Soilborne problems affecting strawberries

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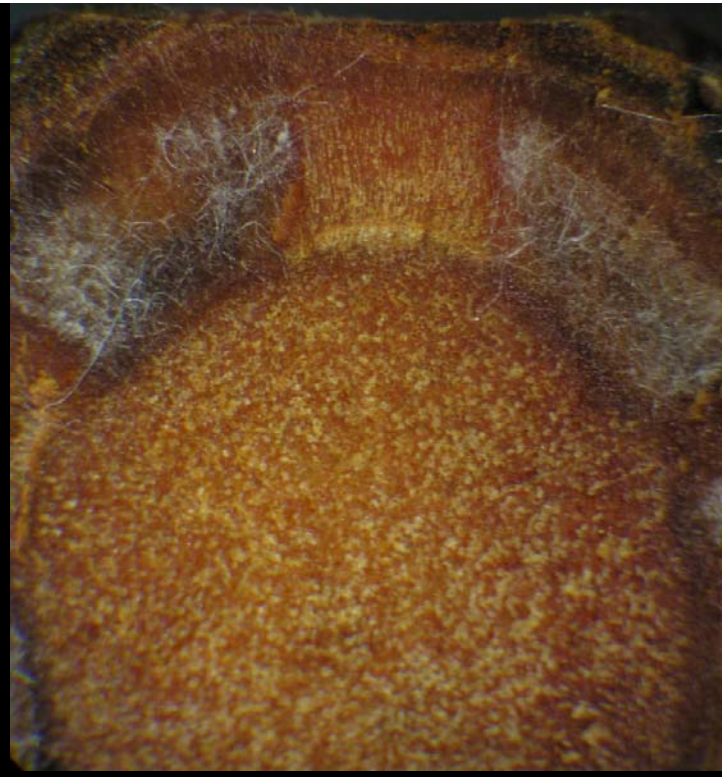
Collaborators:

Oleg Daugovish
Steve Koike

Macrophomina phaseolina

Fusarium oxysporum

Verticillium dahliae



Fusarium wilt

Fusarium oxysporum

Fusarium oxysporum

Common soilborne fungus

Most strains are not pathogenic

Many host-specific pathogens

F. oxysporum f. sp. *fragariae* is the strawberry pathogen

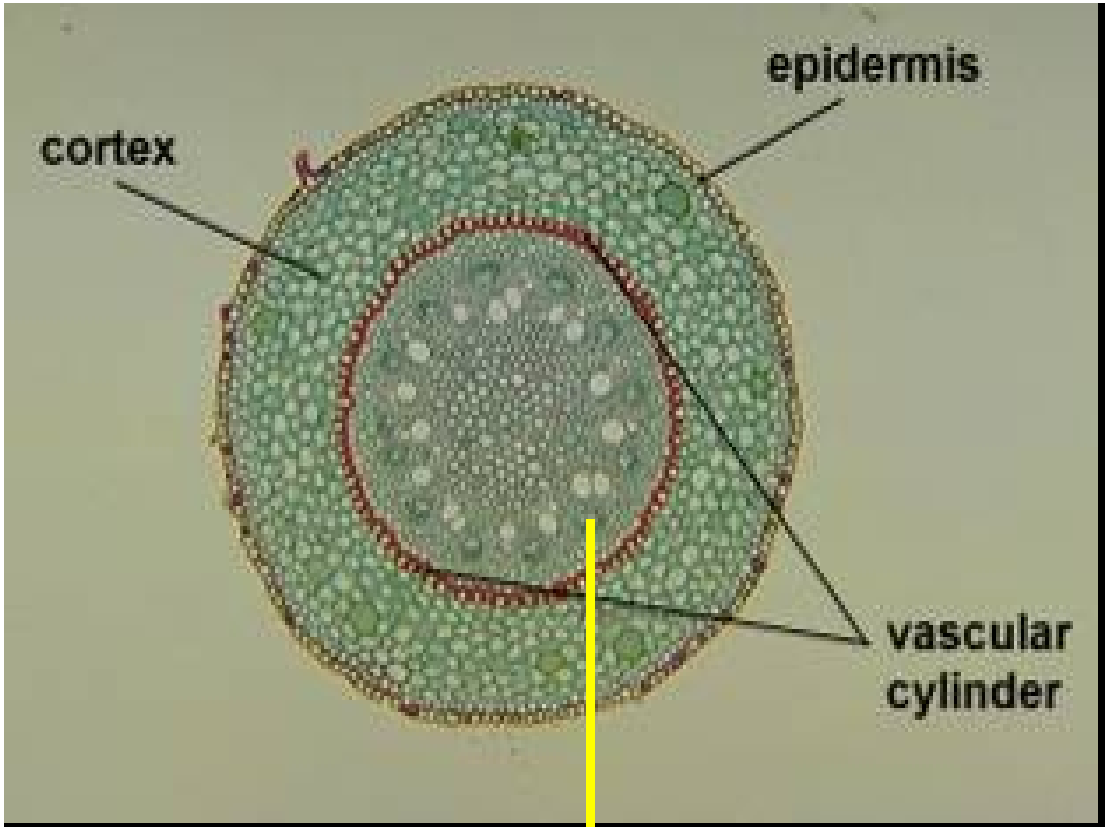
Strains Pathogenic to:

- Tomato
- Melon
- Cotton
- Lettuce

Do not affect strawberry

Fusarium oxysporum

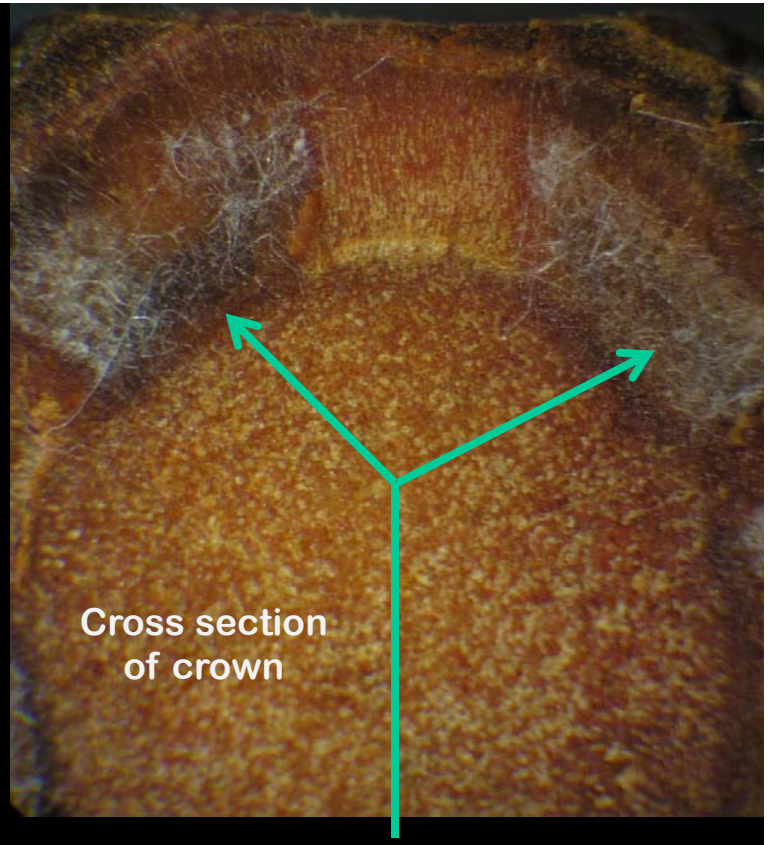
infects plant roots



Non-pathogens are
restricted to the cortex

Pathogens colonize
the xylem
(water conducting tissue)

Causes wilting and plant collapse



The pathogen grows out of vascular tissue

Discovered in Australia in 1962

Soon thereafter in:

?

