CORF News

Floriculture Education from the Kee Kitayama Research Foundation

Winter 2004

Vol. 8, Issue 1

Management of Downy Mildew on Snapdragons

By Stephen Wegulo, Assistant CE Specialist, Plant Pathology, UCR; Miguel Vilchez, Research Associate, Plant Pathology, UCR; and Steve Tjosvold, UCCE Santa Cruz and Monterey Cos.

Downy mildew on snapdragons is caused by *Peronospora antirrhini,* which belongs to a group of organisms called the Oomycetes. *Pythium* and *Phytophthora* also belong to this group. Although traditionally grouped under the fungi, the Oomycetes are not true fungi and have recently been moved from Kingdom Fungi to Kingdom Stramenopila. *P. antirrhini* was first described as early as 1874 on a wild snapdragon in Germany. It was not recorded as a pathogen on cultivated snapdragons until 1936, when it destroyed as many as 50,000 seedlings in Ireland. In the United States, snapdragon downy mildew was first reported in 1939 after it was found in the Santa Clara Valley of California in 1938.

Snapdragon downy mildew is favored by cool, wet conditions, with optimal temperatures for disease development ranging from 40 to 70°F. High relative humidity (above 85%) is essential for downy mildew development. *P. antirrhini* is an obligate parasite, that is, it can grow only in

See Downy Mildew on Snaps–Page 2

Strategies for Managing Powdery Mildew on Delphinium

By Stephen Wegulo, Assistant CE Specialist, Plant Pathology, UCR; Miguel Vilchez, Research Associate, Plant Pathology, UCR and Franklin Laemmlen, UCCE Santa Barbara Co.

Powdery mildew is one of the most common diseases affecting field-grown delphiniums. It is caused by three different fungi: *Golovinomyces cichoracearum, Erysiphe polygoni,* and *Podosphaera xanthii*. These fungi form gray powdery blotches on the surface of leaves, stems, and blossoms. In severe outbreaks, young leaves and growing tips become curled and stunted, significantly lowering quality and yield. Delphinium stems and flowers covered with powdery mildew are generally unmarketable.

Powdery mildew fungi thrive well in cool or warm humid conditions. The white, powdery masses they form on the surface of plants are composed of mycelium and asexual spores. These spores are blown by wind onto healthy plants where they cause new infections. Late in the growing season fruiting structures called cleistothecia form and survive through the winter. When temperatures warm up and there is sufficient moisture, the fruiting structures release sexual spores which cause the initial or primary infections on healthy plants.

Unlike spores of most fungi, those of the powdery mildew fungi generally do not require free water to germinate. Hence, powdery mildew is more common and severe in warm and dry climates. Powdery mildew fungi reduce plant health or kill plants by robbing them of

See Powdery Mildew–Page 12

Diagnosis of New Problems: Defining What is "New"

By Steven Koike and Steve Tjosvold, UCCE, Monterey and Santa Cruz Counties

An important role for researchers, extension personnel, and other horticultural professionals is the diagnosis and identification of new problems. New problems will always be a part of the horticultural system, and therefore the diagnostic process will always be necessary. Why do new problems periodically appear in our production systems? The worldwide movement of seed, plants, and other materials is a significant means of introducing problems. Changes in the crops and cultivars grown by a producer will automatically mean that the particular diseases of those new plants will occur at some time. Mutations and genetic recombinations of pathogens can also result in new strains and pathotypes that will plague the crops.

It is useful to define what "new" actually means. We can categorize a problem as "new" by using four criteria.

See New Diagnosis–Page 5

In This Issue

Downy Mildew on Snaps

Continued from page 1

living plant tissue. It is also host-specific, infecting only snapdragons or plants in the same family as snapdragons. There are two types of infection caused by this pathogen on snapdragons. Local infection is characterized by pale rounded areas on leaves, up to about five-eighths of an inch in diameter. This type of infection is rarely destructive. The second type of infection is systemic, that is, it can spread throughout the plant. Systemic infection can be very destructive especially on seedlings. It causes a downward curling of leaves, which appear paler green than usual. Stunting is a common symptom of systemic infections. Seedling death progresses from the top down to the soil surface. Systemic infection can result in rosetting of growing points. Commonly, the shoots die and infected plants produce many secondary shoots from the base. On larger plants, symptoms of systemic infection include stunting, pale green leaves, and lack of flowering. The incubation period (the time from infection to appearance of symptoms) can be as short as four days. Environmental conditions during the incubation period are most critical in determining how much infection occurs in a snapdragon planting or seedling tray.

P. antirrhini sporulates in cool, humid conditions. During sporulation, examination of the underside of infected leaves reveals a grayish downy growth. This growth, which can also occur on stems and upper leaf surfaces of young succulent plants, consists of sporangiophores and sporangia (spores), the fruiting structures of the downy mildew pathogen. When leaves are disturbed during sporulation, sporangia are detached from the sporangiophores, become airborne, and are spread by wind, air currents, or splashing water. When they land on healthy plants, they germinate and cause new infections. Thick-walled resting spores called oospores form abundantly in the roots, stems, and petioles of systemically infected plants and are the means by which the pathogen survives during unfavorable conditions.

There are several management strategies for downy mildew on snapdragons. Because high humidity is critical for pathogen growth, one management strategy is to keep relative humidity in the greenhouse below 85%. This can be achieved by balancing heat and ventilation. Keeping leaves dry using fans can be effective in preventing infections, but can also increase disease spread because spores can be carried by air currents from infected to healthy plants. Avoid overhead irrigation because splashing water can spread downy mildew spores. Downy mildew can be introduced into a greenhouse through infected seedlings or plugs. It is a good idea to thoroughly inspect all seedlings or plug trays for downy mildew before

See Downy Mildew on Snaps–Page 3

Downy Mildew on Snaps

Continued from page 2

transplanting. If infected plants are found in the greenhouse, they should be removed and destroyed, taking care not to spread the spores. Workers who handle infected plants should thoroughly wash their hands with soap before handling healthy plants. Some snapdragon cultivars have been shown in tests to have good resistance to downy mildew, but no single line has been found to be consistently resistant. Planting resistant cultivars can reduce levels of infection in a snapdragon planting.

