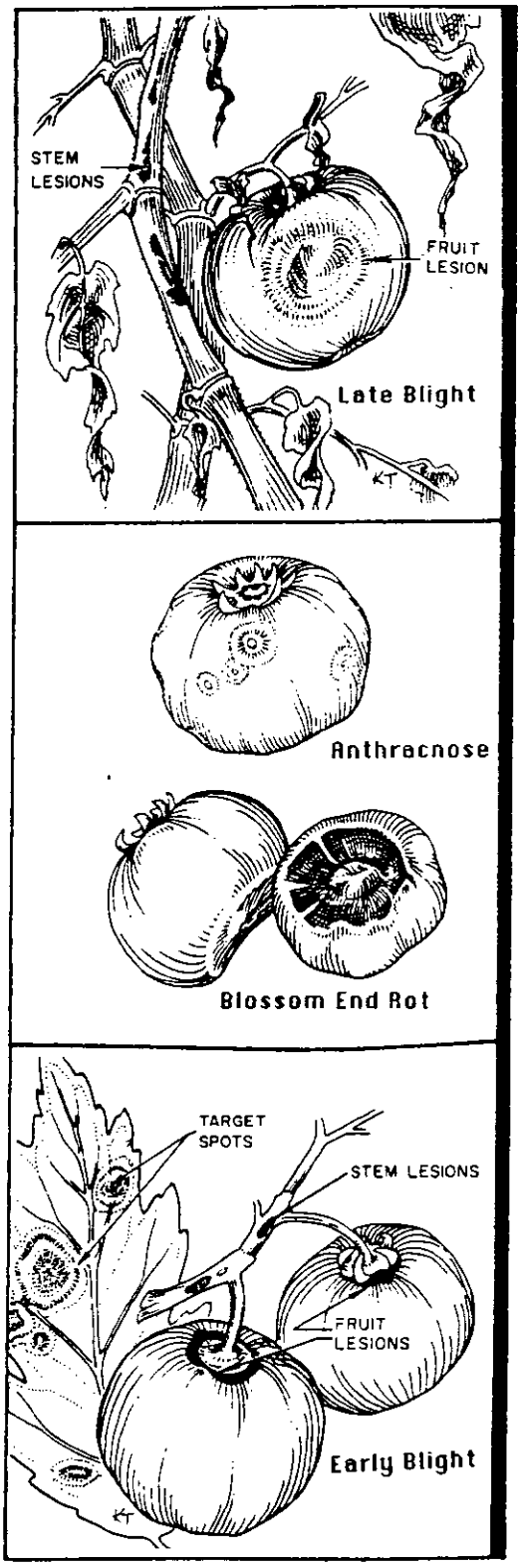
Tomato Diseases



Volume VII Number 2

PLANT DIAGNOSTICIAN'S QUARTERLY

June, 1986

Features

Illustrations by Karen Teramura

The Plant Diagnostician's Quarterly (PDQ) is a nonprofit publication which serves plant pathologists in extension, regulatory and industry clinical laboratories. PDQ is published four times a year, in March, June, September, and December. Yearly subscription is $10.00 in U.S. and Canada; $25.00 overseas airmail.

Send manuscripts and announcements to the editor: Ethel M. Dutky, Department of Botany, University of Maryland, College Park, MD 20742.

Send subscription payments and address corrections to the managing editor: Gail Ruhl, Department of Botany and Plant Pathology, Lilly Hall of Life Science, Purdue University, West Lafayette, Indiana 47907.

Table of Contents

PDQ Volume VII, Number 2
June 1986

Editor's Letter June 10, 1986

This issue has three features. First, the "Foliage Plants in Interiorscapes" beautifully done by Juliet Carroll and Margery Daughtry, with help from Ann Chase who sent the detailed, updated listing of diseases of foliage plants by host. The second feature is from the Potomac Division APS Annual Meeting, and consists of the prepared remarks of speakers at a panel discussion of "Technological Advances in Identification of Plant Pathogens." If your regional meeting has a workshop or panel covering a topic of interest to PDQ readers, let me know. I'd like to include it in PDQ. And the third is from Charles Semer giving his perspective as a diagnostician working in the ornamental plant production industry.

Send me information on events that may be of interest to other diagnosticians. Also, book reviews and job announcements.

The PDQ feature calendar for 1986 is full but there are a few openings in 1987, or for short, timely features in 1986. Don't be shy! Call or write me with ideas.

I'm looking forward to Gainesville and Orlando in August and hope to see many diagnosticians there.

Sincerely,

Ethel M. Dutky
Editor - PDQ

DIAGNOSIS AND MANAGEMENT OF DISEASES OF FOLIAGE PLANTS IN INTERIORSCAPES

Juliet Carroll and Margery Daughtrey

More and more, diagnosticians are called upon to identify the spots, blotches and wilts affecting tropical foliage plants that landscape the quite non-tropical settings of offices, lobbies, shopping malls and atriums in all parts of the United States. As the interiorscaping industry has matured, so has its need to thoroughly understand the causes for plant failure in interiors. Although long accustomed to dealing with houseplant problems, including those that affect foliage plants grown in the home, the diagnostician may find some new challenges when called upon to assist commercial interiorscapers.

The purpose of this article is to provide guidance in diagnosis and management of biotic disease problems commonly encountered in interiorscape plantings. We will not describe all of the diseases that are encountered during Florida nursery or greenhouse production of these plants. A forthcoming APS Compendium on diseases of foliage plants now being compiled by Dr. Ann Chase will soon provide thorough coverage from that perspective. A list of the diseases which are to be covered in the Compendium is included as an appendix to this article. Interiorscapers can encourage improved disease control at the production level if they are trained to recognize signs and symptoms of common diseases. They then will have the option of rejecting infected plants on receipt. Once spotted, leaves will stay spotted. Although an obvious concept to plant pathologists, many interiorscapers may not grasp this reality at first. Disease injury may often ruin the aesthetic quality of plants used as ornamentals in interiors.

The prosper and spread of infectious diseases on foliage plants is rare under the environmental conditions offered by an indoor landscape. Plants with fungal leaf spots on older foliage usually do not develop any further symptoms on new foliage because the environment does not favor sporulation or infection. Likewise, if lesions are due to a non-systemic bacterial infection, the moderate temperatures and humidities found indoors do not foster further spread of a bacterial leaf spot. While free water on above ground parts has been frequently cited as critical for the most troublesome pathogens of foliage plants during production, it is almost always absent in the interior landscape. Ordinarily, irrigation is applied directly to the containers in interiorscapes, rather than as an overhead drench that soaks the foliage. Even if foliage is splashed with water, the low humidities typical of air conditioned or heated interior atmospheres encourage rapid drying and discourage disease development. However, the possibility of spreading diseases while wiping leaf surfaces with such materials as leaf shine or insecticidal soap has not been thoroughly explored.

Careful sanitation procedures should be practiced by the horticultural technicians tending the plants. These individuals should be aware that hands and tools must be disinfested after handling roots or leaves that appeared diseased. When possible, infected leaves should be removed rather than leaving them in place as a potential source of inoculum. Since plants are often placed into interior settings at close to their final size, to state that "new foliage will be clean" may offer little reassurance to an interiorscaper.

Individual infectious diseases commonly responsible for symptoms on foliage plants are listed below, with tips for their diagnosis and management.

POWDERY MILDEW (Oidium spp./cleistothecia rare or unknown)

HOSTS: African Violet (Saintpaulia ionantha hybrids), Begonia (Begonia spp.), Grape Ivy (Cissus rhombifolia), Kangaroo Vine (C. antartica), Jade Plant (Crassula argentea), Kalanchoe (Kalanchoe spp.)

DIAGNOSIS: Look for the characteristic whitish to almost translucent appearance of the powdery mildew mycelium and spores on the upper leaf surface or on emerging leaves. Lesions are often circular in outline. Leaf distortion may result from infections on young leaves. On jade plant or Kalanchoe, browning and scaling of the epidermis may occur. The crusty lesions on Kalanchoe or jade plant often support scant hyphae and few spores. A useful technique for these crusty lesions is to place the symptomatic tissue on the stage of the compound microscope and illuminate from above. Scan the lesion with the low power objective and look for characteristic translucent (almost sparkling) hyphae and barrel shaped spores in chains.

FUNGUS: Oidium sp. is a member of the Erysiphaceae. Little is known of the teleomorphs (sexual stages) of these powdery mildews. Those on Begonia, Kalanchoe, and African Violet might link with Microsphaera tarnavschii (according to E. Eliade)or with Erysiphe polyphaga (according to C. Hammarlund).

Conidia - hyaline, barrel-shaped, 1-celled, catenulate (in chains).

TECHNIQUES:

Scotch tape mount or leaf print - This technique will help preserve the chains of barrel-shaped spores. Use the sticky side of non-transparent tape to gently pick the hyphae and spores off of the plant surface. Mount tape sticky side down over a drop of water or stain on a microscope slide, absorb excess liquid and examine under the microscope.

Scraping - With a scalpel or dissecting needle ,scrape the surface of the lesion over a drop of water or stain on a microscope slide. Gently stir the scrapings into the drop, cover with a cover slip and examine under the microscope for spores and hyphae.

Whole tissue mount - For delicate, thin tissue such as African violet petals, mount a piece of the infected tissue in water or stain as above.

MANAGEMENT: Little can be done to discourage powdery mildew development on such notorious hosts as grape ivy and Begonia when there is a pre-existing infection on plants placed into the interiorscape. Typical indoor humidities do nothing to hamper the development of powdery mildew, and usually enough drafts are provided to disturb spores from their conidiophores and carry them to new infection sites. Since leaf wetness is not a requirement for spore germination of the powdery mildews, they are well-adapted to thrive indoors.

Care should be taken to avoid installing Grape Ivy in a planting if any visible trace of powdery mildew is present. At any time infected leaves are noticed, these should be removed carefully and placed directly into a plastic bag, in hopes of keeping the infestation in check. Fungicidal treatment with Benlate, Milban, Karathane, Actidione, Triforine, Sulfur, Topsin-M or Folpet may be legal on certain ornamentals, but only under outdoor or greenhouse conditions. Plants must thus be removed from the interiorscape for treatment.

