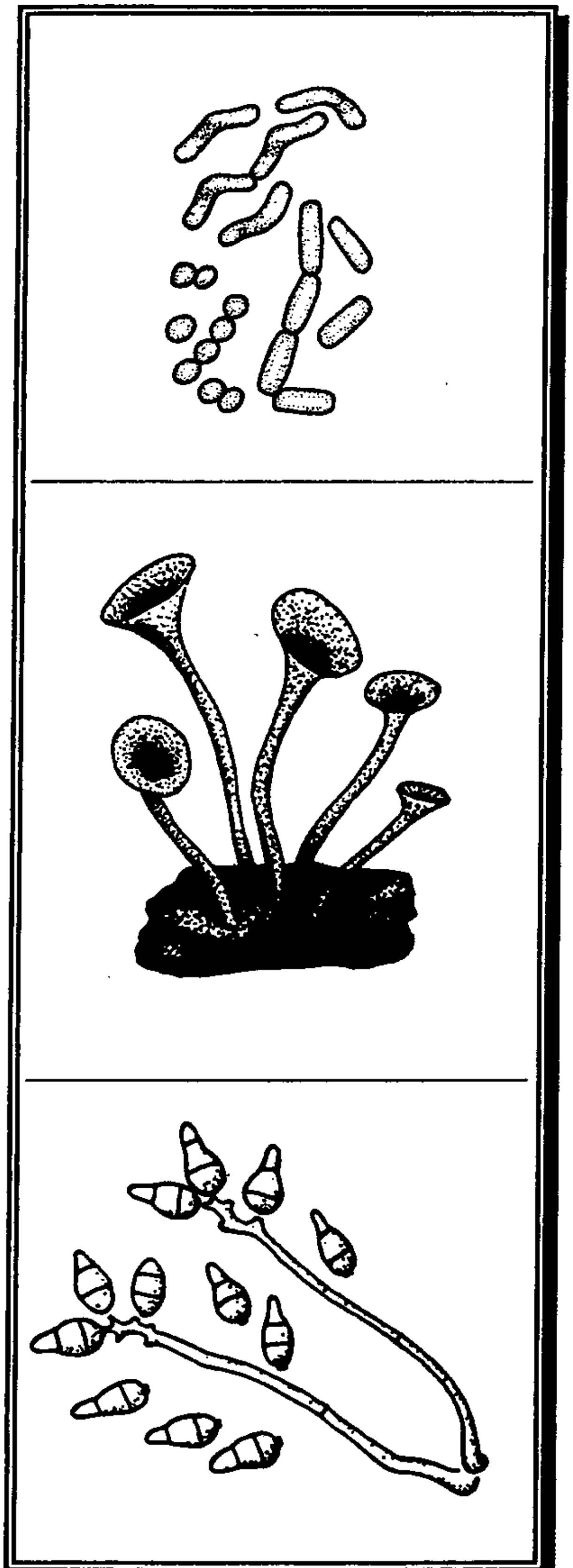

March 1997
Volume 18, Number 1

Plant Diagnostics Quarterly

Feature

Pesticide Use in the U.S. Ornamentals Industry

On the Cover:

Top: Three common bacterial shapes: spherical, rod and comma shaped. Bacteria may also be ellipsoidal, spiral, or filamentous (threadlike). Almost all plant-pathogenic bacteria are rod-shaped (the only exception being *Streptomyces*, which is filamentous).

Middle: Apothecia of *Monilinia fructicola* (Brown Rot of stone fruits) growing from a peach mummy. In the Discomycetes (cup ascomycetes), the asci are produced in an open, cup or saucer shaped ascocarp called an apothecium.

Bottom: *Pyricularia* sp., the fungal genus which causes rice blast and gray leaf-spot of turf grasses.

Cover Art courtesy of Clare Kenaga, retired faculty member, Dept. of Botany and Plant Pathology, Purdue University.

Plant Diagnostics Quarterly (PDQ) is a nonprofit publication which serves plant pathologists in extension, regulatory and industrial clinical laboratories, private consultants, and other interested persons. PDQ is published four times a year.

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Send manuscripts, announcements, and letters to the Editor: Betsy Hudgins, Oklahoma State University Department of Plant Pathology, 110 NRC, Stillwater, OK 74078-3032.

FROM THE EDITOR

For the times they are a-changin'.
- Bob Dylan, 1964 -

Dear Reader:

Suddenly, the elms are blooming and I fear I've missed pussy willow season again. Spring came in like a lion! This time of year makes me feel enthusiastic about diagnostic work which is picking up pace and optimistic about my new appointment as PDQ editor.

Since I first volunteered for this job, I've been working on a great, new email system, started to develop a new database management system for the diagnostic laboratory, figured out how to listen to radio with Real Audio, learned to use Windows 95, played with Adobe Acrobat and Photoshop, dabbled in creating homepages, and brought myself up-to-date with word processing software. Phew! I am still, however, overwhelmed by the choices of printers, software, scanners, and digital cameras...and time doesn't make the decisions any easier. To help keep us informed, Michael Munster will write a regular column about these technologies and more. I hope you enjoy it as much as I have.

My recent plunge into the electronic age has made a world of difference to getting the PDQ assembled quickly. I am keeping my fingers crossed that you actually receive this issue during the month of March. If so, my New Year's resolution came true! Thanks to all the contributors for sending your reports to me in such a timely fashion. I am striving for continued success in getting these issues out on time.

Betsy J Hudgins

Betsy Hudgins, Editor

Plant Diagnostics Quarterly

March 1997 Volume 18, Number 1

Guidelines to Contributors

Submission of articles:

Articles or classified ads may be submitted in any of the following manners:

1) As a "document" or "note" attached to an email message. Send these articles to Betsy Hudgins at **hudgins@okway.okstate.edu**. I use Microsoft Word 7.0a but can accept documents from earlier versions of Microsoft Word or WordPerfect versions 5.1 or higher.

2) As a diskette (3.5). Mail to: Betsy Hudgins, Editor - PDQ
110 NRC
Department of Plant Pathology
Stillwater OK 74078-3032

Please include a hardcopy of the article with the disk.

3) As a camera-ready hardcopy. Follow manuscript guidelines below. Mail to Betsy Hudgins at the above address.

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Margins: 1 inch (Top, Bottom, Left, Right)
Page Numbers: Do not include (although you may lightly pencil page numbers on any hardcopies that are sent
Font: Times New Roman, preferably (although other fonts can be converted)
Spacing: Single-spaced
Latin binomials: Italicized
References: Cite at the end of the article using a consistent format, such as that used in Plant Disease.
Printing: Laser printed articles is preferred; type needs to be clear and dark enough to be reproduced well.

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Send 200 copies of fact sheets to be used as enclosures in the PDQ to:
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West Lafayette, IN 47907-1155

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REGIONAL REPORTS

NORTHEAST

Richard Buckley

After a pretty good spring and summer for diseases, the fall and winter in the Northeast region seems a little uneventful. Maybe it's just the let down from the excitement of seeing all those dead and dying plants, or maybe we are just finally back into our normal patterns after all the outrageous weather the last couple years. Sharon Douglas suggests that her lab is slow because Connecticut growers just know what their doing......At any rate, at least it's not snowing! This report is a compilation of the information gathered from the fall and winter seasons.

.... *Turf*

John Peplinski (Penn State) reports an unusual winter sample of red thread in his clinic. In New Jersey, red thread is quite active during the winter. In fact, as of this writing (Feb. 17^{th}) it is all over the turf research farm (It's a wonderful thing!). New Hampshire and New Jersey report a couple cases of pink snow mold. Yellow patch has also been common this winter on New Jersey golf courses.

.... *Woody Ornamentals*

The Penn state clinic received samples of blue spruce with rust, caused by the fungus *Chrysomyxa weirii*. Other samples of spruce in Pennsylvania had extensive needle browning that was apparently caused by late season mite infestations. John also reports a large number of pine samples with Sphaeropsis tip blight. In New Hampshire a root rot on Norway spruce seedlings was caused by wet feet. Common problems associated with spruce in Connecticut were Rhizosphaeria needlecast and Cytospora canker. Dothiostroma needle blight was identified on several samples of Austrian pine in the New York (Ithaca) laboratory. While this is not an uncommon disease in the Northeast, it might be a first for New York state.