When conditions are favorable for occurrence of downy mildew on snapdragons, it is often necessary to apply preventative fungicides. Appearance of symptoms is an indication that infection has already occurred. In this case curative fungicides should be applied. When applying fungicides, it is critical to achieve thorough coverage, especially on the underside of leaves. In two fungicide trials we conducted in 2003 in a grower's field in Ventura and in a field at the University of California South Coast Research and Extension Center in Irvine, we found significant differences in efficacy among fungicide products (Table 1, below). Fenomen (fenamidone), Fore (mancozeb), Insignia (pyraclostrobin) Aliette (fosetyl-Al), and Stature DM (dimethomorph) had very good to excellent control of downy mildew. Heritage (azoxystrobin) had slightly better control than Compass (trifloxystrobin), but in general these two strobilurin fungicides did not control downy mildew as effectively as the other products.

The best management strategy for downy mildew is to combine all available management options into an IPM program.

Acknowledgments: Funding for the fungicide trials was provided by BASF, Bayer, Olympic, SePro, and Syngenta. Bob Suzuki, Sunrise Ranch, provided field space and snapdragons for the Ventura trial. Don Bleeck, Suncoast Nursery, provided snapdragon seedlings for the South Coast trial.

❖

Table 1. Severity of downy mildew on snapdragons in two fungicide trials in Ventura and at the South Coast Research and Extension Center in Irvine, 2003. (0 – 5 scale, 0 no disease, 5 whole plant diseased)

Treatment/Fungicide[1]	**Active ingredient**	**Rate/100 gal**	**Ventura 8 Jul 2003**	**South Coast 25 Jul 2003**
Non-treated control			3.63	3.4
Compass 0 50WDG	trifloxystrobin	1 oz	3.75	2.9
Compass 0 50WDG	trifloxystrobin	2 oz	3.38	1.0
Heritage	azoxystrobin	1 oz	3.13	1.3
Alternate Heritage, Aliette, Insignia		1 oz, 2.5 lb, 4 oz	2.50	0.6
Insignia	pyraclostrobin	4 oz	2.13	0.8
Alternate Heritage, Stature DM, Aliette		1 oz, 9.6 oz, 2.5 lb	2.00	0.6
Stature DM	dimethormorph	9.6 oz	1.63	0.0
Insignia	pyraclostrobin	8 oz	1.38	0.0
Aliette WDG	fosetyl-Al	2.5 lb	1.38	0.3
Alternate Fore, Heritage, Stature DM		1.5 lb, 1 oz, 9.6 oz	1.13	0.0
Fenomen	fenamidone	7 fl oz	0.75	0.3
Aliette WDG + Fore tank mix		2.5 lb +1.5 lb	0.50	0.4
Insignia + Stature DM tank mix		4 oz + 9.6 oz	0.38	0.3
Fore	mancozeb	1.5 lb	0.25	0.9
Fenamidone + Fore tank mix		7 fl oz + 1.5 lb	0.25	0.0
LSD (*P* = 0.05)			**1.0**	**0.7**

[1]Fungicide sprays were applied on 15 May, 23 May, 2 June, 11 June, and 24 June in both trials.

New Diagnosis

Continued from page 1

Year	Disease	Situation
1920s	Brown blight disease	Cause unknown
1980s	Romaine X disease	Cause unknown
Mid 1990s	Romaine yellowing symptom	Suspect a soilborne virus
Late 1990s	Lettuce dieback	Pathogen is a strain of tomato bushy stunt virus
2000	Lettuce dieback	Pathogen is identified as lettuce necrotic stunt virus, a new tombusvirus

Table 1

1. New location of a previously known disease: both the disease and the pathogen are known to occur elsewhere, but are newly recorded in the area being examined. For example, rust of English daisy, Cercospora leaf spot of bells-of-Ireland, downy mildew of delphinium, downy mildew of foxglove, and powdery mildew of calla lily have all recently been found in California for the first time. All of these problems have been documented elsewhere in the USA and the world.

2. New disease: a particular combination of pathogen and plant host is new and not previously reported; however, the pathogen is already known to infect other plants. For example, Fusarium crown rot of *Lisianthus* was identified for the first time in the world in California. The pathogen, *F. avenaceum*, is well known as a pathogen of grasses and other plants. Each time the sudden oak death pathogen, *Phytophthora ramorum*, is found to infect an additional plant species for the first time, that report documents a new disease. By now, however, the pathogen is not new and has previously been documented.

3. New pathogen: the organism that is causing the problem is new and undescribed. Xanthomonas leafspot of catnip (*Nepeta cataria*) had never been reported anywhere in the world until our 2001 California report. The pathogen has never before been characterized or described.

4. New strain of pathogen: the organism involved is a novel variant of an already known pathogen. Good examples are the new races of spinach and lettuce downy mildews that periodically develop and overcome existing resistance genes in the cultivars. A parallel example of strain diversity is the development of new and different human flu virus strains.

"New" is also relative to advances in our research and knowledge. A disease may have been affecting crops for decades, but the etiology of the problem remained unsolved until sufficient research and detection tools were developed. An interesting case of this is lettuce dieback disease of lettuce, caused by the tombusvirus lettuce necrotic stunt virus (LNSV). There is evidence that lettuce dieback has been damaging lettuce in California since the 1980s, and indications also exist that lettuce dieback is related to brown blight disease of lettuce that was occurring in the 1920s (Table 1, above). However, the cause of lettuce dieback remained a mystery until adequate molecular tools were developed in the late 1990s and 2000. We now know that this disease has been present in the state for many years, but we only recently identified the virus agent. LNSV can be considered a new pathogen and is presently thought to be a new strain of tomato bushy stunt virus.

Another example of technological advances involves aster yellows disease. Aster yellows affects many ornamental plant hosts and was studied extensively in the 1930s and 1940s. Prior to 1967, the aster yellows pathogen was considered to be a virus. After 1967, the agent was found to be an organism closely related to bacteria (a mycoplasma-like organism). Today the aster yellows pathogen is called a phytoplasma, which is a single-celled prokaryotic organism that lacks cell walls. The development of sufficient detection methods allowed researchers to identify a new pathogen (phytoplasma) that caused a disease (aster yellows) that was affecting crops for decades.

There are several useful steps to take in preparing for the new problems that will occur in production systems and preventing them in the first place.

- Be aware of the possibilities of new problems and recognize that they will eventually occur.
- Be careful of the assumptions you make; what appears to be an old familiar problem may be a new one.
- Be familiar with the common problems so you can more readily differentiate new, unusual problems.
- Carefully inspect new propagative and stock plant material for pests diseases, and disorders, and develop a scouting program for production plants.
- Get accurate diagnostic assistance as needed.
- When new problems occur, investigate the situation and conduct research on the problem so that the potentially new disease can be thoroughly documented.

