Chase News

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Biology of Water-borne Pests

Have you ever wondered where all of the diseases start? Some of them start as "bad seed" by hitching a ride on seeds or cuttings while others blow in on an ill-wind. Still others move from plant to plant on the tide of irrigation water. When I worked at the University of Florida in the 1980's, ebb and flood systems started to be used throughout the US. At that point many growers and horticulturists were favorably impressed with plant growth in these systems. It was also an excellent way to address run-off and potential environmental contamination in areas where water was scarce or being monitored for fertilizer or pesticides. However, whenever a plant pathologist was asked about ebb and flood or re-circulating systems they expressed concerns with certain diseases. It seemed like an ideal way to infect a lot of plants all at once and also provide excellent conditions for disease to develop. Another factor was that using ebb and flood or any automatic watering system means that fewer eyes are on the crop on a daily basis. This also leads to outbreaks of disease since the earliest stages may escape notice. Indeed this has been a serious problem in the last 20 years or so as these systems become more widespread.

Re-circulating systems include holding ponds that are used to collect, store and recycle runoff water. The runoff comes from watering crops in containers and even in-ground ornamental plantings in some locations. There are many plant pathogens found in re-circulating systems. They range from bacteria like *Erwinia carotovora*, *Pseudomonas cichorii* and *Ralstonia solanacearum*, to fungi like *Pythium* (*aphanidermatum*, *ultimum* and *irregulare*) and *Phytophthora* (*cryptogea*, *cactorum*, *capsici*, *citrophthora*, *nicotianae*, *drechsleri* and *parasitica*). They also include specialized forms of *Fusarium oxysporum* and even viruses like Tobacco Mosaic. In addition, you have to remember that many algae move with water.


Blue-green algae


Phytophthora oospores

One of the most difficult to conquer features of these water-borne pests is that many are good saprophytes. That means they do not need a plant to infect and survive. *Fusarium* and *Pythium* are especially common throughout nature and are very effective saprophytes. They are also often very wide in their host range meaning that they can take advantage of whatever plant we choose to introduce into the system. When you combine organisms that have the following features you can have a serious problem:

- Making many spores quickly
- Making motile spores
- Good as saprophytes
- Water-loving or water-tolerant
- Long-lasting resting spores
- Wide host range
- Complex "ecosystems"

Research has shown that *Phytophthora* and *Pythium* are common in these collection ponds. Unfortunately, some species of these organisms can survive chlorination treatments. There are often higher levels of *Pythium* than *Phytophthora* and populations peak during seasons favoring each species (usually summer). In Florida nursery retention ponds, several species of *Erwinia* were recovered and 99% of them caused disease when inoculated to dieffenbachia (a common tropical foliage plant). These plant pathogenic bacteria were far more common in nurseries practicing recycling.

What makes a pathogen or pest (like algae) suited for spreading in irrigation water? The most important factor is that the fungus, bacterium or alga makes a propagative structure like a spore that can be carried by the water. Algae, water-molds (like *Pythium* and *Phytophthora*) and bacteria all have a stage with flagella which allow them to actually direct their movement and swim in water films. The motile (moving) stage of *Pythium* and *Phytophthora* is called a zoospore. It can actually find the tips of uninfected roots by a process called chemotaxis and actively seek the plant.

(continued on page 6)

CONTENTS

More Black Root Rot Trial Results

This has really been the year for working on black root rot control. During July, August and September we finished two more trials on pansy and vinca.

We used plugs of *Catharanthus roseus* 'Pacifica Pink' planted on 28 June for the first trial. Plants were established in Sunshine No. 4 Mix for about 10 days. Plants were top-dressed with Osmocote Plus 15-9-12. Fungicide products were applied every 2 weeks a total of four times and plants were inoculated on July 15th, four days after the first fungicides were applied. Products were applied as soil drenches at the rate of about 1 pint/square foot.