Cissus rhombifolia and Cissus rhombifolia 'Ellen Danica' are both highly susceptible to powdery mildew. We are not aware of any resistant cultivars. Plantscapers should be actively pursuing an improved cultivar, however, due to the cost of replacing plants which develop a white coating and drop brown dessicated leaves on the floor. Because powdery mildew is so common on grape ivy used in indoor plantings, it is a real wonder why the industry continues to use this plant. Others with a trailing habit should be considered as substitutes.

ANTHRACNOSE (Colletotrichum gloeosporioides, Colletotrichum spp./Glomerella cingulata)

HOSTS: Anthurium spp, Dwarf schefflera (Schefflera arboricola), Cacti, Chinese Evergreen (Aglaonema spp.), Croton (Codaieum variegatum), Dracaena spp., Dumb Cane (Dieffenbachia spp.), English ivy (Hedera helix), Grape Ivy (Cissus rhombifolia), Kangaroo Vine (C. antartica), Nephthytis (Syngonium podophyllum), Norfolk Island Pine (Araucaria heterophylla), Peperomia spp., Philodendron spp., Pothos (Epipremnum aureum), Rubber Tree(Ficus elastica), Schefflera (Brassaia actinophylla), Sedum spp., Staghorn Fern (Platycerium bifurcatum), Swiss Cheese Plant (Monstera deliciosa), Ti Plant (Cordyline terminalis).

DIAGNOSIS: Lesions may occur on leaves, petioles and/or stems and are usually light brown to brown in color. Within the lesions, usually near their centers, look for tiny, black fruiting bodies (perithecia and/or acervuli). Fruiting may be solitary or aggregated. Acervuli may or may not have setae and if mature may be oozing salmon- to cream-colored masses of conidia. Fruiting bodies are often concentrically arranged in larger lesions on the host. Of the hosts listed above all members of the Araceae (Dumb Cane, Philodendron, etc.), as well as Dwarf Schefflera and Rubber Tree may be commonly infected with anthracnose. English ivy is subject to leaf spots caused by the anthracnose fungus, Colletotrichum trichellum.

FUNGUS: Some Colletotrichum species may invade injured, weak, or moribund plant tissues. In these cases, base diagnosis on symptomology and cultural history of the plant, unless pathogenicity tests will be run. An excellent description of Glomerella cingulata and Colletotrichum gloeosporioides by T.E.M. Mordue is in *CMI Descriptions of Pathogenic Fungi and Bacteria*, No. 315. Colletotrichum gloeosporioides is an extremely variable fungus. Conidia are oval, hyaline, with straight sides and obtuse apices (9-24 x 3-6μ). The formation of brown appressoria is a key characteristic of the genus Colletotrichum.

TECHNIQUES:

Free Hand Sections - The acervuli of Colletotrichum or the perithecia of Glomerella cingulata may be examined.

Moist chamber Incubation - Immature fruiting structures will sporulate on infected tissue incubated in an environment with 100% RH. Galvanized screen or hardware cloth cut and bent to fit in the chamber will keep the plant tissue off of the wet surface and discourage saprophytic growth of other organisms. Perithecia may require several weeks to mature. Daily cycles of 12 hr dark and 12 hr light may help speed sporulation.

Isolation or culturing - Small tissue pieces from the margin of dead and healthy areas may be plated onto water agar, potato dextrose agar, etc. Surface sterilize tissue in 10% bleach for one to five minutes, air dry, excise small pieces from margin and plate out.

Dr. Russell Rodriguez, Postdoctoral Fellow, Cornell, Ithaca, has developed two media for sporulation of Colletotrichum spp. These contain the following per litre of water:

SMA:	Yeast Extract	10.0 g
	Maltrin - 100	5.0 g
	$K_2 HPO_4$	1.0 g
	$Mg SO_4$	0.1 g
	Agar	16.0 g

(For SSMA: add 5g sucrose)

TSM:	Torula yeast	15.0 g
	Sucrose	5.0 g
	K_2HPO_4, $MgSO_4$, Agar - as above	

On both media, well-defined acervuli and profuse sporulation occur. On SMA the isolate may invaginate the medium.

MANAGEMENT: Anthracnose symptoms may be seen on certain foliage plants as mementoes of infections that were able to take place under the foliar wetting and humidity conditions present during production. If plants are being sprayed or heavily misted with water on a regular basis, the anthracnose pathogens may continue to thrive. Any infected leaves should be removed to eliminate the inoculum source. Occasionally uniquely wet environments are encountered in interior plantscapes, such as situations where a pool deck is hosed down periodically, splashing low beds of ivy (Hedera helix), and thus fostering Colletotrichum spread. Moisture regulation is again the key to minimizing the spread of an anthracnose problem on any host. Since the fungus will colonize wounds, plant handling during placement and maintenance should be as gentle as possible. Furthermore, growing conditions that are suboptimal may favor anthracnose infection. Fungicides are not currently labeled for anthracnose control in interiorscapes, but troubles with these diseases will ordinarily be minimal.

BOTRYTIS BLIGHT (Botrytis cinerea and other Botrytis spp.)

Botrytis is rarely a problem in the interior settings, since most foliage plants are not highly susceptible and free moisture is not available to promote spore germination and infection: six to 10 hours of leaf wetness are required for infection. B. cinerea is an opportunist and may infect weak, injured, or abused plants under conditions of poor air circulation.

HOSTS: Many, including African violet (Saintpaulia ionantha hybrids), Boston Fern (Nephrolepsis exaltata), Dracaena spp., English Ivy (Hedera helix), Grape Ivy (Cissus rhombifolia), Kangaroo Vine (C. antartica), Lipstick Vine (Aeschynanthus pulcher), Persian Violet (Exacum affine), Philodendron spp., Rubber Tree (Ficus elastica), Wax Plant (Hoya carnosa), Zebra Plant (Aphelandra squarrosa)

DIAGNOSIS: Look for the silver gray fluff of spores on delicate, dark brown conidiophores growing out of dead plant parts near the soil or in moist areas within the plant canopy. Botrytis stem infections often have a light tan color.

TECHNIQUES: Refer to previous sections for detailed methods.

Scotch tape mount
Scraping
Moist chamber incubation- under 12 hour light/12 hour dark cycle.

Isolation or culturing - Amending media after autoclaving with 100 ppm streptomycin will help inhibit bacterial growth. Botrytis may be slow to sporulate on agar media. This fungus has stout, hyaline hyphae with right angle branching and may thus look like a Rhizoctonia sp. in culture. However, Botrytis has no dolipore septa. Sporulation of B. cinerea may be hastened by growing it on PDA at 18° - 20° C, with a daylength of 12 hours light and 12 hours dark.

MANAGEMENT: Botrytis is very well controlled by purely environmental means. The lowered humidities of interiorscapes are ordinarily quite sufficient to keep it in check. Extremely sharp drops in temperature from daytime to night might generate condensation on plant surfaces and permit some infection, particularly on very susceptible tissues, such as mum flowers used for holiday displays of color.

FUNGAL LEAFSPOTS:

Fungal leaf spots (outside of the category of anthracnoses) most likely to be encountered in the interiorscape will be Fusarium moniliforme leaf spots on various Dracaena spp. and Sansevieria trifasciata, Coniothyrium leaf spot on Yucca elephantipes, and Phyllosticta dracaenae on Dracaena spp. For other listed fungal leaf pathogens, see the appendix at the end of the article.

DIAGNOSIS: Fusarium leafspots on Dracaena are a reddish-brown in color, and appear on young foliage. Spotting may become more obvious as the leaves expand. Heavily infected whorls collapse with a dry rot. To complicate the diagnosis, fluoride toxicity symptoms can mimic leafspot infections on Dracaenas. If the spotting is not visible at the time that the plants are brought in from the nursery, it is highly unlikely that it is due to a fungus infection. Fluoride toxicity symptoms are enhanced by interior conditions, whereas fungus symptom development is reduced. On Sansevieria, Fusarium infection causes tan dry or wet rot lesions (often with reddish borders). Coniothyrium leafspots on Yucca are distinct, brown to black and elliptical; they are about 3 x 8 mm in size, become depressed with age, and develop a purple margin. Phyllosticta leafspot on Dracaena or Cordyline appears as brown dead areas on the older leaves.

FUNGI:

Fusarium moniliforme
chlamydospores - absent
microconidia - in long chains
macroconidia - long and thin, falcate, septate
sporodochia - white to salmon colored
colony on PDA - violet pigment

Coniothyrium concentricum
conidia - brown, 0 - 1 septate, verruculose, small (appro. 6 x 4μ), spherical or elliptical
conidiophores - absent; conidiogenous cells
conidiomata - pycnidia, thin-walled, unilocular, immersed, separate, brown

Phyllosticta dracaenae
conidia - hyaline, 1-cell, tiny, rectangular
conidiomata - pycnidia, black, separate, unilocular, immersed

TECHNIQUES:

Scraping - Fungi Imperfecti
Scotch tape mount - Fungi Imperfecti
Free Hand Section - all
Moist Chamber Incubation - All
Isolation or Culturing - All . Diurnal light/dark cycle will help speed sporulation

MANAGEMENT: Fusarium moniliforme infections on Dracaena take place when water sits in the whorl of the plant-- a situation ordinarily avoidable when plants are established in interior settings. Plants that are badly spotted may be received in shipments from nurseries, and placed on jobs nevertheless.
The Fusarium infections of Dracaenas (especially D. marginata or D. reflexa) may look more disfiguring with time, as the young infected foliage matures and lengthens. Additional infection will probably not take place, but the plant may need to be discarded for aesthetic reasons. For all infectious leaf spots:
Avoid wetting the foliage, remove infected leaves, and rogue severely infected plants.

ROOT AND CROWN ROT

HOSTS: Pythium root rot may be a problem on many plants, but it is particularly notable on Epipremnum aureum (pothos). Other hosts include: Chinese Evergreen (Aglaonema spp.), Anthurium spp., Zebra Plant (Aphelandra squarrosa), Norfolk Island Pine (Araucaria heterophylla), Schefflera (Brassaia actinophylla), Caladium x hortulanum, Rattlesnake Plant (Calathea spp.), Grape Ivy (Cissus spp.), Dieffenbachia spp., Japanese Fatsia (Fatsia japonica), English Ivy (Hedera helix), Peperomia spp., Philodendron spp., Oyster Plant (Rhoeo spathacea), Thanksgiving and Christmas Cactus (Schlumbergera spp.), Spathe Flower (Spathiphyllum spp.), Nephthytis (Syngonium podophyllum).