❖

Field Observations

Chrysanthemum White Rust is still present in San Diego County. This disease is favored by cool, moist conditions. Systhane, Heritage, and Daconil are registered for control of this rust as eradicants. However, it is not a good idea to continue to apply Systhane weekly indefinitely, as it has been associated with plant growth regulator effects. Dithane and Daconil can be used as preventative treatments. Check Julie Newman's Regional Report in this issue for the latest information and CDFA guidelines on eradication and prevention of this serious pest of chrysanthemums.

Growers should be on the lookout for this disease in their crops, in surrounding chrysanthemums in the landscape, and as they bring in new cuttings, especially from "bargain" sources. Infected plants develop light green to yellow spots up to one-fourth inch in diameter on the upper leaf surface of infected leaves. Eventually, raised, waxy, pink-colored pustules are formed on the lower surface of infected leaves. As they mature and produce infectious spores, these pustules become whitish.

On a personal note,

I am officially back from sabbatical leave in Australia. It was a wonderful experience and I learned a great deal which I hope will enhance my research and education program here. I want to express a huge THANK YOU to Julie Newman, Ann King and Steve Tjosvold for assisting with program requests during my absence.

It is great to be back working with all of you!

Regional Report

San Diego County

New Pest Response Guidelines Released for Southern Wilt of Geranium, *Ralstonia solanacearum* race 3 biovar 4

Ralstonia solanacearum is a plant pathogenic bacterium that causes wilt diseases. Various races of this bacterium affect different crops around the world. Race 1 of *R. solanacearum* is endemic to the Southeastern United States, where it can affect tomato crops, but race 3 biovar 4, which affects geraniums, eggplant, potatoes, and tomatoes, is not known to occur in the United States or Canada. This pathogen is an Agricultural Bioterrorism "Select Agent" and growers should understand that this pathogen is taken very seriously by federal officials.

On December 31, 2003, APHIS officially confirmed a finding of *Ralstonia solanacearum*, race 3 biovar 4, on several geranium plants in an upstate New York greenhouse. The plants in question were Goldsmith Plants Inc. varieties 'Americana Coral' and 'Americana Bright Red,' shipped from Goldsmith's Guatemala farm. Goldsmith immediately halted all shipments of geranium cuttings to its customers. APHIS is working closely with the industry to implement a plan for quickly finding and eradicating any other diseased plants that may have entered United States greenhouses, while minimizing destruction for commercial United States growers. At present, all greenhouses receiving Goldsmith geranium shipments of 'Americana Coral,' Americana Bright Red,' and 'Americana Cherry Rose II' have been placed on hold.

The bacteria of all races of *Ralstonia solanacearum* can be transmitted through contaminated soil, irrigation water, equipment, or personnel. It can be spread by transplanting and propagating infected plants, taking cuttings without disinfecting cutting tools between plants, pinching buds of plants without sanitizing, and especially by shared irrigation systems. This bacterium can be spread in contaminated soil and on soiled shoes from contaminated areas. Infection occurs typically through the roots and wounding in root areas. Bacteria are normally concentrated in the lower stem portions of the plant. The pathogen does not readily spread from plant to plant. There are no pesticides to use against this disease. Spread can be controlled in greenhouses by the application of strict, sound sanitation practices.

Geranium growers are reminded to be particularly careful in following these defensive measures to help minimize the impact of any introduction into their greenhouses:

- Do not use sub-irrigation or shared irrigation watering systems - *Ralstonia* and many other plant pathogens spread easily through irrigation water;
- Use strict sanitary practices when handling or propagating plants. Disinfect knives, hands, and gloves when pruning, disbudding, or otherwise caring for plants. It is especially important to disinfect between varieties to avoid transmitting disease from one variety to another;
- Keep varieties from foreign sources separate;
- Disinfect water systems and regularly treat irrigation water from any source;
- Keep greenhouses, areas around greenhouses, and irrigation water holding or overflow ponds free of weeds;
- Scout often for signs of disease. Have problems checked immediately;
- Never grow geraniums on the ground or on any material that allows irrigation water to spread from plant to plant;
- Do not place plants beneath the drip line of hanging geraniums.

Dr. Karen L. Robb
U C Cooperative Extension
5555 Overland Avenue, Bldg. 4
San Diego, CA 92123
Phone: (858) 694-2857
Fax: (858) 694-2849
email: klrobb@ucdavis.edu

Ventura & Santa Barbara Counties

Chrysanthemum White Rust Quarantine

Chrysanthemum White Rust (CWR) caused by the fungus *Puccinia horiana* was found on cut chrysanthemums in a Carpinteria nursery on January 7. An earlier find occurred last November in a cut chrysanthemum nursery in Nipomo. These are the first documented occurrences in the Central Coast area since December 2002, when CWR was found in an Oxnard nursery. Because CWR is under an eradication program in California, county agriculture commissioner staff has been working under the direction of CDFA on a CWR quarantine program that follows federal guidelines. The quarantine has recently been lifted, but county agriculture commissioner staff will continue monitoring and inspecting chrysanthemums, looking for further signs of the disease until the spring. As of this time there have been no other site-findings to date, and hopefully this will remain the case.

Chrysanthemum white rust is found only on chrysanthemums and not all species and cultivars are susceptible. Infected plants develop light green to yellow spots up to one-fourth inch in diameter on the upper leaf surface of infected leaves. Eventually, raised, waxy, pink-colored pustules are formed on the lower leaf surface, which become whitish as they mature. As the disease advances, the spots on the upper leaf surface become sunken, turn brown, and become necrotic. CWR pustules typically form on young leaves and flower bracts but can be found on any green tissue and on flowers. Severely attacked leaves wilt, hang down the stem, and gradually dry up. Infected plants do not always express symptoms during hot and dry conditions.

This rust survives only on living chrysanthemum tissue. Teliospores in the leaf pustules germinate in place producing basidiospores that are airborne and infect by direct penetration. The fungal spores have a relatively short survival time, requiring high humidity and a film of moisture to germinate. Basidiospores spread from plant to plant by splashing water. CWR can also be spread to uninfected plants on contaminated soil, litter, dead leaves, gardening equipment, clothes, shoes and hands.

