CORF news

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Floriculture Education from the Kee Kitayama Research Foundation

Management of *Botrytis* Diseases in Flower Crops

by Stephen Wegulo - University of Nebraska, Lincoln

The fungal pathogen *Botrytis cinerea* is a major threat to floriculture production. It causes gray mold or *Botrytis* blight on many flower crops. Plants at all stages of growth can be infected. Symptoms of diseases caused by *B. cinerea* include blighting of stems, petioles, leaves, and flowers; seedling damping off; stem cankers; and rots. *Botrytis* diseases are favored by high relative humidity and cool temperatures. The optimum temperature range for growth and sporulation of *B. cinerea* is 64° to 73°F. However, the pathogen can remain active outside this temperature range and can cause considerable losses in products stored at temperatures as low as 32° to 50°F. The greenhouse environment is especially favorable to growth and sporulation of *B. cinerea*. Free water on the plant surface is required for infection to occur. During favorable conditions, *B. cinerea* sporulates profusely, producing a mass of gray mycelium and spores. Sclerotia (compact masses of mycelia) can form inside or on the surface of infected plants and are a means of long term survival of the fungus. The fungus also can survive as mycelium in plant debris. Spores are disseminated by air currents and will germinate and infect healthy plants if they land on wounds or senescent plant parts. Insects also can spread spores from infected to healthy plants.

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Methyl Bromide Alternatives Research

by Husein Ajwa, Susanne Klose, and Clyde Elmore - University of California, Davis

Methyl bromide (MB) is a broad-spectrum soil fumigant that has been critical in crop production for over forty years. Mixtures of chloropicrin (Pic) plus MB (i.e., MB/Pic) work synergistically to control a wide range of plant pathogens and pests, including fungi, nematodes, insects, mites, rodents, weeds, and some bacteria. Currently, only three MB alternative fumigants are commercially available for cut flower production, and intensive research is being conducted to optimize application technologies to improve their performance and reduce application costs. Registered chemical alternatives are Pic, 1,3-dichloropropene (1,3-D), and methyl isothiocyanate (MITC) generators such as metam

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Why Does *Phytophthora ramorum* keep Re-Emerging in Nurseries?

by Lani Yakabe and James MacDonald - University of California, Davis

When *Phytophthora ramorum* is confirmed to be present in a nursery, a series of regulatory actions are evoked under the APHIS "Confirmed Nursery Protocol" [Official Regulatory Protocol for Nurseries Containing Plants Infected with *Phytophthora ramorum* (Sudden Oak Death), Revised 15 October 2004 (Minor Updates on 17 March 05)"]. Among the actions evoked is the removal and destruction of "all host and associated plants and plant parts within a [delimited] destruction block." Coupled with the removal

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Editor's Note:

In this issue we focus on plant disease issues. Our feature articles are on methyl bromide alternatives, *Botrytis*, and *Phytophthora ramorum*. Inside, you will find an article on downy mildew. Farm Advisors report on disease issues too in their respective Regional Reports. Don't forget to read the continuing discussions in "Science to Grower" and the last installment on irrigation water filtration techniques in "Get Cultured".

- Steve Tjosvold, Editor, CORF News

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Several strategies can be employed to manage *Botrytis* diseases. Scouting for detection of diseased plants coupled with sanitation and good cultural practices can be effective in reducing damage and losses caused by *B. cinerea*. Removal and destruction of infected plants and infested plant debris can help to reduce the amount of inoculum available to infect healthy plants. Good aeration keeps the plant surface dry, preventing spores from germinating. In the greenhouse, humidity can be reduced by ventilation and heating. In a study in which we used an air flow system to circulate air in lisianthus beds in a greenhouse, plant mortality due to *B. cinerea* was reduced by 44% in air-treated compared to control beds. Since infection can occur through wounds, minimizing wounding of plants during routine production practices can help to minimize disease.

Use of resistant cultivars is an effective and inexpensive means of managing diseases caused by *B. cinerea*. Research is needed to identify flower crop cultivars with resistance to this pathogen. In a series of experiments we conducted at the University of California, Riverside, eight methods were used to evaluate twelve lisianthus cultivars for resistance to *B. cinerea* (Table 1). Cultivar reaction to *Botrytis* varied among the screening methods. Based on average cultivar rank using all eight screening methods, the six most resistant cultivars were Magic Champagne, Echo Pink, Magic White, Avila Ivory, Magic Rose, and Balboa Yellow (Tables 1 and 2). By correlating method 1, in which commercial greenhouse conditions were simulated, with the rest of the methods, the most reliable screening techniques were found to be method 1 – stem lesion length on live plants incubated in a plastic chamber on a greenhouse bench, method 2 – disease incidence from method 1, and method 3 – necrotic leaf area on spore-inoculated detached leaves. Based on average cultivar rank using these three methods, the six most resistant cultivars were Magic Champagne, Magic Rose, Avila Ivory, Echo Pink, Balboa Blue, and Magic White.

Table 1. Responses of 12 lisianthus cultivars evaluated for resistance to *Botrytis cinerea* using eight methods in 2004.

Evaluation method[z]	1	2	3	4	5	6	7	8
Measurement	Stem lesion length (cm)	Disease incidence (%)	Necrotic leaf area (%)	Necrotic leaf area (%)	Stem lesion length (cm)	Stem lesion length (%)	Necrotic leaf area (%)	Necrotic leaf area (%)
Cultivar								
Echo White	14.6 a	79.4 ab	54.8 ab	25.8 a	10.3 a-c	48.4 b	42.6 a-c	61.3 a
Echo Lavender	13.1 ab	85.3 a	57.1 a	43.2 a	8.6 b-d	48.2 b	53.8 ab	53.5 a
Avila Purple	12.4 a-c	76.5 a-c	49.1 a-c	48.8 a	5.8 de	86.5 a	65.9 ab	64.8 a
Avila Blue Rim	12.1 a-d	69.1 a-d	34.6 b-e	48.8 a	13.3 a	49.2 b	71.1 a	68.5 a
Catalina Purple	10.1 b-e	69.1 a-d	41.3 a-d	35.7 a	12.6 ab	39.3 b	68.1 a	43.9 a
Magic White	9.4 c-e	67.6 a-d	19.8 ef	28.0 a	3.7 ef	45.5 b	35.0 bc	46.0 a
Magic Rose	9.3 c-e	64.7 b-d	23.6 e-f	30.8 a	7.8 c-e	45.9 b	45.9 a-c	52.5 a
Balboa Yellow	9.3 c-e	57.4 de	38.5 a-e	31.8 a	5.3 de	51.0 b	49.6 ab	63.4 a
Balboa Blue	8.9 de	58.8 cd	37.5 a-e	37.8 a	8.8 b-d	46.2 b	61.6 ab	68.1 a
Echo Pink	7.6 e	77.9 ab	13.8 f	30.0 a	5.4 de	35.5 b	14.9 c	56.3 a
Avila Ivory	7.3 ef	70.6 a-d	25.1 e-f	27.7 a	8.4 cd	39.3 b	52.0 ab	55.0 a
Magic Champagne	4.0 f	39.7 e	30.2 c-f	35.0 a	0.3 f	42.7 b	35.6 bc	70.4 a
$LSD_{0.05}$[y]	3.4	18.8	20.5	23.7	4.2	34.8	32.2	29.2

Method 1, live plant stem assay in a plastic chamber – spore spray inoculation; method 2, disease incidence in the plastic chamber in Method 1; method 3, detached leaf assay – spore spray inoculation; method 4, detached leaf assay – mycelial disc inoculation; method 5, live plant stem assay in a growth chamber – spore spray inoculation; method 6, cut stem assay – spore spray inoculation; method 7, leaf disc assay – spore drop inoculation; method 8, leaf disc assay – mycelial disc inoculation.

[y]Cultivar means within a column followed by the same letter are not significantly different according to Fisher's least significant difference test at $P = 0.05$.

