

A photograph of a sculpture on a green lawn. The sculpture consists of a large, light-colored, teardrop-shaped bulb and a long, curved, root-like structure that arches over the bulb. The background features trees and a building with a white roof.

Research to Improve Control of Root and Bulb Rot Diseases

Reducing Root Rot, Bulb Rot, and Vascular Wilt Disease Losses in Floral Crops by Improvements in Pathogen Tracking and Management

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G. Moorman, S. Jeffers, G. Chastagner**



Previous team members

Objectives in Four Areas:

- **Pythium management**
- **Phytophthora management**
- **Cultivar choices**
- **Root and vascular wilt disease management**

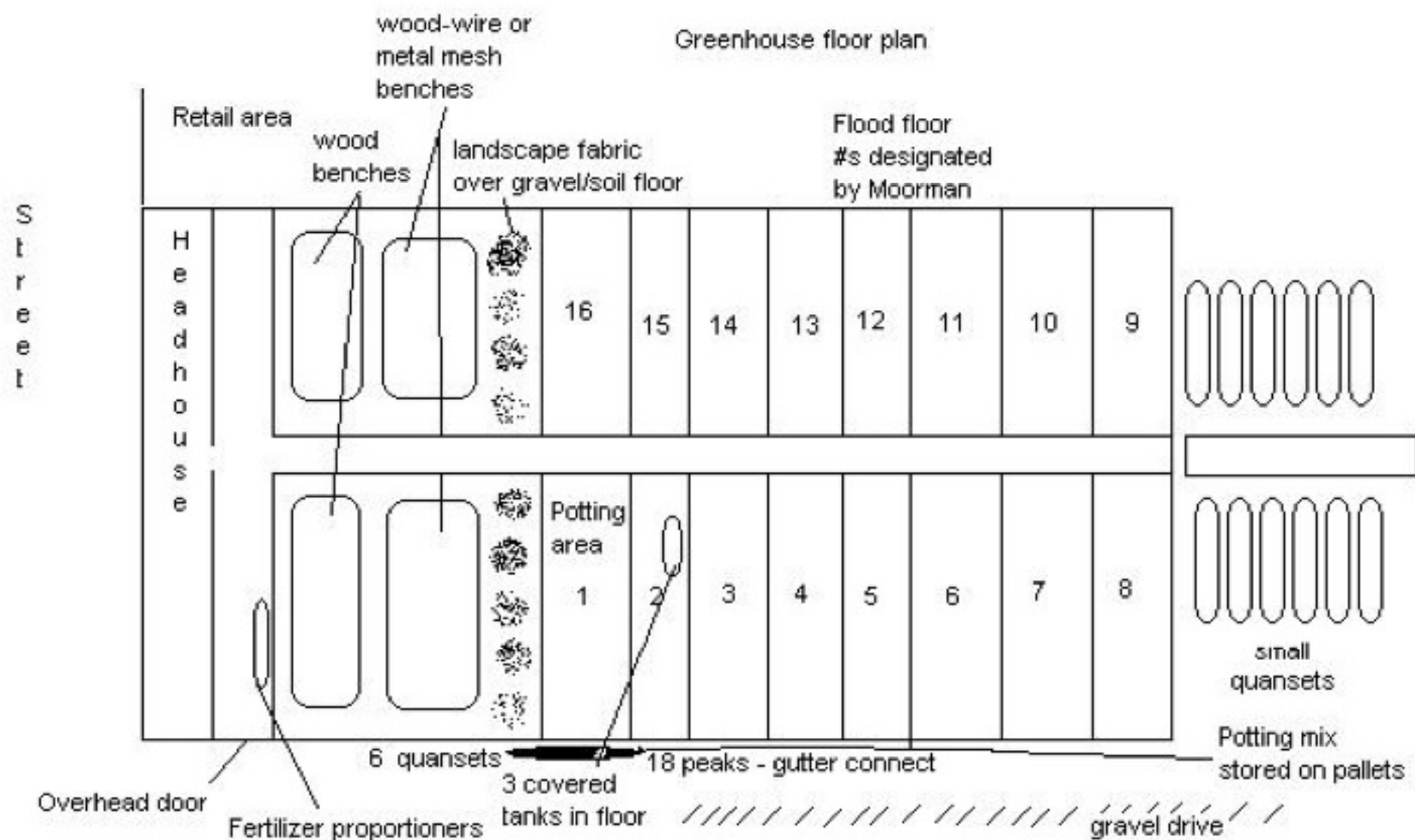
Pythium Tracking!



Symptoms caused by *Pythium* spp.



Intensive, repeated sampling



Every 90 days, sampled 2 PA greenhouses – for 3 years

Sampling

→ 6 greenhouses, 3 repeatedly visited: spring 2007 to spring 2008



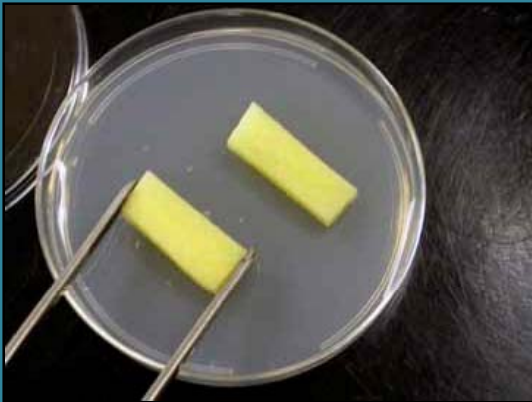
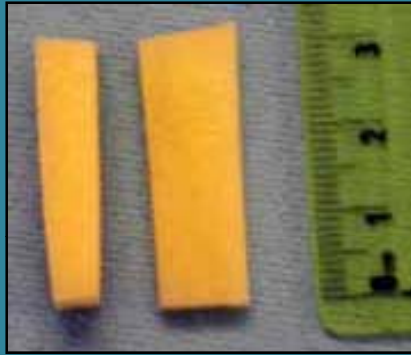
1 tsp X 5 containers
→ 1 bag