DIAGNOSIS:
Blackened, brownish or punky roots predominate on affected plants. Foliage may wilt, yellow, drop off or gradually droop and remain epinastic. The cortex will slough off the central stele tissue of roots infected with Pythium spp. Fusarium may cause distinct to diffuse reddish-brown lesions on roots. At the lesion margin the discoloration may continue short distances into the vascular cylinder. All fungi may colonize crown and lower stems as well as cause more general root rot symptoms.

FUNGI:
1. Fusarium spp. - May be a weak parasite invading moribund tissue. Macroconidia are diagnostic. Microconidia, chlamydospores, and sporodochia will aid in speciation.

2. Cylindrocladium spp. -
conidia - cylindrical, septate, hyaline, in slime
conidiophores - brush-like, long, branching at top, hyaline, phialidic

3. Pythium spp. -
sporangia - round, rectangular, variable, intercalary, germinate to form vesicles.
vesicles - round, thin walled
oospores - round, thick walled. Form in absence of light.

4. Rhizoctonia solani -
dolipore septa (possibly visible with phase contrast)
multinucleate
brown sclerotia may form in culture
no spores (rarely basidiospores)
mycelium acquires tan coloration with age
septum on side branch forms very close to a constricted area at junction with the main hypha
right-angle branches usually present; 45^{o} angles common

TECHNIQUES:
Scraping - Fusarium mycelium and sporodochia and Pythium and Rhizoctonia mycelium, if present, may be gently lifted or teased off the base of the plant near the soil line.

Isolation or Culturing - Rinse soil from roots and trim pieces for culturing. Place them in cheese cloth, fasten closed and wash in running tap water for 1/2 hour or more. Or place root pieces in a sterile water blank and vortex for several minutes, repeating with two fresh sterile water blanks. This will aid recovery of Pythium on simple media such as water agar or water agar amended with 100 ppm streptomycin. Sporulation of Pythium spp. is enhanced by incubation in the dark.

Fusarium, Rhizoctonia, and Cylindrocladium will grow out on non-selective media following sterilization of root pieces in 10% bleach.

MANAGEMENT: Use of a mix with adequate air pore space (at least 15-20%) is important for a healthy root system and can aid in the management of Pythium root rot. Rhizoctonia, Fusarium and Cylindrocladium infections have very little association with cultural problems: normal, desirable soil moisture levels are sufficient to allow growth of these fungi.

Recent changes in Federal labeling now permit the use of either Banrot 8G or Subdue 5G by commercial applicators on interior plantings in public areas. Banrot (ethazol and thiophanate-methyl) is effective against Rhizoctonia, Fusarium and Cylindrocladium, as well as the water mold fungi, whereas Subdue (metalaxyl) is a systemic effective only against the water molds. Subdue 2E also is labeled for use in professional maintenance of interiorscapes. However, because of its high activity at very low concentrations, it is difficult to accurately measure Subdue 2E dosage for small-volume application.

In many interiorscape situations, granules are preferable for application. Work granules into the soil or under a mulch, so that they will not attract casual fingering by children or adults. To reduce hazard to workers, warn against use of the "index finger method" to determine whether soil moisture levels are adequate.

CANKER AND DIEBACK

HOSTS:

Dracaena spp. - Dothiorella sp.
Norfolk Island Pine (Araucaria heterophylla) - Dothiorella sp.
Weeping Fig (Ficus benjamina) - Phomopsis cinerescens
and Dothiorella sp.

DIAGNOSIS: Look for wilting and drooping yellow or brown foliage on branches or stems. Phomopsis canker causes brown, water-soaked, diffuse lesions on young, green Ficus benjamina shoots. On older branches or main stems look for fruiting structures bursting through dead bark. Small twigs may appear dried and shriveled after infection.

FUNGI:

Phomopsis cinerescens
conidia -α: hyaline, fusiform, straight, guttulate, 1-cell
β: hyaline, filiform, hamate, 1-cell
conidiophores - branched and septate at base, hyaline, short to filiform; enteroblastic, phialidic.
conidiomata - stromatic, brown, uni- or multilocular, thick walled
culture - white to buff to pale brown mycelium that develops hard gray brown stroma.

Dothiorella sp.
conidia - hyaline, large, 3 X as long as broad, oval to fusiform, 1-cell
conidiophores - 1-cell, hyaline, phialidic
conidiomata - stromatic, brown to black, botryose, thick walled
culture - off-white to gray mycelium that develops hard, gray-black stroma

Techniques:
Free hand section
Moist chamber incubation - alternating 12 hours of light and dark will help stimulate sporulation.
Isolation or culturing - PDA or dilute PDA will support mycelial growth and sporulation of both these fungi. Light/dark cycles help stimulate sporulation. Phomopsis often produces only alpha conidia in culture. However, inverting the plates causes stroma to form within the agar or between the bottom of the plate and the base of the agar. These "embedded" stroma often contain both alpha and beta conidia.

Management: Prune out affected portions of the branches (dipping tools in 70% ethanol between cuts). Improve the stress level of the tree's environment by 1)Improving lighting 2)Avoiding drought stress periods 3)Controlling scale infestations. If prognosis is poor, consider replacement with a species better adapted to low light conditions or switch to a silk tree.

BACTERIAL DISEASES

HOSTS: All members of the Araceae
Dracaena spp.
Hedera helix

DIAGNOSIS: Brown circular spots or wedge-shaped lesions with water soaked and/or chlorotic margins develop on leaves. On English ivy leafspots are brown, about 0.5 to 1.0 cm in diameter, with a yellow halo. Blights of young foliage or the spike of red leaves on Dracaena marginata or Dracaena fragrans ('Spike') cause tissue to turn brown and mushy.

BACTERIA:

Xanthomonas hederae - local infection
- gram reaction- negative
- KB - non-fluorescent
- Kovacs Oxidase - negative
- Hugh Leifson Media (HL) - negative (both aerobic and anaerobic)
- Colonies - yellow, slimy, mucoid on carbohydrate - rich media (albino forms occur)

Pseudomonas cichorii - local infection
- gram reaction- negative
- HL - negative: anaerobic
  positive: aerobic
- KB - fluorescen
- Kovac's Oxidase - positive
- Arginine dihydrolase-negative

Erwinia chrysanthemi - systemic infection
- gram reaction- negative
- Miller - Schroth - yellow orange
- HL - positive (both)
- KB - non-fluorescent
- Kovac's Oxidase - negative
- Erythromycin Sensitivity - positive
- Phosphatase - positive

TECHNIQUES:
Free hand section - Look for swarms of bacteria oozing from tissue
Whole tissue mount
Isolation or culturing
Diagnostic media - perform tests listed under bacteria (Fahy, Pierce)

MANAGEMENT: Avoid placing plants showing symptoms of bacterial infection in interiorscapes. Once there, little can be done other than keeping water splash and air humidity down to reduce disease spread, and avoiding overfertilization that would increase succulence of the plant tissue.

If the bacterial disease in question is caused by Erwinia chrysanthemi, the prospect for the plant is grim. The systemic nature of the infection may result in the ultimate deterioration of a highly susceptible host such as Philodendron selloum. Philodendron selloum has lost a great deal of its popularity for use in interiors because of the serious disease problem posed by E. chrysanthemi. Because Pseudomonas cichorii and Xanthomonas hederae are not systemic, picking off affected leaves will often be the last that is seen of the problem, unless the plant is splashed or misted frequently, or kept in an unusually humid environment. Bacterial spot on English Ivy will be a serious interior problem only if the foliage is getting splashed by a waterfall or an overzealous mopper.

RUSTS AND VIRUS DISEASES

Rusts are not a problem on the majority of interior plants. Bromeliads may rarely be affected. Usually plant symptoms appearing as "rusty" spotting on the leaves of interior plants are not due to a true fungal rust at all, but are the result of insect injury, fluoride toxicity, or some other non-contagious agent. Virus diseases might be seen occasionally on plants in interiorscapes. A few of the most notable include:

Dasheen Mosaic Virus - Dieffenbachia, Aglaonema: Light green and yellow mosaic pattern and some distortion of leaves.

Cucumber mosaic virus - Maranta: Light green and yellow mosaic on leaves.

Ghost Ring - Schefflera (Brassaia actinophylla): Brown, indented ring patterns on the leaflets

Control of potential insect vectors (aphids, whiteflies, thrips, especially) would be a helpful practice for reducing virus spread. Rogue any plant showing serious virus symptoms; plants with mild symptoms usually go unnoticed or may be tolerated.

****

Closing comments: *From the "non-Koch's postulates" diagnostician's viewpoint, such diseases as root rot, anthracnose, dieback, and Botrytis blight may be difficult to define as primary or secondary. For this reason, it is important to determine the environmental and cultural conditons under which the plants are being grown.*

From the interiorscaper's viewpoint, the most important diseases of interior plants are those affecting the foliage. It will not be the below-ground decay of the plant infected with root rot that is noticed, but rather the drooping and yellowing foliage. The diagnostician may need to point out the life requirements of plants regarded as decorative elements, and to suggest causes of foliar symptoms which relate to the cultural errors common in indoor plantings. Diseases affecting interior plants that result from physiological or cultural disturbances abound. It is beyond the scope of this article to examine these at this time.

Because the information given here represents only our experience, it would be helpful for other diagnosticians to write PDQ with any additional comments, insights or techniques they may have on foliage plant problem diagnosis.

Table . Listing of diseases of foliage plants by host.

