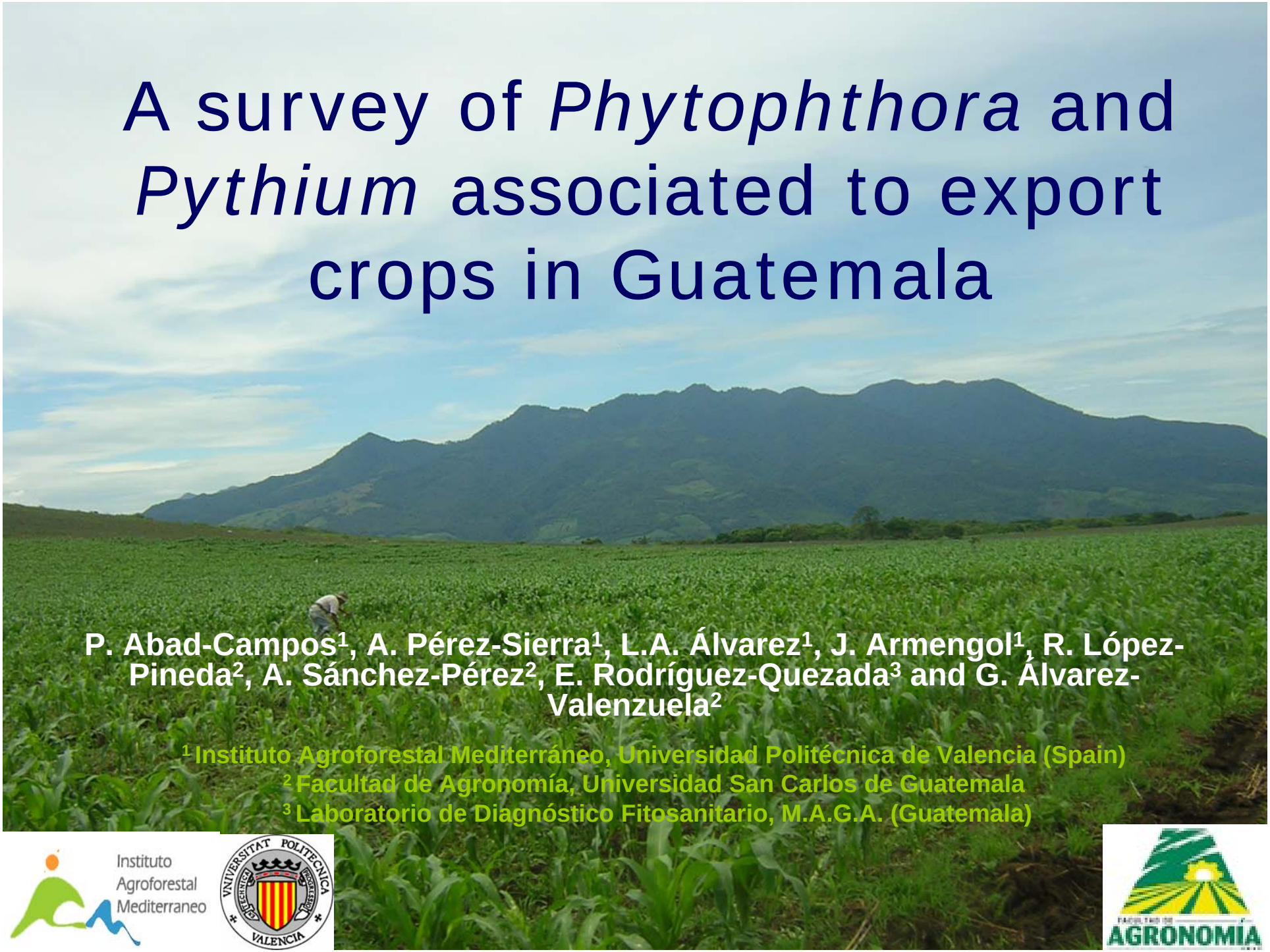
A survey of *Phytophthora* and *Pythium* associated to export crops in Guatemala



