DON'T EXPECT

PYTHIUM ROOT ROT TO ALWAYS ACT THE SAME

Cornell University trials are teaching researchers more about this troublesome pathogen, how it interacts with the plants it infects and how it is becoming more difficult to control — and what they've learned may surprise you.

Seedling geraniums inoculated with Pythium may be stunted or killed. (Photos courtesy of Margery Daughtrey)

By Gary W. Moorman and Margery L. Daughtrey

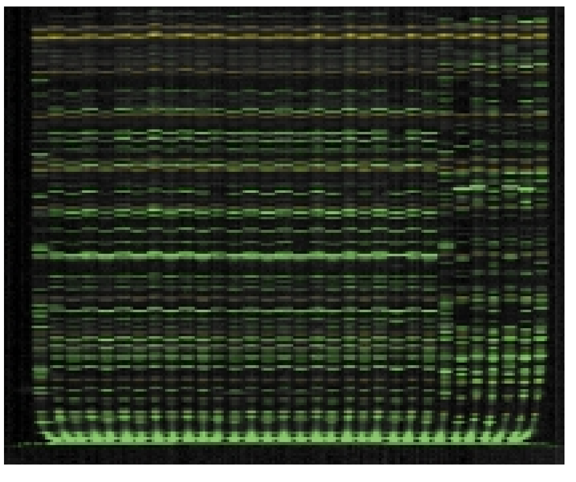
One new development important to our understanding of Pythium species comes from the findings of molecular geneticists. We have long thought of Pythium as a "water mold fungus"— now it has been reclassified according to information gained from comparing gene similarities...and Pythium is no longer a fungus! DNA analysis has shown us that Pythium is more closely related to some of the single-celled algae. It is in a category of organisms called "Oomycetes," along with downy mildews and Phytophthora. Small wonder, then, that Pythium is associated with wet greenhouse environments and that unique chemistries are needed to control it and the other Oomycetes.

THE "BIG THREE"

In a close examination of Pythium-infected plants submitted to plant disease clinics during recent years, we have found that of the over 120 known species of Pythium, three are consistently causing crop losses: *Pythium aphanidermatum, P. irregulare* and *P. ultimum. Pythium aphanidermatum*, the most aggressive of the three, is the one most commonly causing root rot of poinsettias. This species readily spreads in ebb-and-flow systems because it has a swimming spore stage. *Pythium irregulare* also forms swimming spores and is isolated from a very wide variety of greenhouse crops, almost any crop grown. It is less aggressive than *P. aphanidermatum*, often causing stunting but seldom killing plants quickly. *Pythium ultimum*, very commonly noted in old clinic records, is much less common but is still isolated from chrysanthemums, verbenas, geraniums and sometimes poinsettias. Most of the printed information on diseases of ornamentals describes problems caused by *Pythium ultimum. P. ultimum*, a widespread soil inhabitant, may be less of a problem in modern production systems because of the switch from soil to soilless potting media over the years. Several other species, including *P. myriotylum*, have been encountered but much less frequently than the "big three."

The different Pythium species have different environmental preferences. The historic problem, *P. ultimum*, was notorious for attacking poinsettias in the fall, especially when temperatures were dropped in order to hold plants. This follows from two traits of *P. ultimum*. First, it does not ordinarily have a swimming spore (zoospore) stage, hence it favored the days when soil was a component of container mixes and imperfect soil pasteurization could lead to Pythium outbreaks. Second, *Pythium ultimum* favors cool greenhouse temperatures: the minimum for growth is 41° F, maximum 95° F and optimum 77-86° F. When other organisms are inhibited by cool temperature, *P. ultimum* can prosper.

P. aphanidermatum has a higher minimum temperature (50° F) than *P. ultimum* and a very high optimum temperature at 95-104° F. This Pythium produces zoospores readily in flooded soil, so it is well-adapted to spreading in recirculating irrigation systems. *P. aphanidermatum* is also a typical



DNA fingerprint of species of Pythium.

resident of soils in warm regions, where much of our off-shore plant propagation takes place nowadays. Pythium problems on poinsettias have shifted from late-season and cool weather to mid-summer propagation problems, and *P. aphanidermatum* is the species most often associated with poinsettia root problems in recent years.

