Title: Etiological investigations into chronic dieback of Fraser fir in New York State Christmas tree farms: site characterictics and the involvement of *Phytophthora* species

Project Leader: Dr. George W. Hudler, Cornell University, Dept. Plant Pathology and Plant-Microbe Biology, 334 Plant Science Bld., Ithaca, NY 14853; 607-255-7848, gwh2@cornell.edu.

Cooperator(s): Dr. Shawn C. Kenaley, Cornell University, Dept. Plant Pathology and Plant-Microbe Biology, Ithaca, NY; and, Brian C. Eshenaur, Cornell NYS IPM program, Rochester, NY.

Abstract: New York Christmas tree farmers recently reported unusually high numbers of dead and dying Fraser fir with symptoms similar to those caused by Phytophthora root rot and/or waterlogged soils. However, it is unclear whether high soil moisture or *Phytophthora* spp., individually or incombination, are responsible for the recurrent mortality events. The work presented herein is an interim progress report as we continue to investigate: (1) the identity of the *Phytophthora* spp. causing disease in NY Christmas tree farms; (2) the relationship(s) between selected site characteristics and tree health; and, (3) cultural and/or disease control solutions.

Background and Justification: Christmas tree farming is a multi-million dollar industry in temperate regions of the U.S.; providing fresh-cut trees for decoration and live specimens for transplant. In the most recent USDA Census of Agriculture, NYS is seventh in the U.S. for Christmas tree producers (844 farms) and total trees harvested (348,043 trees) – an estimated farm gate and consumer retail value of $8.8 and $14.2 million, respectively. Christmas tree farmers in NY and elsewhere in the Northeast are increasingly growing Fraser fir (*Abies fraseri*) as their major crop tree because the species has excellent needle color and retention and it shapes well when sheared. It is also relatively free of pests and pathogens, thus needing minimal grower investment in pest management during its 8-12 year rotation. Unfortunately, beginning in spring 2010, we have received an increasing number of reports from NY Christmas tree growers of what they perceived to be recurrent episodes of Phytophthora root rot on Fraser fir. The disease is alleged to result in annual losses of 15% to 35% of young Fraser fir at various Christmas tree farms across 5 counties (Livingston, Monroe, Onondaga, Oswego, and Wayne), especially where soils are heavy or poorly drained. Moreover, a brief survey of 49 members of Christmas Tree Farmers' Association of New York (CTFANY) – polling grower's experience with Phytophthora root rot in 2010 – had 22% reporting problems with *Phytophthora* affecting their firs, primarily on Fraser. A strong appeal for education regarding *Phytophthora* spp. (e.g., biology and management) was also expressed by CTFANY membership.

Two hypotheses for the recurrent mortality of Fraser fir in NY State are under consideration. One is that Fraser fir is much more sensitive than other conifers to having its roots under water for one or more weeks. Such immersion happens in most poorly drained sites at least once annually and more often in some years. A second hypothesis is that wet soil predisposes fir to attack by soil-borne microbes in the genus *Phytophthora*. Species of *Phytophthora* are arguably the most destructive and economically important pathogens affecting woody crops and forest ecosystems, worldwide. Phytophthora root rot caused by *P. cinnamomi* is a well-documented nemesis for

1

Fraser fir seedling producers in the Carolinas where it is responsible for the death of 30-90% of trees at some sites. However, that pathogen purportedly does not survive in frozen soil and should not occur in NY on trees that are more than 1-yr post-transplant. There may have been some selection for cold-tolerant strains of the *P. cinnamomi* over time, but a more plausible concern is that the population of *Phytophthora* spp. endemic to northeastern soils is more diverse than previously thought and within that diverse population are one or more pathogens of *A. fraseri* other than *P. cinnamomi*. At least four other *Phytophthora* spp. are known to be pathogenic on *Abies* elsewhere in the U.S., and one or more of these may be having a greater than expected effect on fir health in NY State.

