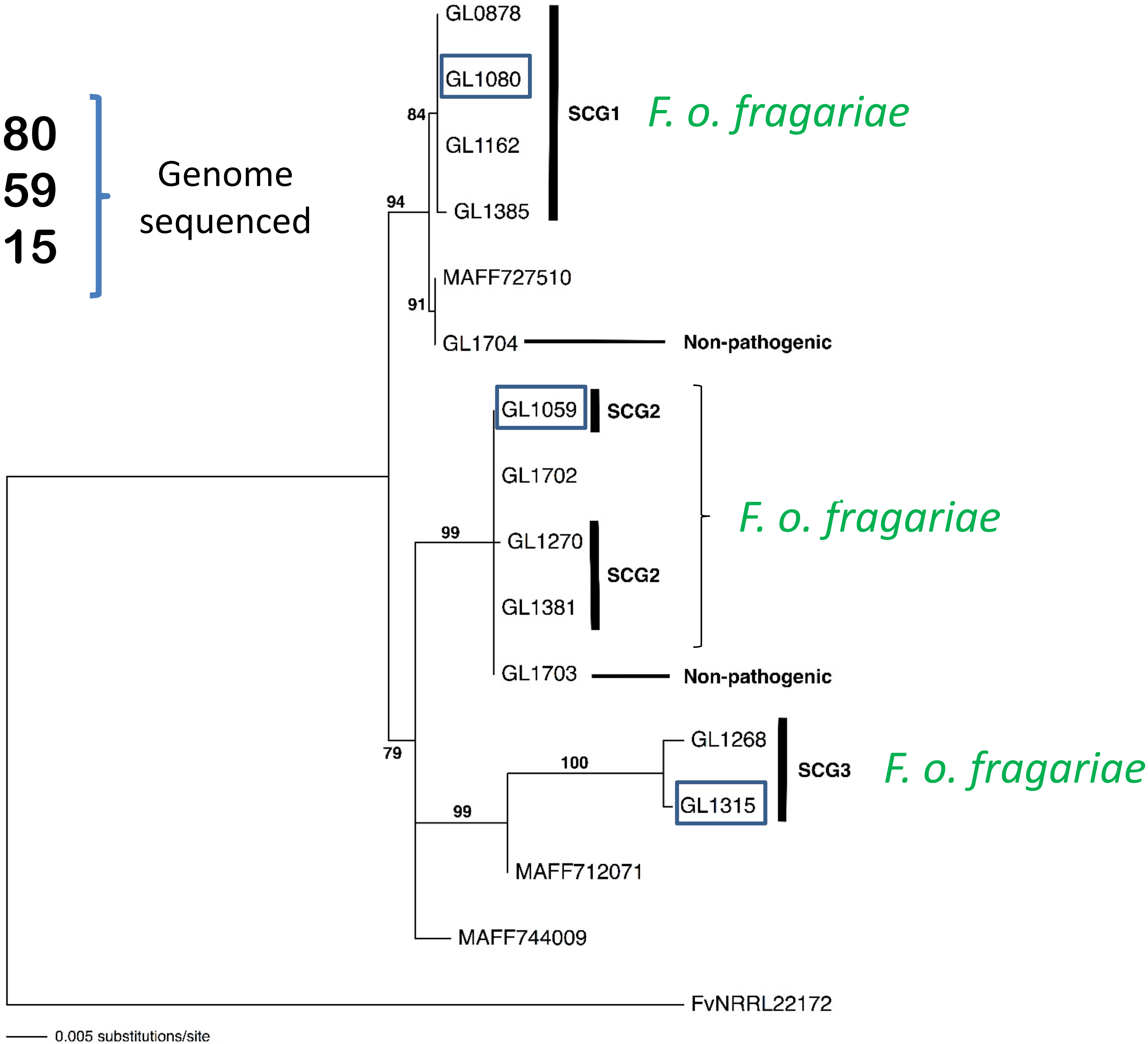
Abstract

The objectives of this study were to investigate the structure of the population of *Fusarium oxysporum* f. sp. *fragariae* in California and to evaluate methods for its detection. Fifty-nine isolates of *F. oxysporum* f. sp. *fragariae* were obtained from diseased strawberry plants and their identity was confirmed by pathogenicity testing. The full nuclear ribosomal intergenic spacer (IGS) and elongation factor 1-α gene (EF-1α) were amplified by polymerase chain reaction (PCR) and sequenced to elucidate phylogenetic relationships among isolates. IGS and EF-1α sequences revealed three main lineages, which corresponded to three somatic compatibility groups. Primers designed to detect *F. oxysporum* f. sp. *fragariae* in Japan amplified a 239-bp product from 55 of 59 California isolates of *F. oxysporum* f. sp. *fragariae* and from no nonpathogenic isolates of *F. oxysporum*. The sequence of this PCR product was identical to the sequence obtained from *F. oxysporum* f. sp. *fragariae* isolates in Japan. Intensive sampling at two locations in California showed results of tests based on PCR and somatic compatibility to be in agreement for 97% (257 of 264) of isolates tested. Our findings revealed considerable diversity in the California population of *F. oxysporum* f. sp. *fragariae*, and indications that horizontal gene transfer may have occurred.

Three strains of *Fusarium oxysporum* f. sp. *fragariae in California*

GL 1080
GL 1059
GL 1315

Genome sequenced



Likely there have been multiple introductions of the strawberry Fusarium to California

Most likely on infected plants

Source of introduction to California?

?