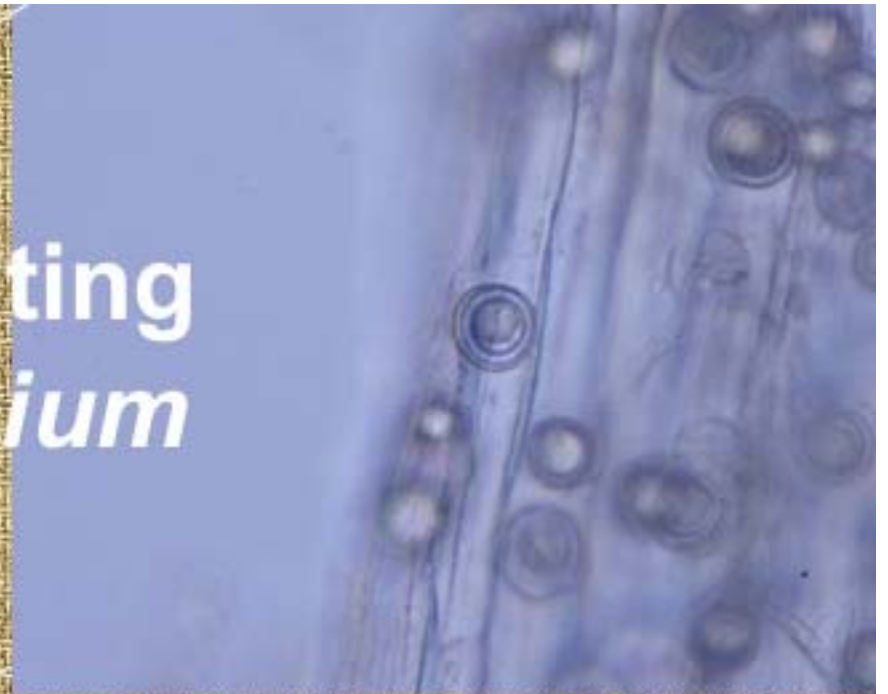
5 tsp/area
→ 1 bag



Baiting system



Isolating *Pythium*



DNA extraction



Growing
Pythium



DNA
extraction

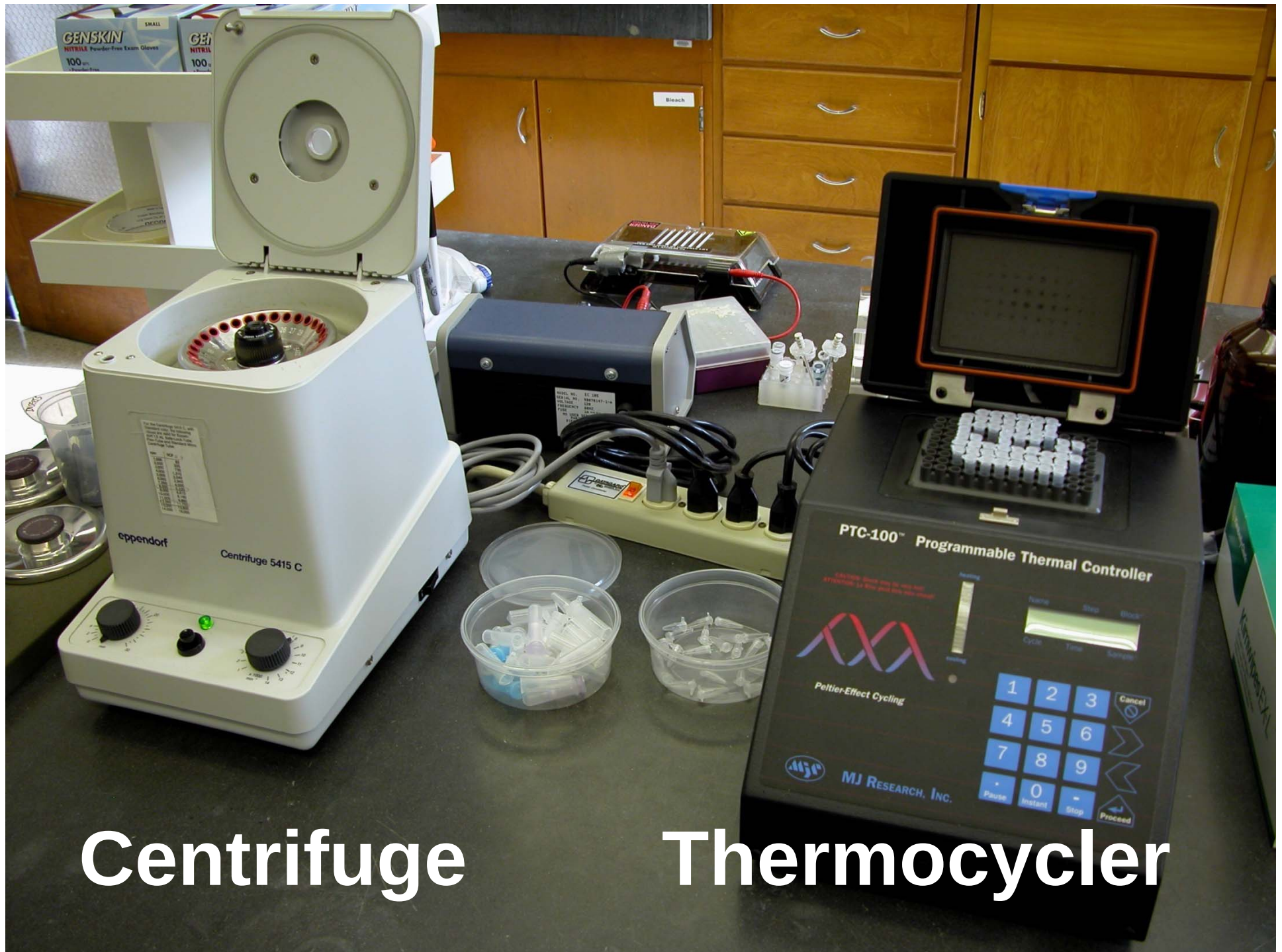


Data
analysis



DNA
sequencing or
fingerprinting





Centrifuge

Thermocycler

AFLP

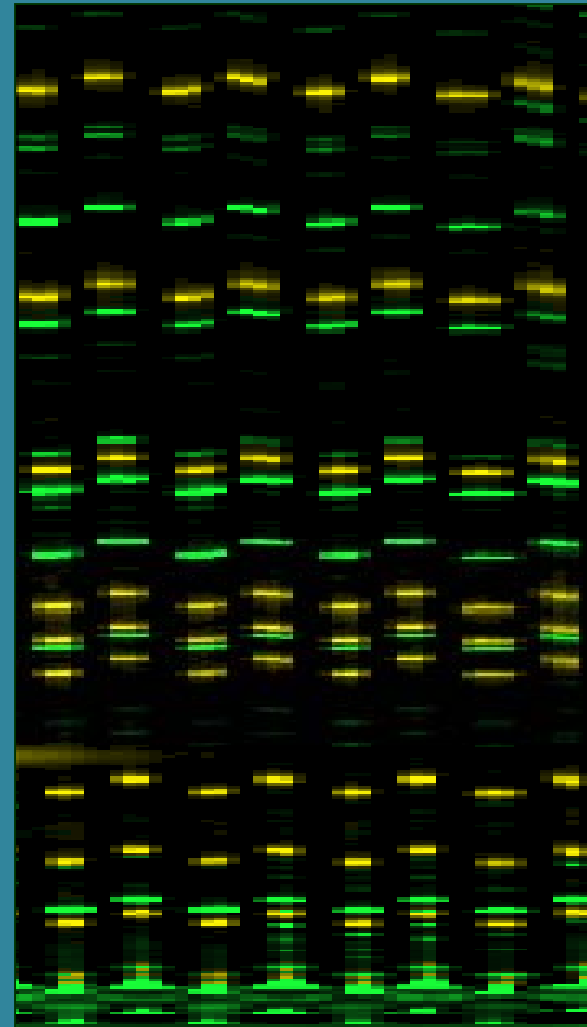
Amplified Fragment Length Polymorphism

AFLP technique:

fingerprinting tool that consists in the selective PCR amplification of restriction fragments.

Combines:

- Power of RFLP
- Flexibility of PCR



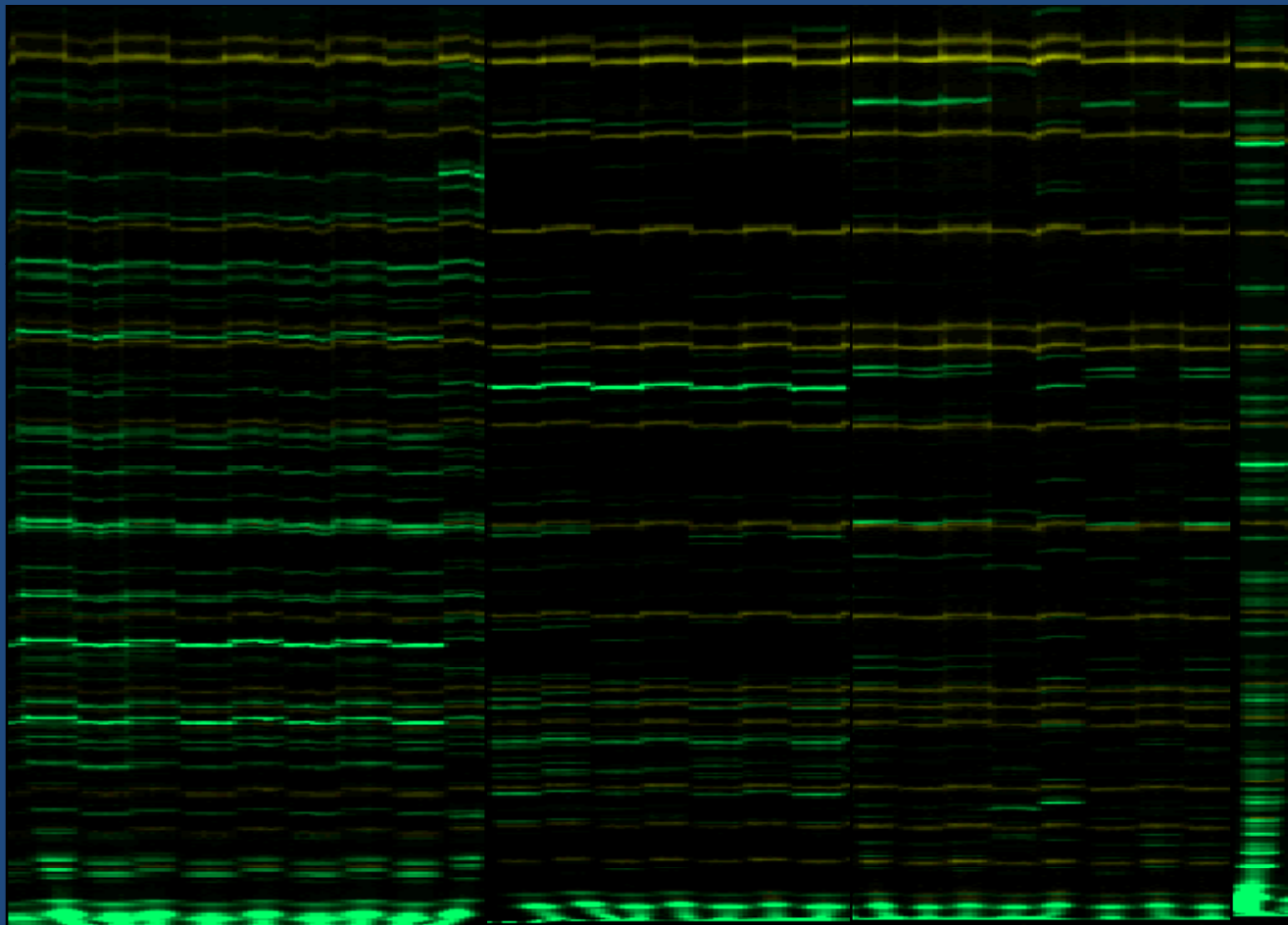
AFLP as a diagnostic tool

P. aphanidermatum

P. irregulare

P. ultimum

C1



Pythium
IRREGULARE =
 (microscopically)

Pythium irregulare
 +
Pythium cryptoirregulare
 +
2 more NEW species

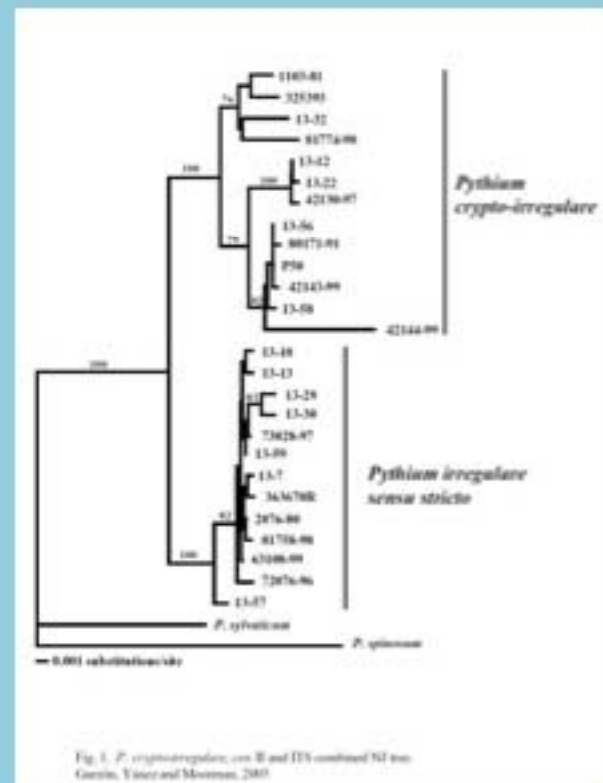


Fig. 1. *P. cryptoirregulare*, con W and ITS combined NJ tree.
 García, Yáñez and Martínez, 2007