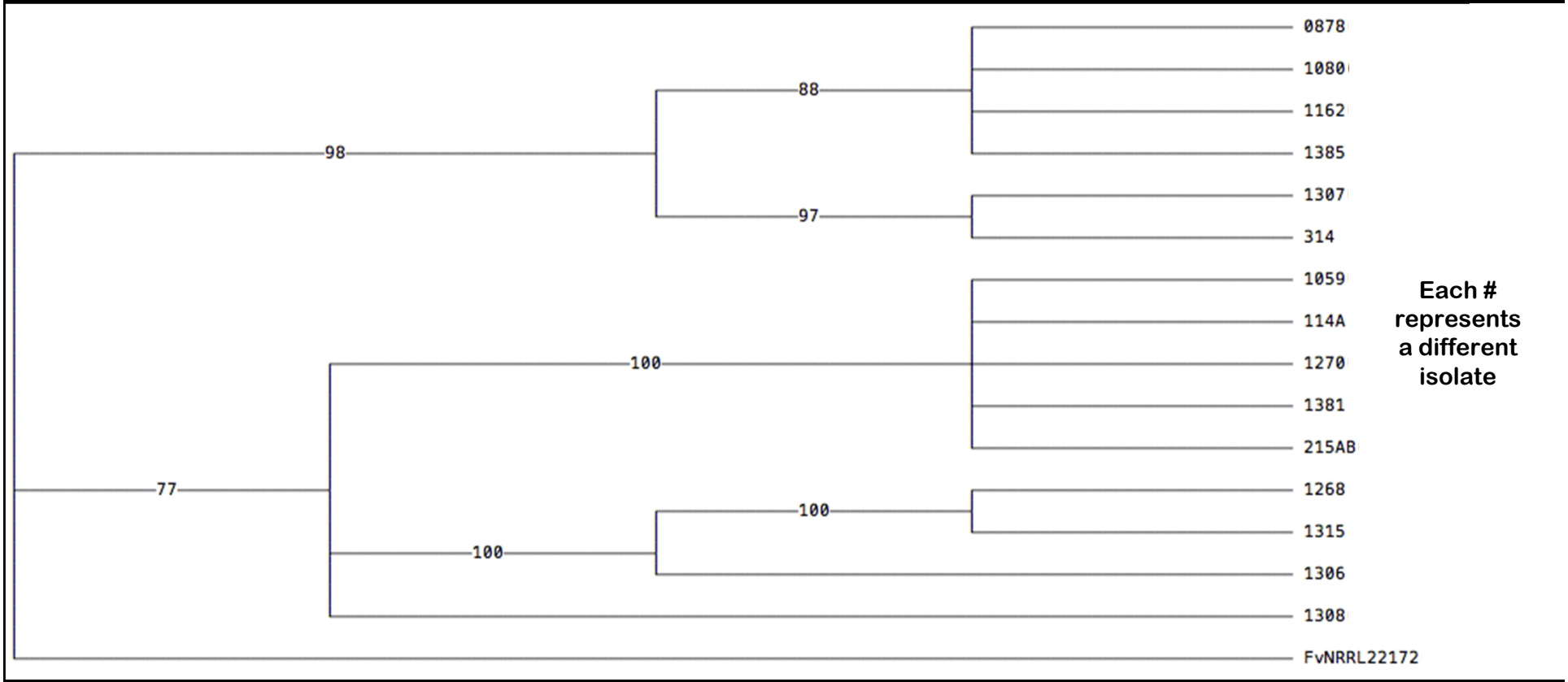
California
2008

Introduction to California

One possibility is infected plants,
which can be symptomless

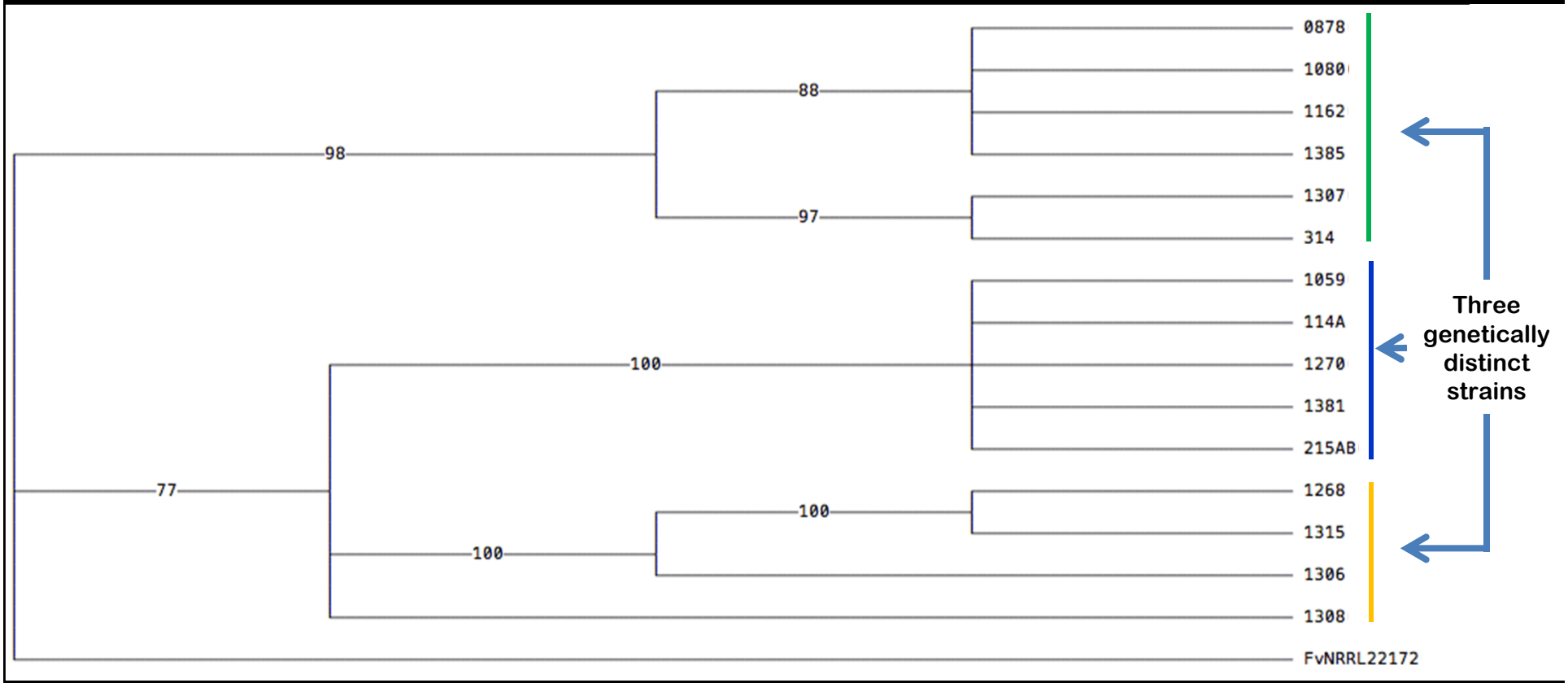
F. o. fragariae has probably been introduced to California more than once

Population of *F. o. fragariae* in CA



Relationships between CA isolates of *F. o. fragariae* based on DNA sequence comparisons

Population of *F. o. fragariae* in CA



Isolates fall into three groups, which we consider to be distinct strains

Breeding for resistance

All three strains will be used in testing for susceptibility

Management

Avoid introduction

This can occur when soil is moved from an infested field to one where the pathogen was not present

Management

Reduce inoculum levels in soil

Pre-plant fumigation

Flat fumigation to treat the entire field is best

Efficacy of fumigants

Methyl Bromide:Chloropicrin 2:1 @ 350 pounds/acre

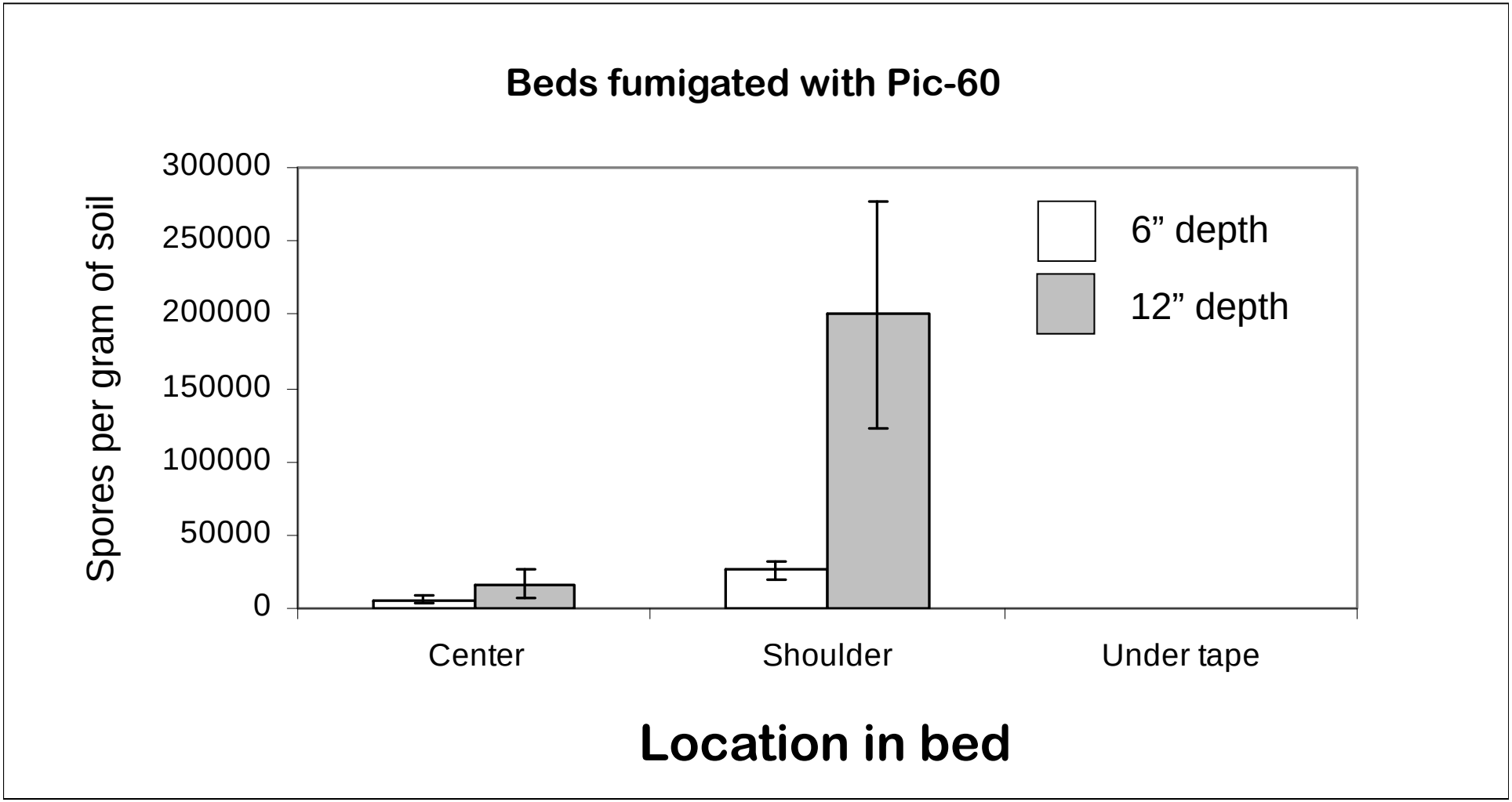
Without methyl bromide a much higher level of chloropicrin is needed to get a similar effect - something in the range of 400 pounds/acre

Telone (1,3-Dichloropropene) is a nematicide and does not contribute to control of fungi