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MEXICO
Candelaria
Orange Walk
Emiliano Zapata
Paxbán
Dos Lagunas
Pozo Guayacán
Belize City
Tenosique
Rio Chancala
Tikal
Belmopan
Bachajón
PETÉN
San Ignacio
Mullins River
Lago Petén Itzá
Dangriga
BELIZE
Caribbean Sea
Flores
La Libertad
Sayaxché
Big Creek
Comitán
Poptún
San Luis
Gulf of Honduras
Punta Gorda
Puerto Cortés
Barillas
Kaibil Balam
Seboi
Modesto Méndez
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Chajul
Cobán
El Estor
Lago de Izabal
San Pedro Sula
Morales
Huehuetenango
Sacapulas
Tactic
Tacaná
Los Amates
Huixtla
SAN MARCOS
TOTO-NICAPÁN
Santa Cruz del Quiché
BAJA VERAPAZ
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Ciudad Tecún Umán
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Antigua Guatemala
Mataquescuintla
Esquipulas
Ocós
Retalhuleu
Mazatenango
SACATEPÉQUEZ
SUCHITEPÉQUEZ
RETALHULEU
Inter-American Highway
JUTIAPA
Champerico
Los Delores
Santa Lucía Cotzumalguapa
Esquintla
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Jutiapa
Metapán
Tulate
ESCUINTLA
Chiquimulilla
Río Paz
Río Lempa
El Semillero
Barra Nahualate
SANTA ROSA
Chalchuapa
Santa Ana
Sipacate
Puerto San José
Ahuachapán
Quezaltepeque
Las Lisas
Sonsonate
San Salvador
Acajutla
EL SALVADOR
NORTH PACIFIC OCEAN
La Libertad
Guatemala
International boundary
Department boundary
National capital
Department capital
Railroad
Road
0 25 50 Kilometers
0 25 50 Miles
Lambert Conformal Conic Projection, SP 1400 N/1730 N

A Survey of *Phytophthora* and *Pythium* associated to export crops in Guatemala

- Located within the tropics and with elevations ranging between sea level and more than 4.000 m, Guatemala experiences a diversity of climates.
- Guatemala has mainly agricultural economy.
- Subsistence crop production includes corn, dry beans, rice,corn, and fruits and vegetables.
- Agriculture accounts for 23% of the GNP and 75% of the country's exports.
- Nontraditional agricultural exports have greatly increased in recent years; such products include: banana, brassicas, beans, cacao, coffee, cucumbers, melon, mango, onion, papaya, pineapple, and ornamental plants.

A Survey of *Phytophthora* and *Pythium* associated to export crops in Guatemala

- Diseases caused by Oomycetes have been detected with increasing incidence in several crops.
- Surveys of ornamental, vegetable and fruit crops were carried out during 2007 mainly in Central Region of Guatemala (Chimaltenango, Sacatepéquez and Guatemala Departments).
- Samples were collected during the humid period of the year (March- November).


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A Survey of *Phytophthora* and *Pythium* associated to export crops in Guatemala

- **Sacatepéquez:** Camino de San Pedro, Chitol, Cruz Verde, El Pilar, Loma Alta, Los Guamuches, Santa Fe Ocaña, Sajcavilla, San Juan, Zet
- **Chimaltenango:** Comalapa, El Tejar, Parramos, Patzicia, Patzún, Rincón, Saragoza, San Andrés Itzapa, San Martín Jilotepeque, Sumpango
- **Guatemala:** Villa Canales, Villa Nueva, Guatemala City
- **Alta Verapaz:** Chirijuyú
- **Baja Verapaz:** Chilasco
- **Jalapa:** Tucurú
- **Petén:** Flores
- **Huehuetenango:** Jacaltenango, El Piol San Sebastián
- **San Marcos:** Malacatán
- **Quezaltenango:** Almolonga
- **Escuintlá:** Escuintlá, Finca Sabana Grande
- **Santa Rosa:** Pueblo Nuevo Viñas, Guazacapán
- **Sololá:** Chiarmira, Chacayá
- **Suchitepéquez:** Bulbuyá

A Survey of *Phytophthora* and *Pythium* associated to export crops in Guatemala

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SAMPLED CROPS

- **Leguminoses: beans and snow pea pod (*Pisum sativum* var. *Saccharatum*)**
- **Vegetables: brassicas, carrot, cucumber, lettuce, onion, pepper, potato, and tomato**
- **Fruits: avocado, lemon, pineapple, and strawberry**
- **Cacao and coffee trees**
- **Ornamentals: asparagus, carnation, chrysanthemum, gladiolus, iris, leatherleaf fern, lilium, peperomia, ponytail grass, pothos, rose, sheflera**
- **Gold tree or 'Palo blanco' (*Tabebuia donnell-smithii*)**