NY Clinic Samples vs Survey Data

Plants submitted for diagnosis

Pythium irregulare
or *cryptoirregulare*:

Geraniums (4)
Chrysanthemums (3)
Poinsettias (3)
Coleus (2)
Oxalis (2)
Snapdragons (2)
Calibrachoa (1)
Dahlia (1)
Hedera (1)
Kalmia (1)
N.G. Impatiens (1)
Rhododendron (1)

Survey

P. cryptoirregulare:

Ivy (4)
Geranium (3)
N.G. Impatiens (2)
Snapdragon (2)
Verbena (2)
Ageratum (1)
Tomato (1)
Impatiens (1)

P. irregulare:

Snapdragon (6)
Geranium (1)
Tomato (1)

Clinic Samples vs. Survey Data

Plants submitted for diagnosis:

P. aphanidermatum:

Chrysanthemums (9)

Poinsettias (5)

Calibrachoa (2)

P. ultimum:

N.G. Impatiens (1)

Survey

P. aphanidermatum:

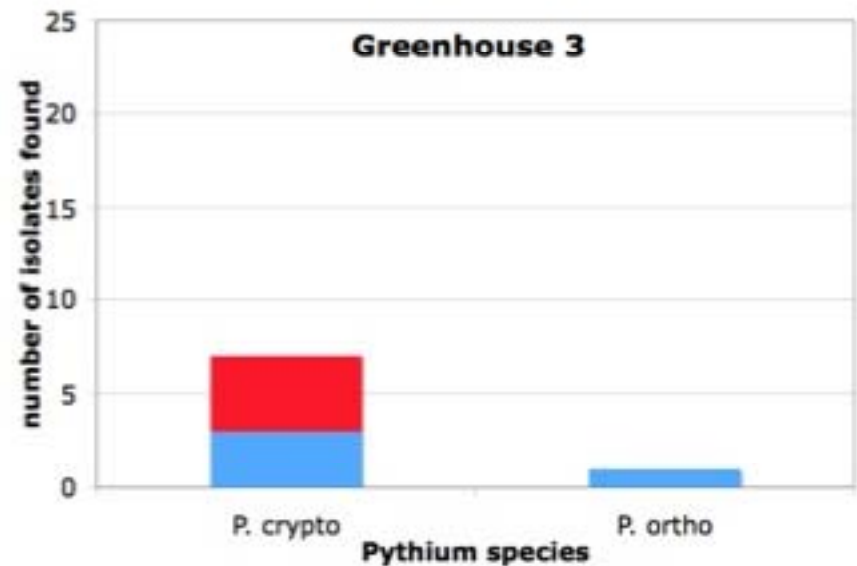
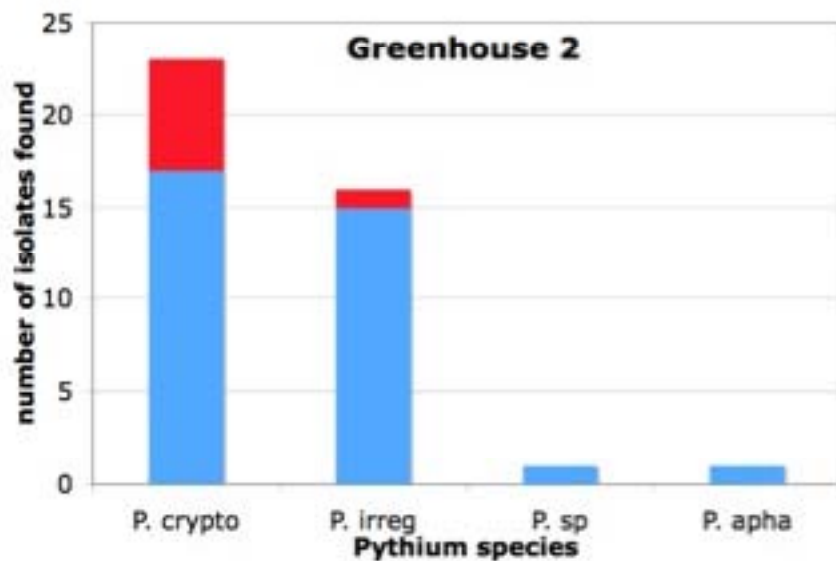
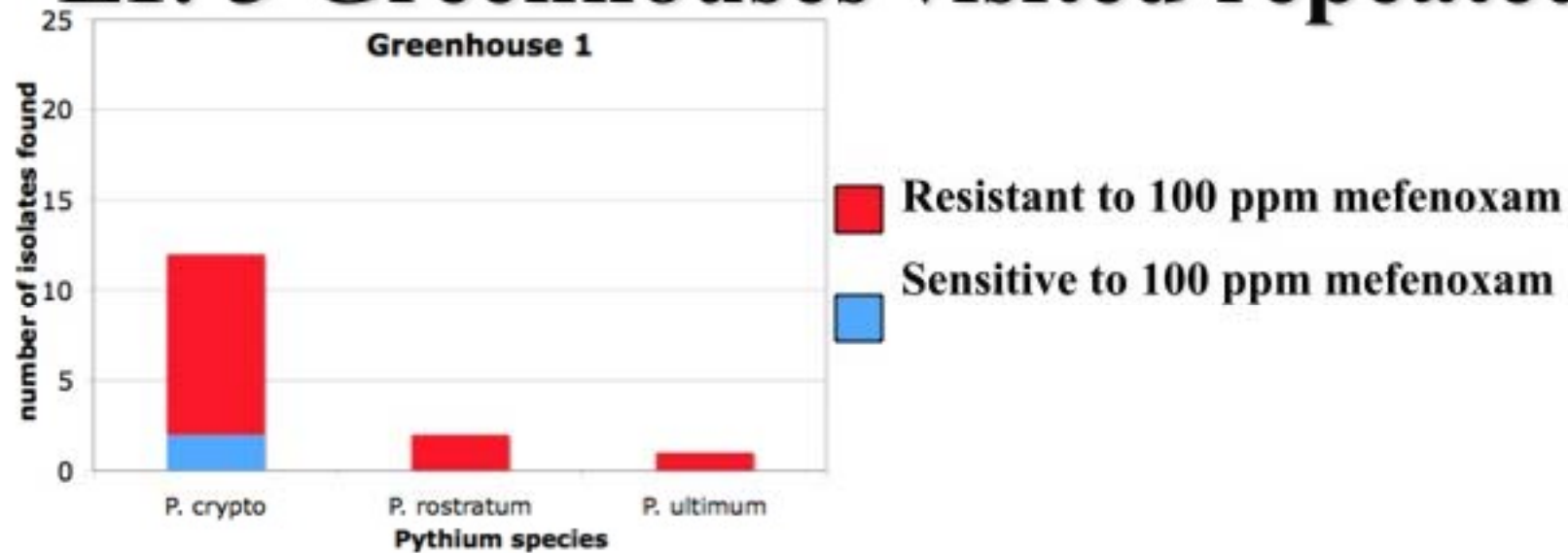
greenhouse floor (4)

P. ultimum:

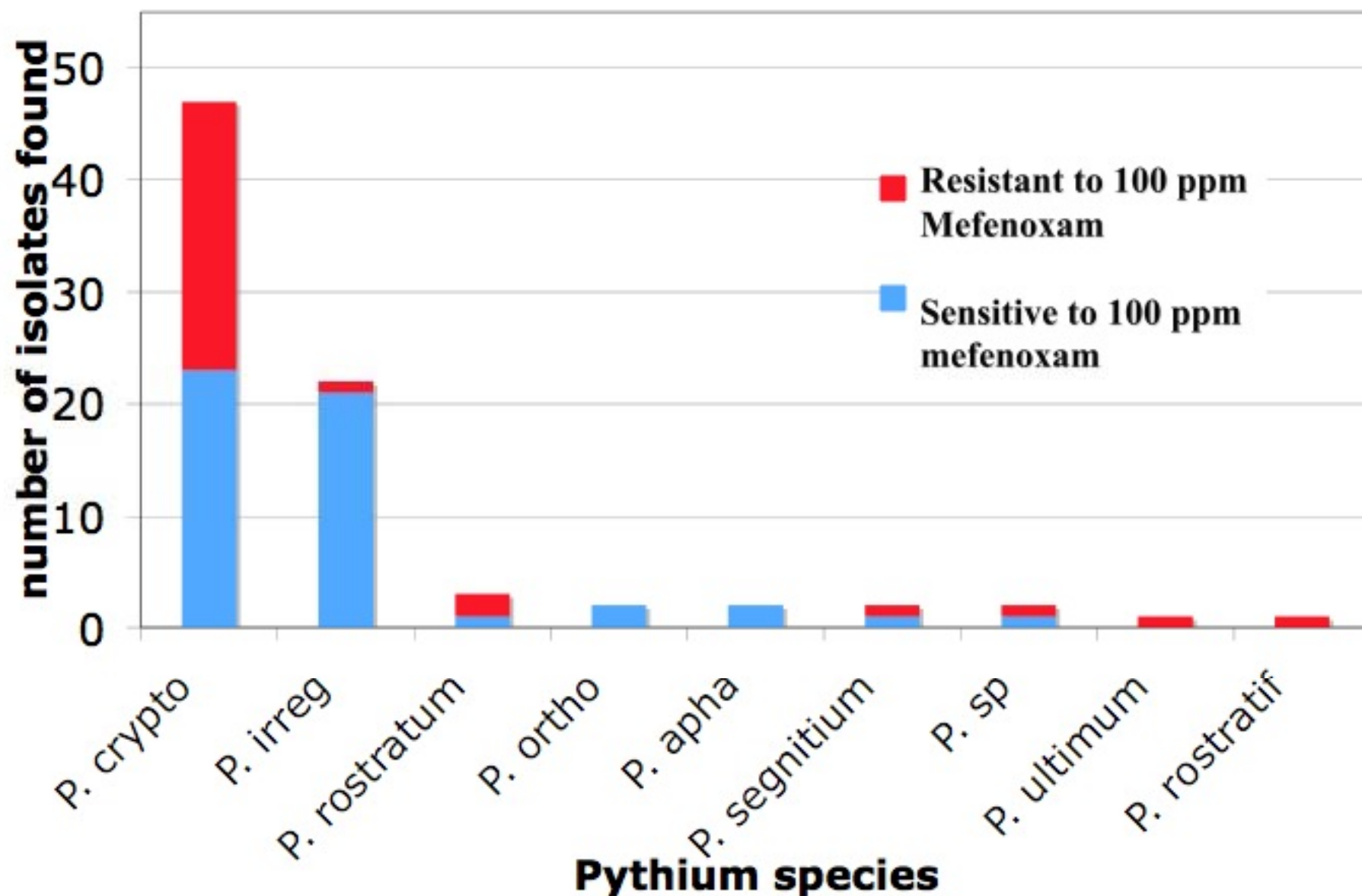
Geranium (1)