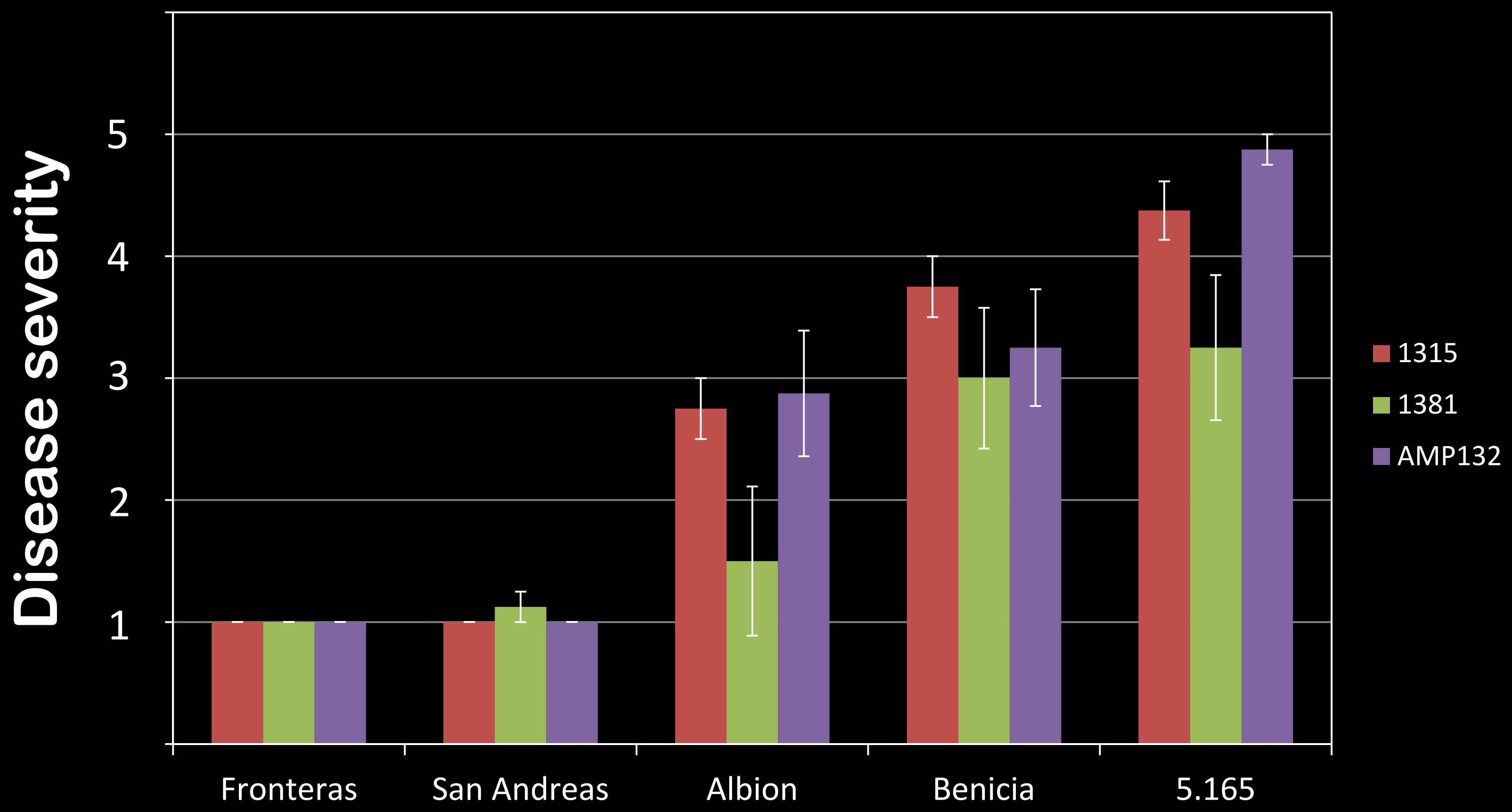
Discovered in California in 2008

Do *F. o. fragariae* strains differ in virulence?