Dianne Karasevicz (New York/Ithaca) reports several cases of Phytophthora root and crown rot on several hosts including boxwood and forsythia. Armillaria root rot was also identified by Dianne. The primary hosts were Fraser fir and maple that suffered drought injury. Maples, especially Japanese red maple, in Connecticut have been hard hit by Verticillium wilt in recent years. Bacterial leaf scorch continues to be a problem on oaks in southeastern Pennsylvania. In New Jersey the "hotspot" for bacterial leaf scorch is around Princeton in the central part of the state.

In a New Jersey nursery, several hundred rhododendrons were affected with Botrytis bud blight. The plants were jammed together in a quonset hut with no ventilation. Virtually every bud was blighted. Leaves that happened to touch infected buds developed nice brown lesions with concentric rings surrounding the point of contact.

Other diseases of note include: tar spot of maple in Pennsylvania and Connecticut; needlecast of hemlock, caused by *Fabrella tsugae*; powdery mildew, caused by *Microsphaeria*, in Delaware; and Cercospora and other leafspots on broad-leaved evergreens in Connecticut.

.... *Herbaceous Ornamentals*

In Delaware nursery crops, Cercospsora leaf spot was widespread on aster. The disease caused extensive defoliation of plants in 1 gallon pots in commercial production, but was not seen in the landscape. Bob Mulrooney (Delaware) also reports aster yellows on fragrant heliotrope; Miscanthus blight on maiden grass; Pseudomonas leaf spot on impatiens; *Botrytis* on geranium, mums, and roses; and foliar nematodes on numerous ferns, *Heuchera*, and anemone. *Spigelia marylandica*, a Delaware native, was diagnosed with southern blight. Bob thinks it is probably a first report. John Peplinski (Penn State) reports downy mildew on nursery-grown aster and birch speedwell, caused by the fungi *Basidiophora entospora* and *Peronospora grisea*, respectively.

In the greenhouse, lantana infected with the rust fungus *Puccinia lantanae* was diagnosed in Pennsylvania. *Botrytis* was very common on Delaware geraniums, mums, and roses in late-fall. The fungus *Cylindrocarpon* caused wilting, root rot, and petiole lesions on African violet samples sent to the New York (Long Island) clinic. New York also reports Verticillium wilt in geranium stock plants, Fusarium leaf spot in holiday cactus, Alternaria leaf spot and Cercospora leaf spot on assorted impatiens, and downy mildew on *Geum*. Dianne Karasevicz (New York/Ithaca) is currently working on a severe case of root and bulb rot of tulip, caused by the fungus *Botrytis cinerea*.

Impatiens necrotic spot virus was detected in schefflera samples from a Pennsylvania greenhouse. In New York (Long Island) the virus was found in *Lobelia*, primula, and New Guinea impatiens. Tospoviruses were also detected in impatiens and cyclamen by the other New York (Ithaca) lab. The Rutgers laboratory had samples of *Lobelia* and poinsettia test positive for arabis mosaic virus. The *Lobelia* was also positive for TSWV and CMV using the Agdia ornamentals screen. The samples were from different growers at opposite ends of the state. Apparently this virus is relatively rare in our area, so keep your eyes peeled. The virus simply stunted the poinsettia and caused a little leaf strapping. The pink varieties were affected, but red and white varieties appeared healthy. The symptoms on the *Lobelia* were confused with those caused by the TSWV and CMV. Margery Daughtry (New York) also confirms TSWV infection in *Lobelia*.

Other diseases of note include: carnation with Cladosporium leaf spot and Fusarium stem rot of jade in the Pennsylvania clinic; Oedema and other cultural problem with ivy geranium in New Hampshire; and a case of bacterial leaf spot of poinsettia in New York (Ithaca).

.... *Vegetables*

Powdery mildew on greenhouse grown tomato is becoming a severe problem in New Jersey and Connecticut. In each case, the disease was reported in recent editions of *Plant Disease*. Powdery mildew was also seen in the field during 1996 in both states. The Connecticut isolates infect a wide range of tomato cultivars, as well as, eggplant, tobacco, and nightshade. Sharon suggests the symptoms were not typical of normal powdery mildew infection. The isolates from Connecticut were very aggressive and cause the plants to decline rapidly. Samples from New Jersey fields actually had early blight-like leaf lesions. If anyone has good ideas for control, please let us know.

A tospovirus that was not INSV or TSWV was detected in greenhouse tomato in New York (Ithaca). Agdia did some testing with it, and according to Dianne, the USDA was working on it too.

In Delaware, *Alternaria* infections caused problems in stored cabbage and many pumpkins were rotted by *Fusarium graminum*. Problems with powdery mildew, downy mildew, and angular leaf spot continued until harvest in the Connecticut pumpkin crop. New Jersey pumpkins were mostly rotted by *Phytophthora*. Black heart on stored potatoes was identified in New Hampshire.

In New York, several late summer cases of late blight led to many tuber samples in the fall. The US-8 genotype, the metalaxyl resistant strain, was most common; however, several cases did not match up to known genotypes and are currently being investigated. The disease was also diagnosed in greenhouse tomato.

.... *Field Crops*

Bob Mulrooney identified a new race of soybean cyst nematode in Delaware. Delaware has now documented races 1, 3, 5, 6, and 9.

In Connecticut, blue mold, caused by *Peronospora tabacina*, showed up in the tobacco crop for the first time in many years. Fortunately, it was late in the production season, so it did not impact the harvest. For those of you who don't know, Connecticut wrappers are highly regarded by Dominican and Honduran premium cigar manufacturers. A serious outbreak and Demi Moore might have to do another movie to afford her cigars!

SOUTHEAST

Jackie Mullen

The first half of the winter (January 1 - February 7) has been seasonably cold after a very late and warm fall.

ARKANSAS (Stephen Vann). Due to wet field conditions at planting time, the wheat crop is approximately 45% less than last year. Most wheat is currently at GS-3 to GS-5. Leaf rust (*Puccinia recondita* f.sp. *tritici*) and Septoria leaf blotch (*Septoria tritici*) have been observed primarily on the lower leaves. Many areas of the state have standing water in fields from recent rainfall. These conditions may result in the appearance of downy mildew in lower areas of the field as the crop matures. Foliar symptoms of winter injury have been observed on pansy (Viola) and Euonymus following cold temperatures in December and January. Photinia leaf spot (*Entomosporium*) continues to be a problem from the area. Cercospora leaf spot on strawberry has been observed from several locations. Follow-up wheat samples submitted to the Arkansas clinic by the state plant board for Karnal bunt processing have yielded no positives to date.

KENTUCKY (Julie Beale). One case of red thread was diagnosed on a mixed fairway of Kentucky bluegrass and perennial rye. Also, the lab received a corn sample which was improperly dried before storage and heavily colonized by species of *Aspergillus*. Another noteworthy sample was a white pine with striking symptoms of ozone damage (discrete chlorotic flecking of the '96 needles). The grower first noticed symptoms last August, soon after we had had periods of high ozone levels and problems with ozone damage in tobacco. (Don't know why he waited until February to send the sample!) Several cases of black knot on ornamental plum and cherry were visible in the winter landscape and, consequently, found their way to the lab for diagnosis.

TENNESSEE (Beth Long). Landscape/nursery ornamental problems included Botryosphaeria canker on juniper; white pine decline on pine; cold injury/winter desiccation-related problems on Southern magnolia and boxwood; Rhizosphaeria needle cast on blue spruce; and Entomosporium leaf spot on red tip photinia. With greenhouse and commercial turf, the following problems were reported: Botrytis blight and Fusarium wilt on basil; blossom end rot and fertilizer burn on tomato; Fusarium stem rot on ivy geranium; and Ascochyta leaf blight and Fusarium patch on tall fescue turf.

NORTH CAROLINA (Tom Creswell) Ornamental samples reported included landscape and greenhouse problems. With turf, fescue problems included net blotch and pink snow mold. With ornamentals, Mycosphaerella leaf spot was found on mountain laurel while *Phytophthora*, *Thielaviopsis* and *Armillaria* root rots continued to plague the usual plants. Botrytis blight and Cercospora leaf spot was present on several pansy samples. Tulip samples yielded Fusarium basal plate rot and leaf withering (caused by *Trichoderma* and [probably] *Fusarium* toxins). Sclerotinia stem rot was noted on geranium and dahlietta (seed- grown dahlia) in commercial

greenhouses. A heuchera (coralbells) sample showed symptoms of decay in the middle of the crown/bud area that strongly resembled anthracnose on strawberry crowns (mottled red/brown discoloration). But, *Rhizoctonia* was consistently isolated rather than *Colletotrichum*.
Vegetable diseases seen included cabbage and collard problems of black rot, downy mildew and Rhizoctonia damping-off. An interesting greenhouse tomato sample had a black saprophytic fungus covering the entire foliage. When the grower was questioned about his cultural practices, we learned that he had sprayed milk on the vines to combat Tobacco Mosaic Virus. "A little learning is a dangerous thing" --Alexander Pope.