greenhouse floor (1)

LI: 3 Greenhouses visited repeatedly



Mefenoxam Resistance – LI 2007-2008



Resistance to Mefenoxam is Not Rare:

May, 2007 Sampling in PA:

57 isolates of *Pythium*

9 different *Pythium* species

24 isolates resistant to mefenoxam

25 sensitive to mefenoxam

8 intermediate

Pythium ultimum - both S and R found

Microsatellites = simple sequence repeats:

(ACC)_n



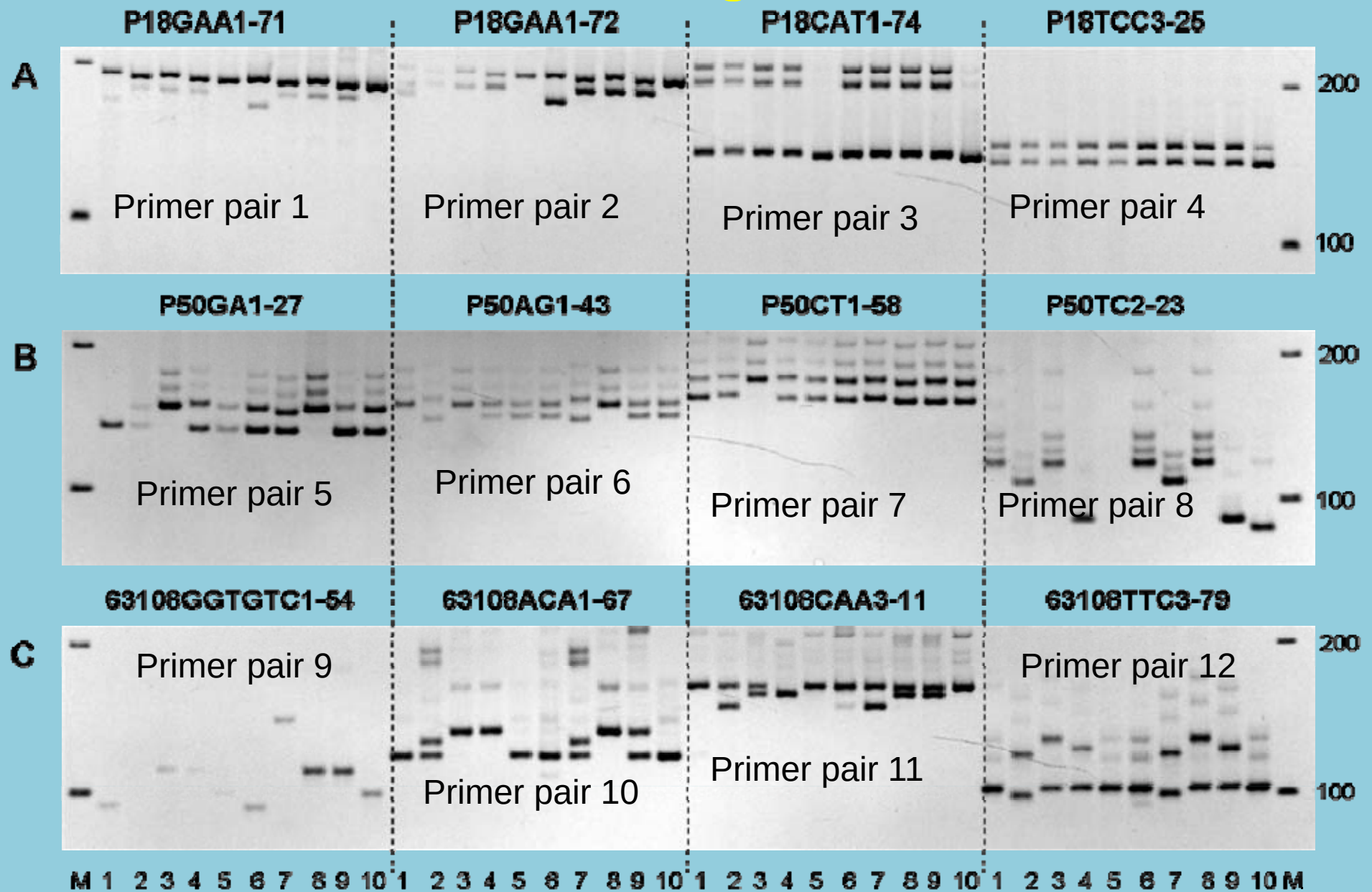
(CAC)_n

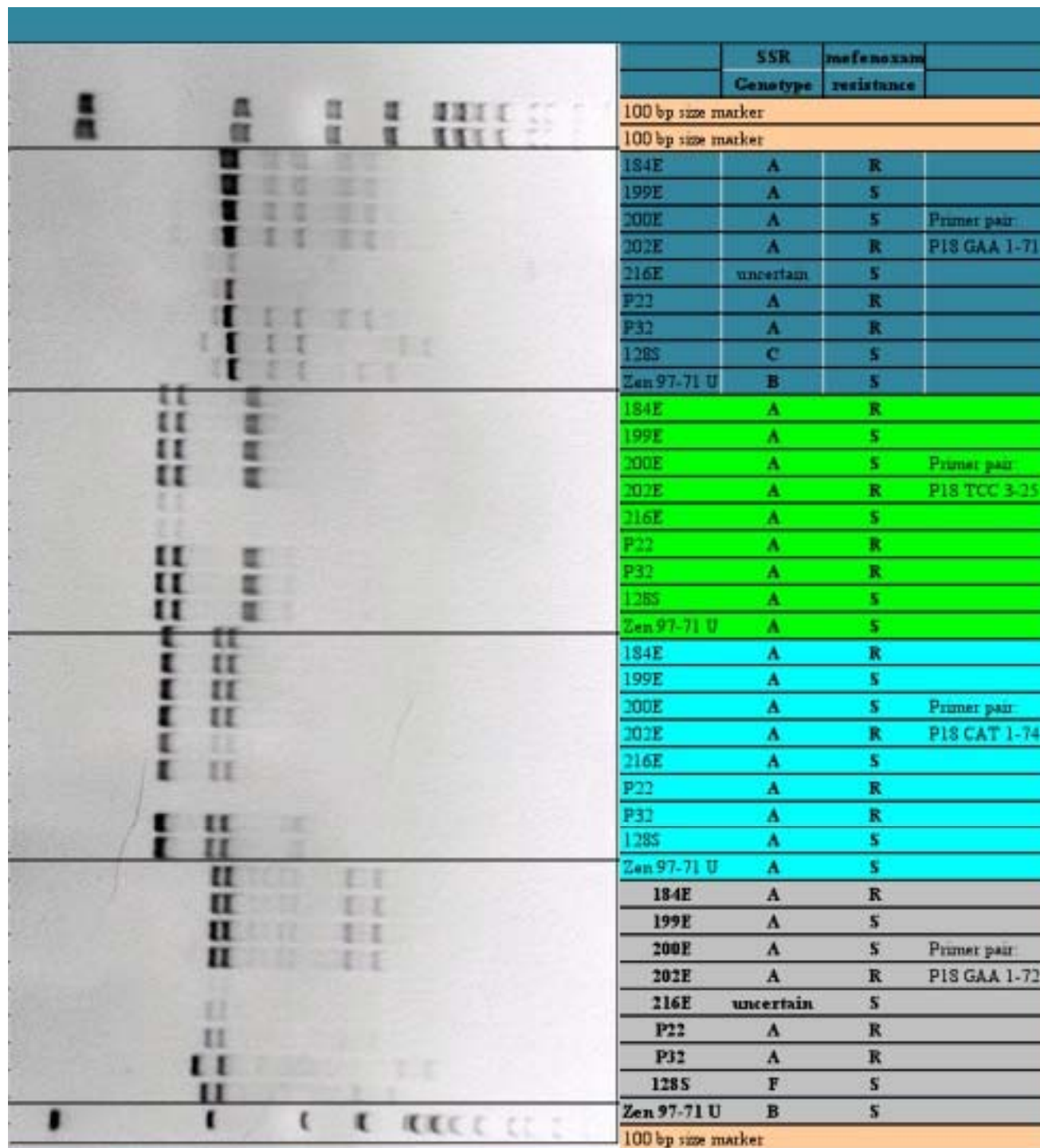
(GGT)_n

(GTGA)_n

n can vary from 5 to 25 or more
= a characteristic of each, different
isolate

Microsatellites = simple sequence repeats for matching isolates





Pythium aphanidermatum comparison

‘Microsatellites’
or
Simple
Sequence
Repeats
(SSRs)

Moorman has developed
21 primers for *Pythium irregulare*
22 for *P. cryptoirregulare*
14 for *P. aphanidermatum* – need more!