The third common species, *P. irregulare*, is somewhat intermediate between the other two in terms of its temperature preferences, but it shares with *P. ultimum* an inability to grow at high temperatures. It can grow at 34° F but has a maximum of 95° F and an optimum of 86° F. *Pithium irregulare*, like *P. aphanidermatum*, does produce zoospores that can move easily with irrigation water.

TELLING TRIALS

Trials run at Cornell's LIHREC in 2000 and 2001 have shown some interesting contrasts in the effects of the "big three" Pythium species on five different red geranium cultivars under different environmental conditions. In 2000, an April trial with temperatures ranging from 60-70° F showed *P. ultimum* to have the strongest pathogenic effect, stunting all cultivars and causing "black leg" stem canker symptoms on 'Yours Truly'. In 2001, a June trial showed a different pattern: only plants inoculated with *P. aphanidermatum* showed stunting or black leg. The temperatures prevailing during this 2001 study ranged from 55-97° F, which favored the heat-loving *P. aphanidermatum*. One lesson from this: growers who wish to protect against the aggressive *P. aphanidermatum* on their poinsettia crop should take care to make treatments early in production, during warm weather conditions — even though their grandfathers may have found poinsettias to be more vulnerable to root rot in the fall.

A few growers believe they have experienced Pythium disease control failures when using the fungicides Subdue (metalaxyl) or Subdue MAXX (mefenoxam). Several scientists have looked into this serious threat; although fungicide resistance is known to exist, the ➧