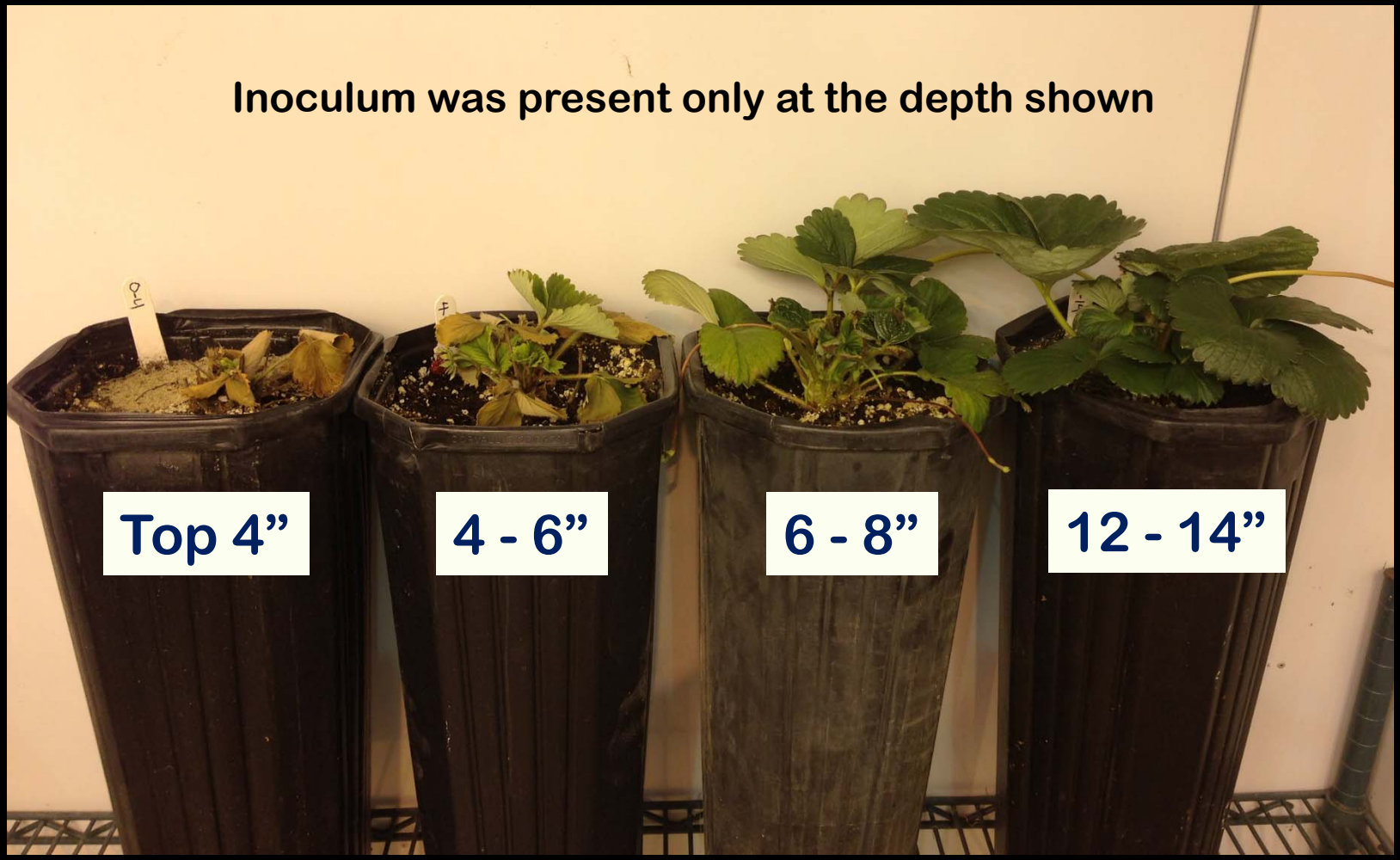
Metam sodium can be effective but results may be inconsistent especially in heavy soils

Bed fumigation is problematic

Fumigants delivered through two drip lines do not completely eliminate the pathogen



Effect of inoculum depth on disease



Nine weeks after planting

Inoculum below 12”

Early symptoms by 14 weeks after planting

Inoculum below 12”

14 weeks after planting

All plants were infected by *F. o. fragariae*

Management

Reduce inoculum levels in soil

Crop rotation can be helpful because the pathogen population in soil should decline in the absence of a susceptible host

Crop rotation

Should be effective because Fusarium wilt is specific to strawberry

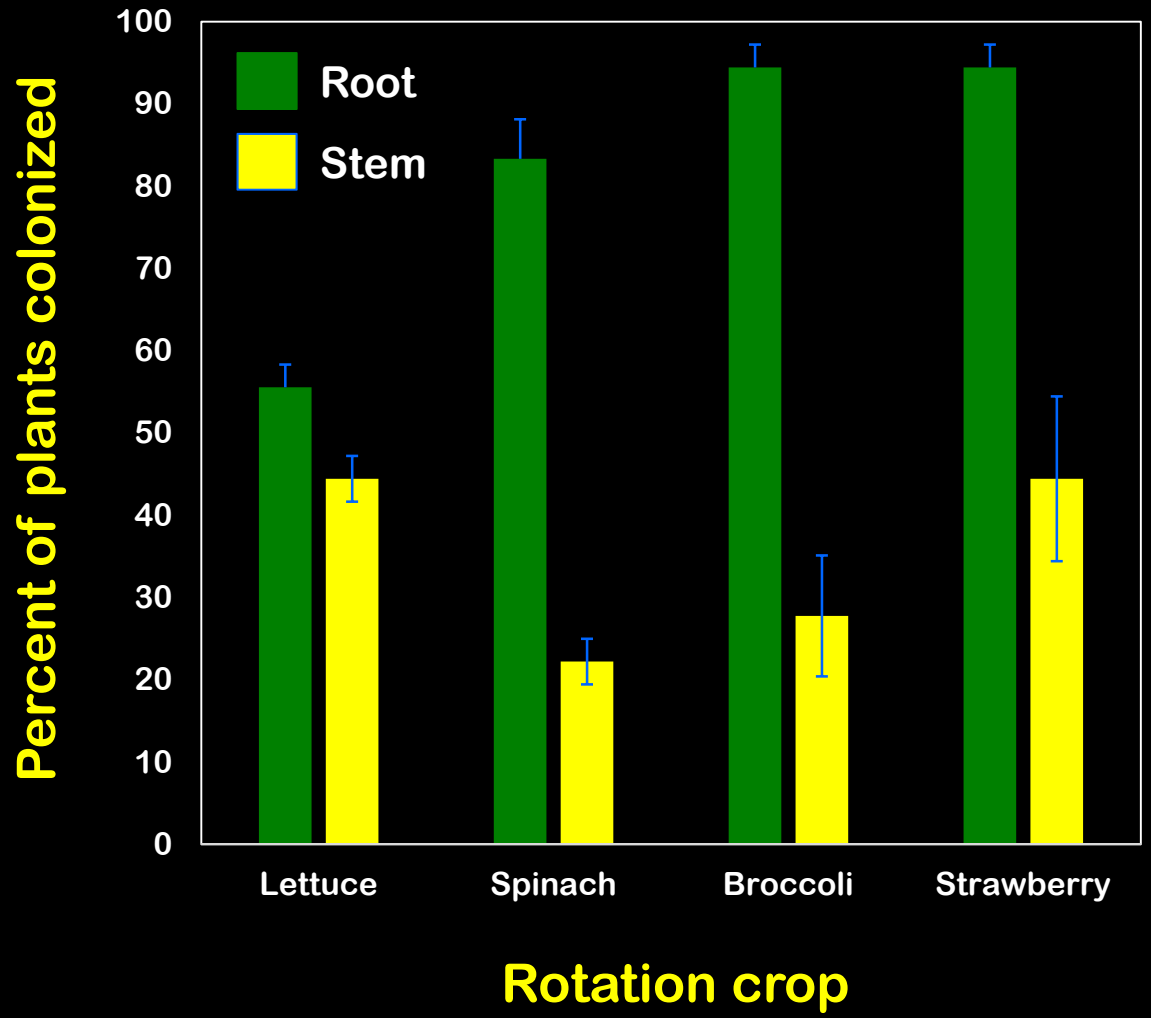
Provided crops that show no symptoms are not colonized by the pathogen

Fusarium will colonize the roots of most crops

But this is not sufficient to negate the benefit of crop rotation

Colonization of rotation crops

The Fusarium wilt pathogen colonizes roots and grows into the stem of lettuce, spinach and broccoli