In this test, we did not see severe symptoms of black root rot develop. We did see some stunting with the higher rates of Trinity but none from the *Thielaviopsis*. At the end of the trial, we checked roots and estimated the percentage of healthy roots visible on the potting medium surface (table to the right). Several products provided excellent prevention of black root rot including Cleary's 3336 (thiophanate methyl), Veranda O (polyoxin D) and Affirm (polyoxin D). Unfortunately, Trinity (triticonazole under development by BASF) was not effective in this trial and also caused severe root damage when used as a drench at the highest rates tested. The picture below shows the comparison between the A-noninoculated control, B-inoculated control and Trinity treatments (F, G, H and I from lowest to highest rates). Trinity is in the sterol inhibitor category which can cause PGR effects on some crops when used at rates are too high. In this case, the drench application was unsafe and typically these products are not used as drench-applied fungicides (with the exception of Terraguard).

Effect of fungicide drenches on severity of black root rot on vinca and pansy.

Treatment	Rate/ 100 gal.	% healthy roots on vinca	Disease severity on pansy
Water Noninoculated	-----	64.0 d	1.0 a
Water Inoculated	-----	47.0 bc	2.5 b
Cleary's 3336	16 oz	65.0 d	1.2 a
Veranda O	8 oz	63.0 d	1.4 a
Affirm	8 oz	61.1 d	1.3 a
Trinity	6 oz	50.0 c	3.1 bc
Trinity	8 oz	39.0 bc	3.1 bc
Trinity	12 oz	36.0 b	3.5 c
Trinity	24 oz	24.0 a	4.4 d

Disease severity on pansy was rated on the following scale: 1 (none, healthy), 2 (slight), 3 (moderate), 4 (severe) and 5 (dead). Numbers in the same column followed by the same letter are not statistically different.

The same fungicide treatments were used in the pansy trial with *Viola x wittrockiana* 'Matrix White' planted on 22 July in Sunshine No. 4 Mix. Plants were top-dressed with Osmocote Plus 15-9-12. In this case plants were treated first on 26 July and inoculated with *Thielaviopsis* on 8 August. The damage to the pansies was severe in the trial with stunting appearing before they were even inoculated. Drenching with Trinity at the rates employed was very damaging to the pansies—even more so than the damage from black root rot. By the end of the trial, black root rot had started to show significantly on the inoculated controls. As with the vinca, 3336 and both fungicides with polyoxin D provided excellent control.

These results are consistent with previous trials conducted across the US where thiophanate methyl and polyoxin D are continuing to perform the best. Other choices for a black root rot rotation include triflumizole (Terraguard) and fludioxinil (Medallion or Palladium). Remember that even the best fungicides sometimes fail when conditions make disease too severe. This condition regularly occurs on pansies grown in the south for the fall crop. The late summer heat often predisposes this crop to severe black root rot and fungicides can fail.

A—Noninoculated, B—inoculated, F—Trinity at 6 oz, G—Trinity at 8 oz, H—Trinity at 12 oz and I—Trinity at 24 oz.

New Fungicides for Phytophthora

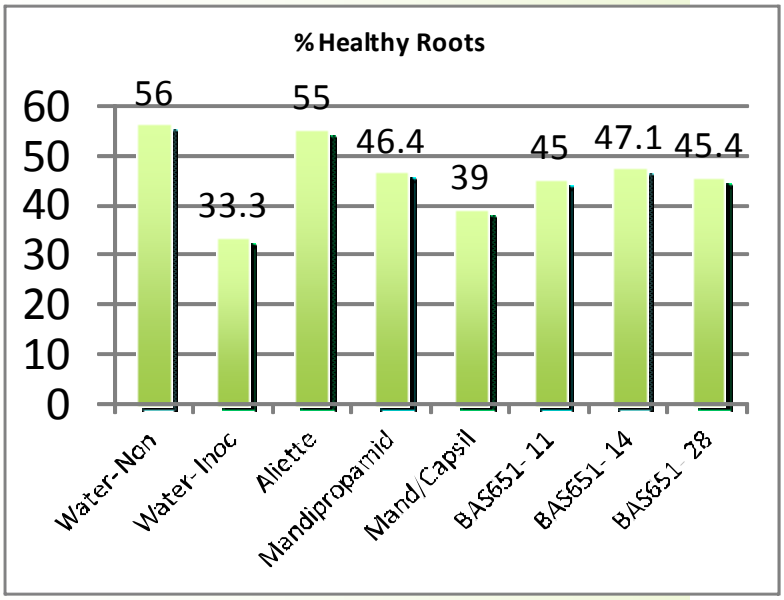
We have been seeing quite an increase in the fungicides being researched for use on Phytophthora diseases over the past five years or so. FenStop (fenamidone from OHP), Segway (cyazofamid from FMC) and Adorn (fluopicolide from Valent) have each been registered for this use. They are each in different MOA groups and have been shown to provide excellent control of many downy mildew and Phytophthora diseases across the US. We have a few more active ingredients being developed as well including mandipropamid from Syngenta and an experimental product (BAS651 from BASF). Our trials this past summer were run on vinca (*Catharanthus roseus* 'Pacifica Pink') and Gerber daisy (*Gerbera jamesonii* 'RYL Peach').