Plant	Common name of disease	Pathogen (s)
Aechmea fasciata (Urn plant, Bromeliad)	Anthracnose	Colletotrichum sp.
	Bacterial leaf spot	Erwinia carotovora subsp. carotovora
	Exserohilum leaf spot	Exserohilum rostratum
Aeschynanthus pulcher (Lipstick vine)	Botrytis blight	Botrytis cinerea
	Corynespora leaf spot	Corynespora cassiicola
	Myrothecium leaf spot	Myrothecium roridum
	Phytophthora stem rot	Phytophthora parasitica
	Tobacco mosaic	Tobacco mosaic virus
Aglaonema spp. (Chinese evergreen and many others)	Bacterial leaf spot	Erwinia chrysanthemi
		Pseudomonas cichorii
		Xanthomonas campestris pv. dieffenbachiae
	Colletotrichum leaf spot (anthracnose)	Colletotrichum sp.
	Dasheen mosaic	Dasheen mosaic virus
	Fusarium stem rot	Fusarium solani
	Myrothecium leaf spot	Myrothecium roridum
	Pythium root rot	Pythium spp.
	Rhizoctonia aerial blight	Rhizoctonia solani
	Soft rot	Erwinia carotovora subsp. carotovora
	Southern blight	Sclerotium rolfsii
Anthurium spp. (Tailflower)	Bacterial leaf spot	Pseudomonas cichorii
		Xanthomonas campestris pv. dieffenbachiae
	Burrowing nematode	Radopholus similis
	Colletotrichum leaf spot (anthracnose), spadix blight	Colletotrichum gloeosporioides
	Dasheen mosaic	Dasheen mosaic virus
	Foliar nematode	Aphelenchoides spp.
	Pythium root rot	Pythium spp.
	Rhizoctonia aerial blight	Rhizoctonia solani
	Soft rot	Erwinia carotovora subsp. carotovora

Adapted from: Chase, A. R. 1985. Diseases of foliage plants - revised list for 1985. Foliage Digest 8(6):3-8.

Plant	Common name of disease	Pathogen (s)
Aphelandra squarrosa (Zebra plant)	Aphelandra stem gall	Nectriella pironii (Kutilakesa)
	Botrytis blight	Botrytis cinerea
	Corynespora leaf spot	Corynespora cassiicola
	Mosaic	Cucumber mosaic virus
	Myrothecium leaf spot	Myrothecium roridum
	Phytophthora stem rot	Phytophthora parasitica
	Rhizoctonia stem rot	Rhizoctonia solani
	Southern blight	Sclerotium rolfsii
Araucaria heterophylla (Norfolk Island pine)	Bleeding canker	Dothiorella sp.
	Colletotrichum needle blight	Colletotrichum derridis
	Cylindrocladium root rot	Cylindrocladium sp.
	Pythium root rot	Pythium spp.
Asplenium nidus (Bird's-nest fern)	Bacterial leaf spot	Pseudomonas asplenii
		Pseudomonas gladioli
	Foliar nematode	Aphelenchoides fragariae
Brassaia actinophylla (Schefflera, Umbrella tree)	Alternaria leaf spot	Alternaria panax
	Bacterial leaf spot	Pseudomonas cichorii
		Erwinia chrysanthemi
	Cercospora leaf spot	Cercospora spp.
	Colletotrichum leaf spot (anthracnose)	Colletotrichum sp.
	Phytophthora leaf spot	Phytophthora parasitica var. nicotianae
	Pythium root rot	Pythium splendens
	Rhizoctonia aerial blight	Rhizoctonia solani
	Root knot nematode	Meloidogyne spp.
	Seedling blight	Pythium splendens
	Southern blight	Sclerotium rolfsii
	Xanthomonas leaf spot	Xanthomonas campestris pv. hederae
Cacti	Cactus cyst nematode	Cactodera cacti
	Colletotrichum stem rot	Colletotrichum gloeosporioides
	Drechslera stem rot	Drechslera cactivora
	Erwinia stem rot	Erwinia spp.
	Virus	Cactus virus X

Plant	Common name of disease	Pathogen (s)
Caladium x *hortulanum* (Fancy-leaved caladium)	Bacterial leaf spot and soft rot	*Erwinia carotovora* subsp. *carotovora*
	Dasheen mosaic	Dasheen mosaic virus
	Fusarium corm rot	*Fusarium solani*
	Lesion nematode	*Pratylenchus* spp.
	Rhizoctonia blight	*Rhizoctonia solani*
	Southern blight	*Sclerotium rolfsii*
	Xanthomonas leaf spot	*Xanthomonas campestris* pv. *dieffenbachiae*
Calathea spp. (Rattlesnake plant and others)	Alternaria leaf spot	*Alternaria alternata*
	Burrowing nematode	*Radopholus similis*
	Cucumber mosaic	Cucumber mosaic virus
	Drechslera leaf spot	*Drechslera setariae*
	Fusarium root rot	*Fusarium oxysporum*
Caryota mitis (Fishtail palm)	Bacterial leaf blight	*Pseudomonas avenae* (= *P. alboprecipitans*)
	Damping off	*Fusarium* spp.
		Pythium spp.
	Drechslera leaf spot	*Drechslera setariae*
	Exserohilum leaf spot	*Exserohilum rostratum*
	Lethal yellows	Mycoplasma-like organism
Chamaedorea spp. (Parlor palm and Florida hybrid palm)	Burrowing nematode	*Radopholus similis*
	Drechslera leaf spot	*Drechslera setariae*
	Exserohilum leaf spot	*Exserohilum rostratum*
	Gliocladium blight	*Gliocladium vermosceni*
	Lesion nematode	*Pratylenchus* spp.
	Phytophthora blight	*Phytophthora* sp.
	Seedling root rot	*Fusarium*, spp.
		Pythium spp.
Chrysalidocarpus lutescens (Areca palm)	Damping off	*Fusarium* spp.
	Drechslera leaf spot	*Drechslera setariae*
	Exserohilum leaf spot	*Exserohilum rostratum*
	Gliocladium stem rot	*Gliocladium vermosceni*
	Phaeotrichoconis leaf spot	*Phaeotrichoconis crotalariae*
	Sclerotinia blight	*Sclerotinia homeocarpa*

Plant	Common name of disease	Pathogen (s)
Cissus spp. (Grape ivy, Kanagaroo vine)	Anthracnose	Colletotrichum sp. (Glomerella cingulata)
	Botrytis blight	Botrytis cinerea
	Downy mildew	Plasmopara sp.
	Powdery mildew	Oidium sp.
	Rhizoctonia blight and root rot	Rhizoctonia solani
	Root rot	Pythium spp.
	Southern blight	Sclerotium rolfsii
Codiaeum variegatum (Croton)	Anthracnose	Glomerella cingulata
	Bacterial leaf spot	Xanthomonas campestris pv. poinsettiicola
	Crown gall	Agrobacterium tumefaciens
	Lesion nematode	Pratylenchus coffea
	Stem gall and canker	Nectriella pironii (Kutilakesa pironii)
Cordyline terminalis (Ti plant)	Anthracnose	Glomerella cingulata
	Cercospora leaf spot	Cercospora sp.
	Erwinia stem and root rot	Erwinia carotovora subsp. carotovora
		Erwinia chrysanthemi
	Lesion nematode	Pratylenchus spp.
	Phyllosticta leaf spot	Phyllosticta draconis
	Phytophthora leaf spot	Phytophthora parasitica
	Southern blight	Sclerotium rolfsii
Cryptanthus sp. (Bromeliad, Earth star)	Colletotrichum leaf spot	Colletotrichum sp.
Dieffenbachia spp. (Dumb cane)	Bacterial leaf spot	Pseudomonas cichorii
		Xanthomonas campestris pv. dieffenbachiae
	Brown leaf spot	Leptosphaeria sp.
	Cephalosporium leaf spot	Cephalosporium cinnamomeum
	Dasheen mosaic	Dasheen mosaic virus
	Erwinia blight and leaf spot	Erwinia carotovora subsp. carotovora
		Erwinia chrysanthemi

Plant name	Common name of disease	Pathogen (s)
Dieffenbachia spp. (Cont.)	Fusarium stem rot	Fusarium oxysporum Fusarium solani
	Glomerella leaf spot	Glomerella cingulata (Colletotrichum spp.)
	Lesion nematode	Pratylenchus spp.
	Myrothecium leaf spot	Myrothecium roridum
	Phytophthora leaf spot	Phytophthora parasitica var.nicotianae
	Pythium root rot	Pythium spp.
	Rhizoctonia blight	Rhizoctonia solani
	Southern blight	Sclerotium rolfsii
Dracaena spp.	Bacterial leaf spot	Erwinia carotovora subsp. carotovora Erwinia chrysanthemi Erwinia herbicola Pseudomonas sp.
	Botrytis blight	Botrytis cinerea
	Colletotrichum leaf spot	Colletotrichum sp.
	Fusarium leaf spot and stem rot	Fusarium moniliforme
	Lesion nematode	Pratylenchus spp.
	Phyllosticta leaf spot	Phyllosticta draconis
	Phytophthora leaf spot	Phytophthora parasitica
	Soft rot	Erwinia carotovora subsp. carotovora
	Southern blight	Sclerotium rolfsii
	Stem rot	Aspergillus niger
Epipremnum aureum (Pothos)	Bacterial leaf spot	Erwinia spp. Pseudomonas cichorii
	Pythium root rot	Pythium splendens
	Rapid decay (soft rot)	Erwinia carotovora subsp. carotovora
	Rhizoctonia leaf spot	Rhizoctonia solani
	Root knot nematode	Meloidogyne spp.
	Southern blight	Sclerotium rolfsii
Fatsia japonica (Japanese fatsia)	Alternaria leaf spot	Alternaria panax
	Bacterial leaf spot	Pseudomonas cichorii Xanthomonas campestris pv. hederae
	Pythium root rot	Pythium splendens

Plant	Common name of disease	Pathogen (s)
Fatsia japonica (Cont.)	Phytophthora stem rot	Phytophthora sp.
	Rhizoctonia aerial blight	Rhizoctonia solani
	Southern blight	Sclerotium rolfsii
Ficus benjamina (Weeping fig)	Corynespora leaf spot	Corynespora cassiicola
	Crown gall	Agrobacterium tumefaciens
	Lesion nematode	Pratylenchus spp.
	Phomopsis dieback	Diplodia sp.
		Phomopsis sp.
	Southern blight	Sclerotium rolfsii
	Verticillium wilt	Verticillium albo-atrum
Ficus elastica (India rubber tree)	Cercospora leaf spot	Cercospora sp.
	Colletotrichum leaf spot	Colletotrichum gloeosporioides
	Crown gall	Agrobacterium tumefaciens
	Foliar nematode	Aphelenchoides besseyi
	Gray mold	Botrytis cinerea
	Lesion nematode	Pratylenchus spp.
	Southern blight	Sclerotium rolfsii
Fittonia verschaffeltii (Nerve plant)	Bidens mottle	Bidens mottle virus
	Rhizoctonia aerial blight	Rhizoctonia solani
	Southern blight	Sclerotium rolfsii
Gronophyllum sp. (Kentia palm)	Damping off	Fusarium spp.
		Pythium spp.
	Drechslera leaf spot	Drechslera setariae
	Exserohilum leaf spot	Exserohilum rostratum
Gynura aurantiaca (Purple velvet plant)	White mold	Sclerotinia sp.
	Pythium root rot	Pythium sp.
Hedera helix (English ivy)	Bacterial leaf spot and stem canker	Xanthomonas campestris pv. hederae
	Botrytis blight	Botrytis cinerea
	Colletotrichum leaf spot	Colletotrichum trichellum
	Phyllosticta leaf spot	Phyllosticta concentrica
	Phytophthora leaf spot	Phytophthora palmivora

