

Phytophthora Root and Crown Rot on Lavender in the USA: An Update

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Outline for Today's Webinar

- Brief review of *Phytophthora* species as plant pathogens
- Overview and update on the *Phytophthora* root and crown rot situation in the United States
- Update on research here at Clemson in the past year
- Questions from USLGA members

Before We Get Started...

- Please review resources on the USLGA website for additional information
- These include...
 - previous USLGA presentations by me and by Dr. Megan Kennelly, Professor at K-State
 - journal publications and fact sheets
 - background information on diseases caused by *Phytophthora* species

Phytophthora species as Plant Pathogens

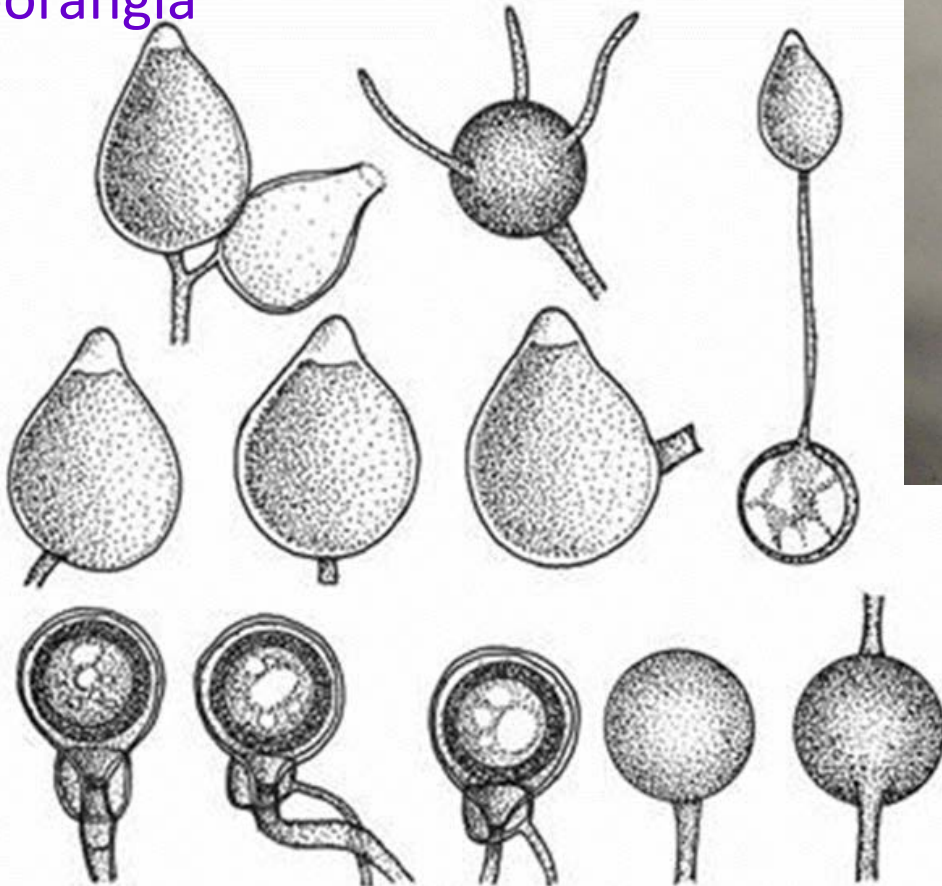
- *Phytophthora* spp. are not true fungi
 - they are fungus-like organisms called Oomycetes or Stramenopiles
 - over 150 known species with more described regularly
- But, they behave like and are treated like fungi
- Cause some of the most economically damaging diseases around the world
 - usually when they are introduced to new habitats and ecosystems – like lavender fields
- Readily moved in/on plants, plant parts, and soil
 - between fields, farms, states, and countries

Why are they so successful as pathogens?

- Because of their biology and adaptability...
- Different species are adapted to all types of environmental conditions and climatic zones
 - including tropic, sub-tropic, temperate, boreal
- Production of unique structures
 - **oospores** and **chlamydospores** have thick walls to allow survival in soil and plant debris
 - **sporangia** produce motile, swimming zoospores
 - **zoospores** can swim in water – including thin films between soil particles, runoff water, irrigation water, streams, ponds, lakes, etc.

Unique Structures of *Phytophthora* spp.

sporangia



oospores

20 μm

chlamydospores

P. *nicotianae*



sporangium releasing
zoospores in water



zoospore with 2 flagella

Phytophthora spp. and Nurseries

- *Phytophthora* spp. are present and persistent in many nurseries and greenhouses worldwide
- They are common pathogens of many species of ornamental plants produced in these facilities
- In the southeastern USA:
 - *P. nicotianae* is the most common species on herbaceous ornamental plants
 - *P. cinnamomi* is the most common species on woody ornamental plants
- Once introduced to a nursery they are extremely difficult to eradicate – but they can be managed

Some Terms and Definitions...