CWR is not established in the United States, nor are transitory outbreaks widespread. However, the disease has the potential to be extremely damaging to the commercial industry if it becomes established. Therefore, the importation of chrysanthemum species is prohibited from several areas where the disease is established.

Chrysanthemum growers should use preventative fungicide treatments during the winter and early spring months because cool, damp weather proliferates the disease. In infested areas, at least three treatments of myclobutanil (Systhane) or other appropriate fungicides, such as azoxystrobin (Heritage) or chlorothalonil (Daconil), at five- to seven-day intervals are required by USDA protocol, with inspections following treatments to confirm freedom of CWR disease symptoms. Myclobutanil, a systemic fungicide with both protectant and curative properties, was previously the only CDFA-approved fungicide that could be used in infested areas. As long as growers adhere to CDFA-approved regulations, it is a good idea to rotate with other fungicides after three consecutive treatments. This is because repeated treatments with myclobutanil can have a growth regulator effect and can cause stunting of growth. Other fungicides that can be used include mancozeb (Dithane) and chlorothalonil (Daconil) as a protectant treatment program. Propiconazole (Banner Maxx), previously recommended as the treatment for eradication programs, may cause phytotoxic symptoms on some cultivars.

Producers of propagative material should make use of fungicidal dip treatments of cuttings using myclobutanil or other appropriate fungicides before planting them. They also should use appropriate cultural practices, sanitation measures, and monitoring techniques to assure that propagative chrysanthemum nursery stock produced is free of CWR. Record keeping is important because should a trace of a CWR infection implicate a particular nursery, the records will be reviewed according to CDFA/USDA guidelines; if record keeping is not adequate, additional trace work may be necessary.

All growers should be on high alert and report any suspects to the county agriculture commissioner. Infected plants/flowers cannot be moved or sold, and clean-up of the infestation in quarantined areas has to be done to CDFA's satisfaction.

New Leaf Spot Disease on Bells-of-Ireland.

A new leaf spot disease in Santa Barbara County on bells-of-Ireland (*Moluccella laevis*) is caused by *Cercospora apii*. This fungal pathogen has a wide host range. Most notably it occurs on celery, where there are good resistant varieties and where chemical control is usually not necessary. However, this pathogen causes a serious disease on bells-of-Ireland. *Cercospora apii* was first found in California on bells-of-Ireland in 2001. Steve Tjosvold, who worked with Steve Koike (Farm Advisor, Monterey County), described it in the winter 2003 issue of *CORF News*. Initial symptoms of the disease are gray-green leaf spots, generally oval in shape, often delimited by the major leaf veins. The spots later turn tan. Lesions form on both the bottom and topsides of the leaves.

Julie P. Newman
UC Cooperative Extension
669 County Square Drive, Suite 100
Ventura, California 93003-5401
Phone:(805) 645-1459
Fax:(805) 645-1474
email: jpnewman@ucdavis.edu

San Mateo & San Francisco Counties

Tank Mixing Pesticides

I get calls from growers about tank mixing two or more pesticides. There is no single answer because it depends on your pest(s) and the materials that you plan to use. Since this issue of *CORF News* addresses diseases and their control, it is a good opportunity to review tank mixing.

Tank mixing involves combining two or more pesticides and applying them at the same time. This is done to get a greater kill of a single pest, or to control more than one pest. Tank mixes can be made with more than one fungicide (or insecticide, or miticide, or herbicide) to control a single pest, or with an insecticide plus a fungicide (to control an insect and a disease, for example), or with pesticides plus fertilizers.

Advantages of tank mixing include convenience, cost-effectiveness (fewer applications, so reduced labor and application costs, and less wear on equipment), and enhanced activity (sometimes two mixed pesticides perform better than when applied separately; this is called *synergism*).

You can run into problems if you do not understand tank mixing, because some pesticides are not compatible or can cause plant injury. It is difficult to get good information on which pesticides can safely be tank mixed. Some, but not many, pesticide labels give information on compatibility and tank mixing.

I searched for a chart of currently used fungicides that can be tank mixed, but have not found one that would be useful to growers. **If you have any leads on this, let me know and I will print it in the next issue.**

I recommend that growers have a copy of *The Safe and Effective Use of Pesticides*, second edition. This University of California publication (#3324; $35; to order 800-994-8849 or http://anrcatalog.ucdavis.edu) is used as a training guide for pesticide licensing, but it also supplies a wealth of basic information.

Here are some concepts you need to understand before tank mixing:

Incompatibility. This is a physical condition that prevents two or more pesticides from mixing properly. This can result from the materials selected, the order they are put into the tank, and even factors such as water temperature or alkalinity. The results of incompatibility may include poor or uneven pesticide coverage on plants, clogged equipment, or other problems. *The Safe and Effective Use of Pesticides* tells how to test for incompatibility (using simple jar tests).

Chemical Changes with Tank Mixing. The toxicity of pesticides can change dramatically when tank mixed, resulting in antagonistic or synergistic or other changes in effectiveness, plant damage (phytotoxicity), and resistance development.

Antagonism occurs when two or more pesticides mixed together *reduces* the effectiveness of one or more of the materials. Synergism occurs when two mixed pesticides perform *better* than when applied separately.

Resistance. When two chemicals with similar modes of activity are tank mixed, there is a potential for resistance to the pesticide(s) to develop. This can occur with insects, mites, diseases, or other pests. As a rule of thumb, do not tank mix pesticides in the same chemical class or with the same mode of action. This is one reason it is important to know the chemical class and mode of action of the pesticide; check the pesticide label for this information.

Phytotoxicity. Tank mixes have the potential to cause plant injury. Especially with ornamentals, where phytotoxicity is usually unacceptable, it is very important to try the tank mix combination on a small number of plants, then wait a few days to see if damage occurs. There are also cultivar or varietal differences in phytotoxicity; just because one cultivar can tolerate a certain tank mix does not mean that other cultivars of that species can, too. Try the tank mix on each cultivar before using it large-scale.

If each pesticide used recommends addition of a spreader-sticker, you may need to reduce the total amount of spreader-sticker used in the tank mix to avoid phytotoxicity.

Field Observations

Downy Mildew on Marguerite Daisy

Steve Tjosvold's regional report on downy mildew discusses a new downy mildew found on marguerite daisies in retail and commercial nurseries in his county last spring. I recently found a potentially new downy mildew on a field of cut marguerite daisies in Half Moon Bay. The grower noticed it a few months ago, and the plants now seem to be coming out of it, but with wet spring weather approaching, it could flare up again.