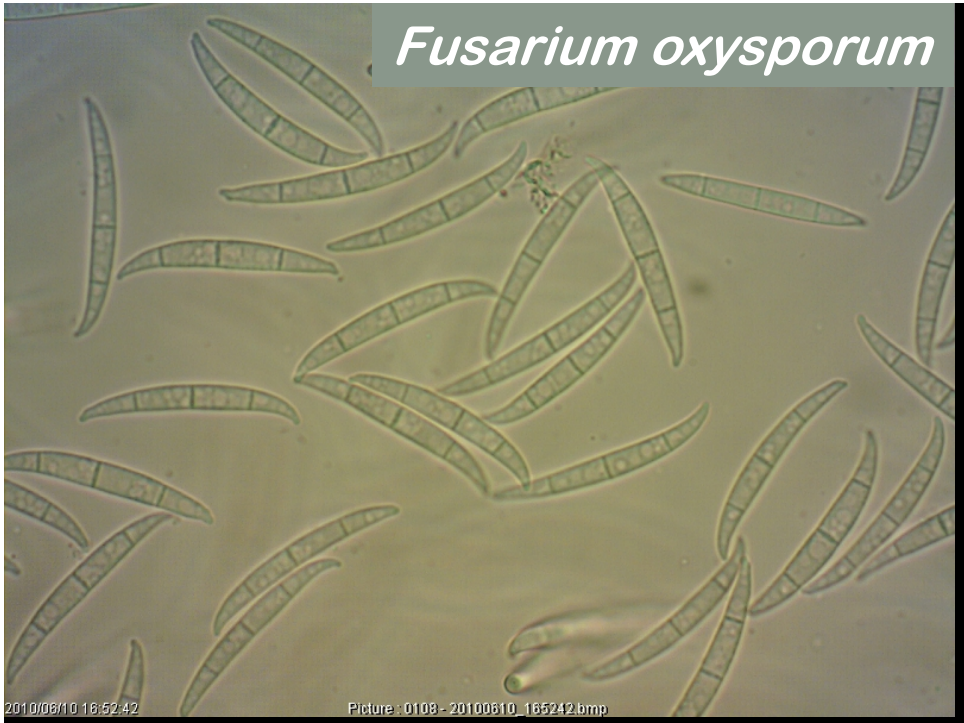


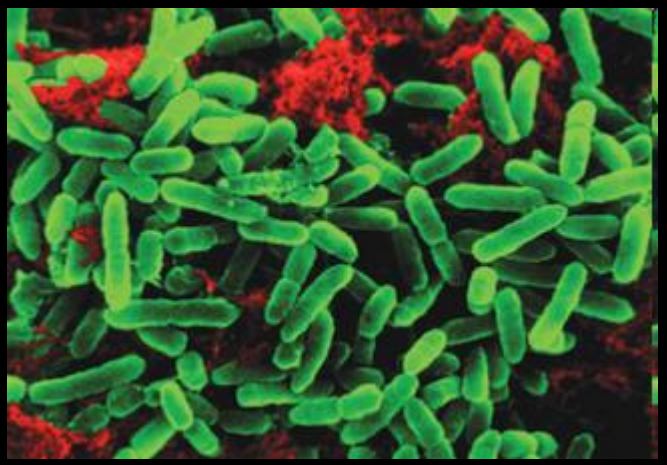
Management

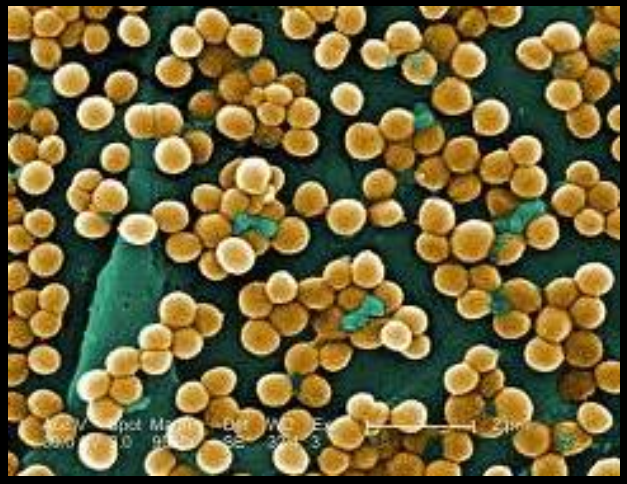
Suppressing pathogen activity in soil

Effect of soil pH on Fusarium wilt

Elevating pH to 7.0 was reported to reduce severity of Fusarium wilt of tomato

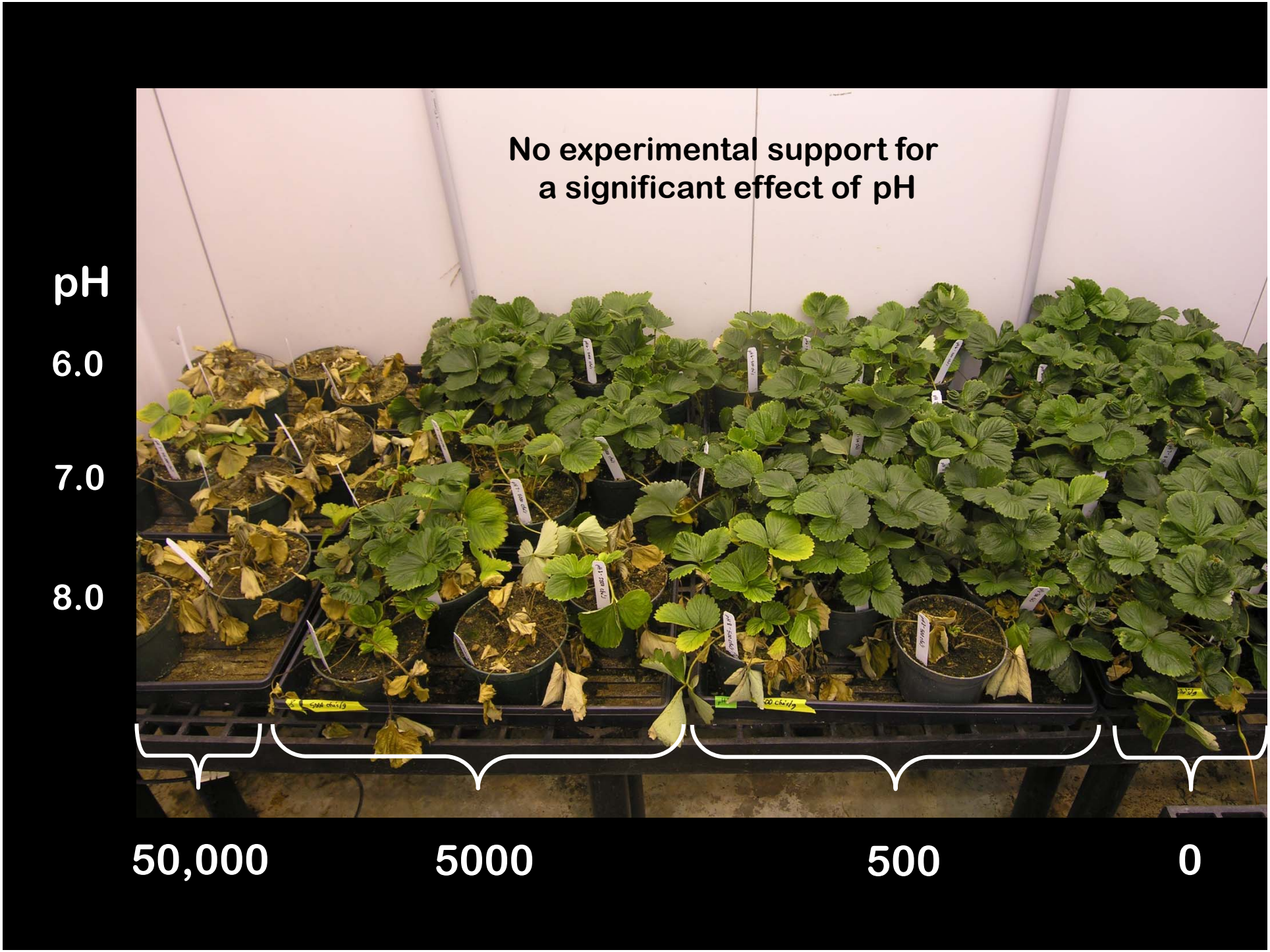






In soil fungi compete with bacteria

Acidic soil tends to
favor fungi over bacteria


No experimental support for
a significant effect of pH
pH
6.0
7.0
8.0
50,000
5000
500
0

Eur J Plant Pathol (2012) 134:619–629
DOI 10.1007/s10658-012-0042-1

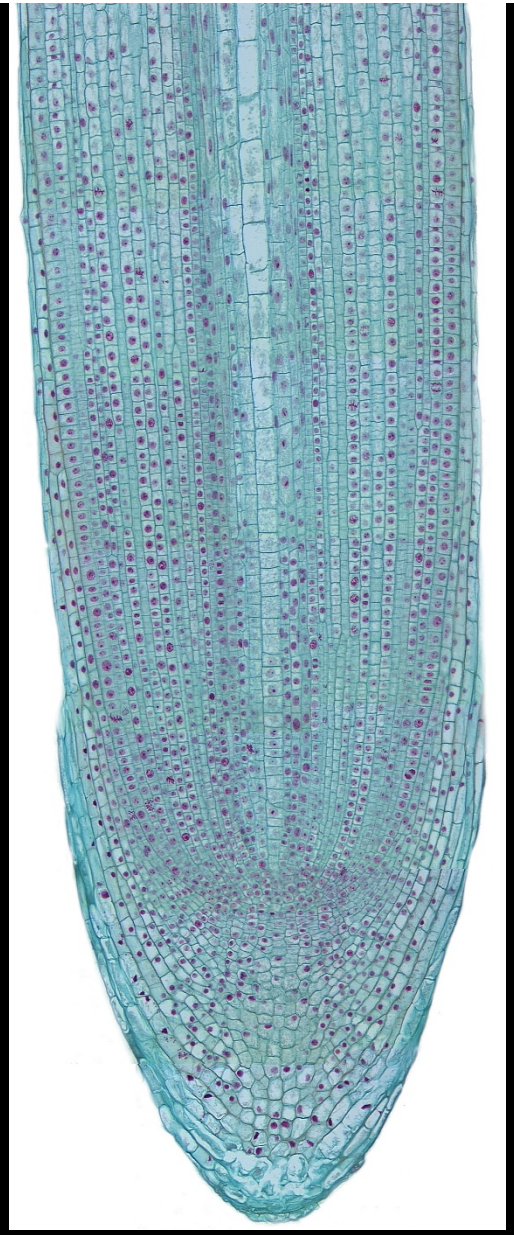
Reduced severity and impact of Fusarium wilt on strawberry by manipulation of soil pH, soil organic amendments and crop rotation

Xiangling Fang · Ming Pei You · Martin John Barbetti

More severe disease under acidic conditions


Soil was collected from a
field with a high population
of the Fusarium wilt pathogen