- **Infected**

- pathogen has invaded and colonized the plant

- **Infested**

- pathogen is associated with the plant or other items
- items that can be infested – soil, water, tools, equipment, nursery & greenhouse benches, etc.

- Therefore, **infected ≠ infested**

- most disinfectants are really disinfestants!

- **Contaminated** = infected or infested

Phytophthora spp. and Nurseries

- Contaminated nursery plants are very effective at moving plant pathogens – like *Phytophthora* spp.
- Plants may be **infected** and show symptoms or they might be only **infested** and appear healthy
- When infected or infested plants are planted in fields and landscapes, they introduce pathogens to their “new home”
- **This is often the case with lavender!**
 - contaminated plants from the nursery are introducing *Phytophthora* spp. to previously clean fields
 - these pathogens are becoming established and may persist for many years – if conditions are favorable...

The Problem

- Root rot on English lavender first described in 1991 in Maryland
 - many plants found dying at a nursery
 - caused by *Phytophthora nicotianae*
- Disease now known to affect the root crown
- **Phytophthora root and crown rot on lavender = PRCR**



PRCR on Lavender Worldwide

- Reported to be caused by at least eight (8) species of *Phytophthora*
- Reported to affect 2 species of lavender:
 - English lavender (*L. angustifolia*)
 - Spanish lavender (*L. stoechas*)

Species – no. countries

- *P. nicotianae* – 7
- *P. palmivora* – 3
- *P. citrophthora* – 2
- *P. drechsleri* – 2
- *P. hybrid species* – 2
- *P. cactorum* – 1
- *P. cinnamomi* – 1
- *P. capsici* – 1

PRCR on Lavender: Worldwide

- PRCR has NOT been reported or documented on lavandin
= *Lavandula ×intermedia* !!
- But, this appears to be one of the most popular species of lavender currently being planted in the USA
- And, over 50% of the diseased samples we have received are lavandin cultivars

PRCR on Lavender in the US

- Based on samples received at Clemson University
 - Jeffers Lab
 - Plant & Pest Diagnostic Clinic = Plant Problem Clinic
- PRCR identified on samples from 21 states
 - AZ, CA, CO, IL, IN, KS, KY, LA, MD, MI, NH, NJ, NY, OH, OR, PA, SC, TN, TX, VA, WA
- PRCR identified on four species of lavender
 - English lavender = *Lavandula angustifolia*
 - hybrid lavender = lavandin = *L. ×intermedia*
 - Spanish lavender = *L. stoechas*
 - sweet lavender = *L. heterophylla*

PRCR on Lavender in the US

- So far, 6 species of *Phytophthora* identified
 - *P. nicotianae* – most common
 - *P. palmivora* – second most common
 - previously reported only in Europe
 - *P. citrophthora* – infrequent
 - *P. drechsleri* (?) – isolated from a nursery plant in IN
 - *P. cinnamomi* – recently isolated from plants in SC
 - *P. megasperma* – reported in WA (I think)
- Currently, *P. nicotianae* and *P. palmivora* are causing the most damage nationwide
- The problem is mostly occurring in new plantings

Primary Sources of Inoculum

- Or, where are these pathogens coming from??
- Several possibilities...
 - already present and established in the field
 - in or associated with contaminated plants
 - infested irrigation or runoff water and soil
 - on infested tools, equipment, shoes, etc.
- Most likely possibilities
 - new & established farms – contaminated plants
 - within & between fields on a farm – movement of infested water, soil, tools, equipment, shoes, etc.
- Unlikely possibilities – naturally infested fields
 - unless replanting a field where diseased plants occurred

Update: Research at Clemson University

- Mr. Daniel Dlugos – PhD graduate student
 - conducting much of this research
- 4 project objectives
 1. Distribution of *Phytophthora* spp. on *Lavandula* spp. in the US
 2. Document pathogenicity of specific species of *Phytophthora* on species of *Lavandula*
 3. Management of PRCR on lavender
 4. Improve detection of *Phytophthora* spp. in nurseries
- To date, efforts focused on Objectives 1 & 2

Distribution of *Phytophthora* spp. on *Lavandula* spp. in the US

- We continue to request and accept PRCR samples
 - both at my lab and the Plant & Pest Diagnostic Clinic
- Eventually plan to document which species of *Phytophthora* attack the different species of lavender in the US
 - identify *Phytophthora* species by both morphology and molecular characters
 - produce a GIS map showing these associations
- Investigate sources of contaminated plants