Even with good sanitation and cultural practices, *Botrytis* diseases can still cause significant losses during favorable environmental conditions, especially because many flower crop cultivars lack resistance to the pathogen. Hence growers often resort to fungicide applications to control *Botrytis*. Results from a fungicide trial we conducted in 2004 in a commercial greenhouse in San Diego County showed that all fungicide products applied to control *Botrytis* on lisianthus significantly lowered disease incidence (percentage of infected plants) compared to the non-treated control (Table 3). The fungicides included in the trial were Rhapsody®, Daconil Ultrex®, Kaligreen®, Fore®, Heritage®, Heritage MAXX®, Decree®, BAS 500, BAS 510, and Medallion®. To maximize efficacy of fungicides, it is important to follow label instructions and to apply the products at label rates. Unless otherwise stated on the label, it is advisable to add a non-ionic surfactant to fungicides to maximize their efficacy. Because *Botrytis* has been shown to develop

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Management of Botrytis cont. from page 2

Table 2. Ranks of 12 lisianthus cultivars (1 = most resistant; 12 = least resistant) evaluated for resistance to *Botrytis cinerea* using eight methods in 2004.

Evaluation method[z]	1	2	3	4	5	6	7	8
Measurement	Stem lesion length (cm)	Disease incidence (%)	Necrotic leaf area (%)	Necrotic leaf area (%)	Stem lesion length (cm)	Stem lesion length (%)	Necrotic leaf area (%)	Necrotic leaf area (%)
Cultivar				Rank				
Echo White	12	11	11	1	10	9	4	7
Echo Lavender	11	12	12	10	8	8	8	4
Avila Purple	10	9	10	11	5	12	10	9
Avila Blue Rim	9	6	6	11	12	10	12	11
Catalina Purple	8	6	9	8	11	2	11	1
Magic White	7	5	2	3	2	5	2	2
Magic Rose	5	4	3	5	6	6	5	3
Balboa Yellow	5	2	8	6	3	11	6	8
Balboa Blue	4	3	7	9	9	7	9	10
Echo Pink	3	10	1	4	4	1	1	6
Avila Ivory	2	8	4	2	7	2	7	5
Magic Champagne	1	1	5	7	1	4	3	12

[z]Method 1, live plant stem assay in a plastic chamber – spore spray inoculation; method 2, disease incidence in the plastic chamber in Method 1; method 3, detached leaf assay – spore spray inoculation; method 4, detached leaf assay – mycelial disc inoculation; method 5, live plant stem assay in a growth chamber – spore spray inoculation; method 6, cut stem assay – spore spray inoculation; method 7, leaf disc assay – spore drop inoculation; method 8, leaf disc assay – mycelial disc inoculation.

resistance to fungicides, especially the benzimidazoles and dicarboximides, fungicide resistance management should be practiced. It can be accomplished by montoring pathogen populations for detection of fungicide resistance, alternating or tank-mixing fungicides with different modes of action, properly timing fungicide applications, and applying fungicides at label rates.✳

Acknowledgments: Greenhouse space and plants for the fungicide trial were provided by Dramm & Echter, Encinitas, CA. Fungicides were provided by AgraQuest, BASF, Dow AgroSciences, Monterey AgResources, SePro, and Syngenta.

Table 3. *Botrytis* incidence on lisianthus cultivar Avila Purple from a fungicide trial in a commercial greenhouse in San Diego County, CA, 2004

Treatment and rate/100 gal		Disease incidence (%)	
	9 Apr 04	20 Apr 04	30 Apr 04
Non-treated control	11.6 a	12.9 a	14.7 a[z]
BAS 500 8 oz	5.4 ab	5.7 ab	7.0 b
Rhapsody 4 quarts	3.4 b	3.6 b	6.4 b
Medallion 2 oz	3.4 b	4.1 b	5.4 b
BAS 510 8 oz	5.2 ab	4.9 b	5.2 b
Decree 12 oz	4.1 b	4.6 b	4.9 b
Heritage® 2 oz	1.0 b	1.0 b	4.9 b
Heritage MAXX® 10 fl oz	2.8 b	2.8 b	4.6 b
Fore® 1.5 lb	0.8 b	2.3 b	3.1 b
Kaligreen® 2.5 lb	1.3 b	1.0 b	3.1 b
Daconil Ultrex® 1.4 lb	1.0 b	1.8 b	2.8 b
Rhapsody® 6 quarts	2.6 b	1.0 b	2.3 b

[z]Means within a column followed by the same letter are not significantly different at P = 0.05 according to the least significant difference test.

Stephen Wegulo
University of Nebraska, Lincoln
448 PS
Lincoln, NE 68583-0722
Phone: (402) 472-8735
Fax: (402) 472-2853
e-mail: swegulo2@unl.edu

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sodium, metam potassium, and Basamid®. Midas® (iodomethane) registration is currently being considered by the USEPA (United States Environmental Protection Agency).

Methyl bromide and alternative fumigants are needed to control soil-borne fungal pathogens such as *Pythium* and *Phytophthora* species, and fungal pathogen combinations (which are the species involved in this disease complex) commonly referred to as "water molds." They can attack a wide variety of plants, causing general root or crown rots and are favored by wet soil conditions. *Pythium* species tend to attack juvenile or herbaceous plants, while *Phytophthora* species tend to be most common on woody, perennial plants. Like *Pythium*, *Rhizoctonia solani* is a fungus that attacks a wide variety of young, succulent plants, often causing damping off or root rot. Other fungal pathogens that are frequently encountered are *Fusarium solani* (causing a generalized root rot), *Fusarium oxysporum* (causing vascular wilt), and *Sclerotium rolfsii* (cause of southern blight), *Sclerotinia sclerotiorum* (cause of white rot), *Thielaviopsis basicola* (causing a root rot), *Botrytis cinerea* (the sclerotium stage), and species of *Cylindrocarpon* and *Cylindrocladium*. Some soil-borne bacterial pathogens of general interest include *Erwinia chrysanthemi* (soft rot and wilt of plants) and *Agrobacterium tumefaciens* (crown gall).

Table 1. Citrus nematode and soil pathogen change after fumigation with methyl bromide and alternative fumigants (average of three studies).

Treatment	Nematode reduction[H]	*Pythium spp.*[I]	General soil pathogens[I]	*Fusarium spp.*[I]
MB/Pic (350 lbs/ac)	68 c	88 ab	93 a	99 a
Midas® (300 lbs/ac)	76 bc	82 b	93 a	73 ab
Midas® (350 lbs/ac)	88 ab	88 ab	92 a	98 a
Telone® C35 (400 lbs) + Metam (75 gal)	94 a	95 a	95 a	99 a
InLine® (400 lbs) + Metam (75 gal)	93 a	94 a	97 a	100 a
Dazomet® (200 lbs) + Telone® C35 (400 lbs)	93 a	98 a	98 a	99 a
Dazomet® (200 lbs) + InLine (400 lbs)	95 a	97 a	98 a	99 a
Control	2 d	0 c	21 b	44 b
Metam 75 gal (320 lb)	91 a	82 b	91 a	97 a

[H] Percent of nematodes killed relative to pre-fumigation counts. Nematode control was likely influenced by the low soil moisture at treatment of the shank treatments of MBr/Pic and Midas®.

[I] Percent of pathogens killed relative to pre-fumigation counts.

Table 2. Ranunculus bulb yield by size class.

Treatment	Jumbo[H]	6's[H]	5's[H]	Total
MB/Pic (200 lbs/ac)	3200	1416	838	5956
MB/Pic fb[I] Kpam	4332	1488	1088	7706
InLine® (300 lbs/ac)	2390	748	548	4044
InLine® fb[I] Kpam	4462	1784	1128	8060
Midas® (200 lbs/ac)	3656	1256	886	6364
Midas® fb[I] KPam	6088	2154	1284	10442
Pic (200 lbs/ac)	3256	1262	864	5826
Pic fb[I] KPam	4912	2182	1260	9066
Untreated[¶]	608	528	484	1996
Untreated fb[I] KPam	1692	1526	1154	5214

[H] Number of bulbs: Jumbo is > 7 cm; 6's is 6-7 cm; and 5's is 5-6 cm.