Figure 1. Effect of Different Pythium Species in April

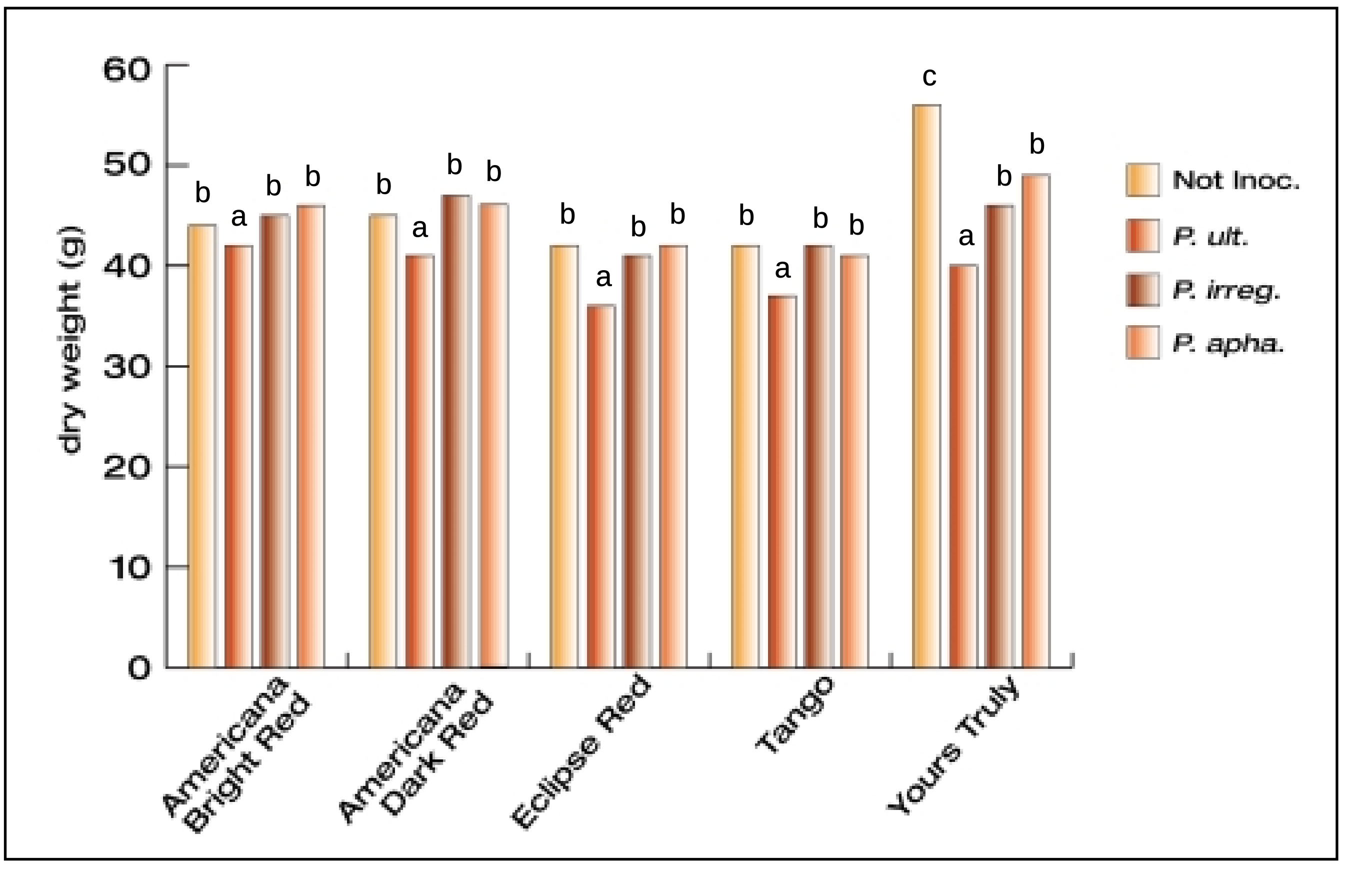
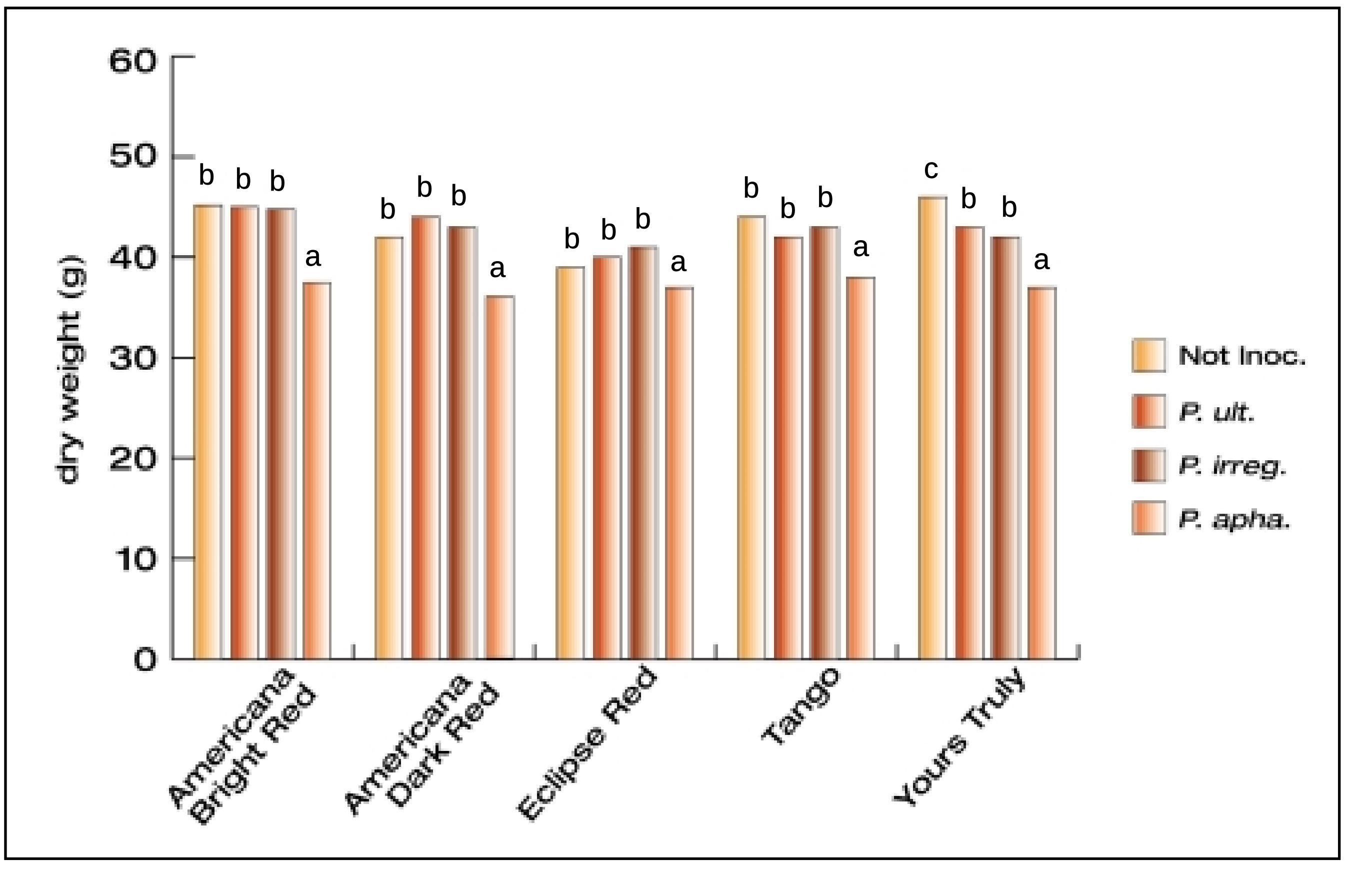