SOUTH CAROLINA (James Blake). January proved to be an unusual month because of the unusual types of plant samples we received, mostly from nurseries. Problems included leucothoe with anthracnose - *Colletotrichum* sp.; *Chamerops humilis* (European fan palm) with Phytophthora leaf spot; phlox with Septoria leaf spot; plumquat with otryosphaeria canker; rosemary with Phyllosticta leaf spot; leyland cypress with Cercospora blight; and *Acorus gramineus* (grassy-leaved sweet flag) with anthracnose - *Colletotrichum* sp.

FLORIDA (Bob McMillan and Bill Graves, Ken Pernezny, Hank Dankers, Richard Cullen). South Florida vegetable growers took a $300 million loss due to a freeze that came unannounced in mid-January. We are all still paying for this in the form of higher produce prices. The freeze caused serious damage to the bean, squash and tomato crops as temperatures remained below freezing for 8-10 hours in some locations in south Florida. The rush for growers to replant after the freeze has resulted in a shortage of transplants, which has lead some growers to settle for lower quality transplants, when and if, they can find them.

Bob McMillan and Bill Graves at the Homestead Plant Disease Clinic reported that in addition to vegetable losses, continuous cold temperatures have resulted in serious cosmetic damage, reducing the grade quality to most ornamental crops in South Florida. Powdery mildew is sporadically infecting the surviving tomato plants. Late blight on potato was evident in early December 1996 and continued through January 1997 in the Homestead area. The number of blight days for potatoes and tomatoes in South Florida has been almost continuous since early December 1996 in Homestead and Immokalee (S.W. Florida). *Sclerotinia sclerotiorum* was isolated from field grown basil. This field had a long history of use in snap bean production. Leptosphaerulina leaf spot was common on bermudagrass greens.

From the Everglades Research and Education Center in South Central Florida, Ken Pernezny reported some fairly widespread Phytophthora blight on eggplants. Exterior lesions often develop at the soil line. Cuts into the stem reveal browning of the vascular and pith tissue, but the discoloration does not extend very far up the stem. He also reported late blight of both tomato and potato and added that for some nice, high-quality pictures of tomato late blight, visit our "Florida Tomato Scouting Guide" Web site (http://gnv.ifas.ufl.edu/~ftsgwab/).

From the Panhandle Clinic, Hank Dankers reported several interesting tomato diseases. These were: zonate leaf spot (*Cristulariella* sp.), buckeye rot (*Phytophthora parasitica*), tomato mosaic virus, and sour rot (*Geotrichum candidum*). Other diseases of interest were soybean stem canker (*Calonectria crotalariae*), tomato spotted wilt virus, Cylindrocladium black rot of peanut, and onion blast (*Botrytis* sp.).

In Gainesville, Richard Cullen reported an interesting new disease to Florida. Black patch of red clover (*Rhizoctonia leguminicola*) was seen for the first time this January. This disease which causes obvious foliar lesions on clover is better known for the 'slobber disease' in cattle and horses that feed on forage from diseased clover. There is a compound that is produced by *Rhizoctonia leguminicola* that causes excessive salivation in animals consuming red clover with black patch disease. This compound is active in feed from pasture, hay, or silage. The cattle will consume from one to three feedings, slobber profusely and refuse further feed. Other diseases of interest were watery soft rot of cabbage (*Sclerotinia sclerotiorum*) and bean golden mosaic virus of snap beans.

The Sixth Annual Virus Inclusion Workshop was hosted at the Plant Disease Clinic this January in Gainesville. This three day workshop gave hands-on experience using virus inclusions in the identification of potyviruses, tobamoviruses, potexviruses, cucumoviruses, comoviruses, geminiviruses, tospoviruses, closteroviruses, and furoviruses. Applying the staining techniques used for virus inclusion detection we also looked at Aster yellows (phytoplasma) and Pierce's disease of grape (*Xylella fastidiosa*). A seventh workshop is planned for January 26-28, 1998.

ALABAMA (Jackie Mullen). Our early winter samples included brown patch (*Rhizoctonia*) and Pythium blight on bentgrass; Sclerotinia crown rot of cabbage seedlings; *Pythium* and *Rhizoctonia* crown rot on cotton seedlings; Pythium root rot on mondograss; powdery mildew (*Erysiphe*) on rescue grass (*Bromus* sp.); and bacterial scorch (*Xylella fastidiosa*) on sycamore (ELISA tested using Agdia materials).

MISSISSIPPI (M.V. Patel). Powdery mildew (*Erysiphe* sp.) and target spot (*Corynespora cassiicola*) diseases on greenhouse tomato have been a problem in Mississippi. Also, bermudagrass decline on golf courses and canola plants infected with *Pythium* and *Rhizoctonia* were diagnosed.

CENTRAL

Karen Rane

Most diagnosticians in the Central Region are on the talk circuit at this time of year, so it's a good thing that sample numbers are traditionally low in late winter. Sandra Gould (Minnesota) and Nancy Pataky (Illinois) are still processing soil samples for soybean cyst nematodes, but most of the diagnostic work focuses on greenhouse ornamentals. The weather has been very cloudy for several weeks, encouraging *Botrytis* problems in many greenhouse crops. In Indiana, *Botrytis* was causing a crown rot of geranium seedlings. Pythium root rot problems in greenhouses are also common, report Judy O'Mara (Kansas) and Sandra Gould. In Wisconsin, Sr. Mary Francis Heimann used pea seedlings to bait *Pythium* out of a soilless mix.

Gail Ruhl (Indiana) diagnosed an unusual problem on kalanchoe. The plants were wilting, and showed blackened stems about 2-3 inches above the soil line. Bacterial ooze was visible on the stem surface, and bacterial streaming was observed in the vascular tissue by microscopic examination. After isolations, Biolog tests, and fatty acid analysis, the culprit was identified as *Burkholderia solanacearum*. Gail is proceeding with inoculations to complete Koch's postulates.

Tomato spotted wilt virus was serologically confirmed on chrysanthemum samples we received at the Purdue Plant and Pest Diagnostic Laboratory. The symptoms included bronzing of leaves and blackened areas on the stems. A few leaves even showed necrotic line-patterns - quite an attractive symptom! Snapdragon samples from the same greenhouse operation tested positive for impatiens necrotic spot virus, and had white lesions and ringspots typical of INSV infection in this host. This was an interesting case (at least for the diagnosticians!) of both tospoviruses being present in the same greenhouse.

SOUTHWEST

Tom Isakeit

ARIZONA (Mike Matheron): 'Tis the season for downy mildews in Arizona vegetable fields. Broccoli and cauliflower fields are showing classic leaf symptoms of downy mildew, caused by *Peronospora parasitica*. There is much less incidence to date of downy mildew on lettuce, caused by *Bremia lactucae*. Powdery mildew, on the other hand, already has been detected in some lettuce plantings. *Erysiphe cichoracearum* normally becomes a serious problem on lettuce harvested in March and April, so we might have a long management season ahead of us for this pathogen. Lettuce leaf drop, which is caused by *Sclerotinia minor* and *S. sclerotiorum* in Arizona, has appeared in many fields this year. The high acreage of lettuce planted in the Yuma and Gila Valley over the past several years is resulting in ever-increasing amounts of this disease (and job security for this extension plant pathology specialist). Abiotic symptoms on vegetables such as head and leaf lettuce, broccoli, cauliflower, and cabbage have been attributed to the combined effects of brief freezing periods, high winds, low relative humidity and airborne soil from two dust storms.

CALIFORNIA, Southland: (Ann Gabrik) reported that with the recent wet weather in southern California, she is seeing a lot of downy mildew on various ornamentals (including snapdragon, alyssum, rose, and salvia) and "lots and lots" of late blight on tomatoes.