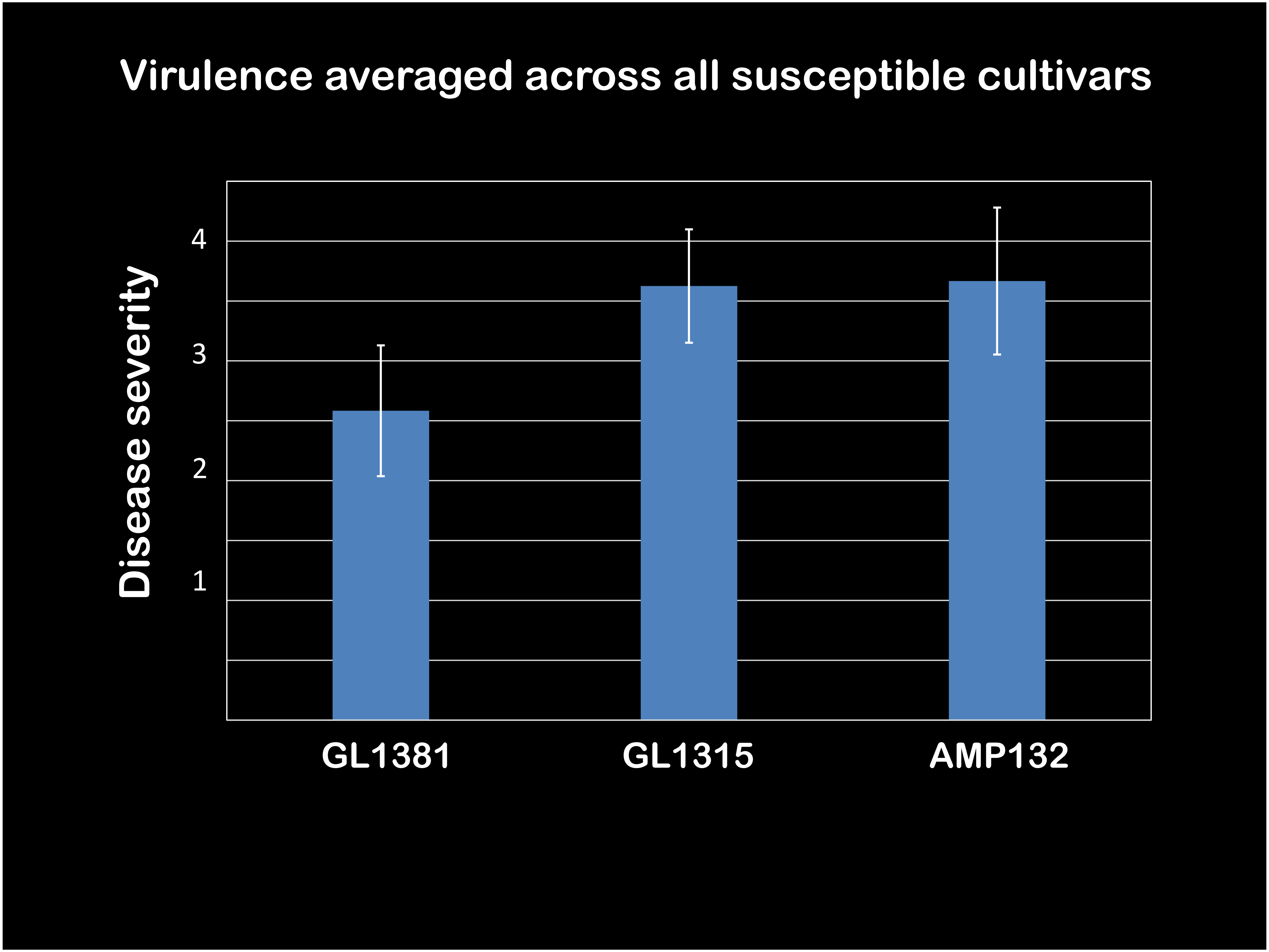
Genotype * strain test

Albion	
Benicia	GL 1315
Fronteras	GL 1381
San Andreas	AMP 132
5.165	

Genotype * strain test

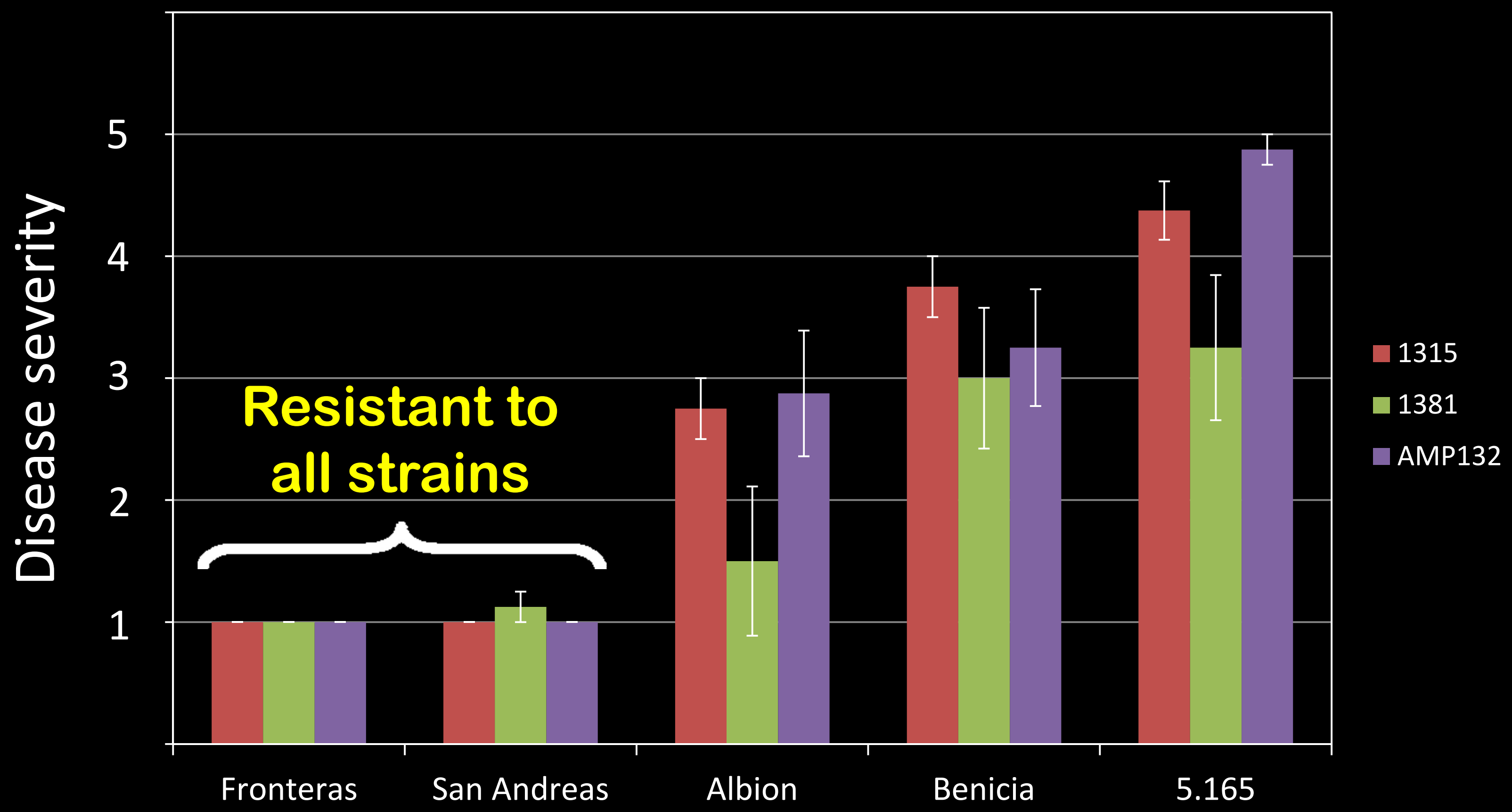


Strains differ in virulence

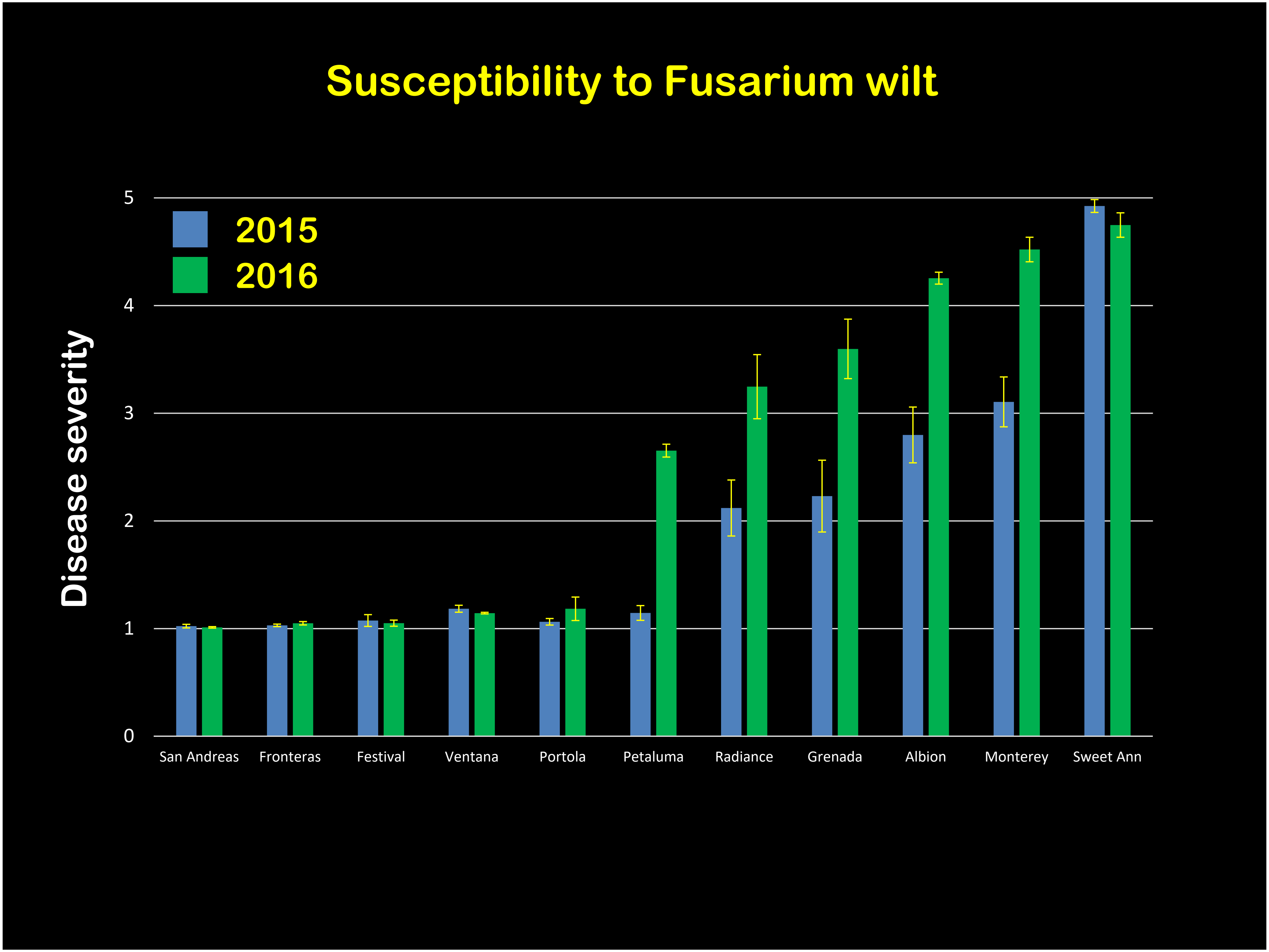


Virulence averaged across all susceptible cultivars
Disease severity