On the Gerber daisy trial treatments were applied as a foliar spray (to drip), a drench at 35 ml per 3.5 inch pot, or a 50 ml drench for the Mandipropamid drench (once) on 15 and 25 July, 4, 15 and 25 August, 2011. Treatments included:

- Water—noninoculated
- Water—inoculated
- Aliette—16 oz/100 gal spray
- Mandipropamid drench
- Mandipropamid/Capsil spray
- BAS651—11 oz/100 gal drench
- BAS651—14 oz drench
- BAS651—28 oz drench

Plants were inoculated with *Phytophthora cryptogea* four days after the first fungicide application. In this trial, crown rot did not develop although root rot was present. The best results were seen with Aliette used as a spray or all of the drenches (mandipropamid or BAS651) (graph below). The Mandipropamid spray was not quite as effective in reducing Phytophthora root rot on the Gerber daisy in this trial. The Aliette spray

Effect of some experimental fungicides on severity of Phytophthora root rot on Gerber daisy.



In the second trial, all treatments were applied as a granular top dress (one experimental biological) or a drench (30 ml per 3.5 inch pot) on 5, 12, 19 and 26 August, 2011. Plants were inoculated after the second application with *Phytophthora nicotianae*. The treatments are listed in the table below.

Effect of some experimental fungicides on severity of Phytophthora crown rot on vinca.

Treatment	Rate/ 100 gal.	Disease severity 9-1-11
Water Noninoculated	-----	1.0 a
Water Inoculated	-----	2.9 b
Aliette drench	12.8 oz	1.8 ab
Mandipropamid drench	8 oz	1.0 a
KleenGrow drench	12.5 oz	3.1 b
BAS651 drench	11 oz	2.2 ab
BAS651 drench	14 oz	1.3 a
BAS651 drench	28 oz	1.2 a
Exp. biological	1/3 tsp/pot	3.1 b
Exp. biological	6 oz	2.5 b
Exp. biological	8 oz	2.8 b
RootShield then Cease drench	8 oz then 6 quarts	3.0 b

Disease severity on pansy was rated on the following scale: 1 (none, healthy), 2 (slight), 3 (moderate), 4 (severe) and 5 (dead). Numbers in the same column followed by the same letter are not statistically different.

Optimal prevention of this crown rot on vinca was seen with the single Mandipropamid drench (100% effective) as well as the 11 or 14 oz/100 gal BAS651 drenches. The Aliette drench (12.8 oz/100 gal) provided intermediate control while the KleenGrow and experimental biological drenches failed in this very severe trial. The alternation of RootShield and Cease was also ineffective in this trial.

The experimental products Mandipropamid and BAS651 are providing very good to excellent control in our trials for Phytophthora prevention. Results from other researchers have shown similar benefits and we are looking forward to adding two new products into the Phytophthora arsenal for ornamentals.