Plant	Common name of disease	Pathogen (s)
Hedera helix (Cont.)	Phytophthora root rot	Phytophthora spp.
	Rhizoctonia blight	Rhizoctonia solani
	Southern blight	Sclerotium rolfsii
Hoya carnosa (Wax plant)	Botrytis blight	Botrytis cinerea
	Cercospora leaf spot	Cercospora sp.
	Rhizoctonia aerial blight	Rhizoctonia solani
Maranta leuconeura	Burrowing nematode	Radopholus similis
	Cucumber mosaic	Cucumber mosaic virus
	Drechslera leaf spot	Drechslera setariae
	Root knot nematode	Meloidogyne javanica
Monstera deliciosa (Swiss-cheese plant)	Bacterial leaf spot	Pseudomonas cichorii
	Colletotrichum leaf spot	Colletotrichum sp.
	Rhizoctonia aerial blight	Rhizoctonia solani
	Soft rot	Erwinia carotovora subsp. carotovora
	Southern blight	Sclerotium rolfsii
Nephrolepis exaltata (Boston fern)	Bacterial leaf spot	Pseudomonas gladioli
	Botrytis blight	Botrytis cinerea
	Foliar nematode	Aphelenchoides fragariae
	Lesion nematode	Pratylenchus spp.
	Rhizoctonia blight	Rhizoctonia solani
Peperomia spp.	Cercospora leaf spot	Cercospora spp.
	Colletotrichum leaf spot	Colletotrichum spp.
	Myrothecium leaf spot	Myrothecium roridum
	Phyllosticta leaf spot	Phyllosticta sp.
	Phytophthora stem and root rot	Phytophthora parasitica
	Pythium root rot	Pythium splendens
	Rhizoctonia leaf spot	Rhizoctonia sp.
	Ring spot	unidentified virus
	Southern blight	Sclerotium rolfsii
	Verticillium wilt	Verticillium dahliae

Plant	Common name of disease	Pathogens (s)
Philodendron spp.	Bacterial leaf spot	Pseudomonas cichorii
	Botrytis blight	Botrytis cinerea
	Colletotrichum leaf spot	Colletotrichum sp.
	Dasheen mosaic	Dasheen mosaic virus
	Dactylaria leaf spot	Dactylaria humicola
	Erwinia blight	Erwinia chrysanthemi
	Myrothecium leaf spot	Myrothecium roridum
	Phytophthora leaf spot	Phytophthora parasitica var. nicotianae
	Pythium root rot	Pythium spp.
	Red edge	Xanthomonas campestris pv. dieffenbachiae
	Rhizoctonia aerial blight	Rhizoctonia solani
	Root knot nematode	Meloidogyne spp.
	Soft rot	Erwinia carotovora subsp. carotovora
	Southern blight	Sclerotium rolfsii
Pilea spp. (Aluminum plant and others)	Bacterial leaf spot	Xanthomonas campestris
	Colletotrichum blight	Colletotrichum capisci
	Myrothecium leaf spot	Myrothecium roridum
	Phytophthora blight	Phytophthora parasitica
	Rhizoctonia aerial blight	Rhizoctonia solani
	Southern blight	Sclerotium rolfsii
Platycerium bifurcatum (Staghorn fern)	Bacterial leaf spot	Pseudomonas cichorii
		Pseudomonas gladioli
	Rhizoctonia aerial	Rhizoctonia solani
Polyscias spp. (Aralia)	Alternaria leaf spot	Alternaria panax
	Anthracnose	Colletotrichum spp.
	Bacterial leaf spot	Pseudomonas cichorii
		Xanthomonas campestris pv. hederae
	Rhizoctonia aerial blight	Rhizoctonia solani
	Southern blight	Sclerotium rolfsii
Rhapis sp. (Lady finger palm)	Damping off	Fusarium spp.
		Pythium spp.
	Drechslera leaf spot	Drechslera setariae
	Exserohilum leaf spot	Exserohilum rostratum

Plant	Common name of disease	Pathogen (s)
Rhoeo spathacea (Oyster plant)	Commelina mosaic	Commelina mosaic virus
	Pythium root rot	Pythium spp.
	Tan leaf spot	Curvularia eragrostidis
Tobacco mosaic	Tobacco mosaic virus	
	Tradescantia virus	Tradescantia virus
Saintpaulia ionantha (African violet)	Botrytis blight	Botrytis cinerea
	Corynespora leaf spot	Corynespora cassiicola
	Erwinia blight	Erwinia chrysanthemi
	Foliar nematode	Aphelenchoides spp.
	Phytophthora stem and root rot	Phytophthora parasitica
	Powdery mildew	Oidium sp.
Sansevieria trifasciata (Mother-in-law's tongue)	Red leaf spot	Fusarium moniliforme
	Root knot nematode	Meloidogyne incognita
	Soft rot	Erwinia carotovora subsp. carotovora
	Southern blight	Sclerotium rolfsii
	Stem rot	Aspergillus niger
Schefflera arboricola (Dwarf or Hawaiian schefflera)	Alternaria leaf spot	Alternaria panax
	Bacterial leaf spot	Erwinia chrysanthemi
		Pseudomonas cichorii
		Xanthomonas campestris pv. hederae
	Cercospora leaf spot	Cercospora sp.
	Rhizoctonia aerial blight	Rhizoctonia solani
	Southern blight	Sclerotium rolfsii
Schlumbergera truncata (Thanksgiving and Christmas cacti)	Cactus cyst nematode	Cactodera cacti
	Drechslera stem rot	Drechslera cactivora
	Fusarium stem rot	Fusarium oxysporum
	Phytophthora stem rot	Phytophthora sp.
	Soft rot	Erwinia carotovora subsp. carotovora
	Virus	Cactus virus X
Sedum spp.	Colletotrichum leaf and stem rot	Colletotrichum gloeosporioides
	Stemphylium leaf spot	Stemphylium bolicki

Plant	Common name of disease	Pathogen (s)
Spathiphyllum spp. (Spathe flower)	Cylindrocladium root and petiole rot	Cylindrocladium spathiphylli
	Dasheen mosaic	Dasheen mosaic virus
	Myrothecium leaf spot	Myrothecium roridum
	Phytophthora leaf spot	Phytophthora sp.
	Pythium root rot	Pythium sp.
	Rhizoctonia aerial blight	Rhizoctonia solani
	Southern blight	Sclerotium rolfsii
Syngonium podophyllum (Nephthytis)	Bacterial leaf spot	Erwinia carotovora subsp. carotovora
		Erwinia chrysanthemi
		Pseudomonas cichorii
		Xanthomonas campestris pv. dieffenbachiae
	Black cane rot or Ceratocystis blight	Ceratocystis fimbriata
	Burrowing nematode	Radopholus similis
	Cephalosporium leaf spot	Acremonium crotocinigenum
	Colletotrichum leaf spot	Colletotrichum sp.
	Erwinia blight	Erwinia chrysanthemi
	Myrothecium leaf spot	Myrothecium roridum
	Pythium root rot	Pythium spp.
	Rhizoctonia aerial blight	Rhizoctonia solani
	Soft rot	Erwinia carotovora subsp. carotovora
	Southern blight	Sclerotium rolfsii
	White Butterfly blight	?????????????
Tradescantia spp. (Spiderwort)	Tradescantia virus	Tradescantia virus
Yucca spp. (Soft-tip Yucca and Spanish bayonet)	Brown leaf spot	Coniothyrium concentricum
	Gray leaf spot	Cytosporina sp.
	Southern blight	Sclerotium rolfsii
Zebrina pendula (Wandering Jew)	Tobacco mosaic	Tobacco mosaic virus
	Tradescantia virus	Tradescantia virus

REFERENCES

1. Alfieri, S. A., K. R. Langden, C. Wehlbaug, and J. W. Kimbrough. 1984 .(rev.). Index of Plant Diseases in Florida. Bull. 11. Fla. Dept. of Ag & Cons. Serv., Div. of Plant Industry, Gainesville. 389 pp.

2. Arx, J. A. v. 1981. The Genera of Fungi Sporulating in Pure Culture 3rd ed. rev., J. Cramer, Vaduz. 424 pp.

3. Benschop, K., J. P. Tewari, and E. W. Toop. 1985. Phomopsis Twig Die-back of some Woody Interior Ornamentals in Alberta. Foliage Digest 9:2-3.

4. Dhingra, O. D and J. B. Sinclair. 1985. Basic Plant Pathology Methods. CRC Press, Boca Raton, 355 pp.

5. Fahy, P. C. and G. J. Persley, eds. 1983. Plant Bacterial Diseases, A Diagnostic Guide. Academic Press, NY. 393 pp.

6. Henley, R. W. (ed.) 1983. A Pictorial Atlas of Foliage Plant Problems. Florida Foliage Assoc. P.O. Box Y, Apopka, Fla. 40 pp. (currently available for $5.00/copy)

7. Marlatt, R. B. 1980. Noncontagious Diseases of Tropical Foliage Plants. Bull. 812. Ag. Expt. Stn, Univ. of Florida. Gainesville, 49 pp.