I first saw the daisy plants in Half Moon Bay two weeks ago, so we have not yet been able to diagnose the species of downy mildew. In the next issue of *CORF News*, I will update what is happening with the downy mildew.

Meanwhile, if growers in San Mateo County suspect that they have downy mildew on daisies or other crops, please call me so that we can assess the outbreak and see if we are dealing with a new species.

Ann I. King
UC Cooperative Extension
625 Miramontes, Suite 200
Half Moon Bay, CA 94019
Phone:(650)726-9059
Fax:(650)726-9267
email: aiking@ucdavis.edu

Regional Report

Santa Cruz & Monterey Counties

Downy Mildews are Serious Concern

Ornamental diseases caused by downy mildews are making headlines in the ornamental industry press, and my field observations support the concern that these diseases are more common and difficult to control. Snapdragon downy mildew is still prevalent in greenhouses, occurring in winter and spring, sometimes with crushing destructiveness. Rose downy mildew also occurs in winter and spring, and seems to wallop susceptible cultivars with a vengeance. We are finding new downy mildews on California ornamentals too. In Santa Cruz County alone, we have found two new downy mildew pathogens–one on foxglove and one on delphinium–just in the last two years. This report is a brief overview of these common and new downy mildew diseases. I also describe an unverified downy mildew on *Argyranthemum* (marguerite daisy) that we observed last year.

Snapdragon downy mildew is caused by the fungus *Peronospora antirrhini*. On seedlings, symptoms appear first as a downward curling of the leaves and a loss of plant vigor. Infection of seedlings can become systemic, in that the fungus moves upward in the stem and can infect developing leaves. Often aerial-borne spores directly infect the leaves. Infected leaves are pale green color and have a downy, gray to white, fungus growth on the lower leaf surface. This pathogen only attacks snapdragons. Infection and disease development are favored by temperatures between 40 to 60°F. and high relative humidity. The fungus can survive in dead plant parts and in soil as dormant, thick-walled oospores. In the winter of 2002, snapdragon downy mildew reached unprecedented destructive levels and was tough to kill with existing fungicides. The concern over poor control stimulated the initiation of fungicide testing at a Salinas nursery in the spring of 2002. Unfortunately, once trials were underway there was no disease occurrence, but Stephen Wegulo (UC Riverside) had set trials up in two other locations where downy mildew occurred. The results of those trials are given in one of the feature articles in this issue of *CORF News*.

Rose downy mildew can be among the most destructive of all rose diseases when environmental conditions favor its development. The causal agent, *Peronospora sparsa*, is found throughout the world, virtually everywhere roses are cultivated. The disease often occurs sporadically, but when it does occur, the disease often results in severe defoliation and loss in crop productivity. The fungus develops best under relatively cool temperatures and high relative humidity. Spores germinate in water in four hours, and sporulation on rose leaves held at high relative humidity occurs within three days after inoculation. The optimum temperature for spore germination is about 64°F.

Foxglove downy mildew was discovered in Santa Cruz County for the first time in the United States in May 2002 on several cultivars of foxglove (*Digitalis*). This disease had been reported previously in Europe, Asia, and New Zealand. The disease is caused by *Peronospora digitalidis*. Initial symptoms on leaves consist of light green, angular areas that finally become necrotic. Under favorable conditions, the purple-gray sporulation of the pathogen can be seen primarily on the bottom of the leaf surfaces. *D. purpurea* cultivars such as 'Alba', 'Apricot', and the Foxy hybrids appear to be most susceptible; *D.* x mertonensis (= *D. grandiflora* x *D. purpurea*) appear to be moderately susceptible; and *D. grandiflora* is possibly resistant.

Delphinium downy mildew caused by *Peronospora ficariae* was discovered in Santa Cruz County in the spring of 2003. The pathogen has been found in other parts of the world and in the United States (Alabama, Idaho, Maine, Michigan, New York, Oregon, Wisconsin, and Wyoming) on delphinium and other hosts including many species of *Ranunculus*, *Anemone coronaria*, and *Helleborus purpurascens*. In Santa Cruz County, the pathogen was found on three cultivars at two production nurseries. One nursery was a cutflower producer where symptomatic *Delphinium* 'Volkerfrieden' were found in adjacent greenhouse and field production areas. The other nursery produced field grown containerized ornamentals where symptomatic *Delphinium grandiflorum* 'Blue butterfly' and *Delphinium* 'Pacific Giant hybrid' were found. Initial symptoms on leaves consist of light green patches. These areas quickly turn dark green to black green and are often delimited by the central vein of the leaf. With favorable conditions, purple-gray sporulation of the pathogen can be seen primarily on the underside of the leaf. Symptoms are most severe on older foliage. As disease progresses, the lower leaves wither and dry up.

Downy mildew on *Argyranthemum frutescens* (= *Chyrsanthemum frutescens*) (marguerite daisy) was observed in Santa Cruz and Monterey Counties in the spring of 2003. The pathogen was a species of *Peronospora*. We did not confirm the particular species as the isolates did not survive during experimentation. Presently there is no documentation of downy mildews on *Argyranthemum* in California. The pathogen was seen on *Argyranthemum* 'Bright Carmine' at a commercial container nursery, and on *Argyranthemum* 'Butterfly' in a retail nursery. Following a very rainy period, the purple-gray growth could readily be seen sporulating on the undersides of newly developing leaves. With only two days of dry weather the sprorulation was no longer observable in the field, and we were unable to produce significant sporulation or demonstrate infection during greenhouse testing. *We need your help to confirm the presence of this disease and identify the pathogen. Please report any suspicious observations.*

Steve Tjosvold
UC Cooperative Extension
1432 Freedom Blvd.
Watsonville, CA 95076-2796
Phone:(831)763-8040
Fax:(831)763-8006
email: satjosvold@ucdavis.edu

Get Cultured – Rapid Sand Filtration

By Donald Merhaut, Extension Specialist, Nursery and Floriculture, UC Riverside

In the previous article, we discussed the process and applications of Slow Sand Filtration (SSF). The following article focuses on Rapid Sand Filtration (RSF). Please note that in the literature, RSF is usually referred to as just 'Sand Filtration.' However, for clarity of this article it will be referred to as Rapid Sand Filtration (RSF) to differentiate it from Slow Sand Filtration (SSF). RSF utilizes coarse sand (> 1.0 mm) and possibly other substrates such as activated charcoal to filter recycled irrigation water.