CALIFORNIA, Imperial Valley (Gerald Holmes): Downy mildew has been common on a number of hosts: cauliflower, broccoli, alfalfa, lettuce. Disease severity has been low enough or late enough that most growers did not treat with fungicides. Several alfalfa fields had high levels of downy mildew and Stemphyllium leaf spot. Growers do not use fungicides for foliar diseases on alfalfa. These diseases are managed by hay cuttings. There was one case of tomato late blight on transplants. It is difficult for *Phytophthora infestans* to survive in the field because of our hot, dry weather, but survival in the greenhouse is a different story. There is some powdery mildew on sugar beets and growers will control the problem with sulfur applications.

Karnal bunt continues to be a big issue here. Some of the first wheat harvested in the U.S. is grown in the Imperial Valley. Last year, harvest began April 25. There will surely be less acreage this year due to the hassles the quarantine has created for growers. Last year, no teliospores of *Tilletia indica* were detected in preharvest samples from all 106,592 acres. Sampling procedures may be modified this year and growers are anxious to find out what the protocol will be.

[Editor's note: This is Gerald's last report for the Imperial Valley, as he recently has taken an extension plant pathology position at North Carolina State University.]

CALIFORNIA, Central Coast (Steve Koike): Spring rains have caused flooding in various areas of California, and water-logged soils everywhere. Perennial crops such as artichoke have experienced root decay due to overly wet soils and anaerobic conditions. Such decay results in plant stunting and reduced spring growth. Foliar problems continue to be prevalent on winter crucifers, and Alternaria leafspot (*A. brassicae* and *A. brassicicola*), white leafspot (*Pseudocercosporella capsellae*), and white rust (Albugo candida) diseases are prevalent. Heterosporium leafspot (*H. variabile*) and anthracnose (*Colletotrichum dematium*) are reducing spinach quality in many California counties. Broccoli head decay problems are causing significant losses in the field. Such decay is caused by *Alternaria brassica*, a bacterial complex, or both.

NEW MEXICO (Natalie Goldberg): Sampling of wheat, durum wheat, and triticale grown in 1996 for karnal bunt was completed. Approximately 925 samples were processed. No karnal bunt was detected. Infectious diseases identified included Fusarium basal rot of iris, Rhizoctonia crown and root rot on pansy, and powdery mildew on oak.

An early freeze (mid-October) occurred in many parts of New Mexico. Some of the plants affected included willow, pine seedlings, lettuce, and tomatoes. Harsh mid-winter freezes affected plants such as eucalyptus, broom, feathery cassia, germander, oleander, and palms. Other abiotic disorders identified were: transplant shock on pecan, storage dehydration of chile pepper fruit, chemical injury on lettuce, drought stress on pine and blue spruce, and salt stress on boxwood, privet, and apple.

OKLAHOMA (Betsy Hudgins): Few samples have been received for diagnosis so far this year. The number of submissions in 1996 was way down, which, I suppose, was caused by the extended drought we experienced. One recent, interesting sample was blossom end rot of tomatoes grown in a hydroponic greenhouse. Normally, with field-grown tomatoes, this disorder is associated with a fluctuating water supply and drying winds. With the hydroponic tomatoes, there are a number of possible reasons, including an actual calcium deficiency. It may take a little further investigating to determine the actual cause or predisposing factor.

Another interesting find was Septoria blight (?) on dogwood stems. I only found information about *Septoria* infections of dogwood foliage, so perhaps this is a new or rare disease? The problem was showing up on nursery plants that are in dormancy. There was some Botryosphaeria canker on some of the dogwoods as well, indicating that environmental stress may be the initial reason for the disease. Very high humidity for an extended period is also likely helping the *Septoria* grow.

TEXAS, North-Central, Stephenville: Thomas ("Chip") Lee reported that because of wet conditions, rust and Septoria blotch of wheat are prominent in that part of the state.

TEXAS, Lower Rio Grande Valley, Weslaco: (Tom Isakeit) In early February, onion downy mildew had appeared in some fields at widely-separated locations in the Valley. Severe damage in some fields occurred partly because this disease was misdiagnosed as purple blotch. However, purple blotch has not been very prevalent this season.

PACIFIC NORTHWEST

Ellen Bentley

Marty Draper (**North Dakota State University**) will be leaving Fargo and heading south to **SDSU** to fill Dale Gallenburg's Extension Plant Pathologist position. He also will have diagnostic responsibilities. Congratulations "Dr. Draper" and we look forward to future reports from South Dakota.

Laura Pottorff **(CSU-Denver Metro)** reports that after another record year, 1997's winter lull is welcome. We are gearing up for a return of craziness starting in April. The first quarter of 1997 brought some interesting tomato diagnoses. Fusarium fruit rot, Rhizoctonia stem canker and both impatiens necrotic spot and tomato spotted wilt viruses have continued to be a problem in greenhouse tomato production. Jim Duffus (USDA, Salinas,CA) has verified ToC virus in one of Colorado's leading hydroponic tomato greenhouses. Other viruses diagnosed include lily symptomless virus on easter lily and impatiens necrotic spot virus in alstroemeria.

There's been no respite in Oregon for Melodie Putnam **(OSU-Corvallis)**. Interior needle blight has been occurring on grand fir. This is a poorly characterized condition with which certain fungi are associated, yet their causality has not been proved. The problem is typified by death of older needles. *Septoria petroselini* is showing up already on parsley grown for seed. The fungus causes a leaf spot, but also can affect the flowering stalks, thereby reducing seed yield. Its presence already does not bode well for the seed producers. Another Septoria species (*S. tritici*) is also showing up on winter wheat. The most interesting disease problem is appearing on a variety of ornamental trees: *Phytophthora syringae* causing a stem canker. Some of these trees were under water during the floods of February and November (1996), but others were not. The fungus has been recovered from the stems of ash, crabapple, ornamental cherry and ornamental pear. The Phytophthora stem cankers came from trees from three different counties. *Phytophthora ilicis*, the cause of holly leaf and twig blight, has also come into the Clinic. This problem was particularly severe last spring, but it is unusual to see it this early. Finally, bacterial wilt was found in some geraniums from a major producer.

The northern half of Eastern Washington is still under one to three feet of snow. Ornamental damage is extensive. Snow mold in small grains and turf is expected. In the south at **WSU-Prosser** (Ellen Bentley) spring is in the air. Many perennials are already growing due to the mild winter. Potato planting should begin soon. Orchardists and vineyardists are rushing to complete their pruning. Only 5 samples so far in 1997.

THE WELL CONNECTED DIAGNOSTICIAN

Michael J. Munster
North Carolina State University

In the heated exchange of jokes between Minnesota and Iowa it was asked, "Why don't office workers in Iowa take coffee breaks?" The answer: "Because it takes too long to retrain them."[1] Nowadays we all might feel a similar uneasiness that as we are busy diagnosing specimens, talking to agents and growers, and preparing reports, the world of technology is speeding ahead, and we're left to play catch-up. The new editor of PDQ had the excellent idea of introducing a regular feature on computer technologies useful in plant diagnostics. It is my pleasure to take up keyboard and mouse to offer this column, not as an expert, but as a fellow diagnostician who falls in that vast, struggling mass of the computer semi-literate. This first column presents many examples from our experience at North Carolina State University, but I hope this will become a group effort -- more on that later. We'll start out gently with a fresh look at something familiar.

Email, the Best Thing Since Agar

It isn't glitzy, but email has become a workhorse in the office and laboratory. From our clinic at NCSU, we can send extension agents and some other clients their diagnostic reports electronically from our main computer's database system. I use email to notify specialists on campus when they have samples to diagnose. (A drawback to that is that if the recipient is out of contact and does not have or does not use a "vacation" feature, I may mistakenly believe that my message was received.) Email is also useful for communicating with large numbers of people at the same time. During the growing season, the *North Carolina Pest News* goes out on Fridays as email and e-news. E-news is a slightly different setup wherein the user must logon to a newsgroup to see the messages. A web version of each *North Carolina Pest News* is posted the following Monday. All this keeps agents, consultants, and others up-to-date on insect and disease problems across the state, which they appreciate.

Here at NCSU we have begun exploring the use of email for submission of certain samples. Those agents with digital cameras can take pictures of a sample and, ideally, its surroundings. Still images can also be captured onto the computer from video tape using a device such as the Snappy. Any of these images can then be sent to us as attachments to an email message, and we can sometimes diagnose right from the pictures. Last month we got a photo of an unknown weed, which we printed on a color printer and showed to the herbarium staff, who identified it! You can't turn a digital leaf over, so you have to tell people exactly what kind of pictures to send. As an example, see the requirements for

[1] Though an ethnic Minnesotan, I bear no ill-will toward anything Iowan.

submission of images of suspected tobacco blue mold, found on the web at http://www.ces.ncsu.edu/depts/pp/bluemold/sendpic.htm. There are other limitations, of course. Even the best pictures won't do much on acid-PDA or in a moist chamber, and the inherent promise of faster turnaround time only comes true if the specialists are available.