Gold tree

A Survey of *Phytophthora* and *Pythium* associated to export crops in Guatemala

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Pothos

Rose

Carnation

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Chrysanthemum

Lilium

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Leatherleaf fern

Ornamental asparagus

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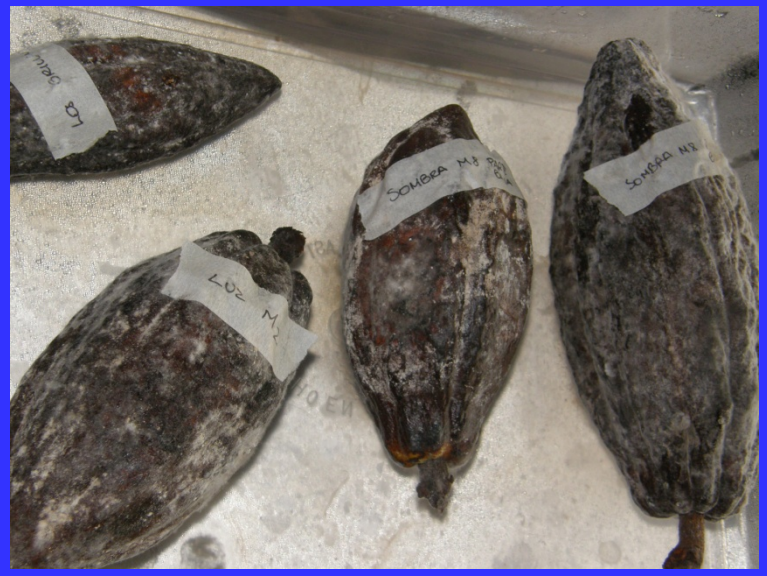
ISOLATIONS

- Isolations from lesions in roots, stems and leaves of symptomatic plants were made by direct planting on selective media for Oomycetes (PARBH and PARB)
- Cacao pods were previously incubated in humid chamber at room temperature
- Soil samples were tested using apple baits
- Pure cultures were obtained by transferring single hyphal tips to PDA



CHARACTERIZATION

- **Cultural pattern on Potato dextrose agar**
- **Morphology:**

  - **Asexual characteristics:**

    - **Sporangia: nonpapillate, semipapillate, or papillate**
    - **Persistence or caducity of sporangia**
    - **Sporangium shape and size**
    - **Sporangium length – breadth (L:B) ratio**
    - **Sporangiophore: distribution**
    - **Hyphal swellings: single, catenulate or clustered**
    - **Chlamydospores: terminal, lateral, intercalary or sessile**

MATERIALS AND METHODS

CHARACTERIZATION

- **Sexual characteristics: pairing of isolates on CMA and V8**

  Isolates paired with A1 and A2 mating types of *P. cryptogea*

  - **Oospore: diameter and wall tickness**
  - **Oospore: plerotic or aplerotic**
  - **Homothallic or heterothallic**

- **Growth cardinal temperatures:** T °C minimum and maximum

MOLECULAR IDENTIFICATION

- **Amplification of ITS-5.8S rDNA** using ITS4 and ITS6 primers

  (White *et al*., 1990; Cooke *et al.*, 2000)

- **Sequencing and alignment** with sequences available in the EMBL/GenBank

RESULTS

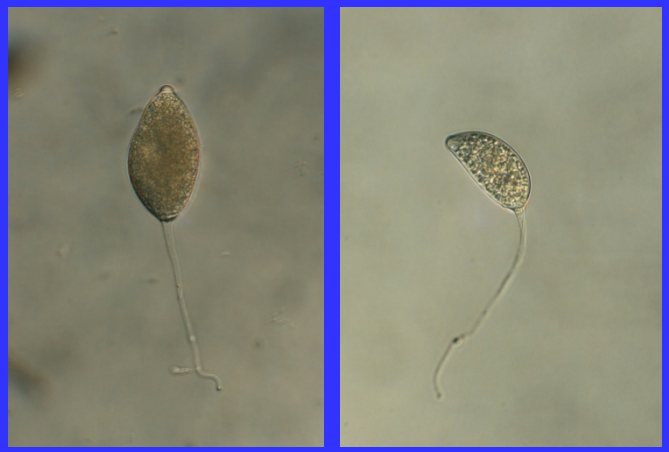
Six *Phytophthora* species were identified associated to different crops:

- ***P. capsici*: pepper and pothos**
- ***P. cinnamomi*: avocado**
- ***P. citrophthora*: pothos**
- ***P. palmivora*: avocado, cacao, and Persian lemon**
- ***P. nicotianae*: 'Palo blanco' tree and Persian lemon**
- ***P. tropicalis*: carnation, peperomia, pepper, pothos, and rose**