Sand filtration is a method of filtering water through coarse sand (usually > 1.0 mm). Unlike the finer sands utilized in Slow Sand Filtration Systems (SSF), rapid sand does not trap many pathogens; therefore, additional means of water sanitation, such as chlorination, may be needed.

Rapid Sand filtration (RSF) is utilized by many nurseries. It is a relatively inexpensive process for filtering out larger debris from runoff water. The operating principles are similar to SSF. Filtration efficiency is based on sand particle size and the types of other substrates, such as activated charcoal, that may also be included in the filter profile.

Advantages of Rapid Sand Filtration

Operation costs – Energy costs are low since the system works through gravity.

Installation costs – Installation costs are low. Financial outputs are primarily for retention basins.

Filtration time – Filtration processes are rapid (15-25 gpm/ft^2) compared to filtration rates for SSF (0.05-0.55 gpm/ft^2).

Technical components – No technical components or control systems are needed.

Maintenance – Maintenance requirements are low. Routine back flushing requires minimal input.

Adaptability – RSF is adaptable to many production systems.

Chemical control – Properly maintained, RSF does not alter the pH of the effluent water.

Space – RSF requires less surface area than traditional SSF systems.

Disadvantages of Rapid Sand Filtration

Chemicals – Other chemicals such as chlorine may be required to kill pathogens.

Labor – Occasional cleaning maintenance requires labor.

Herbicide and Pesticide removal – Filtering or breakdown of herbicides and pesticides does not occur.

Note: Placement of a layer of granular-activated carbon (charcoal) can adsorb certain organic herbicides and pesticides.

Floating debris removal - Larger suspended debris should be removed, so that intervals between cleaning filters is extended.

Dissolved organic matter – Coloration due to dissolved organic matter and acids is not always removed.

Structure and Operational Considerations

Housing

The sand filter can be housed in cement tanks, or completely enclosed in steel tanks.

Note: Like SSF, it is recommended to have two smaller units rather than one large unit, so that one system can be shut off for backwashing, utilizing the water from the other sand filter.

Filtration components

Inlet structure – The inlet for untreated runoff water should be constructed so that the sand surface is not disturbed by incoming water.

Water – A constant depth of approximately 1 meter of supernatant water should be on top, the weight of which allows percolation through the sand below.

Stability

The water level should not fluctuate, so that flow rates through the sand column do not change. Variable flow rates decrease filtering performance.

Level

The water level should never go below the level of the sand filter. The water column protects the beneficial biologically active film/filter that develops on the sand surface. High temperatures and drying will kill or impede the activity of the biological filter.

Flow rates

The flow rate should be continuous. Biological filters will die through oxygen starvation in stagnant water.

Sand – A layer of sand of variable thickness.

Particle size

Particle size of 1 mm and larger is used. As the coarseness of the sand increases, the speed of filtration will increase but the quality of the filtered water will decrease.

Uniformity coefficient

The uniformity coefficient (UC). The UC $= d_{60}/d_{10}$, where d_{60} is the sieve size, in mm, that allows passage through the sieve of 60% of the sand (by weight), and d_{10} is the sieve size, in mm, that allows passage through the sieve of 10% of the sand (by weight). For SSF the UC should be no more than five, but no less than two. However, parameters of this nature have not been defined for coarse-sand filters.

Granular activated charcoal – optional. This adsorbs most organic chemicals such as pesticides and herbicides. This can be placed in between the sand column.

Gravel bed – optional. A layer of gravel prevents sand from blocking the treated water outlet. In more sophisticated systems, three different graded layers of gravel are used.

Drainpipe – optional. A perforated drainage pipe may be placed in the bottom layer of gravel. Additional filtering can be accomplished with a fabric placed over or around the drainage pipe.

Flow meter and control valve – For optimal performance, flow rates should be consistently maintained with the

See Get Cultured–Page 11

Get Cultured

Continued from page 10

installation of a control valve at the end of the drainpipe.

Operational settings

Filtration rate – 15-25 gpm/ft^2 (900- 1,500 gph/ft^2). Unlike SSF, lower flow rates do not assist in the control of pathogens since the sand is so coarse.

Filter capacity – Filter capacity will depend on the type of system being used. However, the filtration rate of 900-1,500 gph/ft^2, makes this system suitable for the large scale nurseries, those with greater than 100 acres that are using overhead irrigation.

Maintenance

Frequency of maintenance is dictated by the dirtiness of the water. Daily backwashing is not uncommon. The debris from the backwash may be pumped back into the reservoir, pumped into fields, or drained and composted. However, one should check with local agencies regarding regulations pertaining to the disposal of backwash debris.

Note: With this system and any collection and filtration system that is described, a small pilot system should be fabricated to test the feasibility of use at each nursery site.

❖

Science to the Grower–Methyl Bromide Alternatives Complicate Life for Growers

The use of methyl bromide as a soil fumigant is scheduled to end by 2005 in developed countries and 2015 in developing countries. In the search for alternatives, biofumigation with brassicaceous amendments has attracted attention. A recent article by Zasada and others in *Plant Health Progress* summarizes results of some experiments conducted in California.[1] These studies show that the effectiveness of these biofumigants depends on the pest target, the source of the biofumigant, the timing and method of application, and the location of the field. Although biofumigants may control some soil-borne pests, they are not a panacea: Growers will need to understand the conditions under which biofumigants work.

Brassicaceous fumigants are generally made from the residue of broccoli, brussels sprouts, cabbage, and horseradish crops. These produce compounds called glucosinolates, which break down into volatile chemicals called isothiocyanates that can kill fungi, nematodes, and weeds. At a coastal site, the researchers found that incorporation of broccoli at a rate of eight dry tons per hectare eliminated citrus nematode at a soil depth of six inches. The biofumigant was less effective for weed control and ineffective for control of *Fusarium* fungi.

Other brassicaceous crops may be more effective than broccoli. For example, broccoli did not control citrus nematode at a soil depth of one foot, but brussels sprouts or horseradish residue reduced citrus nematode populations by 39% and 59%, respectively. (This is one of the few uses humans have found for brussels sprouts.) On the other hand, bindweed control was increased by broccoli residue incorporation, but not by incorporation of other brassicaceous amendments. *Fusarium* fungi were indifferent to any of these amendments.