The process can work in reverse, when the diagnosticians are in the dark. Two weeks ago we received a sample of a shrub with dramatic galls that we did not recognize. The plant had recently arrived from out-of-state nursery supplier, so we sent some electronic images to an expert in the specimen's state of origin. He quickly identified the problem. We are confirming the diagnosis through isolation and incubation.

Email discussion groups offer a way to keep in touch with colleagues. They are sponsored by various organizations to address a multitude of topics. Some lists are moderated by a human being, and others just pass along all messages automatically. You join by sending a subscription email message to the appropriate list server computer. Once subscribed, you will receive all messages sent to the list and can respond to the whole group or individually to the sender. Of course, you can initiate lines of discussion as well and it is often customary to introduce yourself when you join. Note that the address for sending messages to the members of the list is usually not the same as for sending subscriptions and other commands to the list server. It gets pretty old when lots of "subscribe" and "unsubscribe" messages go to the whole list, so be sure to keep those addresses straight. "What other commands are there?", you ask.. For one thing, you can get a list of the email addresses of other members. Also, through simple commands many lists offer the option of sending only daily summaries or of suspending your subscription while you are on vacation. "Are there any email discussion lists for plant diagnostics?", you wonder. As a matter of fact, Agdia maintains one. To subscribe, send an email to majordomo@agdia.com with the words "subscribe diagnostics" (without the quotation marks) as the *body* of the message. You should receive a confirmation message very quickly. You can send messages to the participants via the email address diagnostics@agdia.com. Despite the fact that there are 43 members on this list, there have been subscribed only two messages in the last two weeks, one reporting *Botrytis* as a possible root-rotting organism, and one response to that report! Maybe things will pick up as the weather warms.

Hot Tips

- Be careful when using the "Reply to All" feature. All of the addresses on the original message will get your reply. This could cause mild to severe embarrassment if unintentional.
- You might not be utilizing all the features available on your email program. For example, do you use folders to organize your messages by topic? Do you use the "blind CC" so that when messages go to a large group of people, they don't all see the list of recipients?

- To view digital images, you may have to save them to the hard drive and then open them in a separate graphics program, but if the images are in GIF or JPEG format and you are using Netscape Mail, they will appear below the text of the message.

That's enough for now. I have to get this file packed off as an email attachment to the editor. The next column will plumb the depths of the World Wide Web. Future topics may include digital cameras, computer viruses, or presentation and conferencing programs. I want to keep as up-to-date as possible with what is being done by *you* and maybe get a peek at what is just over the horizon. In all cases, I invite your input. Do you have a web page you'd like the world to see? Do you have a good or bad experience with computer databases? Has your clinic implemented a bar-coding system or electronic forms? Send me an email: mike_munster@ncsu.edu.

PS: Why don't they drink much KoolAid in Minnesota?
A: Because they have a hard time getting two quarts of water into the little foil packet.
(Come to think of it, I have a similar problem with those buffer concentrates.)

PESTICIDE USE IN THE UNITED STATES ORNAMENTALS INDUSTRY - Part I

Trends in Chemical and Non-Chemical Control Methods[1]

Melvin P. Garber, William G. Hudson, and Ronald K. Jones
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General Summary

The study included trends in chemical and non-chemical pest control measures and factors that affect adoption of non-chemical control measures. For the five-year period, 1988-1993, there appeared to be a decrease in chemical usage for disease and insect control and for plant growth regulators. During the same period there was an increase in chemical weed control. The adoption of non-chemical pest control measures was concentrated in the area of insect control. The primary limiting factors to use of non-chemical pest control measures were, (1) availability of effective materials/biological agents, (2) availability of information, and (3) management complexity. The primary information sources on non-chemical pest control used by growers varied by size of firm and region of the country. For all respondents the primary sources of non-chemical pest control options were (1) industry trade journals, (2) other growers in the industry, (3) Cooperative Extension Service and (4) industry sponsored seminars.

Disease Control **(see the expanded results of this study on page 23)**

The fungicides thiophanate methyl (585,000 lb; 45% of respondents), chlorothalonil (354,000 lb; 32% of respondents), mancozeb (241,000 lb; 28% of respondents) and metalaxyl (127,000 lb; 47% of respondents) were used in the greatest quantity and by the largest percentage of the growers. Metalaxyl was used in both greenhouse and field operations by the highest percentage of growers (47%) primarily for control of root diseases (87% of active ingredient used), but many growers reported using metalaxyl for foliar disease control. Overall, more fungicides (pounds of active ingredients) were used in the **field** for foliar diseases (54 %), whereas, almost equal amounts of fungicides were used for foliar (19%) and root diseases (17%) in the greenhouse. The control of root diseases in the field (10%) required the least fungicides. The primary alternative control measures utilized by the industry were monitoring/scouting (92.8% of respondents), inspection of incoming stock (90.6 %) and sanitation (89. 1 %).

Plant Growth Regulation

Daminozide (B-Nine SP) and chlormequat chloride (Cycocel) accounted for 78% of the total pounds of active ingredient and were used by 20% and 17% of the respondents, respectively. In contrast, the rooting compounds indolebutyric acid (Dip 'N Grow, Rootone, and Hormoroot) and naphthaleneacetic acid (Dip 'N Grow, and Hormodin 1, II, and III) were used by 5 3 % and 24 % of the respondents, respectively, but combined accounted for less than 3 % of total pounds active ingredient. Pruning/pinching was used by the greatest number of respondents (82%) and was the only alternative to PGRs rated as very effective by > 60 % of the respondents. Use of chemical

PGRs and non-chemical alternative practices was influenced by region and firm size. In the Northeast United States, growers reported relatively low use of PGRs (frequency and total pounds) and the lowest use of mechanical brushing (physical movement of plants for height control with a non-abrasive instrument) as an alternative practice. In contrast, mechanical brushing was used most in the West. Large firms (> $2M in annual sales) reported the greatest use of chemical and non-chemical means of regulating growth,

Weed Control

Glyphosate was the top-ranking herbicide among the total of 37 reported, both in terms of number of respondents and estimated total amounts of active ingredients applied. It was used by all but two of the respondents that utilized herbicides in their operations. Oryzalin was the top-ranked pre-emergent herbicide, and was second only to glyphosate in number of respondents and amount of active ingredient applied. The highest estimated use in amounts of active ingredient applied was in the Southeast (43 % of total) and North Central (27 % of total), nearly two to three times the estimated use in the Northeast or West. However, there were only about 50% more respondents in the Southeast or North Central compared to the other regions suggesting a higher use rate in these two regions. About 56% of herbicide active ingredients used were in field sites, 22 % in container sites, 19 % in perimeter areas, and 3 % in greenhouses. Large firms (annual sales >$2,000,000) used the greatest estimated total amount of active ingredients, while small firms (annual sales ≤ $500,000) tended to use non-chemical alternatives the most. Nearly all respondents used handweeding or hoeing as part of their weed control program. Mowing was used by 84% of the respondents, 71 % used tractor cultivation, and 66% used mulches (includes gravel and black plastic). Alternative methods were rated as somewhat effective to very effective by 65% or more of the respondents who used them.

Insect and Mite Control

Respondents reported using 46 different compounds, and the industry used an estimated 2.8 million pounds of active ingredients to control insect and mite pests. The most frequently used material was acephate; 52% of the respondents reporting use in 1993. The most heavily used material was a miticide, dienochlor, with an estimated 799,107 lb (363,230 kg) applied, or 28% of the total. Only three other compounds represented more than 5% of the total use: carbaryl (618,724 lb or 22%)(281,238 kg), diazinon (405,132 lb or 14%)(184,151 kg), and propargite (17 8,743 lb or 6%)(81,247 kg). Of the top four products - dienochlor and propargite - are miticides. Together these represented 34% of the total estimated insecticide/miticide use, demonstrating the importance of mites as pests in the industry.

Potential Economic Effects of Selected Pesticides

The loss of even one chemical can have a significant impact on the $6 billion greenhouse and nursery industries. The analysis showed that several chemicals, if lost, would result in a large decline in the gross margin of the combined greenhouse and nursery industries. These include two insecticides, abamectin (10%) and acephate (13%); three fungicides, metalaxyl (12%), chlorothalonil (8%), thiophanate methyl (13%); and the herbicide glyphosate with a 31 percent decline in gross margin. In each case these were among the most widely used chemicals based on the number of respondents that reported their use.