[I] fb, followed by 30 gal/ac of KPam one week later.

[¶] Jumbo and total bulb yields in the untreated control were significantly different (P=0.05) from all other treatments.

Our research evaluated several alternative fumigants applied singly or in combination by shank injection and drip fumigation. Our preliminary results indicated that high rates of all fumigants tested effectively controlled major soil fungal pathogens and citrus nematodes (Table 1). Gladiolus yields (cormlets and stand count) from all plots fumigated with alternative fumigants were similar to yields from the standard MB/Pic and significantly higher than yields from the untreated control. Also, most resident weeds (such as hairy nightshade, nettle leaf goosefoot and lambsquarters) and nutsedge tubers (buried bags) were controlled with the alternative fumigants using rates listed in Table 1.

Recent field study on reduced rates of fumigants documented that Midas® is more effective than MB in controlling soil fungal pathogens. Drip fumigation with Midas® (33/67) at a rate of 200 lbs/ac, chloropicrin at 200 lbs/ac, or Inline® at 300 lbs/ac gave similar Ranunculus bulb yields as MB/Pic at 200 lbs/ac, and significantly higher yield than the untreated control (Table 2). All chemical treatments significantly reduced *Fusarium oxysporum* (in buried bags) and soil *Pythium spp* by more than 85% relative to untreated control. Furthermore, the sequential drip application of metam potassium (KPam, 30 gal/ac) one week past soil fumigation with MB/Pic, Midas®, Pic, or InLine® significantly increased total yields and the control of weeds such as little mallow and clover. Among the fungal pathogens, the sequential application of KPam fully controlled *Fusarium* and *Pythium spp*. Shank

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Grower Issues in San Diego County

by Valerie J. Mellano - UC Cooperative Extension, San Diego County

Grass-lined ditches in drainage areas of nurseries to help minimize erosion problems and nutrient discharges. BMP's like this are part of the environmental requirement for nurseries in San Diego.

Last spring, the San Diego County Board of Supervisors approved a general policy to support and encourage farming in San Diego County. This is in response to the large turnover of land from agricultural uses to residential and commercial uses, largely due to the escalating price of land as well as the regulatory and other difficulties faced by the agricultural community. As is the usual situation, everyone appreciates the open space and other benefits of agriculture, but is dismayed with the negative aspects. The result is a set of extreme rules that makes it difficult or impossible for growers to do business. As a direct result of the policy adoption, San Diego County is developing what is called the "Farming Program Plan: Farming in an Urban County". San Diego County has contracted with American Farmland Trust (AFT) to help develop this plan. It is the intent of the AFT to include in the plan, land use policies and programs to keep land available and affordable for farming, and economic development tools to help improve farm profitability. This is a joint effort between the Department of Agriculture, Weights and Measures; the UC Cooperative Extension; and the Planning and Land Use Department of San Diego County, as well as the San Diego County Farm Bureau.

Early in the process, several local grower/stakeholder meetings were held at various locations in the agricultural areas of the county. The intent of the meetings was to define the highest priority issues that can make farming unlikely to continue in San Diego. Repeated concerns from the meetings included the following, with numerous examples defining the frustrations of the growers:

• **Difficult to Expand Farms:** It is difficult to expand operations due to County permitting costs (a slow process, expensive, and too many regulations as compared to other counties and states) and the rising cost of land in general.

• **Equity Mechanisms:** An equity mechanism such as a Purchase of Development Rights and/or Transfer of Development Rights (PDR/TDR) should be included in the county's General Plan. Alternatively, there should be more tax incentives to keep farmers farming in San Diego County.

• **Proposed Minimum Lot Sizes:** In a misdirected attempt to keep land in agriculture, the county general plan currently proposes 40-acre minimum lot sizes in rural areas. This does not consider that 65% of farms in San Diego County are 9 acres or less with the median being 5 acres. The proposed minimum lot sizes also preclude farmers from being able to subdivide for their children who would take over a portion of the property and continue farming.

• **Development Pressures:** Because of the lack of profitability to farm, some farmers must find other uses for their land.

• **Agriculture/Urban Interface Issues:** Existing farmers must deal with new developments adjacent to their farms. The new developments see existing farms as incompatible to their uses.

• **Endangered Species:** The Multiple Species Conservation Program, particularly within the Pre-approved Mitigation Areas present difficulties for farmers to need to expand, due to mitigation requirements.

• **Water Quality:** There are too many runoff regulations. More educational outreach is needed, and realistic regulations are necessary.

• **Water:** The costs and availability of water in San Diego County is always a concern.

• **Rising Cost of Inputs:** The costs of gas, electricity, and fertilizers, etc. continue to rise while the profit margins decline.

• **Labor:** There is a labor shortage because of tightened border security and other factors. Additionally, the cost of insurance to cover worker's compensation is overpriced. When labor is available, farmers still face unmanageable farm labor housing regulations and restrictions.

• **Competition from Foreign Markets:** The competition is forcing the profit margins to decrease.

• **Exotic Pests and Diseases:** Introduction of exotic pests and diseases creates quarantines and increases the cost of doing business due to treatments and loss of revenues.

• **Research Funding:** More funding is needed for research to develop new crops for San Diego County.

• **Marketing:** Agriculture tourism should be promoted for the County. Additionally, more marketing for locally grown products/labeling is needed.

All of these critical issues reinforce the opinion held by most local growers-farming just isn't what it used to be! A typical grower spends as much time dealing with land use and other regulatory issues as with growing plants.*

Irrigation tailwater pond. All irrigation runoff must be captured and part of the San Diego County storm water regulations. This proves difficult for nursery owners with limited space and on steep hillsides.

Valerie J. Mellano
Environmental Issues Advisor
UC Cooperative Extension
UCCE San Diego County
5555 Overland Ave. Building 4
San Diego, CA 90123
Phone: (858) 571-4204
Fax: (858) 694-2849
e-mail: vjmellano@ucdavis.edu

Disease Problems Plague Australian Cut Crops

by James A. Bethke and Valerie J. Mellano - UC Cooperative Extension, San Diego

Over the last few years, growers of Australian perennial cut flowers in northern San Diego County have experienced serious losses due to soil-borne pathogens. Growers would replace dead stock and subsequently lose the new plants as well. An investigation is underway that will help determine the culprits and hopefully find a solution. Ann Chase was consulted and a task force created in the latter part of 2005.

Ann Chase, James Bethke, Michael Mellano, and Joe Walker toured some of the affected growers in northern San Diego County in August of 2005. Indeed, the losses are significant and current solutions lacking. Losses seemed to be associated with the heavy winter rains of 2004-2005 and marginal or unworkable ground, i.e. virgin chaparral or old avocado and citrus orchards. Samples were taken from each site and Ann Chase took them back to her laboratory at Chase Research Gardens in northern California.

In December we met again and this time, Michael Stanghelini from the University of California Riverside and two of his staff, and Valerie Mellano joined us for the discussion. Ann Chase presented her findings and, unfortunately, it was not just one but several phytopathogens found in several of the locations sampled. Preliminary indications are that the losses are due primarily to a variety of fungi including *Phytophthora, Cylindrocladium, Fusarium* and *Pythium*. The first two are thought to be the critical pathogens to control. It was clear from our meeting that a major effort would be needed to study the problem and provide at least some solutions.

As a result of this meeting, we formed the Australian Cut Crops Task Force and are preparing a meeting to outline a research plan. Initially, we intend to confirm the cause and source of the losses, study tolerant and susceptible rootstocks or cultivars of the Australian perennials, and of course take a look at the common pesticides and application methods in field trials. Another area of study will include the potential for interaction with nutrients and salinity. In the meantime, Michael Stanghellini will try to speciate the *Phytophthora* and *Pythium* isolates, and Ann Chase will try to do the same for the *Cylindrocladium* and *Fusarium* isolates.