Tarping a field after incorporation of broccoli residue generally did not increase pest control in coastal sites, with the exception of a Watsonville trial. In that experiment, the soil temperature reached 95°F for four days and all weeds except common purslane were controlled. Combined tarping and biofumigation was more effective inland, where solarization increased soil temperatures substantially.

At best, the authors are cautiously optimistic. Based on glucosinolate composition and sensitivity of citrus nematode to specific isothiocyanates, they calculate that 115 dry tons/hectare of broccoli or 20 tons/hectare of horseradish must be incorporated to obtain 90% control of the nematode. The researchers noted that the amount and type of glucosinolates depends on the crop variety, age, and part of the plant used, and recommended that future research focus on these factors.

[1] Zasada IA, Ferris H, Elmore CL, Roncoroni JA, MacDonald JD, Bolkan LR, Yakabe LE. 2003. Field application of brassicaceous amendments for control of soil borne pests and pathogens. *Plant Health Progress* doi:10.1094/PHP-2003-1120-01-RS (on-line at http://www.plantmanagementnetwork.org/sub/php/research/2003/amend/)

❖

By Richard Y. Evans, Department of Environmental Horticulture, UC Davis

Continued from page 1

nutrients; reducing photosynthesis, the process by which plants make food; and increasing water loss.

Delphinium growers in California apply fungicides to control powdery mildew. However, not all fungicides are equally effective. Research conducted at the South Coast Research & Extension Center in Irvine and in a grower's field in Lompoc in 2002 and 2003 revealed that Banner MAXX (propiconazole) was the most effective in controlling powdery mildew among 11 fungicides tested. Other fungicides that had good efficacy, but only under low disease pressure were Eagle (myclobutanil), Daconil Ultrex (chlorothalonil), Sulfur, E-RASE (Jojoba oil), and Kaligreen (potassium bicarbonate) (Table 1, below).

A second powdery mildew management option is to grow resistant cultivars. Growing delphinium cultivars that are resistant or partially resistant to powdery mildew can reduce the number of fungicide sprays applied during the growing season. Research on the UC Riverside campus and at the South Coast Research & Extension Center tested nine delphinium cultivars provided by Donald Bleeck of Suncoast Nursery, Carpinteria. The hybrid cultivars Blue Bird, Cameliard, Galahad, and King Arthur were found to be highly resistant in lath house and field experiments, with disease severity ranging from 0.1 to 0.5 on a 0-5 scale. Bellamosum, Blue Shadow, Belladona, Casa Blanca, and Oriental Blue were susceptible with disease severity ranging from 2.9 to 4.6 on a 0-5 scale. These susceptible cultivars are also the most popular and therefore more widely grown. Future research will focus on identifying resistance among the popular delphinium cultivars.

A third powdery mildew management option is adoption of good cultural practices. Spacing plants widely enough to allow air movement within the plant canopy can help reduce the severity of powdery mildew. Although powdery mildew spores generally do not require free water to germinate, fungal growth is optimal under high humidity conditions. Allowing good air circulation lowers relative humidity, which in turn reduces powdery mildew growth. Currently, research is ongoing to determine the effect of single versus double row culture on severity of powdery mildew in delphinium fields. Another cultural practice that can help to keep powdery mildew severity low is to avoid wet and poorly aerated soils.

A powdery mildew management option that is not yet available to

See Powdery Mildew–Page 14

Table 1. Disease severity on 17 March, 2003 (0 – 5 scale; 0 no disease, 5 whole plant diseased) among 12 fungicide treatments applied to control powdery mildew on delphinium (Belladonna dark blue cultivar) in double- and single-row culture at SCREC*, experiment 2.

Treatment**	Rate/100 gal	Interval (days)	Disease severity (0-5 scale) Single row	Double row
Non-treated control	…	…	5.0	4.8
Sporodex (*Pseudozyma flocculosa*)	64 fl oz	7	4.8	4.6
Clearys 3336 (thiophanate-methyl) alt w/ Kaligreen (potassium bicarbonate)	24 oz 3 lb	10	4.8	4.6
Compass 50 WG (trifloxystrobin) alt w/ Sulfur 90W (sulfur)	4 oz 4 tbls	10	4.6	4.5
Heritage 50WDG (azoxystrobin) alt w/ Daconil Ultrex 82.5% (chlorothalonil)	4 oz 1.4 lb	10	4.4	4.4
Kaligreen (potassium bicarbonate)	3 lb	7	4.3	2.9
Rubigan A. S. 11.6% (fenarimol)	5 fl oz	10	4.3	3.8
Sulfur 90W (sulfur)	4 tbls	7	4.1	2.5
Daconil Ultrex 82.5% (chlorothalonil)	1.4 lb	10	4.0	2.8
E-RASE (Jojoba oil)	64 fl oz	7	3.9	3.4
Eagle 40 WSP (myclobutanil)	3 oz	10	3.1	1.8
Banner MAXX 14.3% (propiconazole)	8 fl oz	10	1.6	0.4
Least significant difference, LSD (*P* = 0.05)			**0.6**	**0.7**

* South Coast Research & Extension Center, Irvine, CA

**First treatment applied 28 Jan, last treatment applied 6 Mar. Indicated amounts include active and inert ingredients. Beds were 40 inches apart and 30 inches wide. Plot size was 10 feet by 30 inches. Spacing between plants in a row was 10 inches; spacing between rows in double-row plots was 10 inches.

Campus News & Research Updates

Submitted by Julie Newman, UCCE Farm Advisor, Ventura and Santa Barbara Cos.

State Budget Cut Proposal for UC

The Governor's budget for 2004-05 fiscal year that begins July 1, 2004 was released on January 9. Although it is overall gloomy for the University of California, it contains some good news for the Agriculture and Natural Resources (ANR) Division. Cooperative Extension is fully funded by the Governor at the 2003-04 level.

Apparently the strong message sent to Sacramento last spring by thousands of stakeholders about UCCE's importance to California communities, a healthy economy, and the youth of the state was instrumental in this positive outcome.

ANR Budget Situation is Still Serious

The ANR Division is still facing some very serious budget decisions, however, as a result of the deep cuts to the University since 2001-02. Last year the California Legislature cut UC by $400 million and this has impacted every University program. For the Division, this meant a reduction in state funding of 25% for Cooperative Extension and a second straight 10% cut for agricultural research.