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[1] This summary and the following article on Disease Control were presented at the 10th Ornamental Workshop on Diseases and Insects, Crossnore N.C. 1996 and are printed with permission from R.K. Jones. The complete study is published in HortTech, Vol. 6, no. 3, July/September 1996.

PESTICIDE USE IN THE UNITED STATES ORNAMENTALS INDUSTRY - Part II

Disease Control

Ronald K. Jones, lead author
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Summary

The fungicides thiophanate methyl (585,000 1b; 45% of respondents), chlorothalonil, (354,000 lb; 32% of respondents), mancozeb (241,000 lb; 28% of respondents) and metalaxyl (127,000 lb; 47% of respondents) were used in the greatest quantity and by the largest percent of growers. Metalaxyl was used in both greenhouse and field operations by the highest percentage of growers (47%) primarily for control of root diseases (87% of active ingredient used), but many growers reported using metalaxyl for foliar disease control. Overall, more fungicides (pounds of active ingredients) were used in the field for foliar diseases (54%), whereas, almost equal amounts of fungicides were used for foliar (19%) and root diseases (17%) in the greenhouse. The control of root diseases in the field (10%) required the least fungicide. The primary alternative control measures utilized by the industry were monitoring/scouting (92.8 % of respondents), inspection of incoming stock (90.6 %) and sanitation (89. 1 %).

Introduction

Disease control methods have changed periodically over the years according to both sociological and scientific developments. In the early 1900s, the ornamentals industry used many disease control methods based on cultural controls such as use of pathogen-free planting material

(Priapi, 1993; Murashige, 1974), environmental manipulation, and a few inorganic pesticides such as sulfur and copper used alone or in combination with lime to control diseases. During the 1960s many new organic fungicides became available, which revolutionized disease control in the ornamentals industry. These fungicides were highly effective, active against a relatively narrow range of pathogens with low injury to crop plants, and easier to apply than previously available products. The use of these newer fungicides allowed higher quality, less expensive plants to be distributed throughout the world.

Over the past 10 years, improved environmental management techniques (Cuny, 1995) such as humidity control (Bartok, 1990; Onofrey, 1994), and light and temperature controls, especially with computerized systems (Pritchard and Flynn, 1993), have altered further the balance of pest control methods in the ornamentals industry. Fungicide use patterns have continued to change over the past 5 to 10 years. Decreased, threatened or lost availability of standard industry chemicals such as methyl bromide (Whitten, 1994) dodemorph acetate and benomyl sometimes have forced a shift to less effective products or to nonchemical methods of pest control. New "earth-friendly" (Robb, 1994) products, such as silicon for Pythium control (Lawson, 1994), bicarbonates for powdery mildew control (Horst et al., 1992), horticultural oils (Steward, 1993), biorational (Triact) and biological (SoilGard) products (W. R. Grace & Co. Conn; Grace BioControl, Columbia, MD (USA) currently are being researched and are labeled for use in the United States. At the same time, the industry has been confronted with pest resistance to some of the most commonly used products (Pommer and Lorenz, 1982; Roberts, 1994). Environmental regulations and EPA Worker Protection Standards, such as re-entry restrictions, have complicated further the use of pesticides on ornamentals. Finally, a dramatic shift in public opinion regarding pesticide use has forced all segments of the agricultural industry to rethink the emphasis placed on chemical disease control (Pardo, 1995; Klassen, 1992; and Blaine, 1993).

As scientists and educators, we have been waiting expectantly for commercial ornamental producers to rediscover methods of disease control based in nonchemical methodology (Onofrey, 1994). In recent years, monthly columns in grower magazines have been filled with articles extolling the benefits of integrated approaches to disease control (Barnes, 1993; Barnes, 1994) and annual grower meetings sponsored throughout the United States by Society of American Florists have focused on Integrated Pest Management (IPM). The need for pathogen-free planting stock has been gaining followers (Priapi, 1993) as have the benefits of a well-ventilated greenhouse for both pest and pathogen control (Kelly, 1994). Screening greenhouses to exclude insects, particularly virus vectors, has been gaining acceptance (J.R. Baker-personal communication).

The results of a national survey are presented herein to provide information for targeting new products and services for the ornamentals industry as well as to evaluate the degree of knowledge, use, and efficacy of the full range of disease control methods currently available. Future research, extension, and allied industry efforts might utilize this type of information to serve the ornamentals industry more effectively.

Results and Discussion

Fungicide use Patterns. The number of respondents reporting use of various fungicides/bactericides is given in Table 1 in descending order of active ingredient with at least 1 % of the respondents reporting its use. The most frequently used fungicide was metalaxyl (Subdue) with a total of 47% of respondents reporting its use. The next most commonly applied fungicides were thiophanate methyl (45%) and chlorothalonil (32%). Fungicides (in addition to metalaxyl) used for control of pythiaceous fungi included fosetyl aluminum (27%) and etridiazole (13%), for a total of 87% of the respondents employing at least one fungicide product for control of pythiaceous fungi. About 22% of the respondents reported use of a copper compound and about 28% used some formulation of maneb/mancozeb. The balance between broad spectrum and other fungicides was about equal when considering a narrow-spectrum fungicide is one that gives good control of only one or two major groups of plant pathogens. The most significant factor influencing this balance was the use of fungicides specific for pythiaceous fungi which are considered a non-broad-spectrum group. In general, a preference for broad-spectrum products such as thiophanate methyl, chlorothalonil, copper or mancozeb prevailed.

The volume of fungicide/bactericide differed from the reported frequency, since use rates differ dramatically (Table 1). Highest volume products of the total reported were thiophanate methyl at 585,001 lb (265,910 kg)(31 %), chlorothalonil at 354,249 lb (161,022 kg)(19 %), and mancozeb at 241,125 lb (109,602 kg)(13%). Metalaxyl, used at very low rates, accounted for only 126,895 lb (57,680 kg)(7%) of the total volume of active ingredients reported, even though it was used by the highest percentage of growers. lprodione, captan, and fosetyl al each accounted for about 5% of the total volume of fungicides used. Respondents were asked to report use of each fungicide/bactericide according to treatment site and type of disease targeted for control (Table 2). In general, fewer respondents applied products for control of root diseases in the field than any other type. Greenhouse producers applied more fungicides for root disease control. This may be related to a greater ability to affect the root environment and to the generally higher crop value and production costs which can bear this expense. While most fungicides are used appropriately, inconsistencies with both the label and the potential benefits of the fungicide can be found. A significant number of respondents reported using etridiazole and metalaxyl for foliar disease control which is inconsistent with both label instructions and potential beneficial use. Educational efforts should continue to stress the need for consistency in fungicide use according to labeled directions and known activity.

The percent of active ingredient for each chemical product used under various growing conditions is given in Table 3. Some products (propiconazole, benomyl, and copper) are used almost exclusively for a single target such as foliar diseases in the field. One hundred percent of piperalic acid use was reported for foliar disease control in the greenhouse. Etridiazole was used mainly for root disease control in the greenhouse. Approximately the same amount of metalaxyl was used for root disease control in the field as in the greenhouse (Tables 2a,b and 3). Thiophanate methyl was used primarily for foliar disease control in the field but for root disease control in the greenhouse. Finally, the products with the most broad spectrum were used in roughly equal amounts in the field and greenhouse for both root and foliar diseases (e.g. thiophanate methyl).

A summary of the fungicide use comparing greenhouse vs. field and for foliar disease vs. root-disease use reveals that almost 54% of the active ingredient was applied to field-grown ornamentals for foliar diseases (Table 4). Use of fungicides in greenhouses was considerably less, 19% being applied for foliar disease and 17% applied for root diseases. The smallest amount of active ingredient was applied to field-grown ornamentals for control of root diseases. More respondents used fungicides for foliar diseases (field and greenhouse) than for root disease control. The relatively low use rate (active ingredient) of metalaxyl, which is the most widely used fungicide, may account for all of this effect.