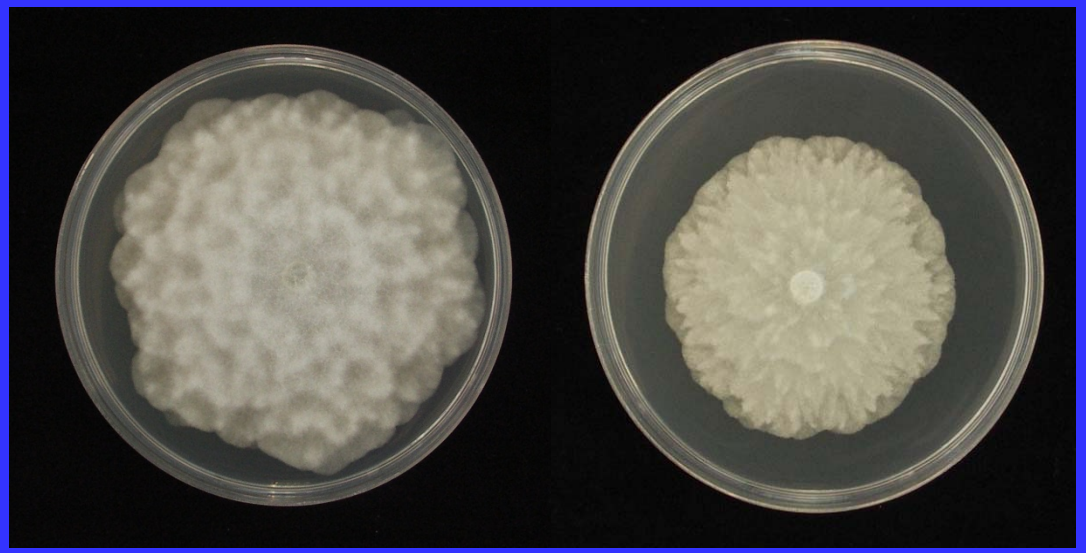
RESULTS

P. capsici and *P. tropicalis*

Long-pedicellate caducous sporangia
Papillate and semipapillate sporangia
Most of them presented a L:B ratio > 1.8:1
Absence of chlamydospores
Heterothallism; present both mating types
Some isolates grew well at 35ºC and others had limited growth or were inhibited at this temperature
ITS sequence was not useful to differentiate both species