Objectives: Research proposed herein, collaborative between Cornell University and CTFANY membership, is intended:

1. identify the species of *Phytophthora* with greatest presence and impact on crop trees in selected farms
2. correlate selected soil features (e.g. soil type, drainage capacity, microbial populations) with tree health in existing farm sites as well as develop a *Phytophthora*-Site Risk Index (PSRI) for culturing Fraser fir.
3. project evaluation (short-term) – provide essentail baseline data for NY Christmas tree farmers and plant health specialists to implement culture/diseae remediation strategies and education programs capable of attenuating future economic loss.

Procedures: Christmas tree farms included within the study were selected basd on previously acquired information from CTFANY membership and close collaboration with Cornell Cooperative Extension personel. We are conducting the study across seven geographically separate farms. **Objective 1 (June 2012 – February 2013)**. At each site, soil samples were systemtically collected from the rhizosphere of symptomatic Fraser fir and, and currently, "traditional" soil baiting assays for the presence and identification of *Phytophthora* spp. are underway. However, because soil baiting techniques are time consuming and often biased toward fast-growing *Phytophthora* spp., we have also taken a molecular approach, combinig detection and identification, using semi-nested PCR analysis of soil DNA to accurately assess the range of *Phytophthora* spp. within the rhizosphere under affected trees. This analysis will be conducted in January 2013.

Tissue samples – collar (cankers) and roots (necrotic lesions) – from "diseased" fir were also assayed for *Phytophthora*. To do this, tissue samples were rinsed (x5) with sterile water and portions of nectroic bark and/or roots, when present, were plated directly onto selective, *Phytophthora*-specific media for culture. Suspected *Phytophthora* isolates from infected tissue were subcultured (x2) on growth media (buffered, 20% V8-juice agar) and confirmed to genus based on morphological characteristics using species descriptions and authenticated cultures. At present, we are delineating species morphologically as well as molecularly via sequence analysis of ribosomal DNA – internal transcribed spacer (ITS) region. Morphological and molecular analyses are scheduled to be completed by January–Febuary 2013. **Objective 2 (June 2012 – Feburary 2013)**. Disease and site data including tree species affected (composition and trees/hectare) and land-use history were collected at each site. In combination with species

2

detection results and site related data, we will utilize univariate and spatial statistics to identify the best-fit relationship(s) among sites and the presence and identity of *Phytophthora* spp. These data will be used to produce the first report examining the assemablage(s) of *Phytophthora* taxa affecting Fraser fir in NY State. **Objective 3 (June 2012 – February 2013)**. In Spring 2013, a final report will be presented to CTFANY leadership as well as disseminated to educators in the Cornell Extension system for use in county newsletters and activities with Christmas and ornamental tree growers. Presentation and analysis of results will also be submitted for publication in one or more contemporary, peer-reviewed scientific journals to ensure that the work reaches the widest spectrum of co-workers.

Preliminary Results: So far, we have examined a total of 95 Fraser fir collected across six Christmas tree farms spanning 5 counties (Livingston Co., Monroe Co., Oneida Co., Onondaga Co., and Ontario Co.). Soils samples (n=30) taken from under dead or diseased trees at three of these farms (Monroe Co., Oneida Co., and Ontario Co.) have also been collected; the diversity of *Phytophthora* species present within these soils will be assayed in the coming months.

Two species of have been identified, thus far, according to morphology: *Phytophthora cactorum* and *P. cryptogea*. Both species, *P. cactorum* and P. *cryptogea*, were isolated from necrotic aboveground (root collar) and below ground (root) tissue, and were widespread among the sites examined as isolation attempts from multiple trees at five of the six tree farms (5/6) yielded numerous cultures of these species. We are in the procress of confirming the putative identity of these species/cultures via DNA analysis of the ITS region. Three additional *Phytophthora* spp. have also been isolated and are awaiting morphological and molecular identifcation. A final analysis of species diveristy and geographic distribution is forthcoming.

Project Locations: Livingston County, Monroe Co., Oneida Co., Onondaga Co., and Ontario Co.

3