8. Mordue, J. E. M. 1971. Glomerella cingulata. No. 315. In: Descriptions of Pathogenic Fungi and Bacteria. C.M.I. Kew.

9. Pierce, L. 1984. Quick Key to Bacterial Plant Pathogens of Ornamental Plants. PDQ 5(4):91-96.

10. Powell, C. C. 1985. Disease Management for Plants in Interior Gardens. Plant Disease 69(10):906-909.

11. Powell, C. C. and R. K. Lindquist. 1984. Pest and Disease Control on Indoor Plants. Bull. 711. Coop. Ext. Serv., O.S.U. Columbus. 19 pp.

12. Spencer, D. M. 1978. The Powdery Mildews. Academic Press, New York. 565 pp. (Chpt. 16, pp 411-445).

13. Sutton, B. C. 1980. The Coelomycetes. C.M.I. Kew. 696 pp.

Editor's Note: The following feature, Technological Advances in Identification of Plant Pathogens was presented at the Potomac Division APS meeting in College Park, MD April 2, 1986. I invited each speaker to prepare a summary of their remarks for publication in PDQ. The formal presentations were followed by a lively discussion session and served as a stimulating start for our divisional meeting.

TECHNOLOGICAL ADVANCES IN IDENTIFICATION OF PLANT PATHOGENS

Introduction

Seong H. Kim

Pennsylvania Department of Agriculture

The immediate objective of plant pathogen identification is for disease diagnosis, and plant health is the ultimate goal.

Plant pathogen identification is often indirectly accomplished by a disease diagnosis. The definition of diagnosis, "the identification of microorganisms as accurately as possible in the shortest period of time (Steel, K. J. 1962. In: Ainsworth, G. C., Sneath, P. H. A., eds. Microbial Classification.)", includes the action of plant pathogen identification. Another definition of diagnosis, "the art or act of identifying a disease from the sign and symptoms (Webster's 3rd International Dictionary)", indicates that a pathogen can be designated to a disease without actual pathogen identification. Plant disease diagnosis and plant pathogen identification are so closely related that the means of disease diagnosis serve the means of pathogen identification. Therefore, diagnosis of biotic diseases will be approached as a means of plant pathogen identification.

Disease diagnosis requires accuracy, speed, and a statement indicating the cause of disease. Traditional field-diagnosis depends largely on symptoms and signs along with the information of the associated biotic and abiotic factors. Disease diagnosis by intuitive judgment, a form of art, needs experience and a combined knowledge of host, pathogen, environment, and diseases. Subsequent laboratory, greenhouse and further field tests are occasionally desired, compelled or required for more definitive disease diagnosis, largely because of uncertainty of field diagnostic results, or the complexity of disease-causing factors instead of a single primary etiologic agent.

Identification of plant pathogens from a diseased plant follows the guide lines of Koch's postulates: 1) a specific organism must be seen in all cases of an infectious disease (symptoms and signs); 2) this organism must be obtained in pure culture (isolation/extraction/purification); 3) organisms from pure culture must reproduce the disease in experimental hosts (pathogenicity); 4) the organism must be recoverable from the experimental hosts (reisolation). A complete fulfillment of the postulates is required to prove an etiologic agent, but this process may not be required if a proven methodology is available for pathogen identification. Plant pathogen identification may be possible by disease diagnosis; when a biotic disease is diagnosed, the cause, pathogen, is designated to the disease without further investigation such as isolation/extraction/purification for pathogen identification.

The common methodologies of disease diagnosis include symptomatology, microscopy, microbiological techniques, serodiagnosis, and bioassay techniques. Symptoms and signs often serve as basic tools for pathogen identification: natural symptoms (eg. Agrobacterium tumefaciens/Crown gall), induced symptoms (eg. Xanthomonas campestris pv vesicatoria/Bacterial spot of tomato), natural macroscopic signs (eg. Sclerotinia sclerotiorum/Sclerotinia stem rot of cauliflower), natural microscopic signs (eg. Spongospora subterranea/Potato powdery scab), induced macroscopic signs (eg. Sclerotium rolfsii/Southern blight of onion), and induced microscopic signs (eg. Leptosphaeria maculans; anamorph:Phoma lingam/ Cabbage black leg). The tedious and time-consuming procedures of isolation/extraction/purification and identification are performed when the diagnostic symptoms and signs are not available. This process includes simple and very sophisticated techniques, however, the pathogen identification process has been getting easier in recent years because universally accepted and improved tools are continuously being made available such as selective media (eg. use of pimaricin for Pythiacious fungi), diagnostic media (eg. King's medium B for fluorescent Pseudomonas), newly applied techniques (eg. enzyme-linked immunosorbent assay), newly recognized tests (eg. KOH test for bacteria), improved procedures (eg. nuclei staining for Rhizoctonia spp. identification), improved and added keys and monographs for pathogens (eg. dichotomous, tabular, and synoptic keys for Phytophthora spp.), and ready-to-use diagnostic kits (eg. for more than 40 pathogens--bacteria and viruses, Agdia Inc., IN). And yet, development of more accurate, rapid and simple techniques, while improving the existing techniques toward 'standardization' continues to be vital. Additionally, a compilation of refereed 'standard' diagnostic-methods for a specific pathogen and a specific pathogen-host complex identification may provide the ability to make a diagnostic statement with a measurable authenticity (eg. Clavibacter michiganense subsp. sepedonicum/Potato ring rot identification by (1) Symptoms and signs, (2) Gram test, (3) Isolation, (4) Pathogenicity on egg plant & (5) ELISA -- 'ready-to-use' diagnostic

kit). Recently advancing DNA homology techniques, dot blot hybridization assays with labeled cDNA probes, hybridoma technology for monoclonal antibody production, and bacterial identification with fatty acid analysis by the computer-coupled gas chromatographic system available from the Hewlitt-Packard Co. are some of the immediate hopes that supplement the existing identification techniques.

Detection of a low population of pathogens; early detection prior to symptom development; detection of pathogens from soil, potting mixtures, water, and equipment; and determination of 'pathogen free' plant propagules (seeds, plantlets, cuttings, bulbs, transplants, etc.) are needed services for plant health. However, most pathogen identification service is currently conducted after commencement of incurable diseases; the damage has been done! Diagnostic techniques that require special tools (Electron microscope-- Leaf dip, Immunospecific electron microscopy; Fluorescent microscopy -- Immunofluorescent techniques, direct fluorescent detection; Inclusion bodies for virus detection; Hewlett-Packard GC for bacteria identification; ELISA -- monoclonal/polyclonal antibodies; cDNA probe; etc.) have limitations unless a diagnostic lab is equipped and staffed properly. Traditional diagnostic pathogen identification for disease control programs has largely been dependent upon practical tools: fungi identification by morphology, bacteria identification by pathogenicity tests, virus identification by symptoms, and nematode identification by morphology. The advancing technology (DNA probe and monoclonal antibody) will hopefully replace or supplement the existing diagnostic tools for 'instant' identification of plant pathogens.

Future of pathogen identification needs: 1) development of more accurate, rapid and simple diagnostic tools; 2) improvement of existing tools toward 'standardization'; 3) compilation of 'standard' methods for a specific pathogen and a specific pathogen-host complex; and 4) 'instant' identification may be possible for certain pathogens.

Immunologically Specific Electronic Receptors

A. L. Newman†, W. D. Stanbro†, A. G. Andreou†, K. W. Hunter‡

†The Johns Hopkins University Applied Physics Laboratory
Laurel, Maryland 20707

‡Uniformed Services University of the Health Sciences
Bethesda, Maryland 20815

Technological developments in instrumentation foretell a simpler, faster, and more automatic future for the diagnostic laboratory. The microelectronics revolution has already greatly enhanced the productivity of diagnostic machinery. Microcomputers in the laboratory range in use as controllers of mechanical devices for automatic material handling to data collection and processing systems. Diagnostic procedures will be greatly enhanced by the development of biosensors.

Sensing devices for a large variety of specific analytes may become available in the next five to ten years. Conceptually analogous to ion-specific electrodes, the operational mechanism of such devices will be generic. A sensor for detecting a specific analyte will be configured simply by choosing the surface chemistry and materials of the device appropriately.

Chemically sensitive field effect transistors (chemfets) described more than fifteen years ago, have yet to become commercially available despite intensive research and development efforts. This technology has been consistently thwarted by problems with stability, calibration, and passivation. A more promising biosensor technology is based on the changes in light transmission and reflection in an optical fiber as immunochemical reactions occur on the fiber's derivatized surface.

At the Johns Hopkins University Applied Physics Laboratory and the Uniformed Services University of the Health Sciences, we have been working on a new biosensor concept. In such a sensor, transduction occurs when a chemical event is converted to an electronic signal. The best choice for the transducible quantity is a directly measurable physical-chemical property that varies as a function of analyte concentration. Capacitance was chosen because it can be electronically measured with great precision. Furthermore, capacitance is a function of the dielectric constant, an inherent physical-chemical property of any substance, including antigen-antibody complexes.

When immobilized antigens on a substrate interact with antibodies in an aqueous environment, the dielectric constant near the substrate surface changes. The most basic form of our biosensor uses two planar capacitors; one senses the substance of interest and the other serves as a reference for non-specific effects related to pH, temperature, and non-specific protein adsorption. The substance to be sensed is the antigen in this system, and it is immobilized on the surface of the sensing capacitor. Antibodies to the sensed substance are then allowed to bind to the immobilized antigen. They are conserved by a molecular sieve that encloses the device. The reference capacitor has immobilized on its surface a "dummy analyte," which is a molecule with no affinity for the antibody to the real analyte. An antibody of the same class and of a similar affinity constant as the real analyte antibody is allowed to bind to the "dummy analyte" on the reference capacitor.

In a test of our sensor concept, the Tricothecene mycotoxin T-2 was used as the analyte. An interdigitated metallic electrode structure was etched on a glass substrate and then passivated by a layer of parylene and a layer of silicon monoxide to form a planar capacitor. The silicon monoxide surface was derivatized with γ-aminopropyltriethoxy-silane. T-2 hemisuccinate was then conjugated with the γ-amino function of the silanized device.

A typical experiment involves measuring the capacitance changes that occur when, first, T-2 specific antibodies are added to a solution bathing the capacitor, and second, free T-2 is added. When 1 μg/ml T-2 specific antibody was added to the test solution, the capacitance (measured at 1 KHz with a Gen Rad 1657 LCR Bridge) dropped from 2180 picofarads to 2120 picofarads. When 1 μg/ml T-2 was added, the capacitance returned to 2180 picofarads in two minutes.