4
3
2
1
GL1381
GL1315
AMP132

Resistance is effective against all strains



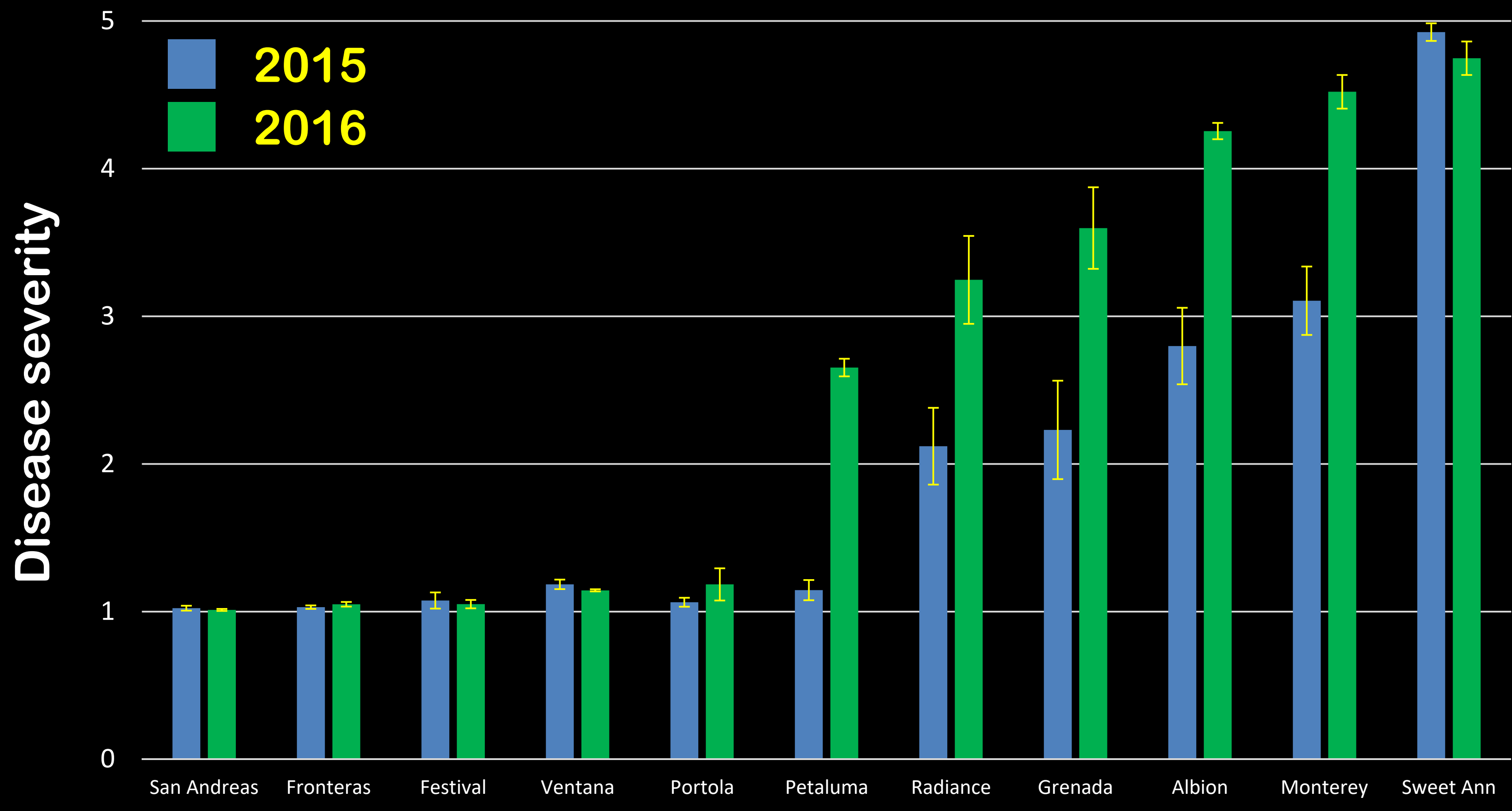

Tests conducted in naturally infested field


Susceptibility to Fusarium wilt
2015
2016
Disease severity
0
1
2
3
4
5
San Andreas
Fronteras
Festival
Ventana
Portola
Petaluma
Radiance
Grenada
Albion
Monterey
Sweet Ann