Strawberry plants were grown for two weeks in soil adjusted to pH 7.0 or 5.1

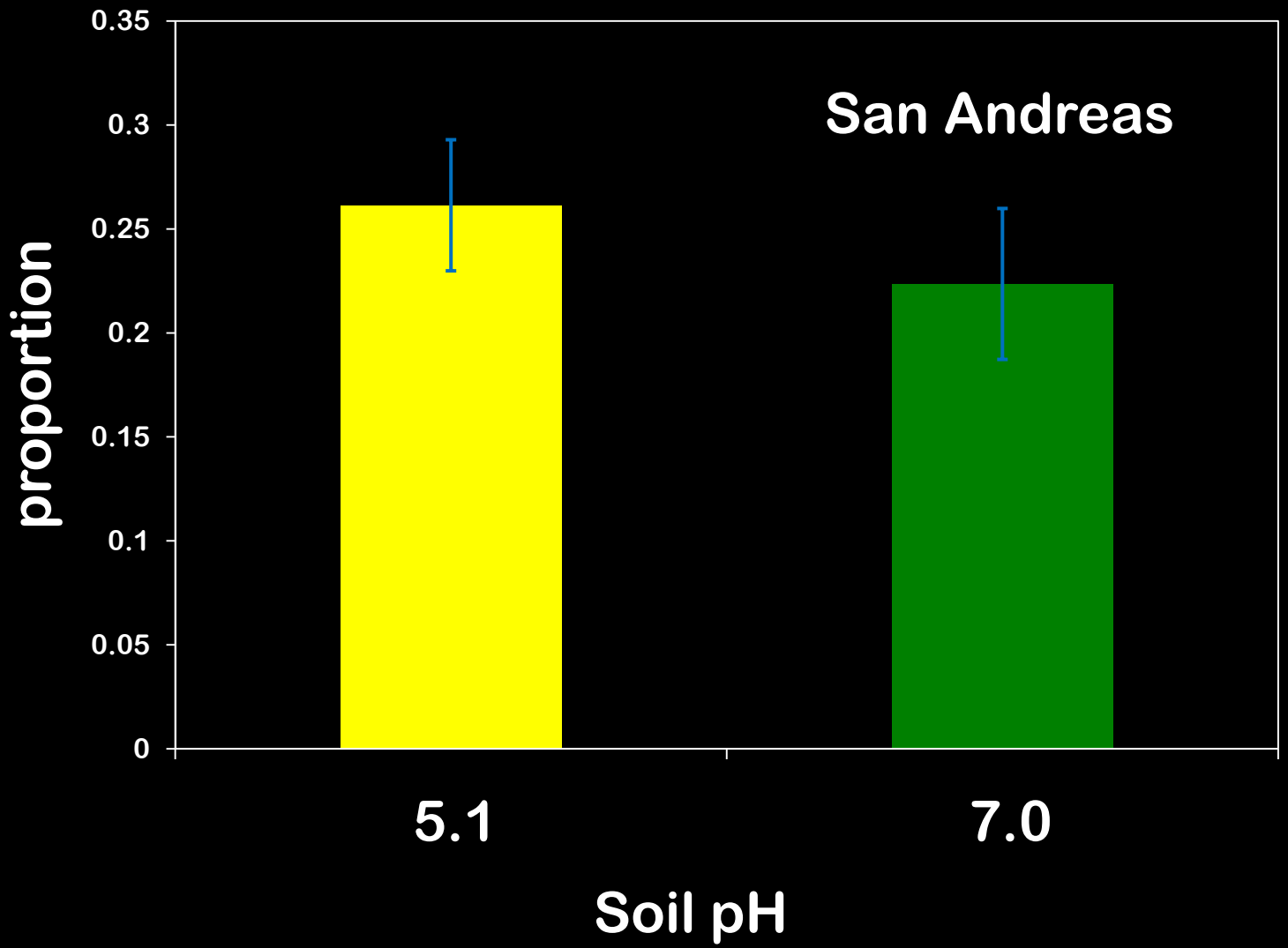


Root tip

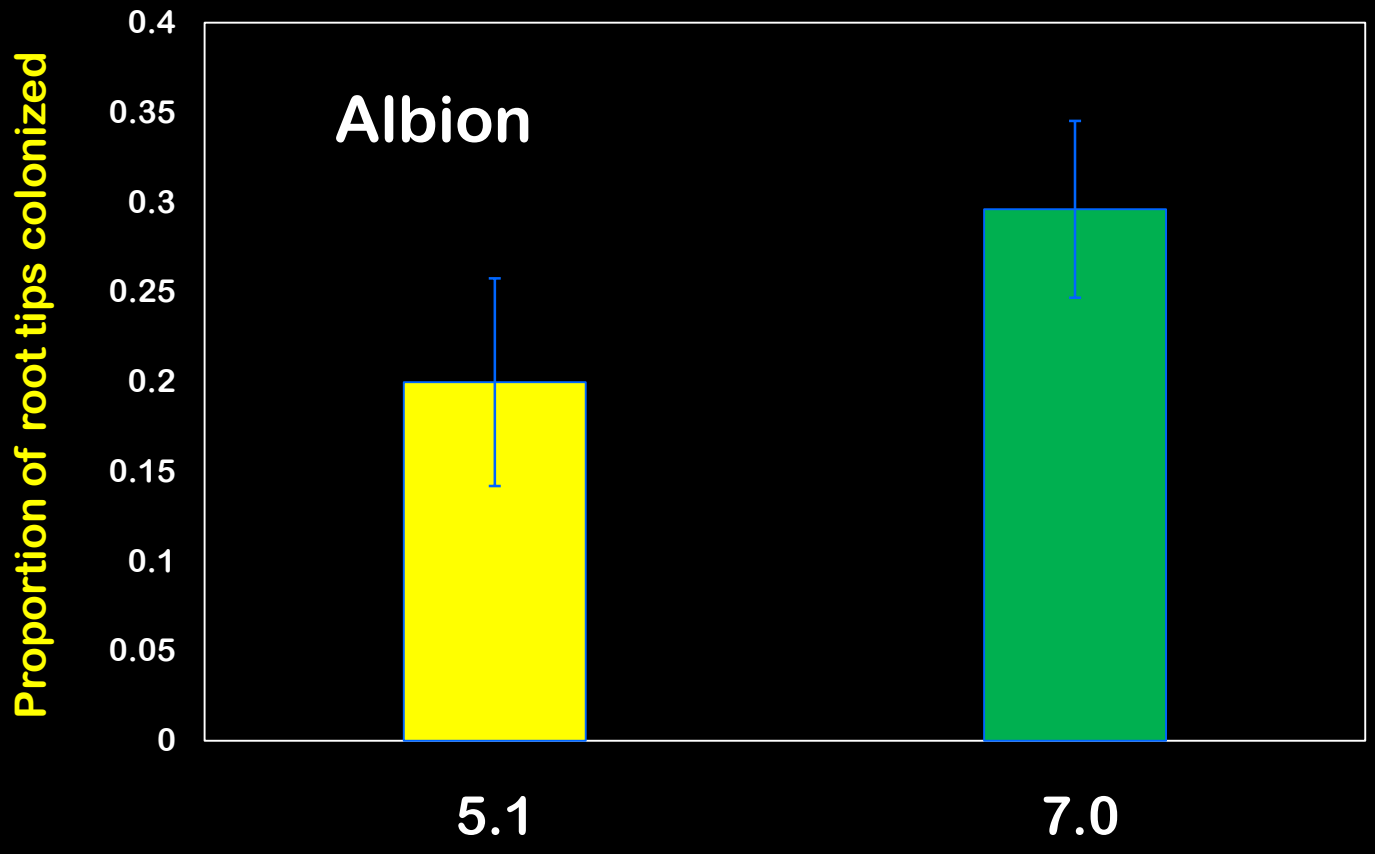
Harvest roots after two weeks

Proportion of root tips infected

Proportion of root tips infected by *F. o. fragariae*



Proportion of root tips infected by *F. o. fragariae*



No significant effect of pH on root infection

Australia

Sandy soil
pH 5.2

$CaCO_3$

pH 6.7

California

Clay soil
pH 7.1

H_2SO_4

pH 5.1

Different results may be due to factors other than pH

Management of Fusarium wilt

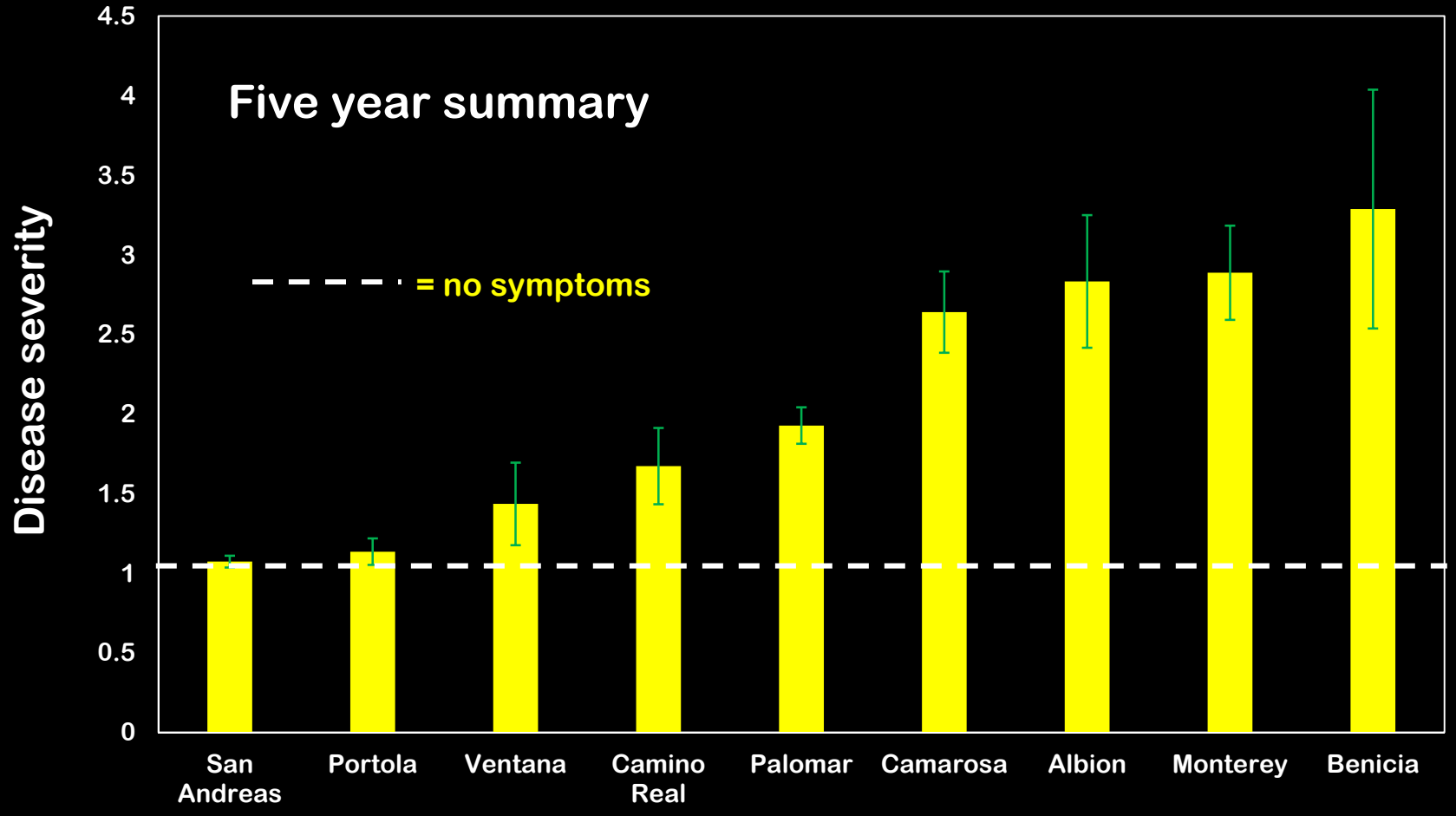
Disease resistance

Differences in susceptibility to Fusarium wilt

Camarosa

Ventana

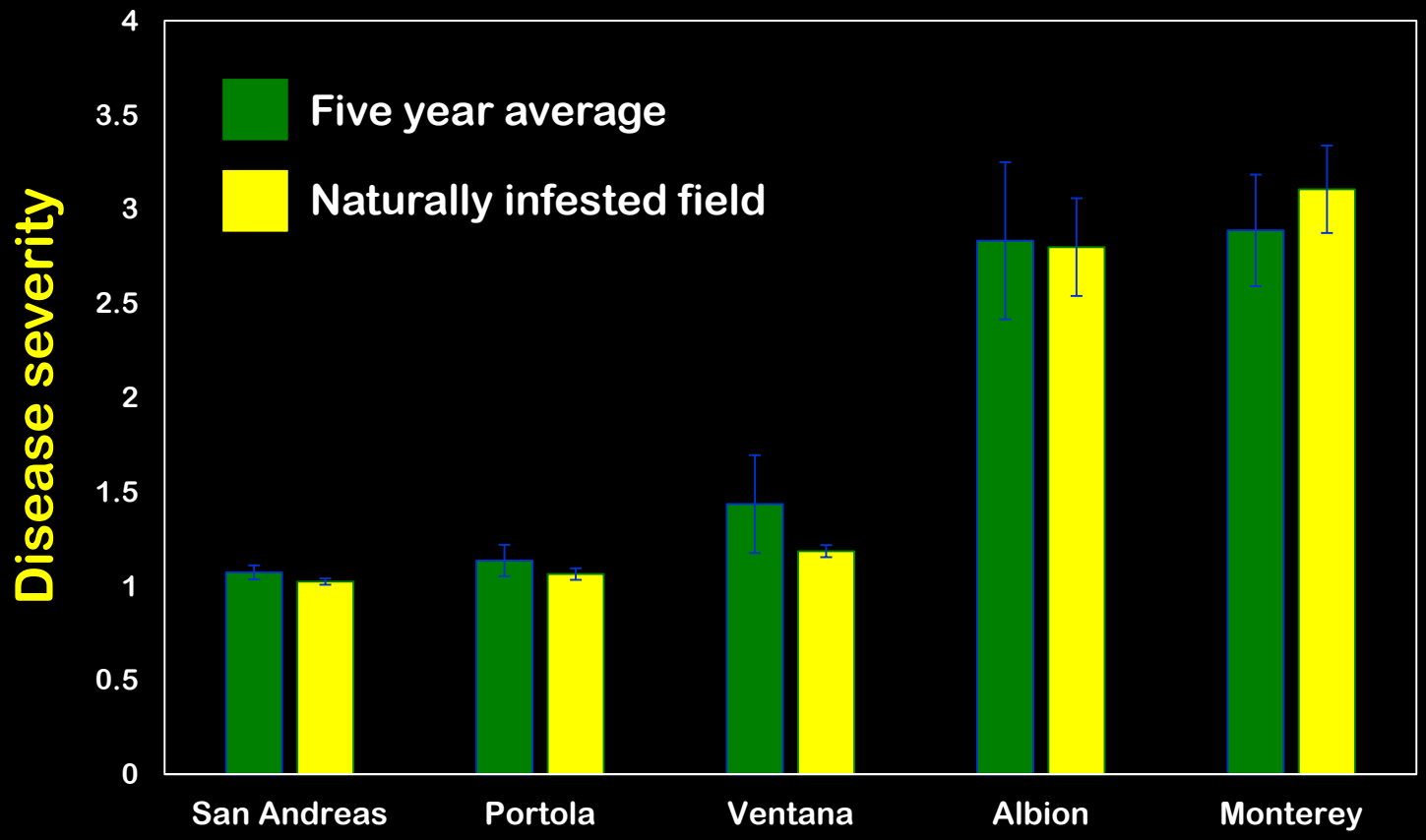
Susceptibility to Fusarium wilt based on controlled inoculations




Cultivars were also tested in a naturally infested field