Pathogenicity of *Phytophthora* spp. on species of *Lavandula*

- Experiments completed
 - *P. nicotianae* on *L. ×intermedia*
 - *P. palmivora* on *L. ×intermedia*
 - *P. nicotianae* on *L. heterophylla*
 - *P. palmivora* on *L. angustifolia*
- Experiments in progress
 - *P. nicotianae* on *L. stoechas*
 - *P. citrophthora* on *L. angustifolia*
 - *P. cinnamomi* on *L. ×intermedia*

Pathogenicity of *Phytophthora* spp. on species of *Lavandula*

Experiments conducted in a greenhouse at Clemson University



Management of PRCR: Soil Remediation

- Use of quaternary ammonia as a soil disinfestant
 - KleenGrow – a 4th generation quaternary ammonia
- Both field and greenhouse trials
 - conducted winter 2016-17
 - trial conducted in infested lavender field
 - trial conducted with infested soil in the greenhouse
 - results – not effective



Management of PRCR: Temperature Tolerances for Survival

- What are temperature extremes of *P. nicotianae* and *P. palmivora* for survival?
 - how much cold and heat is needed to kill pathogens
- Reported temperature limits for growth
 - *P. nicotianae*: 5°C & 37°C
 - *P. palmivora*: 5°C & 35°C
- Goals
 - determine winter hardiness in northern regions
 - determine potential for soil solarization in southern regions

Management of PRCR: Fungicide Evaluation

- Trials will be conducted in the greenhouse
- Evaluate efficacy of registered fungicide products
 - use *P. nicotianae* and *P. palmivora* on *L. × intermedia*
- Fungicides currently registered for lavender
 - Herb and spice crops
 - Ridomil Gold SL – a.i. mefenoxam
 - Fosphite, K-Phite 7LP – a.i. phosphorous acid/phosphite
 - Ornamental crops – nursery & bedding plants
 - Adorn – a.i. fluopicolide
 - Agri-Fos, Alude, Reliant – a.i. phosphorous acid/phosphite

Improve Detection of *Phytophthora* spp.

- Develop sampling methods to optimize detection of *Phytophthora* spp. on nursery-grown plants
- What amount of sampling is required in production flats to ensure likelihood of finding infected plants?
- What is the detection limit of the current baiting bioassay?

Improve Detection of *Phytophthora* spp.

- Collaboration with PathSensors in Baltimore, MD
- Study just completed – conducted March 2018
 - Clemson Plant & Pest Diagnostic Clinic evaluated the CANARY® Zephyr technology from PathSensors for rapid detection of *Phytophthora* spp. in lavender samples
 - 100+ samples tested
 - results will be forthcoming
 - coordinated by USLGA



Other Recent Research Highlights

- *P. cinnamomi* was isolated from roots of Phenomenal plants in SC – March 2018
 - this pathogen occurs naturally in many soils in the Southeast
 - pathogen also was isolated from soil in unplanted open field at same site
 - previously only reported in Europe on *L. angustifolia*
- Root knot nematodes (*Meloidogyne* spp.) have been recovered from roots of lavender plants in SC and KY – March 2018
 - both hybrid and English lavender
 - PRCR also present at both locations

Root Knot Nematodes on Lavender in SC



Galls on roots caused by
root knot nematodes



Foliage symptoms from root
knot nematodes are similar to
those caused by *Phytophthora*
species

Root Knot Nematodes on Lavender in SC



Galls on roots caused by root knot nematodes

Questions from USLGA Members

- **Ecology and Environment**

- Is there physical evidence to show presence of the disease before putting plants in the ground?
- When we say the pathogen is "dormant", what does that mean and can tests still indicate its presence in a dormant stage?
- With the recent study about forms of *Phytophthora* spp. in reservoirs and natural waterways, is there a danger of picking up pathogens, including *P. nicotianae*, from wells or other water sources?
- Do all farms actually have *P. nicotianae* on them?

Questions from USLGA Members

- **Disease Management**

- Best protocol for dealing with *P. nicotianae* at this time
- Recommended products to deal with the disease
- Will a fungicide applied at or before time of planting prevent the activation or spread of *P. nicotianae*?
- To prevent *P. nicotianae* or other pathogens when planting bare root plants, is it wise to apply a fungicide at the time of planting or at a time later?

Questions from USLGA Members

- **Disease Management**

- If the soil has *P. nicotianae*, will applying a fungicide drench prevent plants from getting infected?
- Are either *L. angustifolia* or hybrid lavender cultivars resistant to infection from *P. nicotianae* based on your testing?

Questions from USLGA Members

- **New Information**

- New information about the disease and its spread you have gained in the past couple of years?
- Could you talk about any new information since your last webinar relating to soil temperature and controlling or killing *P. nicotianae* that is in the soil
- What research needs to be done based on your experience with this disease?
- What action needs to be taken by government agencies to help us get rid of this disease?

Questions?