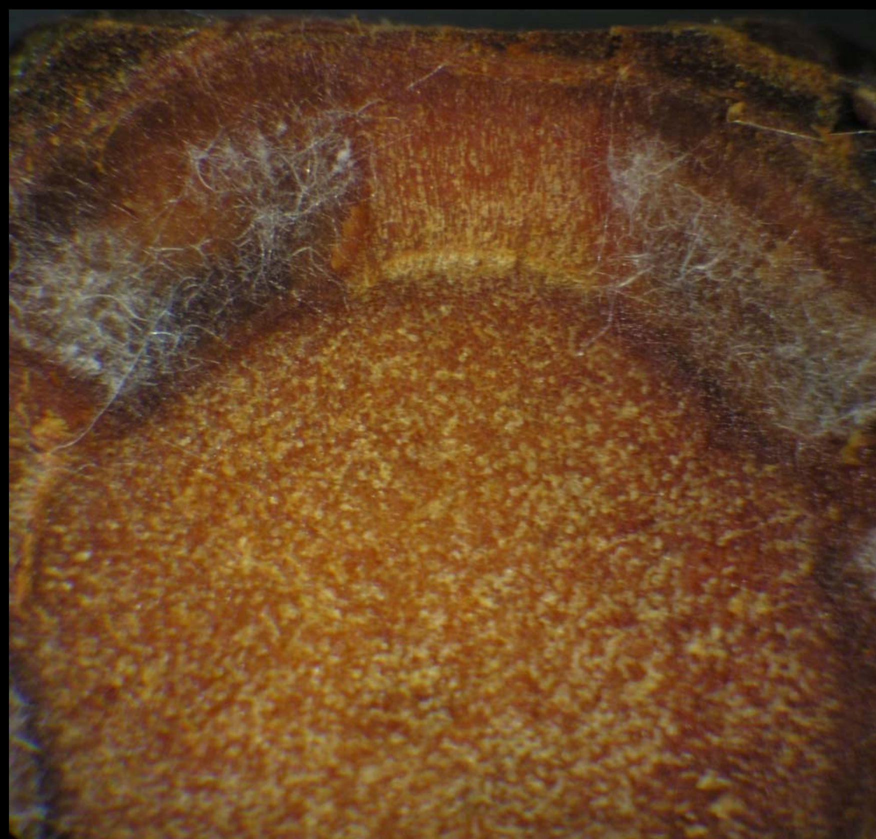
Susceptibility to Fusarium wilt

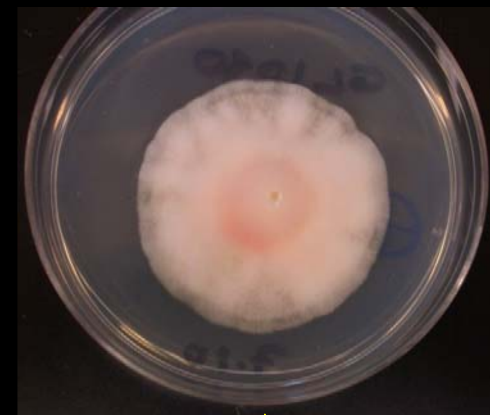
Cultivar	Susceptibility
San Andreas Portola Fronteras	Highly resistant
Ventana	Resistant
Monterey Albion	Susceptible