Comparison of resistance assessments

Correlation coefficient = 0.9908



Susceptibility to Fusarium wilt

San Andreas Portola Fronteras	Highly resistant
Ventana Petaluma	Resistant
Monterey Albion	Susceptible

All are UC cultivars

Susceptibility to Fusarium wilt

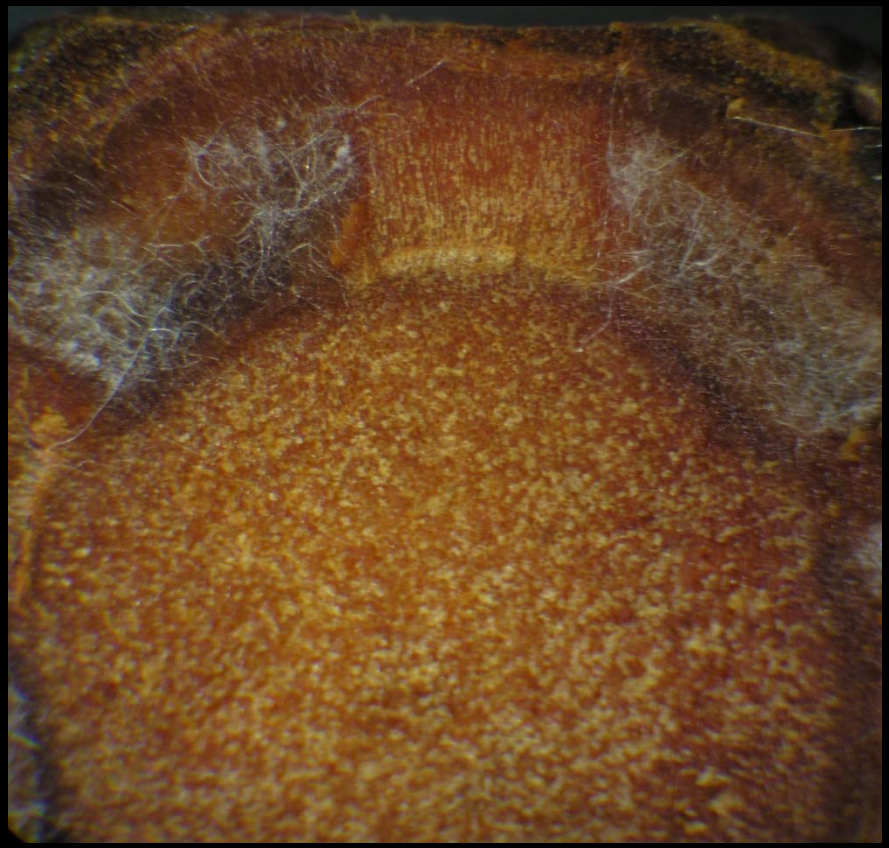
	San Andreas Portola Fronteras	Highly resistant
non – U.C. cultivars*	Festival Safari	Resistant
	Monterey Albion	Susceptible

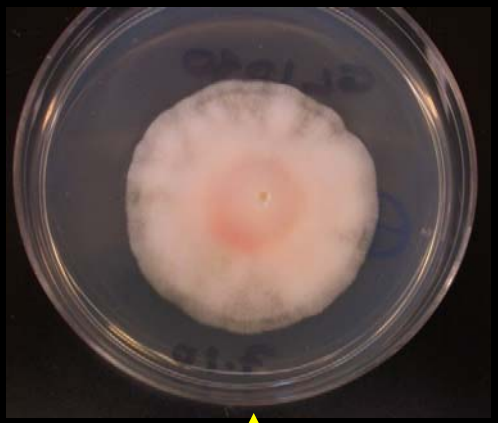
* Only one year of data

By comparison to Sweet Anne, Monterey and Albion are intermediate in susceptibility to Fusarium wilt

San Andreas Portola Fronteras	Highly resistant
Monterey Albion	Intermediate
Sweet Anne	Susceptible

Pathogen can colonize resistant crops





May allow inoculum build-up in soil

Resistance may be overcome

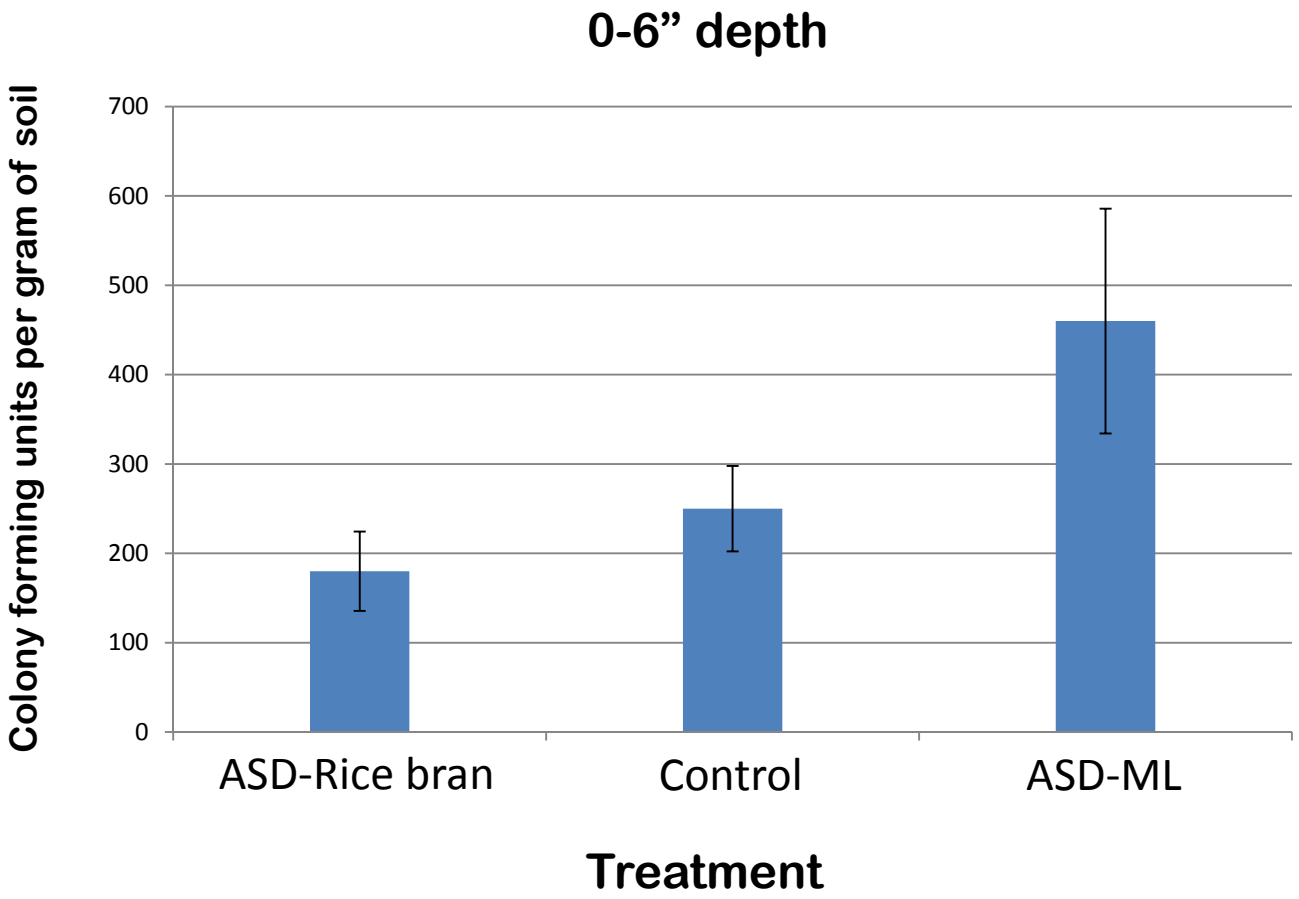
Risk is proportional to pathogen growth and reproduction