These results suggest that significant capacitance changes occur as a result of antigen-antibody interactions, and that these changes occur quickly and are reversible.

Acknowledgement

The authors would like to acknowledge the funding and support of the U.S. Army CRDEC. Drs. P. Ward, W. Seegar, and J. Valdes have been particularly helpful and encouraging.

Monoclonal Antibody-Based Diagnostic Kits in Agriculture
Current Status and Future Prospects

Sally A. Miller, G. David Grothaus, Frank P. Petersen, Richard K. Lankow

Agri-Diagnostics Associates, 2611 Branch Pike, Cinnaminson, NJ 08077

Recent developments in the field of biotechnology are being applied now to many aspects of agricultural science. One of the most promising areas, for near-term practical application, is monoclonal antibody technology. Monoclonal antibodies can be produced against a wide range of substances, from mycotoxins and pesticides to components of plant pathogenic fungi. Immunoassays incorporating monoclonal antibodies can be powerful diagnostic tools for use in crop management. Antibody-based diagnostic tests have been used in plant pathology for a number of years, primarily for the detection of plant viruses. Until recently, these assays were based on the use of polyclonal antiserum produced in laboratory animals such as rabbits, sheep and goats. While polyclonal antisera have been very effective in detecting some pathogens, cross-reactivity and batch to batch variation in antiserum quality have sometimes limited their usefulness. The recent development of monoclonal antibody technology has made it possible to produce antibody reagents that are highly specific for the pathogens against which they are produced. Whereas a polyclonal antiserum represents a "mixture" of antibodies with different specificities, a monoclonal reagent contains only one type of antibody. Monoclonal antibodies are produced by specialized cell hybrids called hybridomas (Kohler and Milstein, 1975), which are made in the laboratory by fusing antibody-secreting cells with immortal cultured cells. In a typical process a mouse is first immunized with the antigen of interest. Then its antibody-producing cells are removed (from the spleen) and fused with the cultured cells. These cells impart immortality to the fusion product, the hybridoma, and the spleen cell partner provides the ability to produce and secrete antibodies. The hybridomas are separated into single clones and screened for antibodies. The clones that produce the desired antibodies are selected, and the antibodies are mass-produced and purified. Hybridomas can be frozen for long-term storage, insuring a uniform source of antibodies. A number of diagnostic tests utilizing antibodies have been developed, including the enzyme-linked immunosorbent assay (ELISA), radio-immunoassay (RIA), immunofluorescence assay and various precipitation based assays. Of these, ELISA best satisfies the criteria set for diagnostic assays ultimately destined for wide use in agriculture: reliability, sensitivity, specificity and user-friendliness. These tests are characterized by the use of antibodies labeled with an enzyme. The addition of an enzyme-specific substrate results in the generation of a colored product that can be readily visualized. One of the most popular versions of the ELISA is the double antibody (sandwich) ELISA, in which the pathogen is captured between two layers of pathogen-specific antibodies. This system is ideal for the detection of a pathogen in complex materials (i.e., soil, plant extracts) because the first antibody is used to "fish" the pathogen out of the mixture, after which non-specific materials are washed away. A second antibody, which has been labeled with an enzyme and is specific for the pathogen of interest, is then incubated with the solid phase. Unbound labeled antibody is removed by washing. Finally, the substrate for the enzyme is added, and a change in color of the solution (generation of a colored product) indicates the presence of the pathogen of interest. The intensity of the color change is proportional to the amount of pathogen present in the test extract.

This technique lends itself to a number of different formats, the most common being the "multiwell" format, in which the assay is carried out in a 96-well micro-titer plate. This format is relatively easy to carry out, can be semi-automated, is well adapted for large numbers of samples, is economical and produces results that can be quantified spectrophotometrically. This format is well suited for diagnostic laboratories, researchers, and other high volume users.

Another format that has been developed recently is the dipstick immunoassay. The reactive end of the dipstick is incubated in the sample extract, washed, then moved to the remaining reagents (enzyme-labeled antibody and substrate) in sequence. A positive reaction is produced when the enzyme converts the substrate into an insoluble colored product that binds to the dipstick. Semi-quantitative results can be obtained by comparing the color resulting from the sample to the color caused by known standards. Quantitative results can be obtained by using an inexpensive, field-adaptable reflectometer which measures the color intensity on the dipstick. The dipstick assay can be carried out rapidly (3 hours or less), and is one of the most user-friendly immunoassays available, making it highly suitable for field use.

While one of the most obvious applications of immunoassay technology is for plant disease diagnosis and detection, additional areas in agriculture will also benefit (Marsden and Miller, 1985). Antibody-based tests are being developed currently for the detection and quantification of pests, such as nematodes and insects, in soil, water, air, and plant tissue. Such tests could complement or replace some of the time-consuming and costly assays presently being used. Other assays are being developed to detect and quantify pesticides in or on crops and in the environment; information provided from these assays will permit growers to monitor pesticide levels and make informed decisions concerning pesticide application, re-application, and crop rotation, among others. In the seed industry, diagnostic tests will simplify indexing and certification procedures, and may also be used to identify specific traits in breeding programs. Finally, as our knowledge of plant gene products and their function is improved, tests may be developed to detect nutrient stress, maturity, and plant hormone levels in major crops.

Plant disease diagnostic kits should be viewed as tools for managing agronomic practices. Because the tests are rapid, reliable, economic and user-friendly, a crop manager can have in hand information that will facilitate a number of decisions, including crop rotation patterns, variety selection, use and choice of seed treatments, use and selection of pesticides, sanitation, and post harvest treatments. For the plant disease diagnostician, whether a professional plant pathologist, crop consultant or informed grower, the availability of such kits will make it possible to quickly and accurately diagnose plant diseases often before symptoms are present. Used in conjunction with weather data and forecasting systems, the kits will make it easier to predict the occurrence of epiphytotics in many crops.

Once diagnostic tests are widely available, they will play an integral role in crop management. Monoclonal antibodies can be produced for most plant pathogens, including fungi, bacteria, viruses, spiroplasmas, and mycoplasma-like organisms (Halk and DeBoer, 1985; Miller et. al., 1986). Thus, it is likely that in the coming years diagnostic tests will be developed for many plant pathogens that affect a wide variety of crops.

Halk, E. L. and DeBoer, S. H. 1985. Monoclonal antibodies in plant-disease research. Ann. Rev. Phytopathol. 23:321-350.

Kohler, G. and Milstein, C. 1975. Continuous cultures of fused cells secreting antibody of predefined specificity. Nature 256:495-497.

Marsden, J. F. and Miller, S. A. 1985. Diagnostics for plant-related agriculture. BioExpo '85. May 14-16, 1985. Boston.

Miller, S. A., Grothaus, G. D., Petersen, F. P. and Papa, S. L. 1986. Detection of Pythium blight in turfgrass using a monoclonal antibody-based diagnostic test (abstr.). Phytopathology (in press).

Use of Fatty Acid Profiles for Identification of Plant-Associated Bacteria

M. A. Roy, Microbial ID, Inc., Newark, DE 19711.

The use of fatty acid (FA) profiles for bacterial classification was first suggested by Abel et al. in 1963, and has since become important for identification as well. With the lack of quick and accurate bacterial identification systems (such as are available for clinical microbiologists), FA analysis is a particularly useful tool for phytobacteriologists. While this paper primarily describes a fully-automated gas chromatograph available from Hewlett-Packard for the identification of bacteria (the HP 5898A Microbial Identification System), information is provided so that microbiologists with access to a gas chromatograph (GC) can identify bacteria using this technique.

Stability of Fatty Acids

Bacteria contain FAs which are stable and reproducible under standardized conditions, and which are not affected by plasmids or minor mutations. The FA profiles are very distinctive for a given species regardless of geographical source. However, for some groups of plant and animal pathogens there are subgroups related to host range. For example, there exist minor differences in FAs within Pseudomonas syringae pv. savastanoi, depending on whether the strains were isolated from privet, olive or oleander (Varvaro and Sasser, unpublished). Fatty acid-based groupings have so far agreed with DNA homology where the DNA homology data are available.

Since FA profiles are altered in response to temperature and other growth conditions, the environmental influences must be held constant so that FA profile comparisons are valid. One large loopful of wet cells (approximately 40 mg) is used per analysis. The cells are placed in a screw-capped test tube, saponified, methylated, extracted into hexane/ether, and chromatographed. (For further details see Miller and Berger 1985).

The FAs between 9 and 20 carbon lengths are most useful in the identification of plant-associated bacteria. Presently the HP 5898A uses 143 FAs for identification purposes, including saturated, unsaturated, hydroxy, cyclopropane, iso and anteio FAs.

Automated Sample Handling

The HP 5898A consists of a GC, an automatic sampler, an integrator and a computer. Under control from the computer, the autosampler injects bacterial whole-cell FA extracts into the GC. The integrator processes the chromatographic data (peaks), which are sent to the computer. The computer names the FAs and compares the profiles to the strains in its data base. A similarity index is given which expresses how nearly the profile of the unknown species fits the closest match in the HP 5898A data base.

A 5% phenyl methyl silicone capillary column gives superb resolution of the numerous bacterial FAs. Retention time stability (to one or two thousandths of a minute) permits automation of the FA naming, and results can be compared to the computer data base of the HP 5898A, containing over 6000 strains of aerobic bacteria from diverse geographical and epidemiological sources. (In August 1986, the data base for anaerobic bacteria will be available, and a yeast library should be available by the end of 1986.)

Non-Automated Sample Handling

Any capillary column GC can be used for identification of bacteria, and one can write software to handle the data. To build the data base, at least 10 strains of each species should be chromatographed. For each entry (species), the mean and standard deviation for each FA in the profile must be calculated. For identification to the genus level, qualitative differences may be used. For best results at the species or subspecies levels, calculate the ratios between FAs which are most stable (i.e., the straight chain, iso and anteiso FAs).

Examples of Fatty Acids in Phytopathogenic Bacteria

Within Agrobacterium tumefaciens, the three biotypes can be distinguished primarily by relative amounts of cyclopropane FAs. The TI plasmid does not affect whole-cell FA profiles, so it is impossible to distinguish the avirulent A. radiobacter from the tumour-inducing A. tumefaciens.