Figure 2. Effect of Different Pythium Species in June



Values represent means of 6 replications. Bars (of the same color) marked with the same letter are not significantly different (Fishers' Protected LSD, p=0.05).

more likely possibility is that the fungicide was applied too late in disease development or that the wrong amount of chemical was applied, rather than the Pythium being resistant to the fungicide. If a fungus is resistant to a fungicide, that fungicide no longer effectively controls the fungus and using the chemical is a waste of time and money.

We are testing the sensitivity of isolates to Subdue MAXX (mefenoxam) and Banol (propamocarb) by growing the Pythium on an agar medium with a range of fungicide concentrations. To date, several Subdue-resistant isolates of *P. aphanidermatum* and *P. irregulare* have been identified. For example, of the 35 *P. irregulare* isolates thus far tested, 12 are resistant to Subdue and 10 of 27 *P. aphanidermatum* isolates are resistant. Also of concern is the fact that some of these same isolates (three of the 12 *P. irregulare*) were able to grow on agar containing high concentrations of Banol. Although we did not find any P. ultimum isolates resistant to Subdue, five of the nine tested thus far grew on high concentrations of Banol. Work has been done to show that if a Pythium can grow well in the presence of high Subdue concentrations in culture, it can overcome the fungicide and cause disease on whole plants treated at the label rate of fungicide. This has not yet been proven to be the case with Banol, and those studies are underway.

Testing Truban, Banrot or Terrazole in agar is tricky because the active ingredient, etridiazole, works by vapor action. As soon as the agar is prepared, the concentration of Truban begins to decline, and we are not sure how much chemical is really present during the tests. However, to date, we have no indications that any of the Pythium isolates have resistance to etridiazole. One thing we have observed is that although some isolates are not resistant to Subdue or Banol, they keep growing very slowly and are not killed at high concentrations of the fungicides. That may indicate that Pythium could survive at a low level of activity, waiting until the concentration of fungicide declines as it inevitably does over time. For that reason alone, it is extremely unwise to put fungicides directly in subirrigation reservoirs. They must be put in the pots, where they will maintain the proper concentration for the longest time.

In addition to testing for resistance in culture, we are exploring other ways of detecting that an isolate is genetically resistant to fungicides. Using molecular techniques to examine the DNA, not only can we identify individual species, but we believe we have found a genetic "fingerprint" of fungicide-resistant individuals of *P. aphanidermatum*. We have not yet found such a fungicide resistance fingerprint for *P. ultimum* or *P. irregulare* or for Banol resistance. In parallel research, we are testing DNA analysis methods that should allow us to determine whether, for example, the *P. irregulare* in a particular crop is identical to or different from the *P. irregulare* we may find in unused potting mix, the water supply or soil under the benches in that greenhouse. By pinpointing the source of the Pythium causing crop losses, the grower can then target control measures to eliminate that source. GPN

Cornell University and Penn State are collaborating on several phases of research to better understand what is occurring in Pythium root rot. This work is funded by the American Floral Endowment, the Fred C. Gloeckner Foundation, the Pennsylvania Floral Industry Association, Cornell, Penn State and by a special cooperative agreement with the USDA-ARS.

Gary W. Moorman is a professor of plant pathology at The Pennsylvania State University, and Margery L. Daughtrey is a senior extension associate at Cornell University. They may be reached by phone at (631) 727-3595 or E-mail at mld9@cornell.edu.

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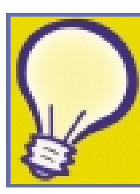

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