Suppression of pathogen populations remains important

Anaerobic soil disinfestation can be effective against soilborne pathogens

But is not fully effective against *Fusarium*

Inoculum density of *Fusarium oxysporum* f. sp. *fragariae*



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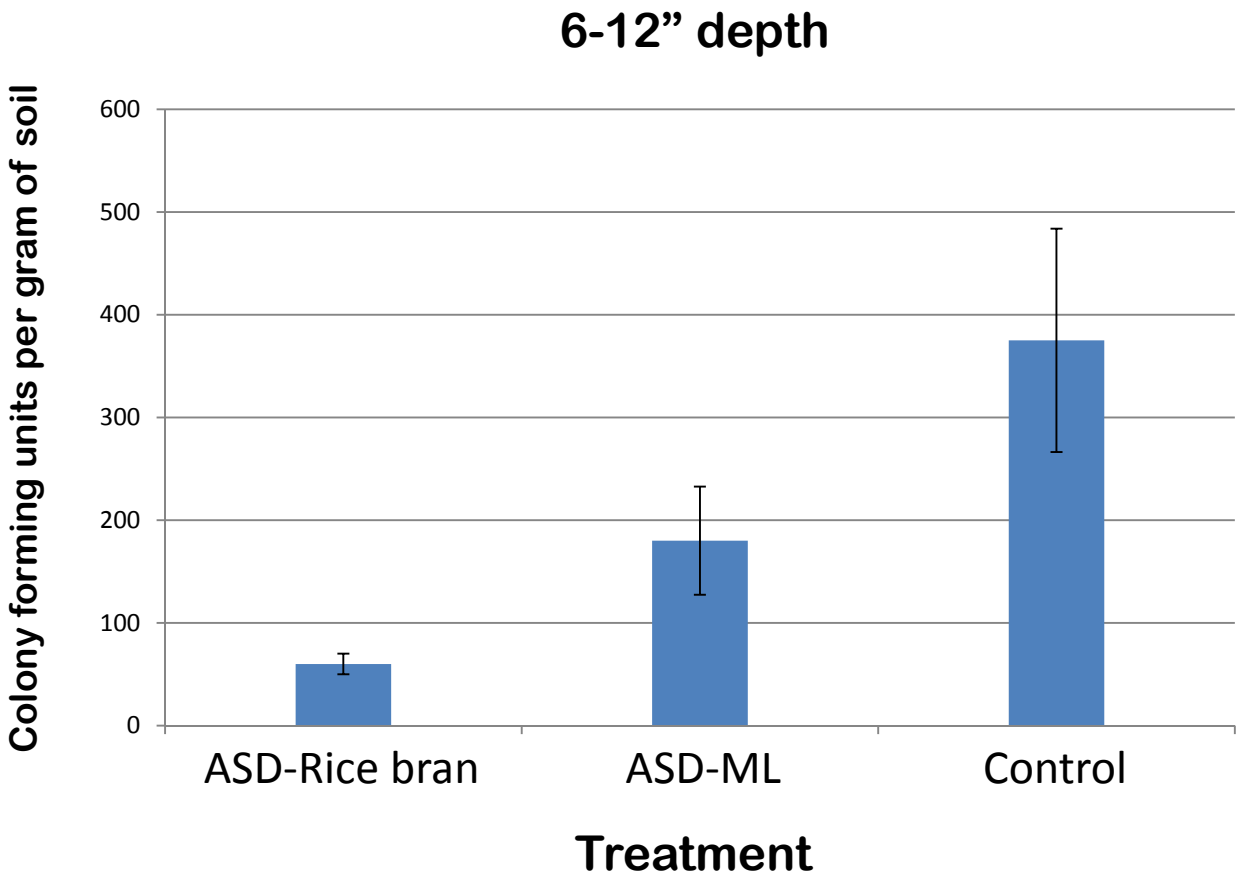

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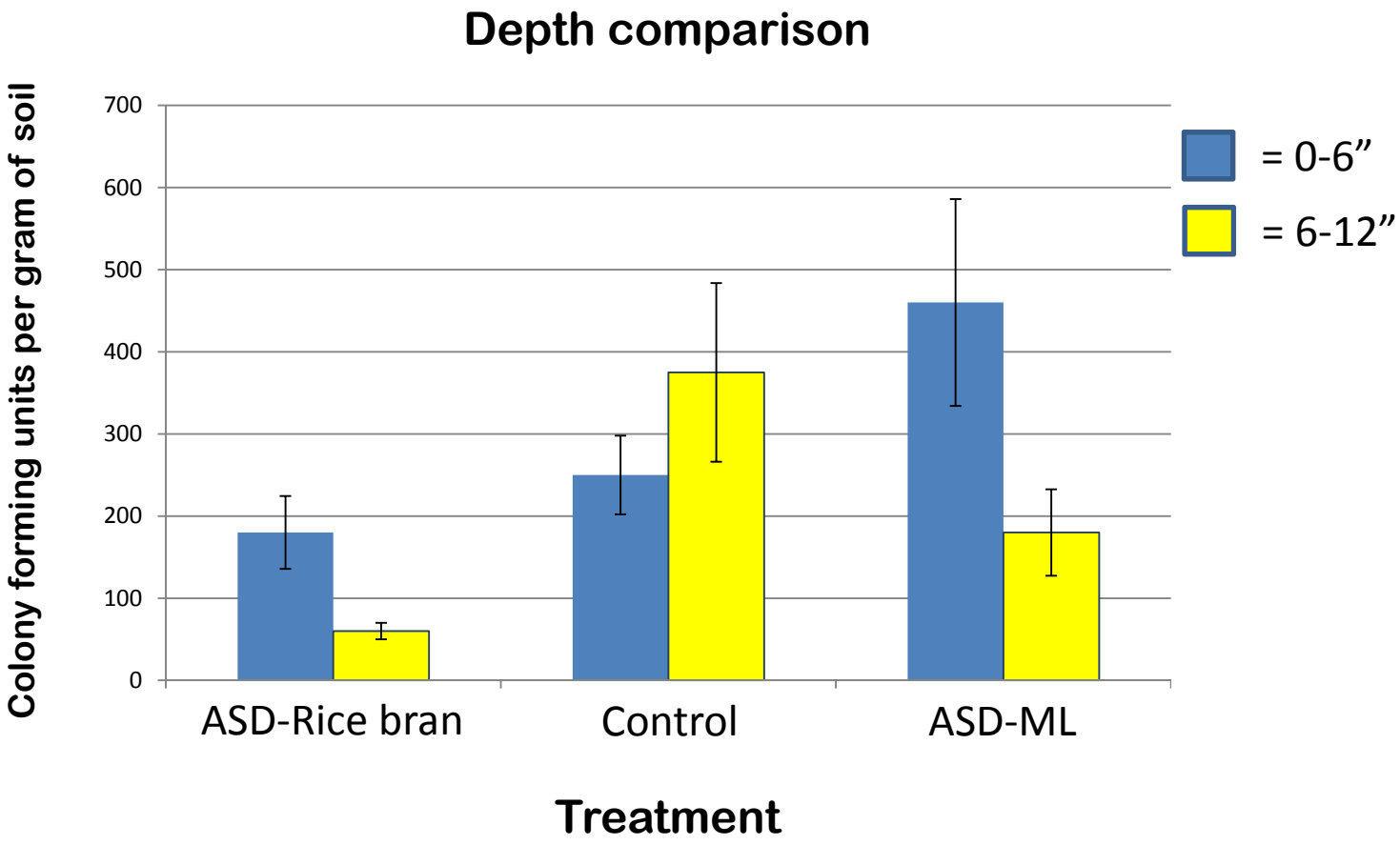


ASD was more effective in soil below 6”