Patterns of fungicide use also differed by regions. More captan was used in the Northeastern region (Table 5) than any other fungicide; whereas, thiophanate methyl was the most widely used fungicide in the other three regions. Metalaxyl was used by the greatest percentage of the growers in the Northeastern (Table 5) and the Western regions (Table 8); whereas, thiophanate methyl was used by the highest percentage of the growers in the Southeastern (Table 6) and North Central (Table 7) region. The greatest total estimated use of fungicide occurred in the Southeastern region (Table 6). The lowest amount of fungicide use was reported in the Northeastern region (Table 5). The amount of captan used in the Northeastern region (Table 5) and thiophanate methyl used in the North Central region (Table 7) was more than three times that of any other fungicide. In the Southeastern (Table 6) and Western (Table 8) regions, the amount of fungicides used was more evenly distributed among several fungicides. The percent of estimated active ingredient for captan in the Northeastern region (Table 5) was

41%, whereas it represents only 1% in the Southeastern (Table 6) and the North Central (Table 7) and 2 % in the Western (Table 8) regions. Chlorothalonil was the second most heavily used fungicide in all four regions; thiophanate methyl was the most heavily used fungicide in the Southeastern, North Central, and Western regions.

Alternatives to chemical disease control. The most frequently used alternatives to disease control chemicals were monitoring/scouting (92.8%), inspection of incoming stock (90.6%), sanitation (89.1%), irrigation delivery/timing (82.6%), and resistant cultivars (79.5%)(Table 9). Fertility management (71.3%), crop rotation (60.7%), roguing (60.1%) and isolation (54.7%) also were used by at least 50% of the respondents. Media sterilization (48.9%), greenhouse relative humidity control (48%), and culture-indexed starter plants (31.8%) also were reported but less commonly used. The general experience with each method was very good, and all methods were reported as effective. Isolation of starter material was reported as effective (73.5%), but a significant percentage of respondents reported it as effective but impractical (16.5%). It is apparent that if an alternative method is employed, it is very successful (Table 9). Additional alternatives listed by the respondents for foliar drying and reduction of relative humidity were foliar rinse with a surfactant following watering, horizontal air fans, plant spacing, and aeration. Spot treatment, pH management, pruning, biological control, and control of run-off to prevent standing water also were mentioned by at least one respondent. The use of hydrogen peroxide and chlorination of water also were reported as alternatives to chemical disease control methods, despite the fact that these are chemical products.

Regional use of alternative methods showed a similar response for most methods. The most obvious differences in use were in greenhouse relative humidity management and media sterilization which were used significantly more in the Western (66.1% and 60.2%, respectively) than in the other regions (41.3 to 47% and 40.8 to 52.1%, respectively). Fertility management was used a little more frequently in the North Central region than in the other regions. Respondents in the Northeast reported nearly all methods were effective or very effective whereas at least 10% of the respondents in the Southeastern and the North Central regions reported media sterilization and isolation were effective but impractical (Table 10). In the Western region, over 21% reported that isolation was effective but impractical, and 10% reported crop rotation as effective but impractical.

The effect of firm size on frequency of use of alternatives to disease control chemicals varied. Frequency of use of fertilization management, irrigation management, culture-indexed plants, humidity control, roguing, and isolation increased as firm size increased. In contrast, use of resistant cultivars, rotation, sanitation, scouting and monitoring was approximately the same for all size firms. Use of media sterilization increased from small to medium-sized firms but was lower for large firms than medium-sized firms. This may be due to an increased use of prepared, bagged potting media by the largest firms. Experience with alternatives generally was not affected by firm size. As firm size increased, there was an increase in frequency of responses listing the following alternatives as effective but impractical: resistant cultivars, media sterilization, and isolation. Large firms were more likely to report the alternative methods as effective but impractical.

The extensive use of alternative disease control demonstrates a willingness and perceived need by the greenhouse and nursery industry to employ alternatives to chemical products. Most alternatives were viewed with a moderate degree of enthusiasm and have met with at least some success. The least utilized alternative is culture indexing which is the backbone strategy for control of *Xanthomonas* blight on geranium and several serious viral diseases. Due to limited applications on other major ornamentals the technique has not been utilized fully. Many plants are produced using tissue culture methods, but their pathogen-free status is not a primary concern and is not rigorously sought by either the ornamental grower or the tissue-culture specialist. Application of this alternative should be expanded if we are to realize optimal disease-control strategies.

Over 90% of the respondents utilized resistant cultivars of their ornamental plants. The industry may need added emphasis in this area as we encounter increased regulations, decreased chemical pesticide availability and increased environmental awareness. This is critical for both the plant producer and the ultimate consumer who also needs a resistant plant to eliminate the future need for fungicides in the landscape. This would also be a good marketing tool.

The best-utilized alternatives, scouting and monitoring, are two components of the same methodology and have perhaps come to disease control via insect and mite control. Media sterilization may have lost importance in the past 10 years due to the widespread availability of packaged potting media which are relatively free of plant pathogens.

The availability of chemical bactericide and fungicide products changes rapidly as products are lost and others are introduced. Since DuPont removed ornamentals from the Benlate label in 1991, the sales of thiophanate methyl for use on ornamentals and turf increased 200% (1991 - 1994). Despite the changes, it is obvious that chemicals are still an integral part of most disease-control programs. It is important to note that most growers are starting to address disease control with an integrated approach, and the days of spraying on a calendar basis are limited for most ornamental producers.

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Table 1 . Estimated fungicide usage in the United States.

	Respondents		Amount (lbs)	
Fungicide	Number	Percent respondents[z]	Estimated total active ingredient[y]	Percent
Thiophanate methyl	316	45	585001	31
Chlorothalonil	225	32	354249	19
Mancozeb	197	28	241125	13
Metalaxyl	330	47	126895	7
Captan	159	23	107224	6
Fosetyl Al	187	27	92375	5
Iprodione	165	24	87104	5
Copper	157	22	82570	4
Propiconazole	59	8	44807	2
PCNB	84	12	42830	2
Triforine	78	11	36538	2
Etridiazole	90	13	35829	2
Vinclozolin	87	12	22210	1
Triadimefon	133	19	5856	<1
Ferbam	28	4	5801	<1
Fenarimol	47	7	3619	< 1
Triflumizole	14	2	759	< 1
Ziram	8	1	644	< 1
Other[x]	64	9	24054	1
TOTAL	**2431**		**1904999**	**100**

[x] Includes Agribrom, AMCL, benomyl, dinocap, dodemorph, dodine, myclobutranil, oxycarbofuran, phaltan, piperalic acid, steptomycin and sulfur.

[y] Usage for respondents expanded to total estimated usage using USDA total sales for greenhouse/nursery industry; ratio of respondent sales to USDA sales used to estimate total usage.

[z] Determined by dividing number of users for each chemical by number of respondents

Table 2a. Type of diseases controlled by fungicides in the U.S. Nursery Industry (field use)

	Foliar disease		Root disease	
Fungicide/bactericide	No. respondents	Amount ai	No. respondents	Amount ai
Thiophanate methyl	131	52499	45	9912
Chlorothalonil	145	62053	10	1765
Mancozeb	109	40520	5	97
Metalaxyl	40	1667	158	13922
Captan	85	3366	25	302
Fosetyl Al	62	3175	102	11653
Iprodione	63	7582	21	2158
Copper	106	15310	8	17
Propiconazole	20	9759	4	87
PCNB	10	563	28	6391
Triforine	49	4755	5	28
Etridiazole	5	15	12	23
Vinclozolin	29	740	1	1
Triadimefon	73	716	5	34
Ferbam	19	1336	2	153
Fenarimol	22	671	1	1
Triflumazole	-	-	1	4
Ziram	4	78	1	35

Table 2b. Type of diseases controlled by fungicides in the U.S. Greenhouse Industry

	Foliar disease		Root disease	
Fungicide/bactericide	No. respondents	Amount ai	No. respondents	Amount ai
Thiophanate methyl	142	36429	147	28249
Chlorothalonil	113	122029	12	321
Mancozeb	72	7911	2	2
Metalaxyl	51	2334	202	12783
Captan	55	753	45	16630
Fosetyl Al	54	2235	69	2308
Iprodione	116	10901	54	7432
Copper	66	1175	5	60
Propiconazole	11	380	2	1
PCNB	8	26	51	2336
Triforine	35	2925	4	14
Etridiazole	18	146	81	1490
Vinclozolin	69	4815	4	45
Triadimefon	74	627	7	4
Ferbam	5	11	3	1
Fenarimol	28	144	2	1
Triflumazole	2	3	9	118
Ziram	1	18	2	4

Table 3 . Fungicide usage for different types of disease control.