Fungicides for Cyclamen Anthracnose

Controlling anthracnose diseases remains a challenge for many ornamental producers. In this trial on Cyclamen we tested an experimental product, Trinity from BASF, for possible prevention of this disease. Plugs of *Cyclamen persicum* (cyclamen) 'Stirling Pink' and 'Halios Purple' were planted in 4 inch pots containing Sunshine Mix No. 4. The plants were top-dressed with 1/2 tsp. Osmocote Plus 15-9-12 the same day. The test was conducted in a greenhouse with poly and shade cloth covering the top and sides.

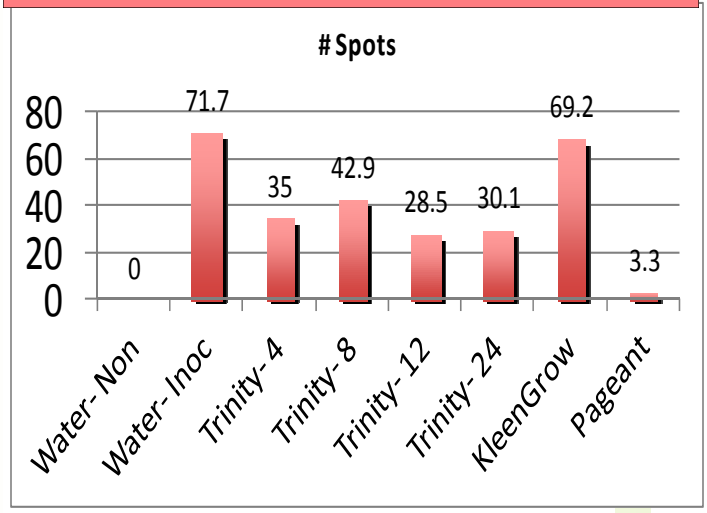
Plants were inoculated with a culture of *Colletotrichum gloeosporioides* by scraping the spores off in sterilized water on 11 August, 2011. After inoculation the plants were placed into clear plastic bags (high humidity) under mist for 48 hr. Bags were removed and plants remained under intermittent mist conditions (30 sec/hour for 12 hr/day) for the duration of the trial.

Fungicide products were applied weekly for a total of four weeks. Treatments included:

- Water—noninoculated
- Water—inoculated
- Trinity—4 oz/100 gal
- Trinity—8 oz
- Trinity—12 oz
- Trinity—24 oz
- KleenGrow—12.5 oz
- Pageant—18 oz

On 24 August we counted the number of spots per pot as well as measuring plant height and assessing top quality. The data show that although Trinity decreased disease about 50%, it was still not commercially acceptable control. KleenGrow did not give any control of this disease on Cyclamen but Pageant provided excellent preventative control.

Effect of fungicides on severity of Colletotrichum anthracnose on Cyclamen



The image above shows the typical plant for each treatment. A is the water-noninoculated and B is the water-inoculated. You can see the overall loss of plant quality simply due to the anthracnose infection. The middle row shows the effects of Trinity at 4, 8 and 12 oz/100 gal (left to right). The back row shows the highest rate of Trinity (24 oz—F), KleenGrow—G middle, and Pageant—H right.

Results of our previous trials we have completed on cyclamen anthracnose are summarized in the chart below.

Fungicide	Rate/100 gal	efficacy
Chipco 26019	16 oz	some-good
Cleary 3336	16 oz	some
Clevis	32 oz	good
Cygnus	6.4 oz	some
Daconil Ultrex	22.4 oz	some
Heritage	2-4 oz	good-excellent
Insignia	10 oz	excellent
KleenGrow	12.5 oz	none
Medallion	4 oz	good-very good
MilStop	2.5 lb	poor
Pageant	8-18 oz	good-excellent
Palladium	4-6 oz	very good-excellent
Pentathlon	24 oz	good
Phyton 27	15 oz	excellent
Rhapsody (Cease)	128 oz	good
Spectro	24 oz	excellent
Terraguard	8 oz	none
Trinity	4 oz	some
Veranda O	7 oz	poor

IR-4 Grower Survey

Many ornamental researchers are getting together the first week of October in Sacramento, CA for the IR-4 meeting. This is held every 2 years and the main purpose is to review data collected over the previous two years and determine priorities. Weed science, entomology and plant pathology groups meet over the course of a few days. One of the ways the program coordinator—Cristi Palmer—helps to determine target pest groups is a grower survey. I am presenting some of the results before meeting this year.