In facing these unprecedented cuts, Vice President Gomes' priority has been to maintain programs that directly serve local communities and local needs. Cuts to county-based UCCE programs were held to 15% while distributing larger percentage cuts across other programs, especially system-wide administration.

Currently Gomes is conducting Listening Sessions throughout the state with stakeholders and UC administrators for input into shaping the future direction of ANR within these budget constraints.

UC Budget Reductions

For the University as a whole, the governor proposes a budget reduction of more than $370 million for 2004-05. The cuts being proposed for UC, coming as they do on top of deep previous budget cuts, will have a very real impact on what the institution is able to accomplish for the people of California. The cuts include a 5% ($11.6) million reduction in state-funded research (on top of the 20% cut these programs have taken over the last two years). The cuts also would eliminate funding for K-12 Outreach and the Digital California Project (which brings internet to the California public schools).

The governor also proposes budget reductions in the following areas: student financial aid, faculty salaries, academic and administrative support including libraries, development of UC Merced, and construction and retrofit projects. In addition, reduction in UC enrollment and increases in student tuition are proposed.

State Budget Process

The governor's budget proposal marks the beginning of the state's 2004-05 budget process. The legislature must agree on a budget, and the final budget won't be decided for months. In May, after taxes have been filed and the

See Campus News–Page 14

Powdery Mildew

Continued from page 12

growers is the use of a warning system to time fungicide sprays. Applying fungicides only when powdery mildew is likely to develop can result in significant spray savings. Research is ongoing to determine the environmental conditions that trigger release of delphinium powdery mildew spores that cause initial or primary infections as well as conditions that are most favorable to survival and growth of delphinium powdery mildew fungi. The research is intended to provide information which growers can use to determine when to apply fungicides to prevent powdery mildew infections.

Although the management options discussed above can be applied individually, the best approach to managing delphinium powdery mildew is to integrate all available options into an IPM strategy. This means combining fungicide applications with use of resistant cultivars, good cultural practices, and, when available, a disease-warning system for timing fungicide applications.

Acknowledgments: Funding provided by the Kee Kitayama Research Foundation.

❖

Campus News

Continued from page 13

Department of Finance has a better estimate of revenues, the budget picture may change.

UCD Plant Sciences Merge

Last year, a faculty committee under the direction of Dean Neal van Alfen, College of Agricultural and Environmental Sciences, developed a structure for the merging of the plant sciences departments into one department, and identified issues and ideas related to the merge. The plan was approved on a broad level, and this fall a faculty committee has been charged with implementation and with addressing the many issues required for successful integration.

Environmental Horticulture is one of four departments involved in this effort. The other departments are Agronomy and Range Science, Vegetable Crops, and Pomology. The resulting department will have several sections that would group faculty into interest groups. The vision is that this change will allow exciting opportunities for collaboration and investment in the plant sciences, and will thus sustain UC Davis' leadership in the field far into the future.

The implementation committee is currently developing a detailed proposal that ultimately will go to Chancellor Vanderhoef for approval. The projected date for implementation is July 1, 2004.

While it is too early to present specific results from this effort, Heiner Lieth, chair of the Department of Environmental Horticulture, reports that the faculty are united in an effort that will optimize ability to respond to specific problems with greater focus and broader expertise.

Heiner Lieth points out that as a result of the merge, instead of working independently in separate plant science departments on similar environmental issues facing agriculture, faculty will now be able to approach the broader issue in a more concerted effort. According to Lieth, "Our various clientele groups can count on greater access to faculty with wider interests and skills when they are looking for scientists to work on specific, important issues."

❖

CORF

Floriculture education from the Kee Kitayama Research Foundation

CORF News is the quarterly publication of CORF, the California Ornamental Research Federation, a statewide partnership of growers, floriculture associations, allied industry and researchers/educators whose mission is to identify and meet the research and educational needs of the California floriculture industry.

Reproducing and distributing material from this newsletter is encouraged, provided credit is given to the author and *CORF News*

Managing Editor:
Steve Tjosvold
UCCE Monterey & Santa Cruz Counties

Editorial Committee:
Ann King
UCCE San Mateo & San Francisco Counties
Michael A. Mellano
Mellano and Co.
Julie Newman
UCCE Ventura County
Karen Robb
UCCE San Diego County

Design & Layout:
Susan Bearden Thomas
News submissions:
Ph/Fax: 707/467-0815
email: sbeardenthomas@adelphia.net

Advertising Sales:
Melissa Keiper
858/509-9518

The University of California prohibits discrimination against or harassment of any person on the basis of race, color, national origin, religion, sex, physical or mental disability, medical condition (cancer-related or genetic characteristics), ancestry, marital status, age, sexual orientation, citizenship, or status as a covered veteran (special disabled veteran, Vietnam-era veteran or any other veteran who served on active duty during a war or in a campaign or expedition for which a campaign badge has been authorized).

University Policy is intended to be consistent with the provisions of applicable State and Federal laws. Inquiries regarding the University's nondiscrimination policies may be directed to the Affirmative Action/Staff Personnel Services Director, University of California, Agriculture and Natural Resources, 1111 Franklin, 6th Floor, Oakland, CA 94607-5200; tel. (510) 987-0096.

California Ornamental Research Federation

P.O. Box 318
Freedom, CA 95019-0318
Ph: 831/724-1130
Fax: 831/728-7337
www.corf.org

Address service requested

Thanks to these Sponsors of CORF Educational Programs

Sustaining Sponsors

CA Cut Flower Commission/Kee Kitayama Research Foundation
CA Assoc. of Flower Growers & Shippers
UC Cooperative Extension

Calendar of Industry Events

February

20–22 . SAF Pest Management Conference, San Jose, 703/836-8700

23–27 . Southern California Plant Tour Days, Del Mar & So. Cal tour sites, 760/431-2572

27–29 . Michigan Floral Assoc. Spring Convention, Lansing, MI, 517/575-0110

March

1–3 ..... AgriFlor, Miami, FL, +31-20/662-2482

6–7 ..... Northeast Flora Expo, Hartford, CT, 203/268-9000

15-16 .. SAF Congressional Action Days, Washington, DC, 703/836-8700

17 .... CSFA Legislative Action Day, Sacramento, 916/448-5266

17–20 . WF&FSA Annual Convention, Coronado, 410/573-0400

April

14–17 . ICFG 2004 Spring Meeting, Leamington, Ontario, Canada, 517/655-3726