*These are tools that can be used for
tracking Pythium . . .*

Isolate X is causing crop losses.

Does X match isolates from

- cutting supplier
- potting shed floor
- parking lot
- irrigation water
- shoreflies
- front-end loader bucket
- potting mix
- bench debris
- cutting supplier
- soil in reused pots and flats



Recent Data Analysis Suggests
Greenhouse Environment Not
Necessarily the Source of
Disease Outbreaks

Cultivar Comparisons

Plants challenged with
Pythium aphanidermatum



Red poinsettias from 3 breeders:

Prestige Red – 75% mortality

Silent Night – no mortality

Phytophthora

New Diseases are a Reality!



Osteospermum - *Phytophthora* sp.



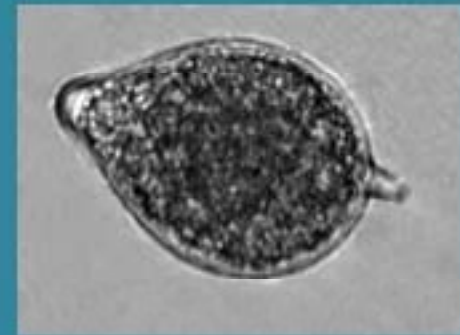
Gerbera – *Phytophthora cryptogea*

Ornamental Plants Associated with *Phytophthora* spp. Clemson University Plant Problem Clinic (1995-2008)

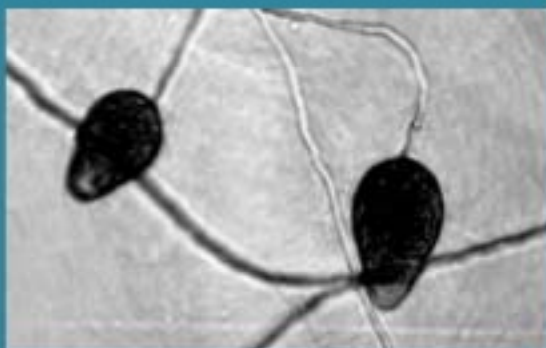
<i>Phytophthora</i> sp.	Associations	New associations ^a
<i>P. nicotianae</i>	50	29
<i>P. palmivora</i>	13	8
<i>P. cinnamomi</i>	12	12
<i>P. drechsleri</i>	8	7
<i>P. cryptogea</i>	8	7
<i>P. citrophthora</i>	4	4
<i>P. citricola</i>	2	1
<i>P. tropicalis</i>	1	0
<i>P. capsici</i>	1	1
<i>P. megasperma</i>	1	1
<i>P. sp.-clemson1</i> ^b	3	3
<i>P. sp.-clemson2</i> ^b	1	1
Totals: 12	104	74

^a Host-pathogen associations not reported previously.

^b Unknowns—species not yet described.



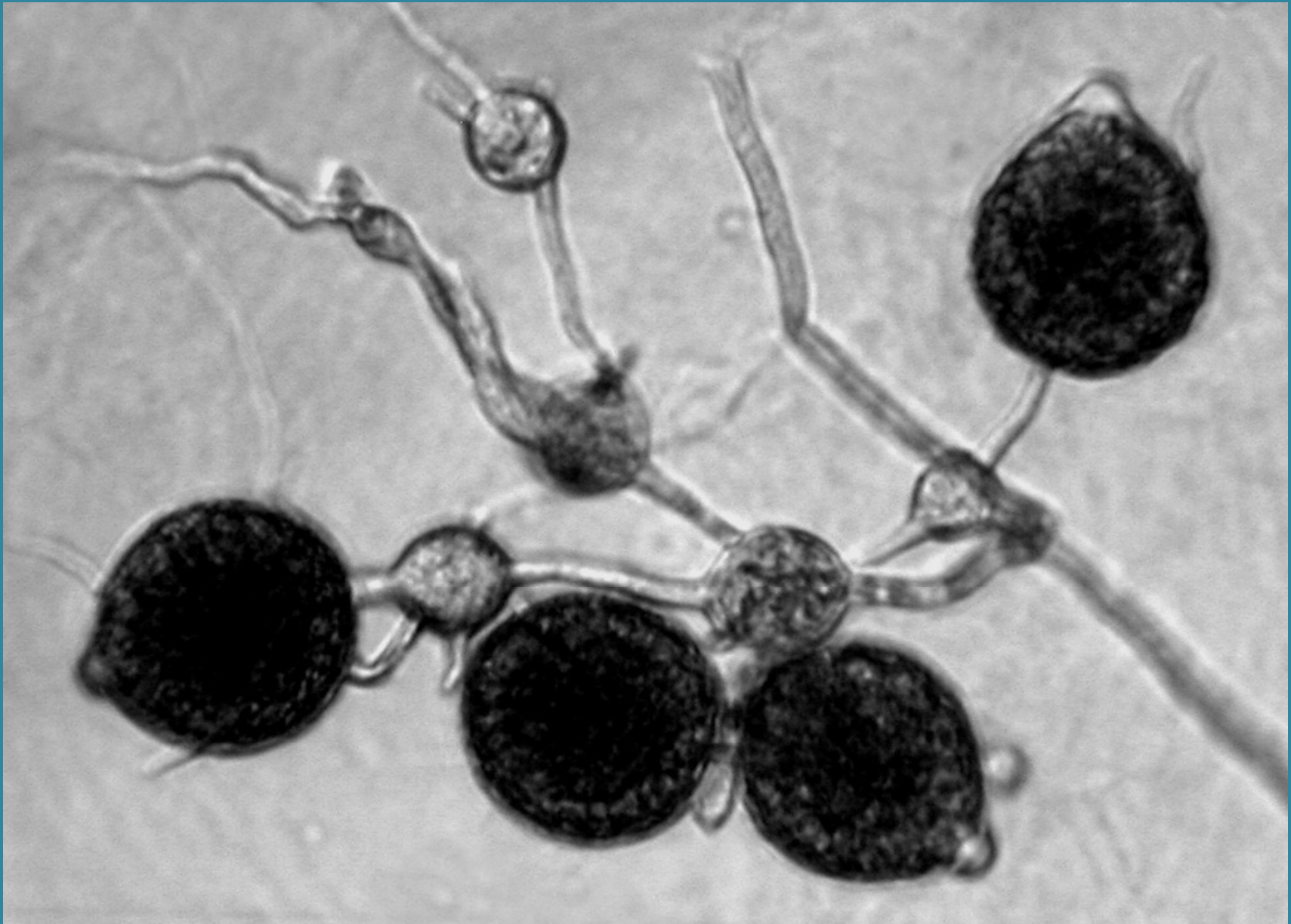
58 new diseases
12 spp on 63 orn hosts
RFLP and morphology



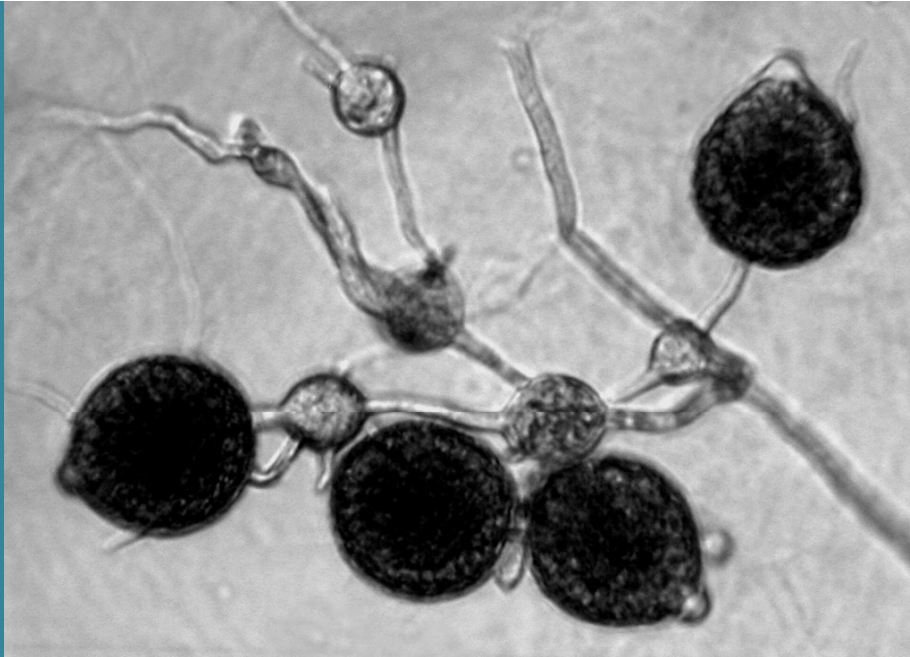
Phytophthora drechsleri
from gerbera and fuchsia
was resistant to 100 ppm
mefenoxam