The intent of the Ornamental Horticulture Survey is to poll growers, landscapers, research and extension scientists and anyone else associated with our industry. The questions are designed to evaluate types of control employed as well as gaps in labeling to solve weed, insect and disease problems.

There were 346 responses divided into regions:

- North Central—12%
- Northeast—45%
- Southern—25%
- Western—18%

About 62% of the surveys came from growers with 11% from the landscape industry and 11% from the research community.

Almost 50% of the surveys were from greenhouse operations, 31% from container nurseries and 20% from field nurseries.

The respondents also described the type of control methods they employed:

- Biological control—31%
- Chemical control—44%
- IPM—38%
- Organic—15%

Finally, the types of crops grown by these respondents included:

- Bedding plants—41%
- Cut flowers—12%
- Christmas trees—10%
- Foliage plants—26%
- Perennials—40%
- Ornamental grasses—35%
- Palms—10%
- Seasonal potted plants—20%
- Shrubs—36%
- Trees—34%
- Turf grass—12%

Overall, for insect and mite control respondents ranked the following as most needing additional research:

- Thrips
- Mites and spider mites
- Scales and mealy bugs
- Borers

The top disease issues were ranked:

- Crown and root rot
- Bacterial diseases
- Phytophthora and Pythium
- Leaf spots and anthracnose
- Powdery mildew

This covers just about everything that can happen to a plant and I wonder about how often a disease is misidentified through sight ID. If this happens, then the ability to determine actual needs would be influenced.

The types of disease problems encountered was influenced by crop type as one would expect. Bedding and season color growers listed crown and root rot as number one problems with Phytophthora and Pythium second, bacterial diseases third and powdery mildew fourth. Cut flower growers listed powdery mildew first and crown and root rot second. Ornamental grasses appear to be most affected by Phytophthora and Pythium most while foliage and perennial plant growers reported Phytophthora and Pythium first, crown and root rot second, powdery mildew third and bacterial disease fourth.

Nematodes were mentioned by cut flower producers and the foliage and perennial growers for quite different targets. The main nematodes for perennial growers are likely foliar whereas cut flower growers are encountering root feeding nematodes since many are produced in the soil.

The top weed pests were:

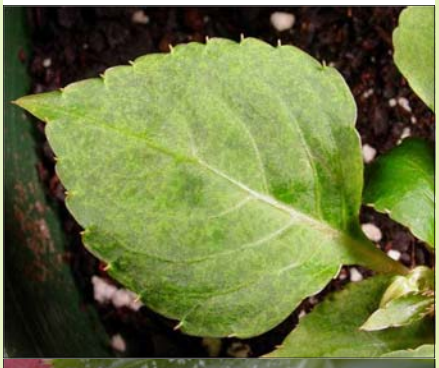
- Broadleaf weeds (by far the most requested)
- Liverworts, Mosses and algae

The most commonly mentioned weeds were nut sedge and liverwort. The most commonly mentioned broad-leafed weeds were thistle, bittercress, spurge and oxalis.

It is interesting to me that the same disease targets were identified by the working group for the previous two years. This may be an educational opportunity as well as a call for research.

Disease Alert- Impatiens Downy Mildew

An outbreak of downy mildew on impatiens has been reported from recently. The disease first appeared a few years ago and has not been reported again until quite recently. Margery Daughtrey (Cornell University Senior Extension Specialist) told me she had seen reports of this downy mildew from Cape Cod, Long Island, Illinois and California in the landscape. The images below are from Marge and show the symptoms of yellowing and mottling from the upper leaf surface as well as the white sporulation on the undersides.