Future meetings are planned, one in late March that will involve the Task Force and two Australian growers/researchers, and one in late April to bring together the Task Force and the local wax flower growers. One of these trips will include another tour of affected growers. Watch for notices of these meetings in future newsletters.✳

New Rust Problems on Myrtle

by James A. Bethke, and Valerie J. Mellano - UC Cooperative Extension, San Diego

Eucalyptus Rust (Guava Rust) *Puccinia psidii* is common in California and has not been a concern for ornamental growers or regulatory agencies. It is also commonly found on guava and is a serious disease of *Eucalyptus spp.* in other parts of the world. Recently, however, it was found on commercial myrtle plantings in northern San Diego County.

Symptoms include bright yellow-orange pustules on both the upper and lower leaf surfaces and also on the stems of the plant. Powdery-looking spores are released from the pustules and can spread the disease to nearby plants, or they can be airborne, or carried on clothing, boots, tools, plant materials, animals etc. to other locations.

Treatment of the disease is extremely important, as it can potentially cause devastating losses to the commercial plantings of myrtle locally. To date, recommended treatment includes applications of Heritage® and Daconil® according to label instructions and the careful removal and destruction of any infected plant material. Destruction of the infested plants through burning or burying is important in minimizing the spread of the rust. It is very important to continuously be on the lookout for the presence of the fungus, and to eradicate it immediately if found. Widespread infection could be devastating to the cut greens industry.✳

Rust-infected guava fruits showing powdery masses of orange-yellow urediniospores. Photo by Marli F. S. Papa São Paulo State University

James A. Bethke
Valerie J. Mellano
UC Cooperative Extension
San Diego County
5555 Overland Ave. Building 4
San Diego, CA 90123
Phone: (858) 571-4204
Fax: (858) 694-2849
e-mail: james.bethke@ucr.edu
e-mail: vjmellano@ucdavis.edu

Phytophthora ramorum Detected in *Camellia* and *Rhododendron* Flower Buds

by S.Tjosvold, D.Chambers - UC Cooperative Extension Santa Cruz and Monterey, S. Thomas and C. Blomquist - CDFA Sacramento

We have observed in field experiments, extensive infection of *Camellia* flower buds by *Phytophthora ramorum*, the pathogen that causes Sudden Oak Death. *Rhododendron* flower buds were also found infected at the same location and time but to a much lesser extent than on *Camellia*. Flower bud infection has never been documented in the field until now.

***Camellia* flower bud infected with *Phytophthora ramorum* (left), *Camellia* flower bud not infected (right).**

Symptoms

We made our observations and detected *P. ramorum* on *Camellia japonica* 'Kumasaka'. The infection was first observed on tight to swelling (just starting to open) flower buds beginning December 20, 2005, after several rain events. Infection and development became more widely spread and severe by mid-January following an extensive rainy period. Infection mostly started on the lowest sepals attached to the flower bud receptacle. Sepals had relatively large areas of necrotic tissue and often were surrounded by diffuse necrosis. The infection developed down through the sepals to the receptacle, and then into the internal portions of the flower bud. Within the flower bud, the petals became completely necrotic, but at least initially, male flower parts, appeared unaffected. In many cases, the necrosis developed into adjacent vegetative and flower buds via stem tissue but the growth in stem tissue was generally very limited, and was only detected about 1 cm from the receptacle of an infected flower bud or vegetative bud. Infected flower buds never opened and eventually abscised.

Secondary Leaf Infection

Some leaves became infected that were adjacent to infected flower buds. Flower buds were washed with de-ionized water just following a rain event on March 10, 2006, and rinse water was collected and plated on selective media. *P. ramorum* propagules were readily detected in a concentration equal or higher than that found with *Rhododendron* infected-leaf washes. In a nearby associated field experiment, similarly leaf-inoculated, *Rhododendron* 'Cunningham's White' flower buds were also found infected with *P. ramorum*. At the time of detection, the flower buds were completely necrotic, and infection developed down the stem about 10 cm and into associated leaf petioles.

The initial inoculum for flower bud infection apparently came from the experiment's artificially inoculated leaves or secondary leaf infections arising from inoculated leaves. For our field experiments, there were three different groups of plants inoculated at three different time points, July 18, 2005, October 26, 2005 and February 1, 2006. For *Camellia*, most of the inoculated leaves had fallen by the time infection was first observed on the July- and October- inoculated plants. On March 10, 2006, flower bud infection was noted on the February- inoculated plants. Inoculum came originally from a nursery isolate from *Rhododendron* (North American genotype, #217).

Flower Buds Might Go Undetected, But are Important for Disease Cycle

Camellia and *Rhododendron* are two of the most important host plants of *P. ramorum*, accounting for the majority of detections in infested commercial nurseries. Regulatory authorities have focused on monitoring and detection of leaf infections. Infested flower buds could be an important source of inoculum and the continuity of the pathogen's life cycle. Flower bud sepals appear to be readily susceptible to infection and as seen in our field experiment can be present when no leaf infections or ostensible leaf infections are present. In addition, they can produce propagules readily and whole flower buds or sepals can fall from the plant and could be blown in the wind to other parts of the nursery or become a suitable source of long-lived propagules in the soil or leaf litter. We have observed other mimic symptoms on *Camellia* flower buds with 'Kumasaka' and other cultivars in the nursery and landscape. Generally, it is typical to see a necrosis on the edges of sepals on swelling and opening flower buds. In addition, infection of other pathogens and *Phytophthora* species could be possible. Laboratory isolation would of course be recommended when symptoms are present.✳

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

Preventative Control of Diseases

by Julie P. Newman - UC Cooperative Extension, Ventura and Santa Barbara

Prevention is the best control method for all diseases and is critical to any disease management program. Once disease symptoms are evident, management can be difficult and costly. In some cases, the only solution is destroying infected plants. Methods to prevent disease development and spread include use of resistant varieties, good sanitary practices, and proper plant culture.

Use of Resistant Varieties

Certain plant varieties or cultivars have physical or biochemical characteristics that make them resistant or less affected by diseases. Some varieties may be less suitable for infestation by plant pathogens while other varieties may be able to support diseases without suffering appreciable damage. Before buying plant material, especially propagation stock, check for information concerning resistant varieties. Keep records of different varieties that have demonstrated good disease resistance.

Good Sanitation Practices

Sanitation practices remove sources of inoculum before they spread and infect another plant or another part of the same plant, thus breaking up the disease cycle. Use the following examples of good sanitation practices whenever possible and appropriate.

• **Use certified plant material**. Use seeds, bulbs, or tubers that are certified to be pathogen-free.

• **Inspect incoming plant material**. Inspect all new shipments of plants, plugs, cuttings or transplants brought into the nursery; treat or dispose of infected plants promptly before introduction to the growing area.

• **Quarantine plants prior to general introduction**. Because symptoms may not be immediately expressed, isolate plants before placing into the growing area. A separate facility is not required if you have a greenhouse or shade house where you can construct walls using insect screening material.

• **Eliminate weeds**. Many plant disease vectors proliferate on weeds, e.g. western flower thrips infected with tospoviruses. Weed control also reduces competition for water and nutrients and increases air circulation.

• **Eliminate pathogen reservoirs.** Move diseased plants away from healthy plants and either destroy them or treat them in an isolated area. Plant debris and cull piles are excellent reservoirs for plant pathogens and should be kept away from and downwind of healthy plants and production areas.

• **Treat planting areas and media before establishing new crops.** This can be done by fumigating, heat steaming (at 140°F for 30 minutes), or chemically treating media. Alternatively, purchase planting media that has been pasteurized to kill plant pathogens and pests. All media should be stored in original bags or should be covered to prevent contamination by plant pathogens prior to use.

• **Treatment of Containers and Equipment**. Debris, soil, and plant material cling to containers and equipment; thoroughly wash equipment to remove all soil or planting mix particles. Heat treatment is effective in killing the plant pathogens that adhere to containers or that are in the debris. Where steam is not available, hot water can be very effective. The minimum water temperature should be 140°F (60°C) whenever possible. Treatment time can be as short as 1 minute. Commercial disinfectants are also available.