Species	Host	Mefenoxam 100ppm	Mating Type
<i>P. cryptogea</i>	Gerbera daisy	S	A1, A2
	<i>Evolvulus</i>	S	A2
	Verbena	S	A1
	Dusty miller	S	A2
<i>P. drechsleri</i>	Gerbera, Fuchsia	R	A1
<i>P. nicotianae</i>	Dusty miller	R	A1
	Gerbera daisy	S	A1
	Petunia	R	A1
	Calibrachoa	R, I	A1
	Gardenia	S	A2
	Fuchsia	R	A1
	Annual vinca	S	A2
	<i>Euphorbia</i>	S	A1
	Verbena	S	A2
	Gerbera, Verbena	S	A2
<i>P. tropicalis</i>	Gloxinia, Pothos	S	A2
	Verbena	S	A1
<i>P. citrophthora</i>	Petunia	S	A0
<i>P. sp.</i>	<i>Ajuga</i>	S	A2

Benson – NC State - Phytophthora Mefenoxam Sensitivity



Phytophthora nicotianae



**Salvia and vinca
not susceptible
to petunia isolates!
ID'd landscape plants
with immunity or
tolerance**

***Phytophthora nicotianae*
vs.
petunia**



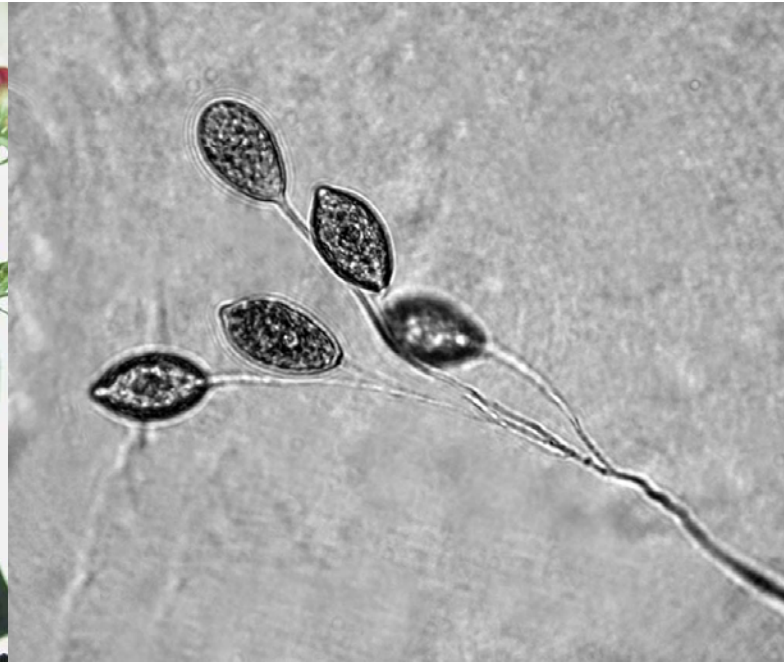


Hosts: Red President
Yellow President
Garden Princess

Non-host: Passionale

Tulip
Phytophthora
citricola – 1st
Also found
P. cryptogea
(UK & Australia prev.)

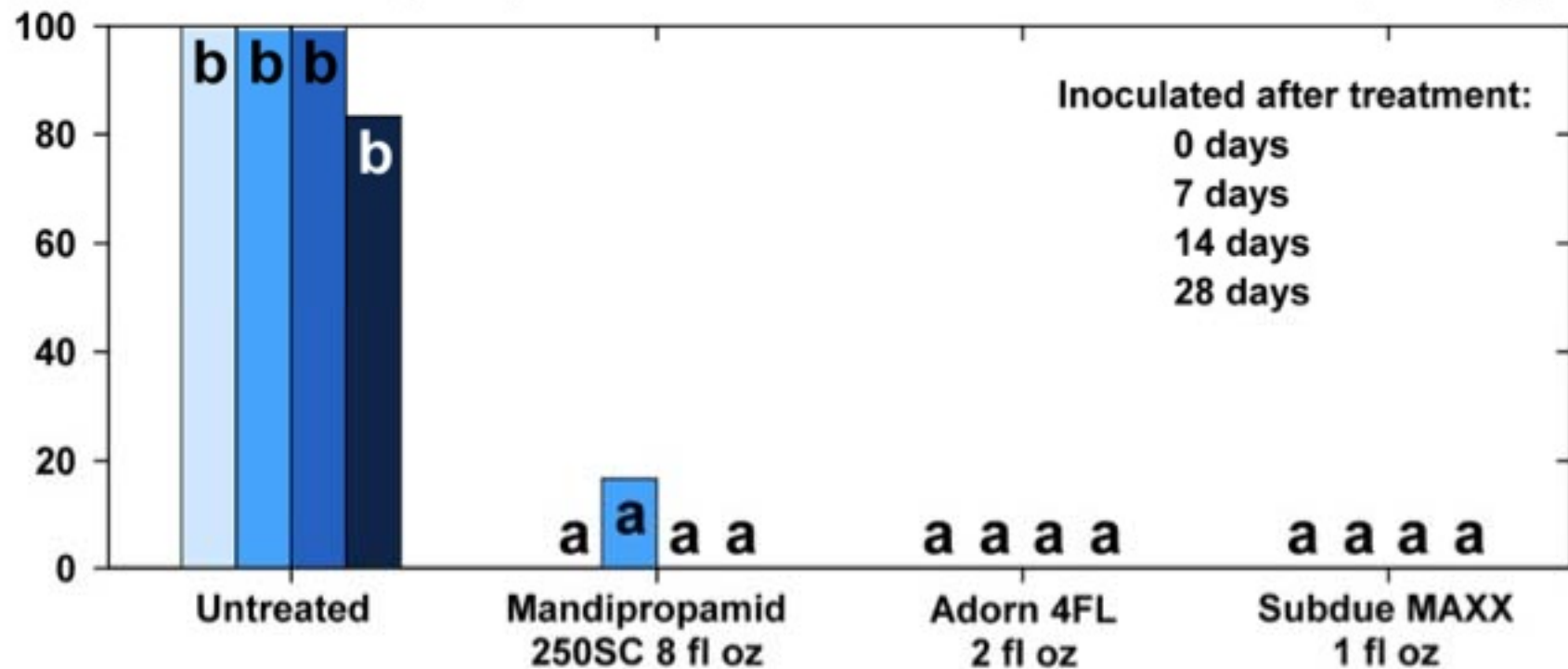




New crown rot disease identified on calibrachoa, caused by *Phytophthora capsici*.

Greenhouse trials showed the pathogen to be insensitive to mefenoxam, but sensitive to fosetyl-Al, phosphonates, pyraclostrobin, cyazofamid, dimethomorph, etridiazole, EXP-01623B and V-10161.

Trial 6. *Phytophthora nicotianae* on Snapdragon

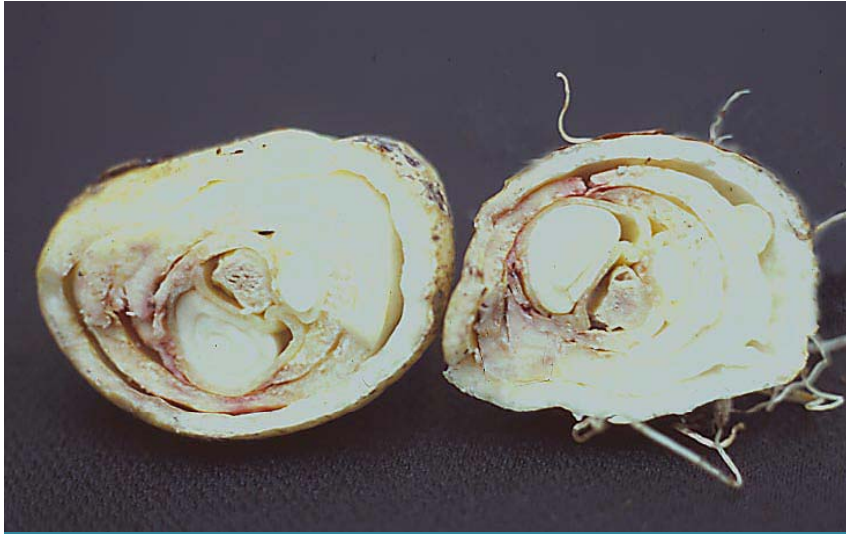


Hausbeck Lab- Mich. State Univ.