Susceptibility to Fusarium wilt

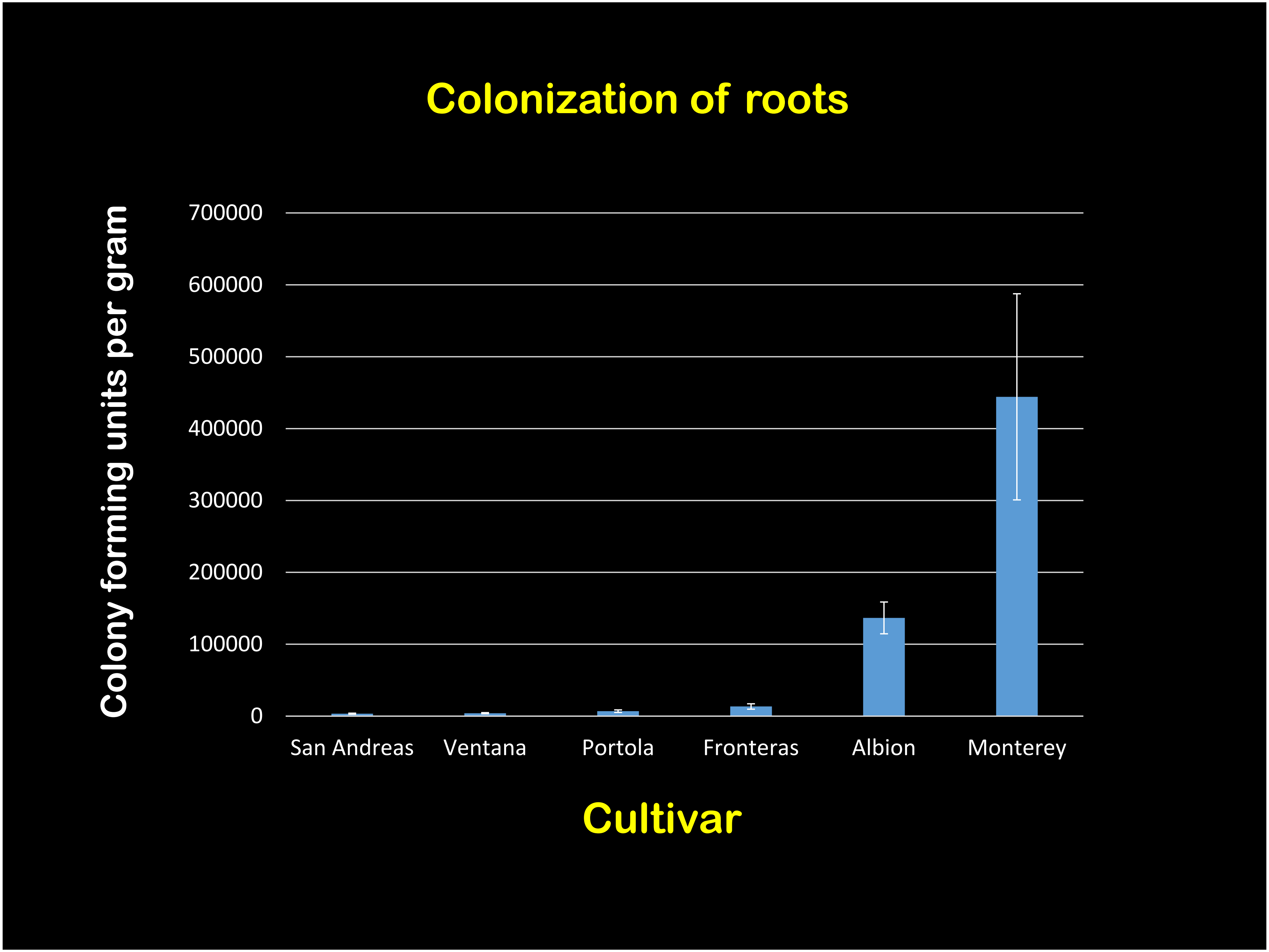


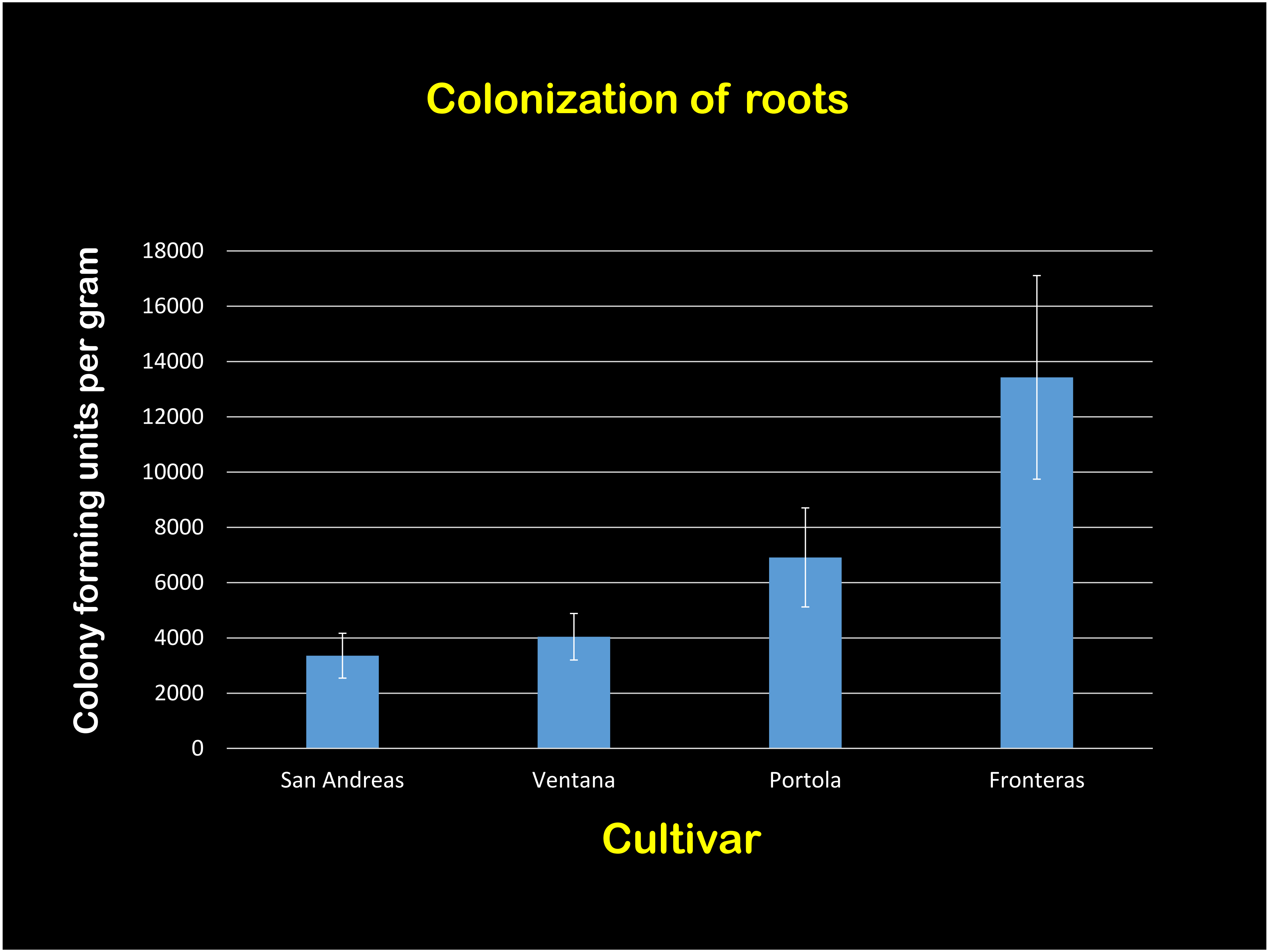
Pathogen can colonize resistant crops



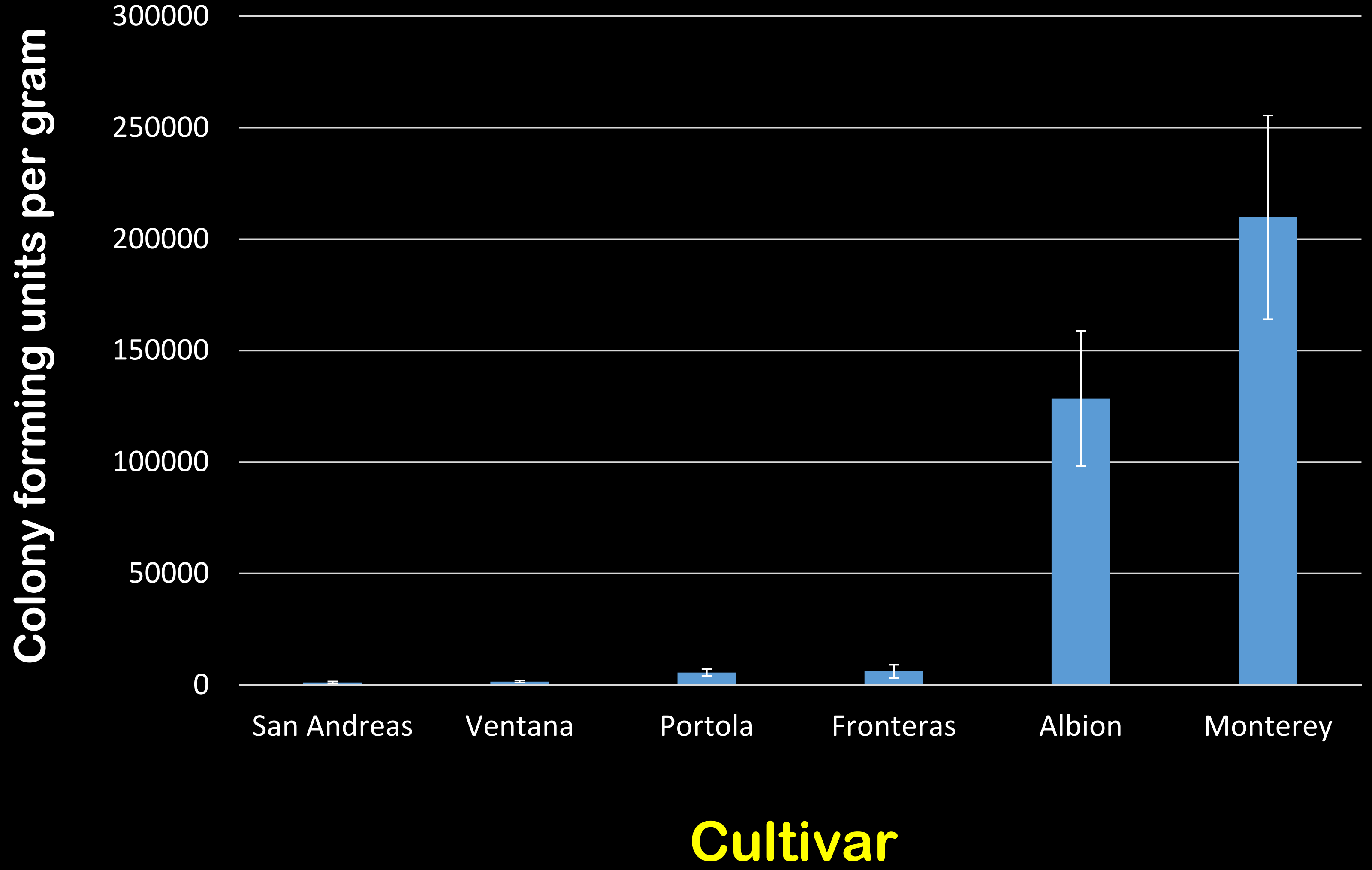


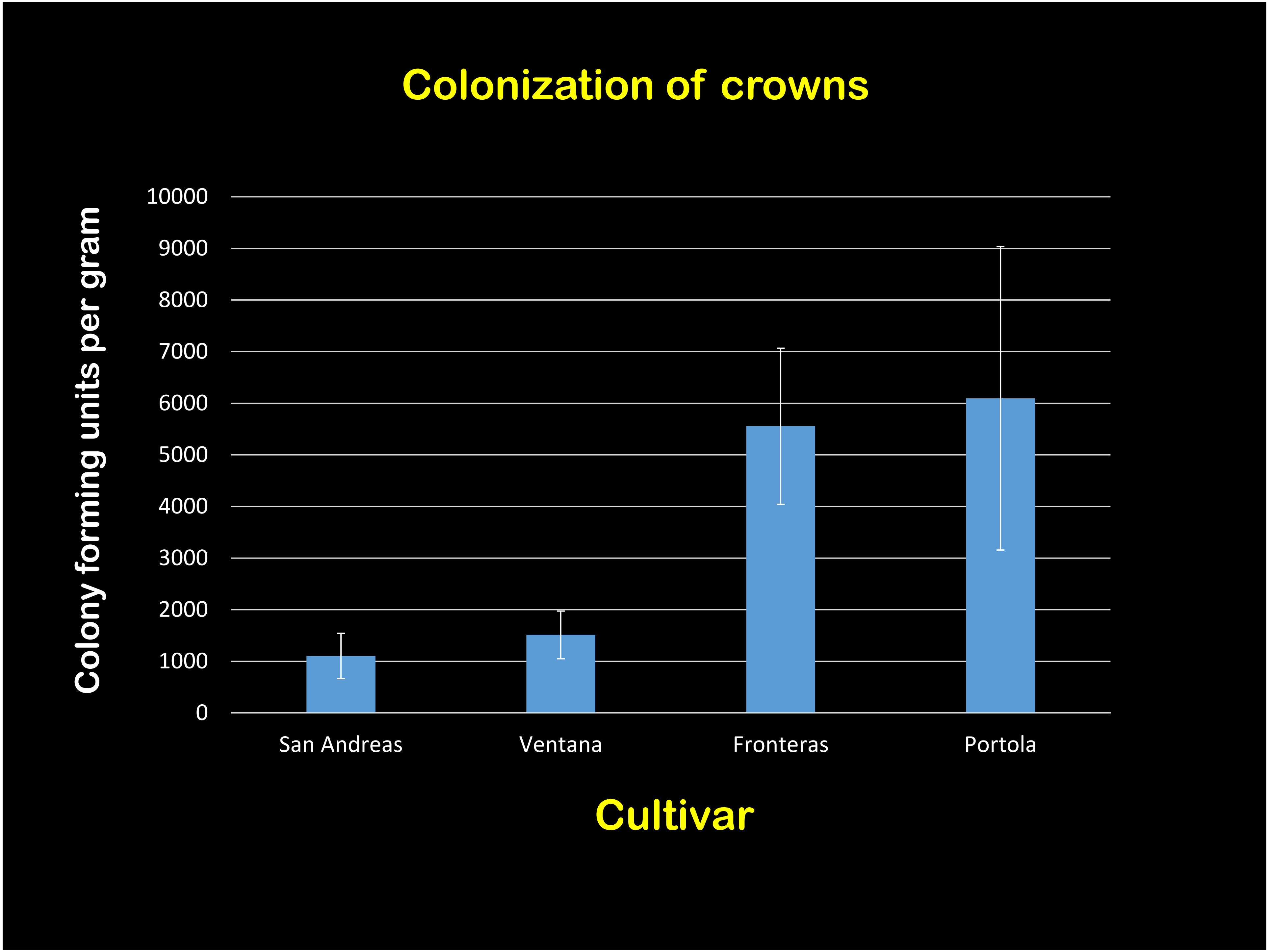
May allow inoculum build-up in soil


Colonization of roots
Colony forming units per gram
700000
600000
500000
400000
300000
200000
100000
0
San Andreas
Ventana