• **Keep hoses off the ground**. This practice can save many headaches down the road by avoiding the transfer of pathogens from the ground to plants.

• **Treat contaminated irrigation water.** Plant pathogens can be inoculated onto healthy plants through irrigation systems. This occurs when using recycled water, irrigating with surface water from ditches or holding ponds, or when irrigating with an ebb-and-flow system. Treatment (e.g. UV light, ozonation, chlorine sanitizers) can reduce pathogens in contaminated irrigation water.

• **Avoid mechanical transmission of pathogens.** Hands and pruning tools can be readily contaminated when working with diseased plants, especially if the causal agent is bacterial, viral, or present in the vascular system. Routinely sanitize all items which come into contact with plants, soil, or debris, including shoes.

Hands and pruning tools can be readily contaminated when working with diseased plants. Routinely sanitize all items which come into contact with plants, soil, or debris, including shoes.

Plant Culture

Provide good growing conditions to avoid environmental stresses.

• **Provide adequate fertilization.** Adequate fertilization is needed to avoid nutrient deficiencies and keep plants healthy enough to resist and recover from diseases. Too much nitrogen, however, can encourage excessive growth of new shoots, which may be more susceptible to plant pathogens than "hardened" more mature growth. In extreme cases, over-fertilization can also cause an excess of soluble salts in the soil which can lead to leaf scorch symptoms and damaged root systems.

• **Provide good air circulation**. Adequate plant spacing promotes good air circulation, thereby decreasing periods of leaf wetness. Early morning irrigation, sub-irrigation, or the use of a drip system is also recommended and use of a good horizontal air flow system.

• **Avoid prolonged leaf wetness**. Wet leaves encourage the development of foliar diseases. Free moisture is necessary for germination of many fungal spores e.g. *Botrytis*. Avoid overhead watering during blooming. If this is the only method of irrigation available, then do it early in the day so that the foliage can dry as rapidly as possible.

• **Provide good drainage and water management.** Overwatering and poor drainage promulgate root rot diseases. Avoid pools of water that spread disease or serve as breeding areas for pests that may vector diseases, e.g. fungus gnats and shore flies.✳

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

Downy Mildews: an ever-present threat to ornamental production

by Stephen Wegulo - University of Nebraska, Lincoln

The downy mildews are obligate parasites of many ornamental plants. They belong to a class of fungi called the *Oomycetes*. *Phytophthora* and *Pythium* also belong to this class. Most downy mildews that infect ornamental plants belong to the genus *Peronospora*. Other genera include *Basidiophora, Bremia, Bremiella,* and *Plasmopara*. Severe losses can result from downy mildew infection in relatively short periods of time. Downy mildews occur most commonly on greenhouse grown ornamentals, but can also infect outdoor plants during cool, wet weather. The downy mildews attack above-ground plant parts. Symptoms are most noticeable on leaves, which often appear pale yellow on the upper surface. Symptom expression can vary from one ornamental species to another. During humid conditions (above 85% relative humidity) sporulation occurs leading to a downy growth usually on the underside of leaves but also on the upper leaf surface in some ornamental species such as limonium, or when relative humidity is very high. The downy growth varies in color from purplish gray to white depending on the ornamental species. In some ornamentals, for example impatiens and rose, considerable defoliation can result from downy mildew infection.

Infection usually occurs in young, actively growing parts of the plant. Systemic infection results if the pathogen spreads throughout the plant. This type of infection is very destructive especially on seedlings. In older plants, systemic infection causes stunting, curling of leaves, rosetting, and eventually plant death. For infection to occur, free water is required on the plant surface, hence downy mildews are favored by cool, wet conditions. The optimum temperature range for downy mildews is 40° to 70°F. When sporulation occurs, sporangia are formed. To infect plants, the sporangia can germinate directly to produce a germ tube from which mycelium grows and invades the plant or they can germinate by producing zoospores. Most downy mildews germinate by producing zoospores. The sporangia or zoospores are spread by splashing water or blowing rain. Therefore, downy mildews can spread very quickly during rain or overhead irrigation.

A combination of strategies can be used to manage downy mildews. Routine scouting for downy mildew detection is necessary for timely action to prevent disease spread. In the greenhouse, avoiding overhead irrigation not only prevents spread of spores from infected to healthy plants, it also keeps humidity low which slows down disease development. Humidity can be lowered by ventilation, aeration, and heating. In the evening, greenhouse temperature should not be allowed to drop suddenly as this can significantly increase humidity. Plants showing severe symptoms and infested plant debris should be removed and destroyed. Resistant cultivars, if and when available, should be used.

Field-grown ornamentals are at the mercy of the weather and availability of downy mildew inoculum. During rainy weather, downy mildew can spread rapidly in the field. To minimize disease spread during periods when there is no rain, drip rather than sprinkler irrigation should be used. As with greenhouse-grown ornamentals, field-grown ornamentals should be scouted for early detection of symptoms.

Fungicide applications are often necessary to control downy mildew. The best strategy when using fungicides is to apply them preventatively. If infection has already taken place but has not progressed to the point where symptoms are severe, systemic

Table 1. Results of a fungicide trial on downy mildew of limonium conducted in San Luis Rey, San Diego County, CA in 2005

Treatments and rate/100 gal	Necrosis[z] 9 Jul 04	Downy Mildew growth[y] 9 Jul 04	Necrosis[z] 19 Jul 04	Residue[x] 22 Jul 04
Non-treated control	2.0 a[w]	2.7 a	4.2 a	0.0 d
Heritage® (standard) 1.0 oz	1.4 b	0.8 b-d	3.6 ab	0.1 b-d
BAS 500 8.0 oz	1.1 bc	0.9 bc	3.3 bc	0.2 b-d
EXP[v] 12.5 oz	1.1 bc	0.8 bc	2.8 b-d	0.2 b-d
Stature DM® 9.6 oz	1.1 bc	1.1 b	2.6 cd	0.3 bc
EXP 6.0 oz	0.8 cd	0.5 cd	3.3 bc	0.3 b
Fenstar® 7.0 fl oz	0.4 de	0.2 d	2.0 de	0.0 cd
Aliette® 2.5 lb + Fore® 1.5 lb	0.3 de	0.3 cd	2.0 de	0.8 a
Fenstar® 14 fl oz	0.3 e	0.3 cd	1.7 e	0.2 b-d

[z] 0, no visible symptoms of downy mildew; 1, 2, 3, 4, and 5 represent 0.1-20, 21-40, 41-60, 61-80, and 81-100% of leaf surface symptomatic, respectively (whole-plot rating).
[y] 0, no visible signs of downy mildew; 1, 2, 3, 4, and 5 represent 0.1-20, 21-40, 41-60, 61-80, and 81-100% of leaf surface covered with downy mildew, respectively.
[x] 0, no visible residue; 1, 2, 3, 4, and 5 represent 0.1-20, 21-40, 41-60, 61-80, and 81-100% of leaf surface covered with residue, respectively.
[w] Means within a column followed by the same letter are not significantly different at $P = 0.05$ according to the least significant difference test.
[v] Experimental product, confidential.

Downy Mildews cont. on page 13

Phytophthora ramorum cont. from page 1

of plants from the "destruction block" are methods for treating or disinfecting the targeted site. The stated goal of the protocol is to ensure that any infestations are consistently and effectively addressed, mitigated, and eradicated. Indeed, following evocation of the Confirmed Nursery Protocol (CNP) and subsequent failure of any new symptoms to appear on bordering plants, the pathogen is considered to have been eradicated.

Unfortunately, experience has shown that the CNP is not 100% reliable. For example, a nursery in the central valley of California has had positive detections in each of three successive years, even though eradication efforts followed each detection event. Similarly, a large nursery in southern California had a major outbreak in February of 2004, underwent a major eradication effort under the CNP, but still had the pathogen re-emerge during the winter of 2005.