Papillate (left) and semipapillate (right) sporangia

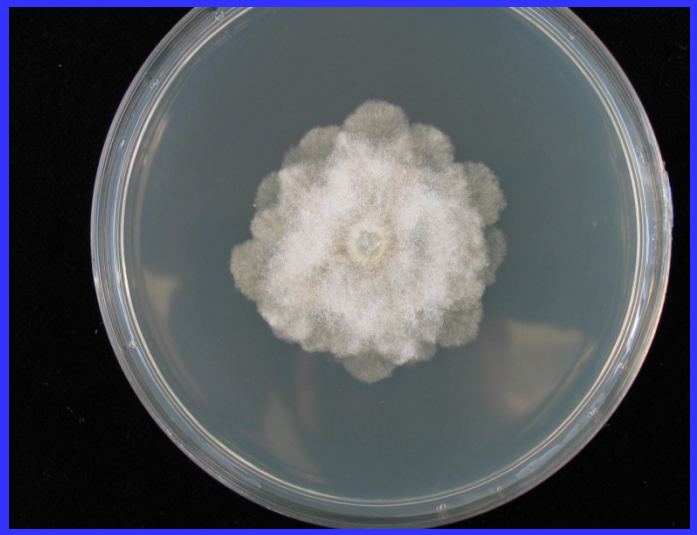


P. capsici ***P. tropicalis***

RESULTS

P. cinnamomi

Non papillate sporangium



Colony pattern on PDA

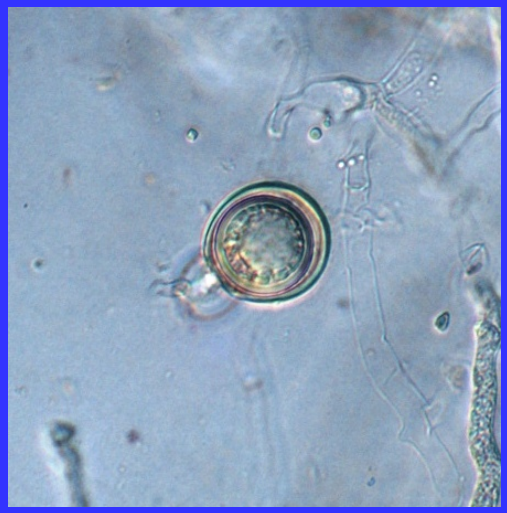
Oogonium

Chlamydospores

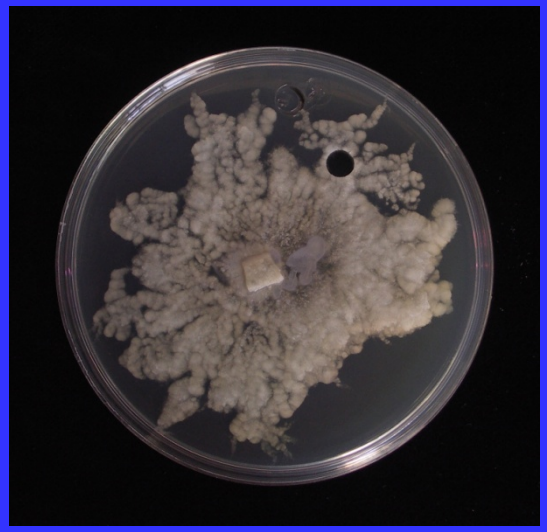
RESULTS

P. palmivora

Sporangia



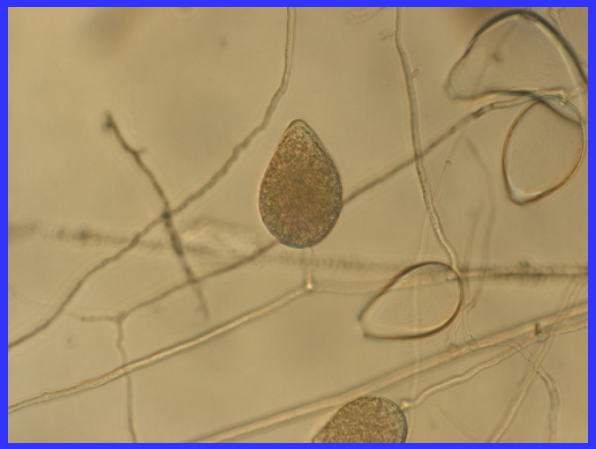
Oogonium



Colony pattern on PDA

RESULTS

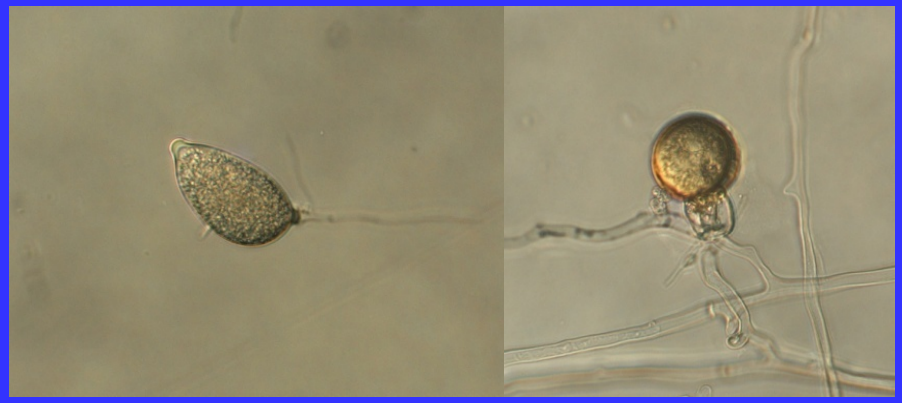
P. citrophthora



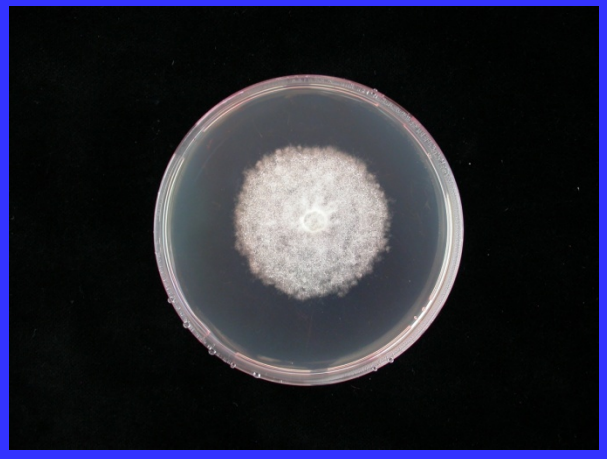
Sporangia

Colony pattern on PDA

P. nicotianae



Sporangia Oogonium



Colony pattern on PDA

Several *Pythium* species were isolated from different crops

Identification was based on ITS sequence

- *Py. cucurbitacearum*: broccoli, carnation, onion, papaya, pepper, Persian lemon, and ponytail grass
- *Py. splendens*: avocado, coffee tree, and ornamental asparagus
- *Py. sylvaticum*: ornamental asparagus
- *Py. ultimum*: iris, lettuce, potato, and squash
- *Pythium* sp.: avocado, chrysanthemum, coffee tree, leatherleaf fern, lilium, sheflera, and snow pea pod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