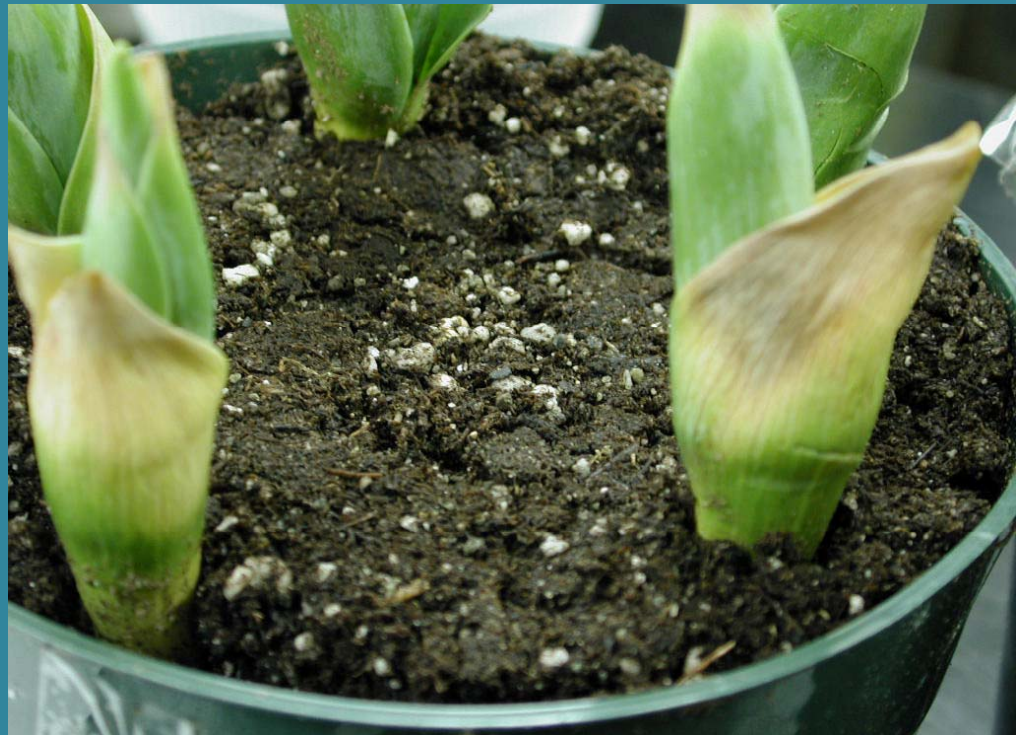
Fusarium



Coreopsis verticillata 'Moonbeam' – *Fusarium oxysporum* f. sp. *coreopsii*



Fusarium rots of bulbs





Fusarium basal rot of tulip

Basal Rot



- Tulip

Fusarium oxysporum f. sp. *tulipae*

- *Bulbous iris*

F. oxysporum f. sp. *gladioli*

- Lily

Fusarium oxysporum f. sp. *lilii*

- Daffodil

F. oxysporum f. sp. *narcissus*



Basal Rot of Narcissus



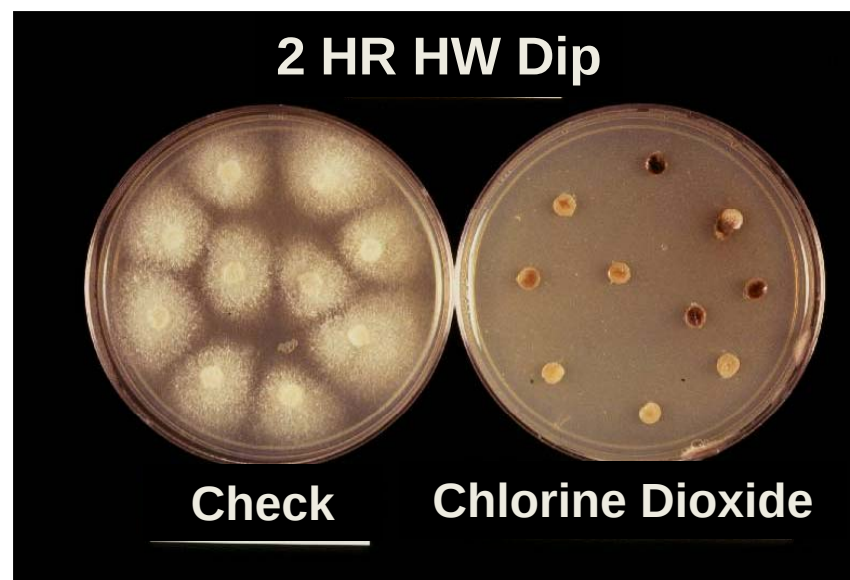
- Daffodil

F. oxysporum f. sp. *narcissicola*

Chlorine Dioxide Shown to be an Effective Alternative to Formaldehyde to Prevent the Spread of Basal Rot During the Hot Water Treatment



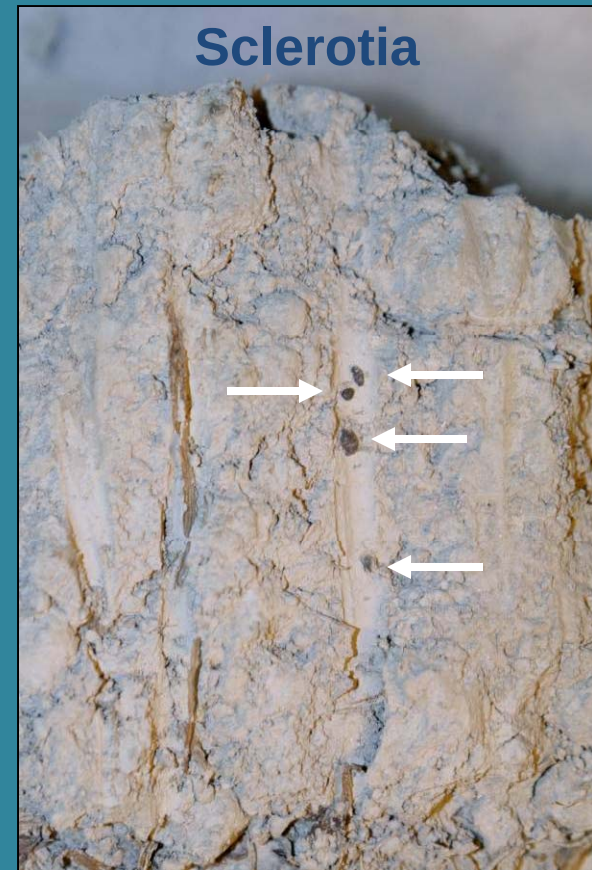
CH₂O International



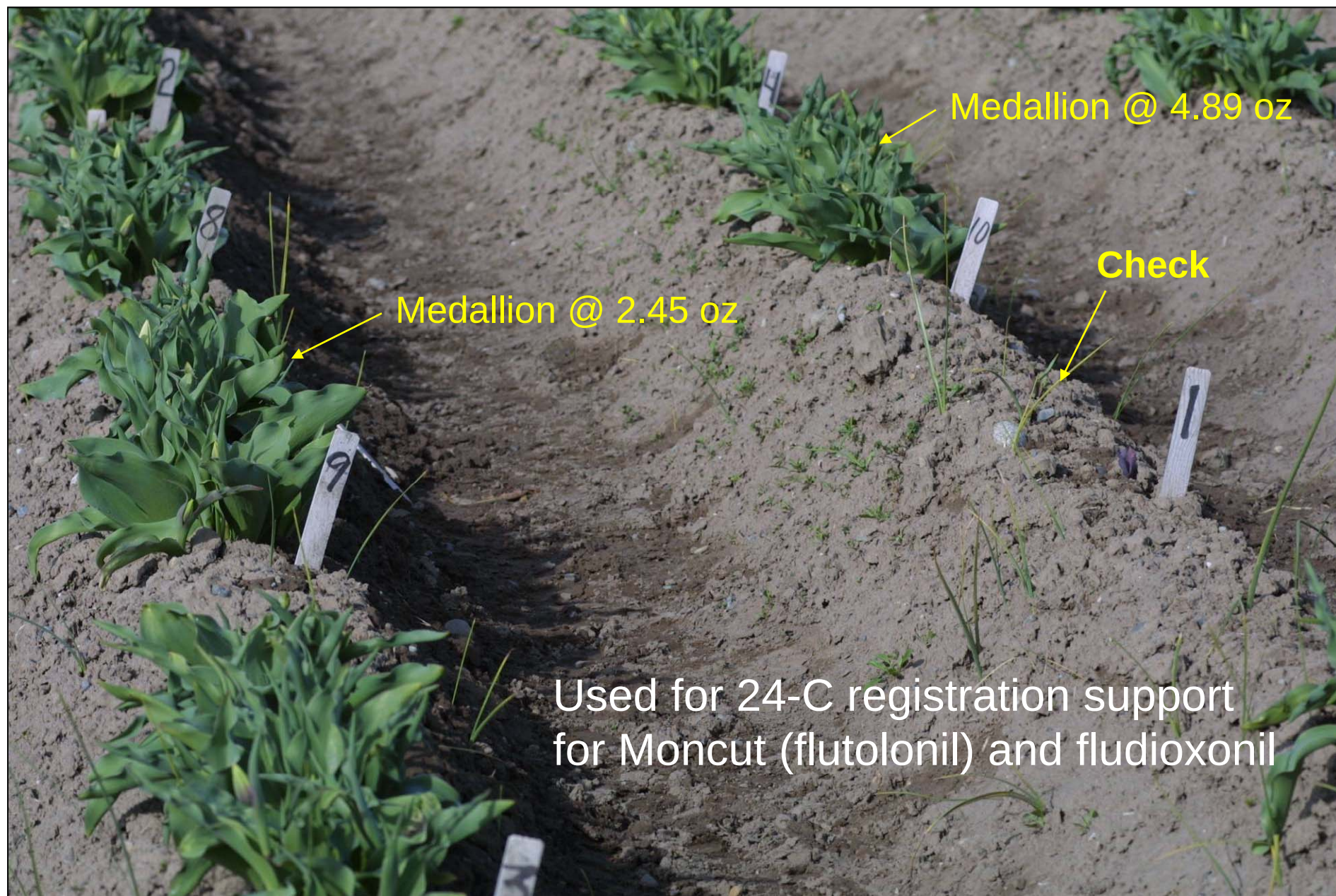
Gray Bulb Rot on Tulips and Iris



Rhizoctonia tuliparum



Control of Gray Bulb Rot on Tulips



Effect of gray bulb rot treatments on the number of healthy tulips and flowers

Treatment	Prod./1000' of row	No. of healthy plants on 2/24	No. of flower buds on 3/24
Terraclor 75WP	6 lb	26.5 a ¹	21.8 a
Contrast 70WP	8 oz	25.5 ab	18.3 ab
Contrast 70WP	4 oz	23.3 ab	16.5 ab
Contrast 70WP	2 oz	22.0 b	13.0 b
Check	-	6.5 c	1.8 c

¹ Numbers in columns followed by the same letter are not significantly different, P=0.05, DMRT

Effectiveness of Fungicide Bulb Dips in Controlling Disease on Greenhouse Forced Iris

Gary Chastagner¹, Jim Finch², and Annie DeBauw¹

¹Washington State University Puyallup

²Washington Bulb Company



**Fusarium basal rot and
blue mold harm
greenhouse-grown iris
flowers**



Penicillium Blue Mold

Penicillium spp.