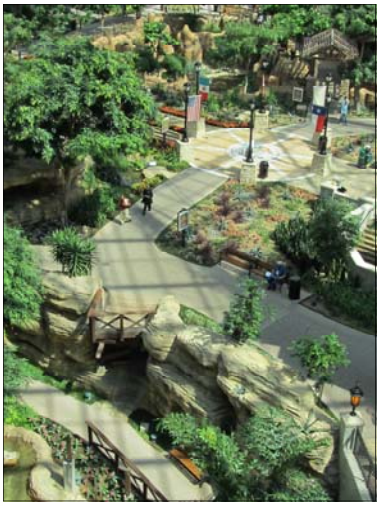
September Travels

Since the August newsletter came out, Mike and I have been ridiculously busy traveling all over the west. We started the week before Labor Day and have still not moved 100% into our Arizona home. The rental truck road show will finally be complete around the 8th of October and we are looking forward to our last 16 hour drive from Mt. Aukum to Clarkdale being completed. We had started to wonder about our decision to move ourselves but this was dispelled when we spoke with some friends about the costs of professional moving.

On the professional front, Mike found us a new office in Cottonwood, AZ and we moved our office into it in mid-September. It is all still in boxes but we will let you know the new address and phone soon.

In between moving events, we attended the Plug and Cutting Conference in San Jose, CA. Attendance was good and we heard good reviews of the educational program too.

The next week of September, Mike and I were back in California. This time visiting some growers in Carpinteria and Santa Maria. Then we participated in the 10th anniversary celebration at Ball Tagawa Growers in Nipomo, CA. This two day even focused on cut flowers the first day and nursery and landscape crops the second. There was an educational program tailored to each day and we got to visit with some friends we don't often see. Then back to Clarkdale for two days before leaving again.



Our most recent trip was to attend the BWI EXPO at the Gaylord Texan in Dallas. The central atrium was a bonus for me so I collected some new photos and enjoyed seeing what could be a "landscape" ground cover.

This three day trade show launched with a couple of seminars—mine was on disease control and was very well attended. Lots of great questions from the audience and one intrepid attendee tried to help with audio difficulties. He succeeded in helping with lighting and projector issues but the microphone situation stumped us all until a professional from the convention center appeared. It was especially challenging to have the microphone work intermittently but a real ice breaker!

And as they say, there is no rest for the wicked. I am back to California for some consulting in Salinas, a visit to Mt. Aukum and more consulting in the Sacramento area starting October 3rd. Near the end of the week, I will be attending the IR-4 Ornamental meeting where we will be planning the program for the next two years.

Biology of Water-borne Pests (cont. page 1)

Fungi like *Fusarium* and *Thielaviopsis* do not make motile spores but their spores are so numerous and withstand a water transport quite well. In addition, many of these organisms produce long-term survival structures that can be very hard to treat and remove from an infested area. *Pythium* and *Phytophthora* make oospores and chlamydospores and *Fusarium* makes chlamydospores (as well as conidia) which act something like a seed and can withstand adverse conditions for relatively long periods of time. *Thielaviopsis* makes two types of spores – an aleuriospore which is dark-colored and more long-lived and easily transported than the thin-walled endoconidium. So making two types of spores can make controlling these organisms quite a challenge.

A green alga

Algae can be especially hard to control in re-circulated water systems due to their "close" relationship with the plants we grow. The conditions that make the plants grow well usually are the same as those that the algae require for optimal growth. Applying fertilizer in the irrigation water is one of the things that favor algae explosions. Finally, many products or approaches that would kill the algae would damage our crop making the results unacceptable.

Bacteria, on the other hand, multiply very rapidly into the millions, have flagella for some movement and produce a slime-like substance. This substance is sticky and can help them adhere to surfaces between irrigations, resist desiccation and protect them from toxicants. All in all they are very hard to remove once established in a growing environment.

It is also rarely true that a single organism is causing a problem and our efforts to find a "one size fits all" fail due to the complexity of the plant-cultural-pest combination. It is critical to effectively clean these systems between crops but no matter how effective an approach is you need to remember that each new crop will probably introduce a new set of pathogens. Thus the problem becomes cleaning the system of the "old" problems and preventing introduction of "new" ones.