Macrophomina

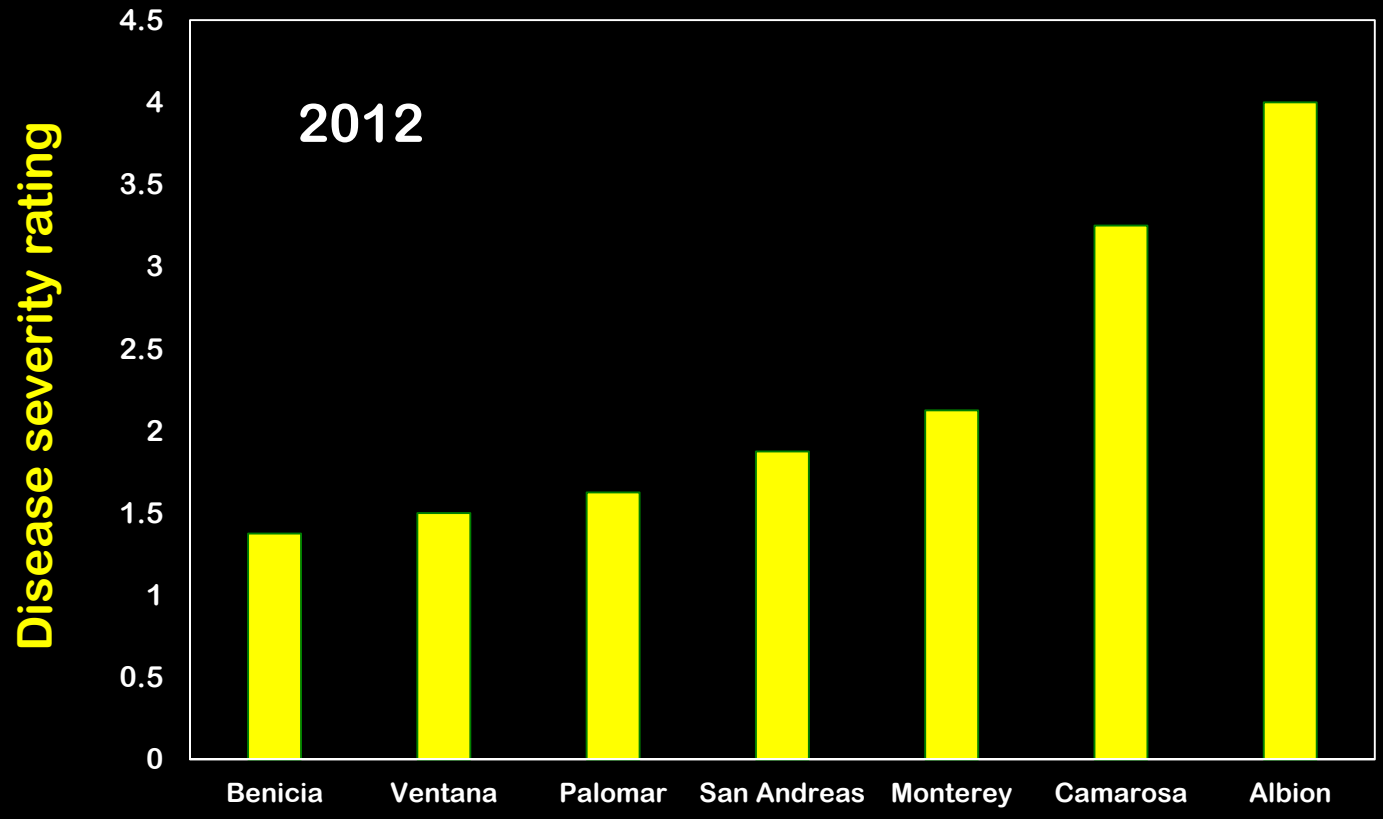

Macrophomina is found in all major production areas

Screening for resistance to Macrophomina

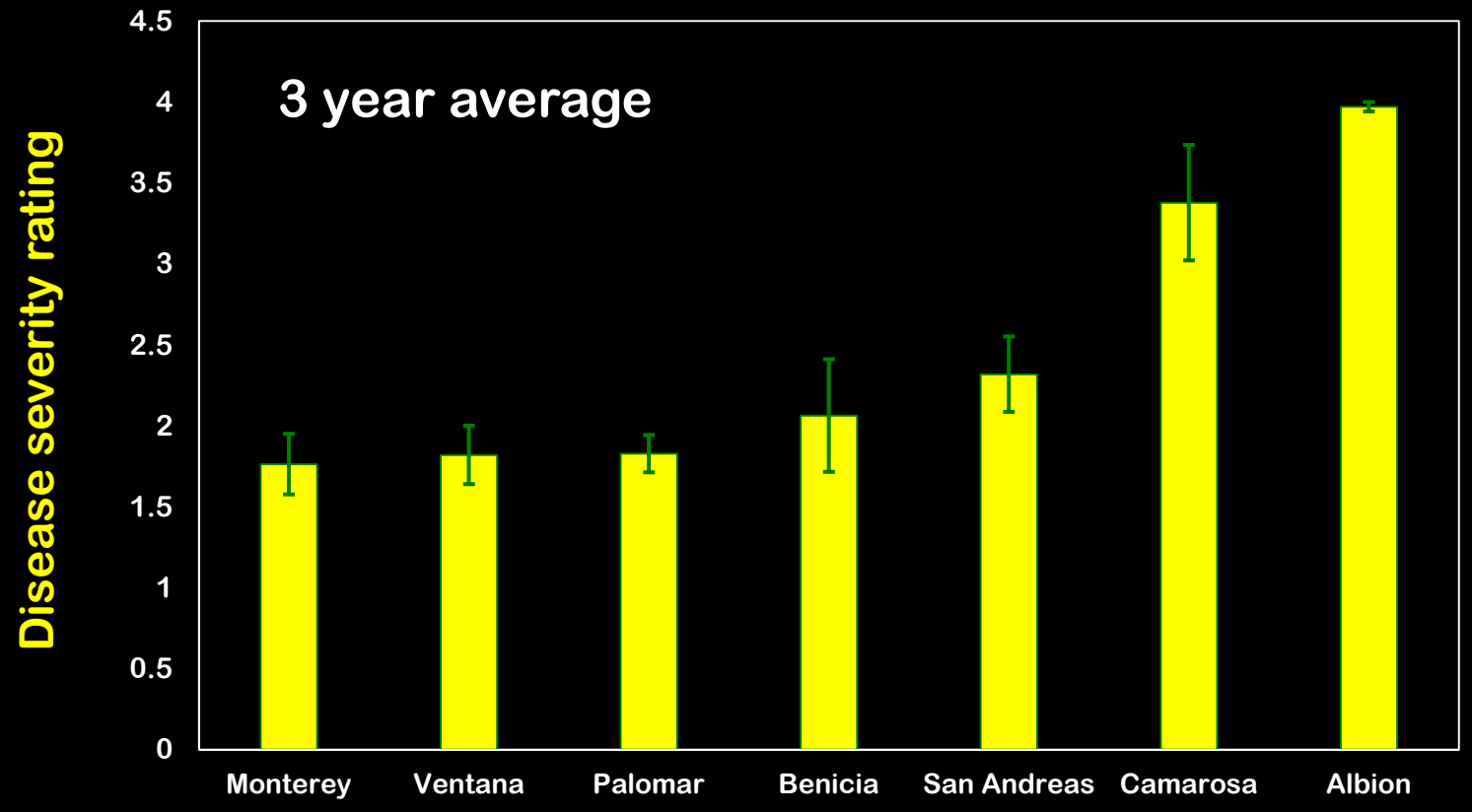
Our goal was to develop a test that would detect differences in susceptibility among genotypes

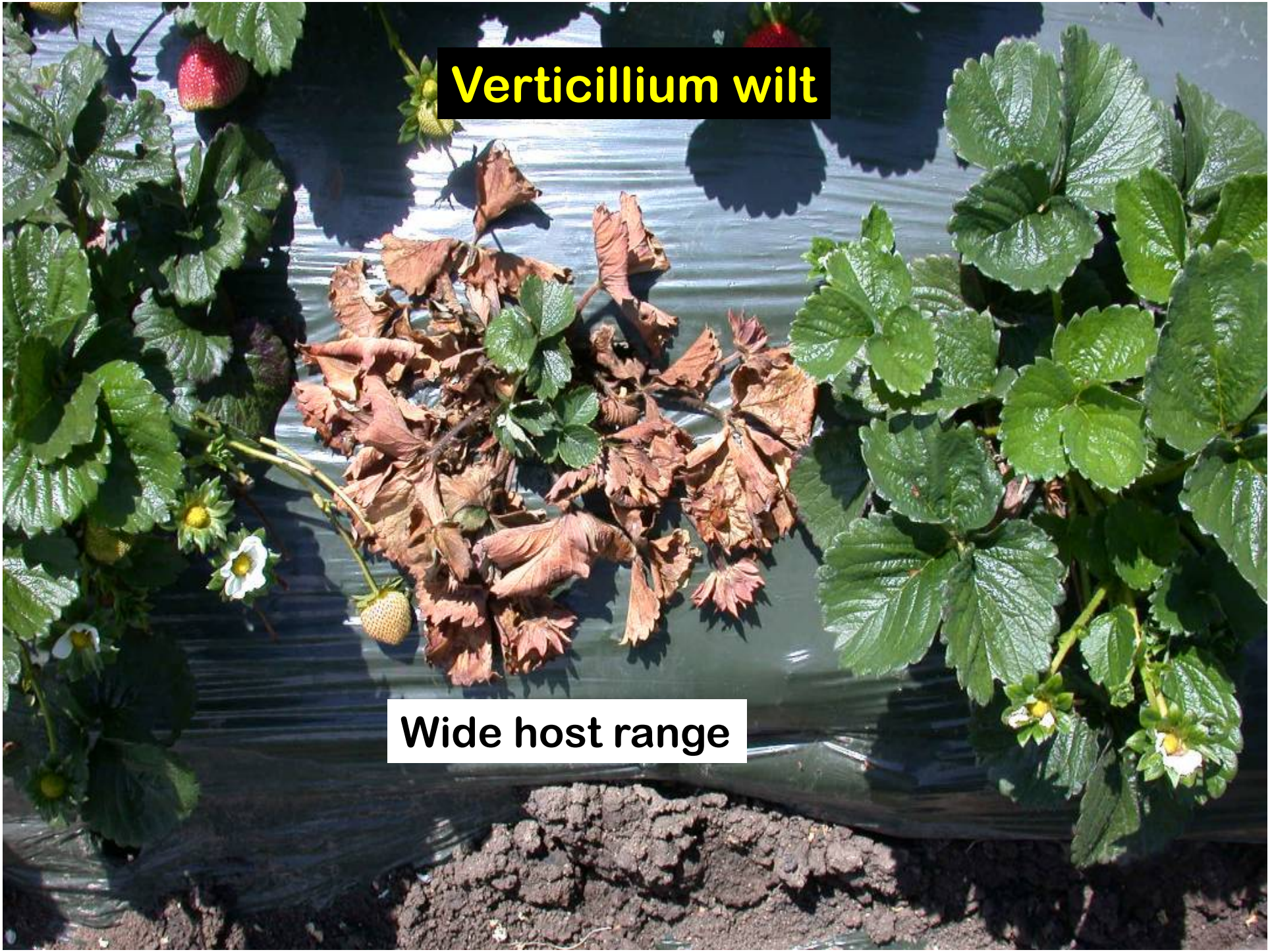
Differential susceptibility to Macrophomina was evident in our tests

Susceptibility to Macrophomina among UC cultivars



Consistent differences in susceptibility to crown rot caused by *Macrophomina*




Verticillium wilt
Wide host range

Crops to avoid

Lettuce

Potatoes

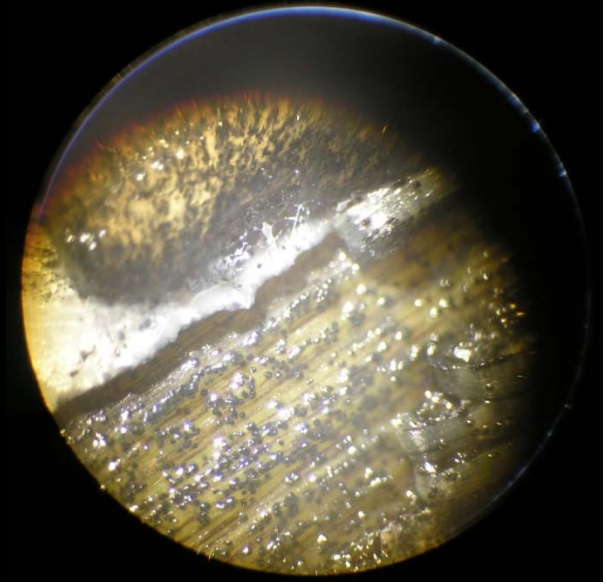
tolerate high levels of inoculum

Legumes

Infected plants are symptomless

But they are colonized by *Verticillium dahliae*

Black spots are survival structures of *Verticillium dahliae*



Management of soilborne pathogens

Avoid introductions

Reduce inoculum levels

Know the history of the field
and use cultivars with the highest
levels of resistance to diseases of concern

Sources of support for this research