On the California Department of Food and Agriculture (CDFA) web site, information is provided regarding the numbers of nurseries where *P. ramorum* has been detected in regulated or quarantined counties, and whether the pathogen was detected via trace-forwards, trace-backs, or inspections related to stock cleanliness or established compliance agreements. In 2004, 33 nurseries were detected as positive and underwent the APHIS Confirmed Nursery Protocol. In 2005, there were 8 recurrent nurseries, 7 of which were among the 33 treated in 2004 (i.e., ~ 21% of nurseries that went through the CNP in 2004, were found positive again in 2005). The inspections for 2006 have begun and by February the first positive detection was made. It was a re-emergent nursery that had been found positive in 2005 and underwent the CNP procedures.

This relatively high rate of re-emergence is a concern, particularly since the number of confirmed nurseries increased in 2005. Re-emergence generally has not been attributed to nurseries importing new batches of infected plants. Perhaps it results from plants in the "buffer zone" harboring low-grade infections that escape detection in the 90-day inspection, or perhaps it results from the survival of propagules (chlamydospores, sporangia, zoospore cysts) in soil for long enough to initiate a new round of plant infections. Indeed, although we do not know the form of propagule(s), we have found evidence over the past year that some treatments applied to eradicate *P. ramorum* from confirmed nursery soils do not always work.

The CNP recommends disinfectants (e.g., 10% Clorox®) for the treatment of non-porous surfaces such as concrete. For soil, the CNP recommends Chloropicrin, Dazomet®, Metam sodium, and methyl bromide. However, because of buffer zone requirements, some of these soil treatments are not viable options for many small nurseries that often are located very close to homes and schools. There also is uncertainty among growers regarding the use of these materials since most nurseries do not place plants directly onto soil beds. Instead, plants typically are placed on a thick layer of gravel that overlays the soil. Such conditions are not accounted for in the standard soil treatments reported in the CNP, and there is virtually no information to guide growers in deciding how to treat such beds.

For example, during the winter/spring of 2005 we worked with a large nursery in southern California that had a re-emergence of *P. ramorum* in a *Camellia* crop. The year before, there had been a severe outbreak of *P. ramorum* in the *Camellia* crop and the nursery underwent the procedures specified in the CNP. Because the crop of *Camellias* had been set on beds that were largely gravel-over-soil, and because the gravel was considered a "non-porous" surface, the bed areas were cleaned of all litter and then treated with a Clorox® solution as recommended in the CNP. However, in 2005, *P. ramorum* re-emerged and another crop of *Camellia* plants was infected. This event, combined with the fact that the site was going to be abandoned for nursery crop production, provided an opportunity to test the efficacy of the Clorox® treatment. We established a field plot at the location of the "destruction block" after all plants had been removed for destruction. We established a randomized complete block design that included untreated and Clorox®-treated areas. We collected samples of gravel/soil from the plots prior to any treatments, transported them to the laboratory, and assayed them for living *P. ramorum* by saturating the samples with water, and placing *Rhododendron* leaves in the saturated samples. After two days, the baits were removed and tested for *P. ramorum* infection by culturing tissue pieces onto selective agar media and subjecting other tissue pieces to DNA analysis (using the APHIS-approved PCR method). After treatment, we continued to sample the plot beds over time to detect viable propagules. We found that detection of viable (infectious) *P. ramorum* in the plots decreased and became erratic over time, suggesting a dwindling population and corresponding increase in sampling error. We found no difference between the Clorox®-treated and non-treated control beds. We also found that propagules could be detected at least 75 days after removal of the crop (we could not sample longer because we lost control of the plot after 75 days due to sale of the land to a developer).

Phytophthora ramorum was confirmed at another southern California nursery in the spring of 2005. In carrying out the CNP here, the grower felt that Basamid® would be the best treatment option due to the proximity of residential housing to the infested area. We sampled the site prior to treatment, collecting a relatively large amount of soil material since the entire bed had to be treated and our collected material had to double in the lab as an "untreated control." The area then was treated by tilling Basamid® into the upper layer of the bed at the maximum label rate. After the Basamid® was tilled in, the area was irrigated to provide a water "seal." At the recommended interval after treatment, the treatment was considered complete and we collected additional samples for a post-treatment assay. Both the pre- and post-treatment plot samples were baited and tested as described above. Our results showed that both sets of samples contained living *P. ramorum*. We hypothesized that the Basamid® treatment might have been less effective than expected due to the use of a water barrier instead of a polyethylene tarp to better trap volatiles in the soil.

Our documented failure of the first treatment prompted the grower to apply a second. The second treatment was applied four weeks later, and the bed was allowed to dry out between the two treatments. Before the treatment was applied, we again sampled from the bed to obtain a pre-treatment sample. This time, after tilling to incorporate Basamid® at the maximum label rate, the grower installed a polyethylene tarp over the area to better trap chemical volatiles. After the treatment was complete, a post-treatment sample was collected. This time, both the pre-and post-treatment samples yielded negative results when tested for viable *P. ramorum*. The failure to detect viable *P. ramorum* in the pre-treatment samples suggests the population was reduced by the month of desiccation between treatments, or perhaps the population was too low to be detected reliably by our sampling method. Other baiting trials at confirmed nurseries where the soil was allowed to dry out in the sun also yielded negative results. This has led us to hypothesize that desiccation and/or solar heating of soil can accelerate

Phytophthora ramorum cont. on 13

Get Cultured

Reverse Osmosis, Nanofiltration, Ultrafiltration and Microfiltration Processes

by Donald J. Merhaut - University of California, Riverside

The following article is the last in a series of articles related to water filtration and sanitation, so don't take your wetsuit off yet! Hopefully, through the series of articles that has been presented during the past year, you will be able to decide which type of water treatment process is right for your production facility. We will be combining all articles related to this topic and place them on the CORF website.

Membrane-Mediated Filtration Processes

There are basically four types of membrane-mediated filtration processes: (1) Reverse Osmosis, (2) Nanofiltration, (3) Ultrafiltration, and (4) Microfiltration. All of these techniques involve passing dirty water through membranes, which filter out unwanted substances. Pressure (energy) is also required to pump the water through the membranes, with the smaller-pored membranes requiring more pressure to force water through the pores compared to the larger pored membranes. The major differences between these systems are the sizes of the membrane pores. The advantages and disadvantages of these systems are described in Table 1 and the relative sizes and weights of chemicals and organisms found in irrigation water are described in Table 2.

Table 1. Physical characteristics, cost of operation, and advantages and disadvantages of four types of membrane-mediated filtration systems.

Membrane type	Approximate filtration pore size	Relative Cost	Advantages	Disadvantages
Reverse Osmosis	0.1 nm	High	*removes charged ions *removes compounds ≥ 250 amu *almost essentially all pathogens	*removes dissolved fertilizer
Nanofiltration	1.0 nm	Moderate	*removes some charged ions. *removes compounds ≥200-1000 amu *removes essentially all pathogens	*may remove some chelates
Ultrafiltration	1- 20 nm	Low	*removes bacteria *fungal spores *removes nematodes	*virus may not be removed
Microfiltration	100 to 10,000 nm	Lowest	*requires least amount of energy	*many pathogens will not be removed

Table 2. Relative sizes of water and fertilizer molecules and some common pathogens sometimes found in irrigation water. Sizes of pathogens are ranges, since there are many types of viruses, bacterial and fungi. Please note that there is no correlation between weight and size, since some organism may be denser (heavier) than other organisms or chemicals of the same size.

Organism/particle	Weight (Daltons)[z]	Size (nm)
Water molecule	18	0.20 nm
Iron-EDTA chelate	526	NA
virus	7,000,000	20 to 200nm
E. coli	Over 3,000,000,000	2000 nm
Fungal spores	NA	2000 to 5,000 nm
nematodes	NA	

[z]A dalton is equal to 1 atomic mass unit (amu).