Hosts – Many different types of bulbs, including tulip, iris, and lily





Marketable Flowers

- Percentage of marketable flowers was determined
- Plants were then graded to commercial standards



Overall effect of treatments on the percentage of marketable iris flowers

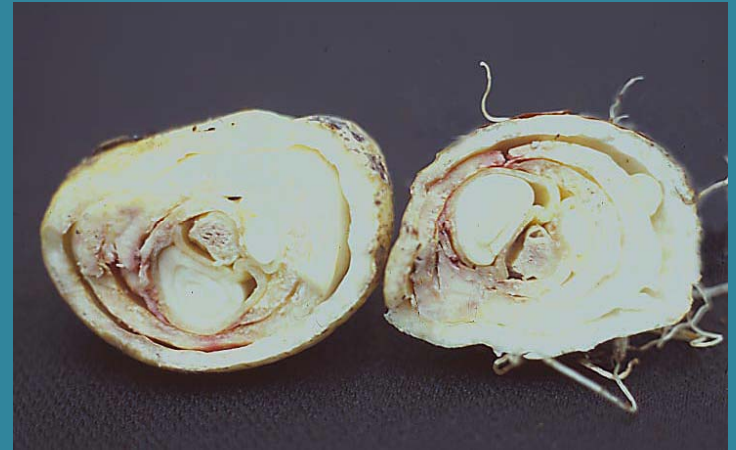
Treatment	Product per 100 gal	% Marketable flowers
Mertect 340F + Captan 50W	30 fl oz + 7.5 lb	78.7 a ¹
Captan 50 WP	7.5 lbs	66.9 a
Mertect 340F	30 fl oz	41.4 b
Heritage 50WP	8 oz	39.6 b
Check	-	38.3 b
Medallion 50WP	8 oz	36.9 b

¹Numbers in columns followed by the same letter are not significantly different, P=0.05, Tukey's Studentized Range Test

Summary

The results of these trials indicate that none of the newer reduced-risk fungicides we tested were effective in reducing disease losses under our test conditions.





Fusarium oxysporum
f. sp. *tulipae*



Fusarium oxysporum
f. sp. *tulipae*

Ethylene generation varies with temperature, for susceptible tulip cvars.

5C=1X

17C=2X

21C=4X

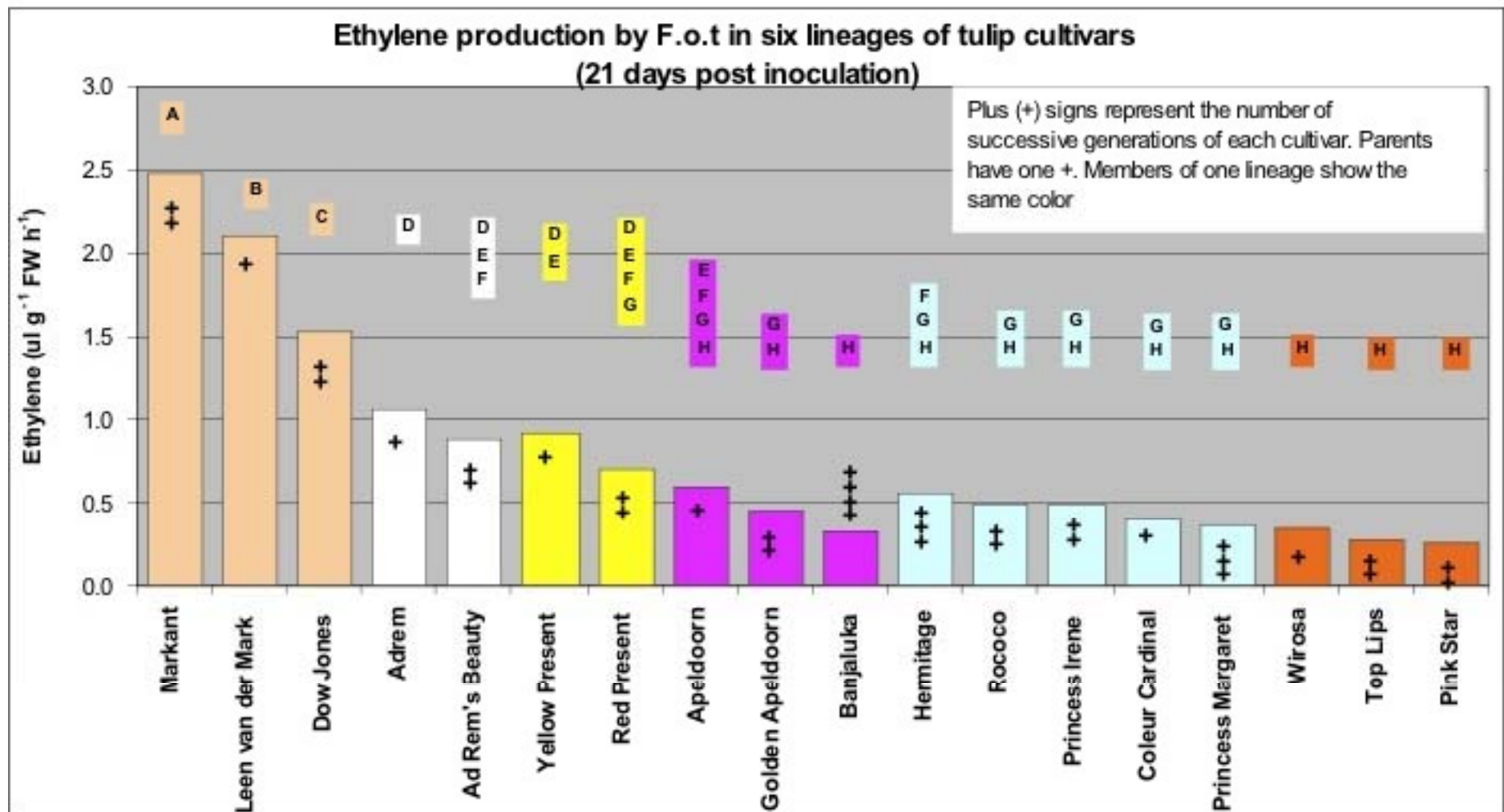
Cultivar		Ethylene ($\mu\text{l g}^{-1} \text{FW h}^{-1}$)
<i>T. turkestanica</i>	A	2.73
Friso	B	1.58
Oscar	B C	1.31
Mondial	B C D	1.07
Purple Flag	C D E	0.94
Christmas Dream	C D E	0.91
Yokohama	C D E F	0.88
Passionale	C D E F	0.87
Kikomachi	C D E F G	0.74
Ile de France	D E F G H	0.54
Yellow Flight	D E F G H	0.51
Blue Ribbon	D E F G H	0.49
Calgary	D E F G H	0.48
World's Favorite	D E F G H	0.47
Sprying	E F G H	0.42
Cummins	E F G H	0.39
Flaming Parrot	F G H	0.29
Pink Impression	F G H	0.26
Judith Leyster	G H	0.21
<i>T. tarda</i>	G H	0.18
Negrita	G H	0.15
Parade	H	0.09
Strong Gold	H	0.08
Bright Parrot	H	0.06

Values are averages of two experiments with n=8

Cultivars not connected by the same letter are significantly different at $p=0.05$ according to Student's multiple comparison test

Table 1. Tulip lineages

Mother	Daughter	Granddaughter	Great granddaughter
Leen vd Mark	Dow Jones Markant		
Ad Rem	Ad Rem's Beauty		
Yellow Present	Red Present		
Apeldoorn	Golden Apeldoorn		Banjaluka
Couleur Cardinal	Rococo Princess Irene	Prinses Margriet Hermitage	
Wirosa	Top Lips Pink Star		



Values are averages of two experiments with n= 8

Cultivars not connected by same letter are significantly different at $\alpha = 0.05$ according to Student's multiple comparison test

A close-up photograph of a field of pink tulip buds. The buds are in various stages of development, some showing the characteristic six-petaled shape. They are surrounded by long, green, lance-shaped leaves. The background is slightly blurred, showing more of the same plants.

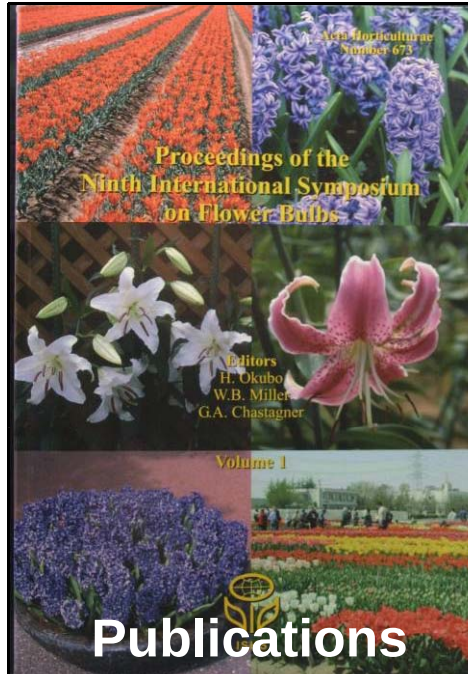
Sources of Funding/Materials

- USDA-ARS Floral & Nursery Crop Initiative
- Washington Bulb Commission
- The Fred C. Gloeckner Foundation
- Knutson Farms, Inc.
- Washington Bulb Company
- Vander Salm Bulb Farm
- Wilbur-Ellis of Auburn
- BASF
- Bayer Corporation
- Gowan Company
- ICA TriNova
- Syngenta Incorporated



WSU Bulb Grower Field Day, May 13, 2009, Puyallup, WA.

Dissemination of Information



Field Days



Grower Conferences



Grower Quizzes