	% active ingredient			
	Field Use		Greenhouse Use	
Fungicide/bactericide	Foliar	Root	Foliar	Root
Thiophanate methyl	41.6[z]	7.6	19.4	31.4
Chlorothalonil	81.3	2.3	16.0	0.4
Mancozeb	82.5	0.8	16.6	0.1
Metalaxyl	5.5	45.3	7.6	41.6
Captan	16.0	1.4	3.6	79.0
Fosetyl Al	16.4	60.2	11.5	11.9
Copper	93.3	0.1	6.2	0.4
Propiconazole	95.5	0.8	3.7	-
PCNB	6.0	68.6	0.3	25.1
Triforine	61.9	-	37.9	0.2
Etridiazole	5.7	13.1	7.5	73.7
Vinclozolin	27.0	7.7	38.8	26.5
Triadimefon	51.8	2.5	45.4	0.3
Ferbam	89.0	10.2	0.7	0.1
Fenarimol	82.2	0.1	17.6	0.1
Triflumizole	-	3.2	2.4	94.4
Ziram	62.8	30.9	3.3	3.0

[z] Calculated by amount active ingredient for different site/total amount active ingredient for each fungicide/bactericide

Table 4. Total-disease-control fungicide used for four categories of disease.

	Amount		Frequency	
Fungicide/bactericide	Active Ingredient (lbs)	Percent[z]	Number	Percent[y]
Field Use				
Foliar	248048	53.8	1100	33.9
Root	47020	10.2	442	13.6
Greenhouse Use				
Foliar	87647	19.0	985	30.4
Root	78246	17.0	715	22.1
Total	460962	100.0	3242	100.0

[z]Amount of active ingredient used in each category divided by total amount of active ingredient for all fungicides.

[y]Calculated as the total number of users in each category divided by total users of fungicide; some totals exceed number of respondents in survey due to use of more than one fungicide by some respondents.

Table 5. Estimated fungicide usage in the Northeast region.

	Respondents		Amount (lbs)	
Fungicide	Number	Percent respondents[z]	Estimated total active ingredient[y]	Percent
Captan	32	22	86590	41
Chlorothalonil	33	23	26017	12
Thiophanate methyl	42	29	20029	10
Fosetyl Al	23	16	17040	8
Mancozeb	39	27	12923	6
Metalaxyl	58	41	9873	5
Vinclozolin	13	9	8064	4
PCNB	10	7	7997	4
Etridiazole	17	12	4898	2
Copper	17	12	2470	1
Iprodione	16	11	1735	1
Fenarimol	8	6	1097	1
Triadimefon	20	14	1020	<1
Ferbam	8	6	438	<1
Triforine	10	7	326	<1
Triflumizole	2	1	378	<1
Propiconazole	5	3	130	<1
Ziram	1	1	34	< 1
Other[x]	16	11	8562	4
TOTAL	**370**		**209519**	**100**

[z] Determined by dividing number of users for each chemical by number of respondents from the respective region

[y] Usage for respondents expanded to total estimated usage using USDA total sales for greenhouse/nursery industry; ratio of respondents sales to USDA sales used to estimate total usage

[x] Includes benomyl, dodemorph, phaltan, piperalic acid and sulfur

Table 6. Estimated fungicide usage in the Southeast region.

	Respondents		Amount (lbs)	
Fungicide	Number	Percent respondents[z]	Estimated total active ingredient[y]	Percent
Thiophanate methyl	111	53	288568	30
Chlorothalonil	82	39	217394	22
Mancozeb	67	32	165238	17
Metalaxyl	107	51	49648	5
Iprodione	40	19	45217	5
Propiconazole	29	14	40280	4
Fosetyl Al	61	29	36130	4
Copper	62	30	30075	3
Etridiazole	22	11	28486	3
Triforine	24	11	22320	2
PCNB	20	10	18854	2
Captan	49	23	8771	1
Propamocarb	3	1	5510	1
Ferbam	12	6	2704	<1
Triadimefon	32	15	1944	<1
Vinclozolin	17	8	1581	<1
Triflumizole	4	2	248	<1
Fenarimol	1	<1	97	<1
Ziram	5	2	22	< 1
Other[x]	15	7	3585	<1
TOTAL	**763**		**209519**	**100**

[z] Determined by dividing number of users for each chemical by number of respondents from the respective region

[y] Usage for respondents expanded to total estimated usage using USDA total sales for greenhouse/nursery industry; ratio of respondents sales to USDA sales used to estimate total usage

[x] Includes Agribrom, AMCL, Benomyl, Dinocap, Dodemorph, Piperalic acid and Steptomycin.

Table 7. Estimated fungicide usage in the North Central region.

	Respondents		Amount (lbs)	
Fungicide	Number	Percent respondents[z]	Estimated total active ingredient[y]	Percent
Thiophanate methyl	98	46	160378	54
Chlorothalonil	64	30	48445	16
Metalaxyl	81	38	27087	9
lprodione	44	21	18870	6
Mancozeb	47	22	8707	3
Vinclozolin	26	12	7243	2
Fosetyl Al	43	20	4448	1
Propiconazole	16	7	4223	1
Captan	52	24	3470	1
PCNB	29	14	3148	1
Copper	28	13	2761	1
Etridiazole	40	19	2258	1
Ferbam	6	3	1890	1
Triadimefon	39	18	1190	1
Triforine	20	9	837	1
Fenarimol	11	5	563	<1
Triflumizole	3	1	139	<1
Other[x]	14	7	1120	1
TOTAL	**661**		**296776**	**100**

[z] Determined by dividing number of users for each chemical by number of respondents from the respective region

[y] Usage for respondents expanded to total estimated usage using USDA total sales for greenhouse/nursery industry; ratio of respondents sales to USDA sales used to estimate total usage

[x] Includes benomyl, dodemorph, dodine, myclobutranil, oxycarbofuran, and piperalic acid

Table 8. Estimated fungicide usage in the West region.

Fungicide	Respondents Number	Respondents Percent respondents[z]	Amount (lbs) Estimated total active ingredient[y]	Amount (lbs) Percent
Thiophanate methyl	65	49	116026	27
Chlorothalonil	46	34	62393	14
Mancozeb	44	33	54258	13
Copper	50	37	47263	11
Metalaxyl	84	63	40287	9
Fosetyl Al	60	45	34757	8
Iprodione	65	49	21283	5
Triforine	24	18	13055	3
PCNB	25	19	12831	3
Captan	26	19	8393	2
Vinclozolin	31	23	5322	1
Fenarimol	23	17	1937	1
Triadimefon	42	31	1702	1
Ferbam	2	1	769	<1
Ziram	6	4	513	< 1
Propiconazole	9	7	175	<1
Triflumizole	5	4	94	<1
Etridiazole	11	8	187	<1
Other[x]	19	14	10787	2
TOTAL	**637**		**432031**	**100**

[z] Determined by dividing number of users for each chemical by number of respondents from the respective region

[y] Usage for respondents expanded to total estimated usage using USDA total sales for greenhouse/nursery industry; ratio of respondents sales to USDA sales used to estimate total usage

[x] Includes Agribrom, AMCL, benomyl, dodemorph, myclobutranil, oxycarbofuran, piperalic acid, and sulfur

CLASSIFIED

POSITION OPENING:

PLANT PEST DIAGNOSTICIAN - NDSU EXTENSION SERVICE

NORTH DAKOTA STATE UNIVERSITY, FARGO, ND

APPLICATION DEADLINE: March 15, 1997 or until suitable applicant is found. Position is available immediately.

POSITION DESCRIPTION: Assumes responsibility for plant pest diagnosis, coordination of seed pathogen testing services, and teaching introductory plant pathology laboratories. The position is classified as a full time non-tenure track extension associate. A Master's degree in Plant Pathology, Plant Protection, Plant Health Technology or closely related field is required with supporting course work in entomology, crop, weed and soil science desirable. Knowledge or experience with modern diagnostic techniques (e.g.; serology, electrophoresis, PCR, etc.) and pathogen identification is desirable. The opportunity exists for an applicant to actively pursue a Ph.D. program in Plant Pathology or closely related field in combination with this job. Salary will be commensurate with experience and responsibilities. NDSU is an equal opportunity employer with a strong fringe benefit package, including, Group health and life insurance, TIAA CREF retirement plan, Workmen's Compensation, annual and sick leave according to University policy. Tuition waiver for course work.

Further information may be obtained by contacting: James R. Venette, Interim Chair
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