Reverse Osmosis (RO) – also called hyperfiltration, utilizes membranes with the smallest pores of the four filter systems. Because of the relatively small pores, dissolved salts, charge particles, and compounds of molecular weight greater than about 200 daltons (1 dalton = 1 atomic mass unit [amu]), as well as most pathogens are removed from the water. Nurseries that are forced to use low quality (salty) water, usually must utilize RO to remove dissolved salts. Since this process removes dissolved salts, including fertilizer, one should not utilize this method after fertilizer has been added to the irrigation system; otherwise you are removing your fertilizer from the irrigation water.

Nanofiltration – utilizes membranes of a larger pore size than those used in RO; however, pores are still small enough to filter out larger sized molecules (≈ 200-1000 daltons). These pores are usually large enough to allow chelated nutrients to pass through, since most chelates such as iron-EDTA have a molecular weight under 500 daltons. Also, some charged particles may not pass through these filters.

Ultrafiltration – utilizes membranes with pore sizes of approximately 1.0 to 20 nm, which are larger than pores of nanofiltration systems. No dissolved salts (fertilizer) will be removed with this system. However, ultrafiltration will still remove suspended clay and pathogens such as bacteria, nematodes and most fungal spores and some viruses. However, some smaller viruses will not be removed. Therefore, it may be necessary to do additional sanitation treatments to the water.

Microfiltration – utilizes membranes with pore sizes of approximately 100 to 10,000 nm (0.0002 to 0.0100 mm). While this filtration system requires the least amount of energy to pass water through the membranes, it also does not screen out most pathogens; therefore, additional sanitation treatments will be required. This process is sometimes used before the RO process.

Maintenance

Flushing -All membrane systems will require periodic flushing of membranes, the frequency of which is dependent on the cleanliness and the volume of water being treated during a given time period.

Concentrate Disposal – The residues collected will need to be disposed of, the method of which will depend on regulations in your region.

Membrane replacement – Membranes will need to be replaced after a given period of usage.

Remember: Regardless of the filtration system that is utilized, be sure that a water sample is analyzed for proper pathogen control and chemical stability. A small pilot system should be built to test the suitability of the systems with your facilities water supply.✳

Donald J. Merhaut
Department of Botany & Plant Sciences
University of California
4118 Batchelor Hall
Riverside, CA 92521
Phone: (951) 827-7003
Fax: (951) 827-5717
e-mail: donald.merhaut@ucr.edu

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Angular, purple lesions indicative of downy mildew.

fungicides can be used to stop the infection. In a trial we conducted on downy mildew of limonium in 2004, Fenstar® and a tank mix of Aliette® and Fore® provided the best control. Other products that provided good control were Stature DM® and BAS 500 (Table 1). Similar results were obtained in a previously published trial conducted in 2003 on downy mildew of snapdragons (CORF News Winter 2004). In another trial on downy mildew of limonium in 2005, a tank mix of Aliette® and Fore® reduced disease severity by 97%. Phyton 27® also significantly reduced disease severity by 39%. Fenstar® and other products included in the 2003 and 2004 trials were not included in the 2005 trial. When using fungicides to control downy mildew it is essential to rotate or tank-mix products with different modes of action. This prevents or slows down build up of fungicide resistance in downy mildew pathogen populations. It is also desirable to add a non-ionic surfactant or adjuvant unless the label specifically states otherwise. Results from studies we conducted in 2004 and 2005 on downy mildew of limonium showed that non-ionic surfactants enhanced efficacy of Fore®, Heritage®, Stature DM®, and Fenstar® in a four-fungicide rotation. The 2004 study has previously been published (CORF News Winter/Spring 2005).✳

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Stephen Wegulo
University of Nebraska, Lincoln
448 PS
Lincoln, NE 68583-0722
Phone: (402) 472-8735
Fax: (402) 472-2853
e-mail: swegulo2@unl.edu

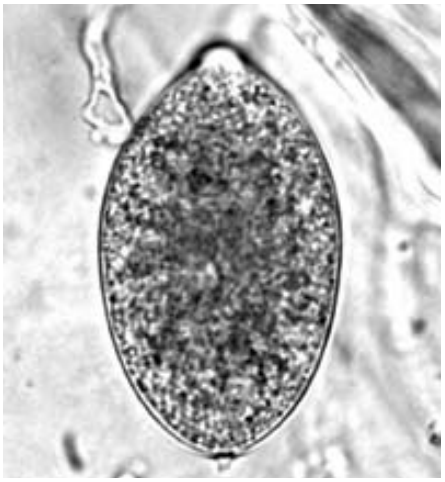
Phytophthora ramorum ***cont. from 11***

propagule senescence or quiescence.

Our studies show that even though nurseries implement the CNP, *P. ramorum* may not be eliminated. Perhaps this situation could be improved if there were more and potentially better treatment options. Unfortunately, conducting experiments at confirmed nursery locations is very difficult. Few confirmed nurseries are willing to cooperate in experiments because their goal is to carry out the CNP and get back into production. Furthermore, using treatment materials that are not on the CNP list (i.e., "approved fumigants") raises a question as to whether any experiments with alternative treatments would be considered a valid effort under the CNP.

Because of the need for more data regarding soil treatments, and because of the complications of working at confirmed nursery sites, we have begun testing treatments in vitro. We currently are testing (1) chloropicrin (at 100 and 200 lb/acre rates), (2) 1,3-dichloropropene at 100 lb/acre, (3) Telone® C35 at 79 gal/acre (4) Vapam® at 75 gal/acre (5) iodomethane at 100 lb/acre singly, as well as combined with chloropicrin (100 lb/acre iodomethane:200 lb/acre chloropicrin), (6) dimethyldisulfite at 200lb/acre singly, as well as combined with chloropicrin (200 lb/acre dimethyldisulfite:100 lb/acre chloropicrin) (7) Basamid® at 200 lb/acre. We are just now beginning to obtain data from these experiments. In addition to the fumigant experiments, we also are beginning tests to evaluate solarization and desiccation.

While we can develop lots of data in the laboratory, one of the most important things we need are field locations where we can learn more about *P. ramorum* in the nursery environment. This is the only way to develop the most meaningful data. We cannot deliberately infest field soils for the purpose of conducting eradication experiments, so we hope that we can continue to have cooperation from growers with confirmed nurseries. We need to know more in order to develop the best possible confirmed nursery protocol.✳



***Phytophthora ramorum*, photo courtesy of Matteo Garbelotto, UC Berkeley**

Lani Yakabe & James MacDonald
University of California
150 Mark Hall
Davis, CA 95616
Phone: (530) 752-6730
Fax (530) 752-4789
e-mail: jdmacdonald@ucdavis.edu
Lani Yakabe
e-mail: leyakabe@ucdavis.edu

Campus News & Research Updates

UC Riverside, Department of Entomology

The Sweetpotato Whitefly Q-biotype Studied at the UC Riverside Quarantine Facility.

by James A. Bethke, Frank J. Byrne, and Richard A. Redak - UC Cooperative Extension, Riverside

The Quarantine Facility at UC Riverside was built in 2002 with the intent to study, characterize, and progate foreign parasites and predators collected abroad and sent to California for the purpose of releasing them to control accidentally introduced exotic insect pests. It was not intended for the study of serious invasive pests, but the facility is certainly qualified to hold them. With the introduction of the sweetpotato whitefly Q-biotype into California, the facility provided us an opportunity to do research on an invasive pest that otherwise would not have occurred. In addition, research was expedited by the efforts of the quarantine facility staff and by APHIS. This research was crucial in providing some of the short-term solutions needed for ornamental horticulture in California.

Silverleaf whitefly

California ornamentals were at threat due to quarantines (subsequently lifted) placed on infested greenhouses and nurseries and the subsequent movement of host plants. Due to the strong insecticide resistance characteristics of this biotype, the CDFA in their eradication efforts were merely guessing what pesticides to use. Therefore, we requested permission from APHIS and the CDFA to import the pest from Arizona where it was first detected in retail gardens on poinsettia. Dr. Tim Dennehy from the University of Arizona shipped some of the whiteflies from his colonies so that we could determine if the latest pest control products would have an effect on this pest.