Portola
Fronteras
Albion
Monterey
Cultivar


Colonization of roots
Colony forming units per gram
18000
16000
14000
12000
10000
8000
6000
4000
2000
0
San Andreas
Ventana
Portola
Fronteras
Cultivar

Colonization of crowns





Colonization of crowns
Colony forming units per gram
10000
9000
8000
7000
6000
5000
4000
3000
2000
1000
0
San Andreas
Ventana
Fronteras
Portola
Cultivar

Resistance may be overcome

Risk is proportional to pathogen growth and reproduction

Every cell is a reproductive unit

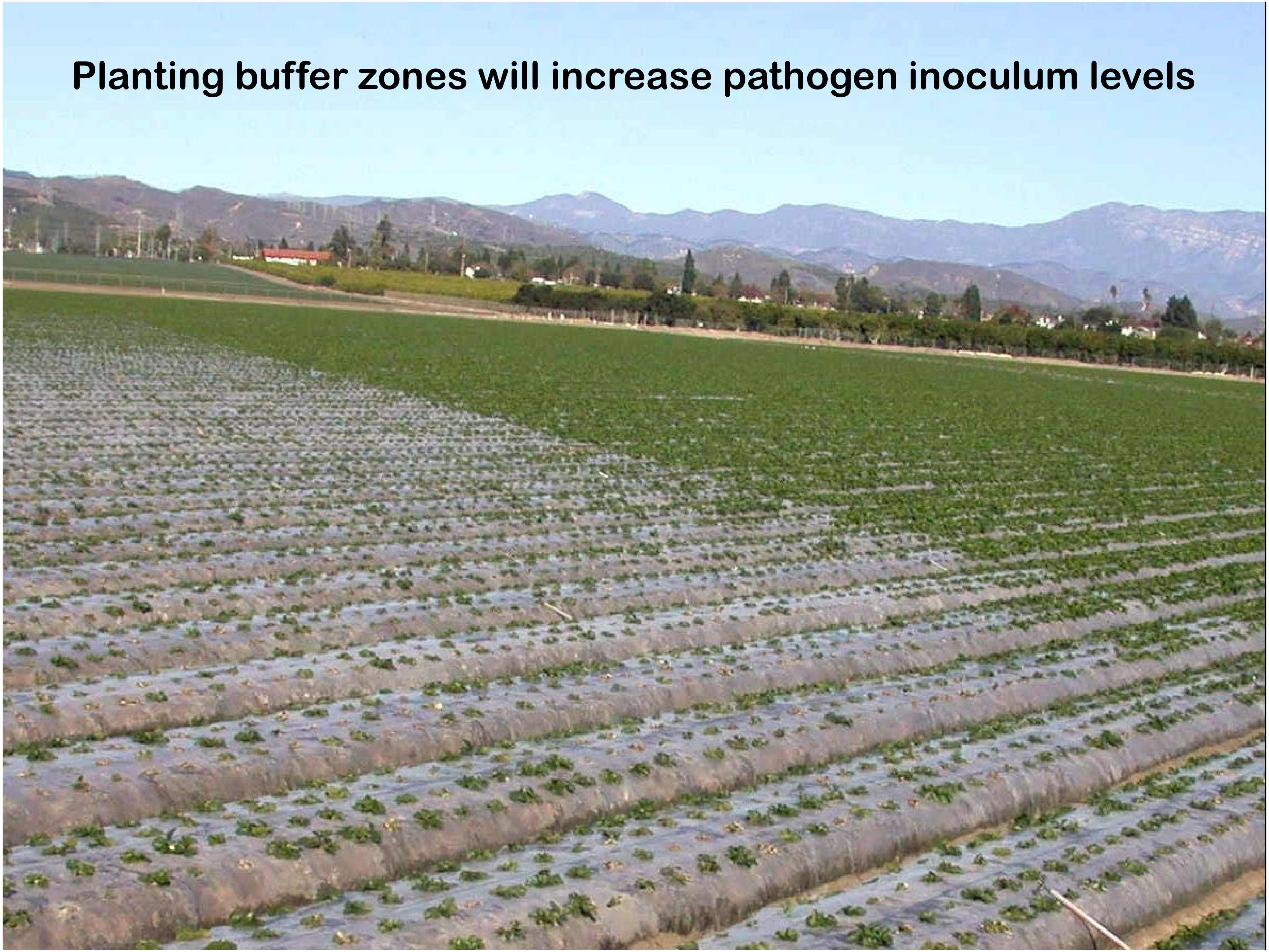
Suppression of pathogen populations still important

Management of soilborne pathogens

Reduce inoculum levels

Avoid introductions

Disease resistance


Planting buffer zones will increase pathogen inoculum levels

Thanks

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