Quarantine facility

Following numerous insecticide trials, we have found several products that work quite well against the Q-biotype. This information was provided to APHIS and across the country through a number of venues so that growers were prepared to control the Q-biotype (**see http://www.mrec.ifas.ufl.edu/LSO/bemisia/bemisia.htm**).

The vast proliferation of this pest was averted this year, but we are not out of the woods yet. There is still great potential for this pest to become very serious in ornamentals. It is highly resistant to many of the latest chemicals and can build resistance much quicker than the B-biotype, *Bemisia argentifolii*, the silverleaf whitefly. The take home message is to remain diligent and vigilant.⁕

Stephen Wegulo Moves to University of Nebraska – Lincoln

Last year Stephen Wegulo accepted a faculty position at the University of Nebraska – Lincoln. He joined the Department of Plant Pathology at UNL as an Assistant Professor on June 1, 2005. He has a 75% extension and 25% research appointment. His responsibilities are on diseases of small grains, forages, and ornamentals. Prior to joining UNL, Stephen was an Assistant Specialist in Cooperative Extension at UC Riverside with a 100% extension appointment. At UCR, he had statewide extension responsibilities on diseases of floriculture and nursery crops. Research projects in his lab included integrated management of powdery mildew on delphinium, integrated management of *Botrytis* on lisianthus, and effects of coir on soilborne plant pathogens with an emphasis on pathogens in recycled water. He also conducted fungicide trials on downy mildew of snapdragon and limonium, powdery mildew of rose, *Botrytis* on lisiathus, Alternaria leaf spot on alstroemeria, and Fusarium diseases and sugar rot of gerbera. Stephen wishes to thank everyone who worked with him during his time at UCR. He is especially indebted to the public and private organizations that funded or supported his research and extension efforts. Stephen can be reached by phone at (402) 472-8735 or by e-mail at swegulo2@unl.edu.⁕

Methyl Bromide cont. from page 4

application of Midas® (50/50) at a rate of 300 lbs/ac showed similar efficacy in the control of soilborne pathogens and weeds as MB/Pic at a rate of 350 lbs/ac.

Although significant information is available on the efficacy of some fumigants applied by drip fumigation, the drip irrigation systems are not commonly used by cut flower growers and/or these techniques are not applicable at certain fields due to their topography (steep slopes) or heavy soil types. Therefore, research on shank application of alternative fumigants will be continued. However, several factors may limit the use of alternative fumigants at the commercial level at the high rates as in our field experiments shown to be consistently effective to control problem weeds and pathogens. For example, stringent regulations to mitigate risks of human exposure limit the utility of 1,3-D products (Telone® C35 and InLine®) by extensive buffer zones. Also, the township caps severely restrict 1,3-D availability in areas with a higher percentage of agricultural land.

While Pic is registered for field application at a wide rate range (up to 500 lbs/ac), Agricultural Commissioners in some counties in California do not permit application of Pic at rates that were shown to be efficacious in our field studies (i.e., 200 to 300 lbs/ac). Therefore, developing application methods to reduce workers exposure, volatilization losses are crucial to overcome regulatory limitations that restrict the availability of alternative products, such as Pic, 1,3-D, metam sodium and metam potassium.

Application of 1,3-D or Pic singly controlled most soil-borne pathogens, but provided limited weed control relative to the MB/Pic mixture. Therefore, fumigant combinations with metam sodium, metam potassium or Dazomet® are recommended for fields with high weed pressure. Midas® was highly effective in controlling weeds and pathogens in cut flower production, and can be applied by shank injection or drip fumigation. When registered, Midas® will be a full replacement for methyl bromide.✳

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Husein Ajwa
Extension Specialist
Department of Plant Sciences
University of California, Davis
1636 E Alisal
Salinas, CA 93905
Phone: (831) 755-2823
Fax: (831) 755-2844
e-mail: haajwa@ucdavis.edu

Science to the Grower

Old and New Insights into Protea Leaf Disorders

by Richard Y. Evans - UC Cooperative Extension, Davis

Most people think *Proteas* are exotic despite their availability for decades as cut flowers. They look unusual, with massive globular inflorescences atop stems with leathery leaves, and their management requirements are also unusual. *Proteas* are adapted to nutrient-depleted soils and tolerate a narrow range of soil nutrient levels. Specialized roots (called proteoid roots), which efficiently extract soil phosphorus beyond the grasp of normal plants, are key to their adaptation. However, these roots make *Proteas* intolerant of phosphorus-rich soils. *Proteas* are also susceptible to some exasperating production problems, including scorching of leaf tips, which occurs during production, and postharvest blackening of leaves subtending the inflorescence.

Recent findings at the University of Stellenbosch in South Africa add to the arsenal of *Protea* growers seeking to combat these problems. Cramer and others[1], after eliminating disease as a cause of leaf scorch, reasoned that it might result from a nutrient deficiency. They analyzed the mineral composition of soil and leaf samples from plantings of *Protea* 'Sylvia' and searched for a relationship between leaf scorch and the concentration of elements in those samples. Leaf scorch was more prevalent in soils with higher salt concentrations (although the EC_e of 1.1 dS/m would be acceptable for most crops). Two results led the authors cautiously to conclude that poor distribution of calcium in the plant may cause leaf scorch: Calcium levels in scorched leaf tips were 20% lower than in normal ones, and spraying plants with a calcium chelating agent induced leaf scorch. High soil EC may exacerbate the problem, especially during cool, wet weather, when plants are less able to distribute calcium.

In the early 1990s researchers at UC Davis associated postharvest leaf blackening in *Protea eximia* with low leaf carbohydrate content.[2] That led to inclusion of sucrose in holding or pulsing solutions for cut *Proteas,* but such treatments are not universally successful. A few years ago Stephens and others at Stellenbosch demonstrated that 2.5% glucose holding solutions prevent leaf blackening in *Protea* 'Sylvia' (a cross between *P. eximia* and *P. susannae*), but sucrose solutions do not.[3] Last year that group examined effects on several *Protea* cultivars of glucose pulses and holding solutions.[4] They found no simple solution, so to speak. Leaf blackening after 3 weeks of storage was generally reduced by pulses with 10 ml of 4-10% glucose, but leaves or inflorescences of some cultivars were damaged by the higher glucose concentrations. Other cultivars responded only to the higher concentrations. After a glucose pulse and storage, blackening in some cultivars was further reduced by 1-2% glucose in the holding solution. Some cultivars did not respond to this treatment, but none were adversely affected. The authors recommend glucose for members of the Ligulatae section of *Protea*, and discourage use of hypochlorite as a preservative.✳

[1] Cramer, M.D., A.I. Gerber, and G. Jacobs. 2004. Causes of leaf-tip scorch in the cultivated *Protea* hybrid 'Sylvia'. *Scientia Horticulturae* 103: 65-77.

[2] Bieleski, R.L., J. Ripperda, J.P. Newman, and M.S. Reid. 1992. Carbohydrate changes and leaf blackening in cut flower stems of *Protea eximia*. *Journal of the American Society for Horticultural Science* 117: 124-127.

[3] Stephens, I.A., G. Jacobs, and D.M. Holcroft. 2001. Glucose prevents leaf blackening in 'Sylvia' *Proteas*. *Postharvest Biology and Technology* 23: 237-240.

[4] Stephens, L.A., C. Meyer, D.M. Holcroft, and G. Jacobs. 2005. Carbohydrates and postharvest leaf blackening of *Proteas*. *Hortscience* 40: 181-184.

Richard Y. Evans
Extension Specialist
Department of Plant Sciences
University of California
Davis, CA 95616
Phone: (530) 752-6617
Fax: (530) 752-1819
e-mail: ryevans@ucdavis.edu

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California Ornamental Research Federation
820 Bay Avenue, Suite 109
Capitola, CA 95010
Phone: (831) 479-9724
Fax: (831) 462-8040
www.corf.org

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