Clavibacter michiganese subsp. michiganense has a simple profile which is characterized by iso and anteiso FAs. To delineate subspecies, ratios between major peaks must be calculated.

Erwinia carotovora subsp. atroseptica is distinguished from E. c. subsp. carotovora by the rations of 12:0/14:0, of 16:0/12:0 and of 16:1/18:1. The values for these ratios for E. c. carotovora are <3.7, >4.9 and <2.7 respectively, while the contrasting values apply to E. c. atroseptica (deBoer and Sasser, unpublished). Erwinia herbicola and Enterobacter agglomerans cannot be distinguished by FA profiles. This agrees nicely with the DNA homology studies of Brenner et al. (1984) which suggest synonymy of the two names.

The fluorescent Pseudomonas seldom contain more than a trace amount of 14:0 3OH (a major peak in P. cepacia and related bacteria) but do contain 10:0 3OH. Within P. syringae, it is possible to distinguish pathovars such as P. s. tomato and P. s. papulans, for example, from other P. syringae pathovars based on presence (others) or absence (P. s. tomato and P. s. papulans) of 17:0 CYCLO.

In the genus Xanthomonas, the presence of 11:0 ISO, 11:0 ISO 3OH, 13:0 ISO 3OH, 15:0 ISO and 15:0 ANTEISO are important components of a very complex profile, while calculation of ratios between 15:0 ISO and 15:0 ANTEISO are necessary to determine the species. Xanthomonas campestris pathovars are by definition indistinguishable using biochemical tests, yet xanthomonads can often be discriminated at the pathovar level using this technique.

It is possible to extract bacterial FAs directly from infected plant tissue for identification to the genus level and often to the species level. Since the bacteria are grown on plant tissue and not under controlled laboratory conditions, their FA profiles will be slightly different than their counterparts in the existing data base. Improved methods for this extraction technique are being developed, and as well as the corresponding software data base.

Literature Cited

Abel, K., deSchmertzing, H. and Peterson, J. I. 1963. Classification of microorganisms by analysis of chemical composition: I. Feasability of utilizing gas chromatography. J. Bacteriol. 85:1039-1044.

Brenner, D. J., Fanning, G. R., Knutson, J. K. L., Steigerwalt, A. G., and Krichevsky, M. I. 1984. Attempts to classify Herbicola group-Enterobacter agglomerans strains by deoxyribonucleic acid hybridization and phenotypic tests. Int. J. Syst. Bacteriol. 34:45-55.

Miller, L. and Berger, T. 1985. Bacteria identification by gas chromatography of whole cell fatty acids. Hewlett-Packard Application Note 228-41. 8 pp.

Plant Disease Diagnosis in Industry: Yesterday, Today and Tomorrow

Charles R. Semer IV

My first introduction to Plant Disease Diagnosis was with Yoder Brothers, Inc. In my first year with Yoder Brothers, Inc., I was responsible for walking the some 90 acres of chrysanthemum production and an additional 30 acres of azalea production area. Initially I scouted all the production areas for disease. This resulted in the publication of a weekly disease report which was distributed to the production personnel. As part of the disease scouting program I collected samples from the production areas, examined the plants for symptoms and took the samples into the laboratory where I cultured the plant material to isolate the pathogen. Thus, I learned the symptoms associated with chrysanthemum and azalea diseases commonly found in our Florida production areas. This learning process relied upon field observation of the symptoms and laboratory culturing of the collected specimens.

After one year, I moved my efforts into the laboratory and undertook routine identification of the plant disease(s) present on the samples submitted. The laboratory phase of disease diagnosis was conducted with the plant sample submitted to the lab by the grower responsible for a specific production area or by the sales service office. Common laboratory practices included culturing the specimen tissue onto selected media and incubation of plant material in a moist chamber. The plant sample was submitted along with a four part form that contained information on the source of the sample, crop, variety name, code, and planting location. The form also contained two short lines for symptom description and a line for disease control recommendations. This form was completed by the grower or salesman submitting the sample with the symptom description portion being filled in with a numeric code that corresponded to possible pathogens, i.e. 652 = Alternaria sp.

The form submitted with each specimen has undergone several revisions in the past seven years. The major revisions have been the inclusion of an area on the form exclusively for laboratory use. This area was used to indicate to the technician culturing the specimen which media were to be used with each individual specimen. Any special instructions were handwritten onto the specimen ID form.

Recently our laboratory obtained a small computer. The primary use of this machine has been as an electronic file cabinet. Also, it is a source for monthly generated summaries of the total number of specimens processed as well as the source of the specimens, i.e. customer, crop area, etc.

Once we started using the computer for filing it became apparent that additional documentation was needed for use with each incoming specimen. The first additional document to be developed, due to the volume of specimens being processed in our laboratory, was the laboratory worksheet. Our lab processes between 150 and 250 samples per month throughout the year. However, the identification and diagnosis of plant diseases from samples is only 20-25% of the laboratory function. The balance of the responsibility is focused upon basic and applied research for plant disease control. In addition to plant specimens, we receive water and soil samples from a wide range of ornamental crops including Azaleas, Carnations, Chrysanthemums, Geraniums, Foliage Plants, Poinsettias as well as a number of developmental crops.

The work sheet was developed using information from similar documents being used by clinics at various universities. This sheet provides the diagnostician the opportunity to examine specimens, write a description of the symptoms, indicate the quality of the specimens received and indicate, using a check off system, the testing procedures to be used with each individual specimen submitted. They provide a written record of the symptoms and diagnosis of each sample processed and are maintained in a laboratory file. Since we strive to provide an answer on each sample submitted within 7 days of receipt, the work sheet can be annotated and the supplier of the sample contacted and informed that additional testing is required and the results are anticipated to be available on a specific date. This is especially useful when testing is conducted to confirm the pathogenicity of the organism isolated.

This same work sheet is also used when examining a submitted specimen for the presence and identification of virus diseases. Conventional procedures for virus identification are use of ELISA and PAGE analysis of the sample as well as grafting of the plant specimen with an indicator plant is required and the results then cannot be returned to the person submitting the sample until 12-16 weeks after submission.

Other documents in preparation are a lab manual containing color photos of disease symptoms and pathogen identification.

In my experience, one of the problems any diagnostic facility faces is that of specimen quality. Some specimens are received in excellent condition and the diagnosis can be made with ease. However, other specimens are received in poor condition and diagnosis can be difficult. Sample collection, preparation and shipping is an area that requires constant education of the sample supplier(s). Each diagnostic lab handles this matter to fit the same general guidelines, i.e. the specimen provided should reflect the range of symptoms observed and contain sufficient material, plant and/or soil, such that diagnostic testing can be conducted.

Yoder Brothers, Inc. has provided for its sales personnel a single page instruction sheet with specimen collection and shipping instructions. The sheet also can be completed with additional information indicating the crop history, fertilizer and spray programs, etc. However, commonly these sheets are used only to indicate the variety, grower and the salesman's name. Thus, the form although available, is not utilized to its fullest. In some cases, the growers, from various company facilities submitting samples, do not utilize this form but rely on verbal or written communication about the problems they are experiencing. The issue of instruction regarding collection and preparation of specimens is currently being addressed by the printing and distribution of brochures detailing the procedures to be followed in the submission of specimens for diagnosis, along with photographs of good versus poor quality specimens.

So far I have written about my experiences and the evolution of the diagnostic practices that have accompanied the increase in the number of samples our lab handles on a routine basis. Now, I want to address an area of plant disease diagnosis that is of importance to the development of efficient handling and diagnosis of the various plant samples submitted.

In the past seven years, we at Yoder Brothers, Inc., have collected from the literature various techniques and procedures that are now currently used in our laboratory. Some of these techniques are adaptations of techniques used on other crops and some are techniques developed in our own lab. Our collection of techniques is, by its very nature, focused upon ornamental diseases. Therefore, the techniques specifically applicable to other commodity groups have either been overlooked or ignored in our development of routine methods. The specialization in the crop areas we serve thus limits the scope of the diagnostic techniques and procedures we undertake. I feel that this specialization is on the one hand necessary because it allows the development of methods etc. suited directly for our crops, but is on the other hand a disadvantage because it does not frequently expose us to methods and techniques commonly used with other commodities.

As a diagnostician, I feel that specialization can only be useful when it is built upon the solid foundation of knowledge of a wide range of methods and procedures applicable to a broad range of crops. In order to provide a sound basis for education and training, a manual of standard procedures of plant disease diagnosis should be compiled and published. This manual would contain testing procedures and methods as well as techniques that have been tested over a wide range of conditions and verified in practice in a number of laboratories both private and public. The publication of a manual of techniques and procedures can be beneficial in a wide variety of circumstances. It can provide a ready reference of documented methods used across the total range of agronomic crops, fiber crops, fruits, vegetables, ornamentals, timber crops, etc. This would focus the use of techniques and procedures on crops rather than present exclusively techniques and procedures.

Dr. Paul Bachi in his recent article "The Doctor of Plant Health Degree", Plant Diagnosticians Quarterly, March 1986, indicates the demand for competent diagnosticians and improved diagnostic techniques as a result of the development of a DPH program. I would further suggest that as more diagnosticians conduct business in the private sector, governmental agencies may demand certification and impose regulation upon plant disease diagnosticians. The availability of a manual of standard methods would provide a basis for educating plant disease diagnosticians and can be useful in developing certification guidelines. Further, should questions of liability arise regarding a particular diagnosis, the manual of standard methods could become the basis for establishing precedent for the selected method or technique. Finally, since diagnosis is as much an art as it is a science, a manual of standard methods would provide the diagnostician with an initiation point from which the development of new methods and practices could originate.

I look forward to the changes this manual would bring to the practice of plant disease diagnosis and I hope that such a manual will be developed in the near future.

Diagnostic Committee Report

E. M. Dutky - Chairperson

The diagnostics committee will meet on Sunday, August 10, 1986; time and place will be in the meeting program.

I. Agenda

1 - Discussion of bylaws (see later in this report).
2 - Election of chair-elect who will preside as chair in 1987.
3 - Lottery for committee member terms.
4 - Report of PDQ Editors - E. Dutky, G. Ruhl
5 - Status of workshop on Identification of Phytophthora for 1987 (Ohio) APS meeting. R. Wick
6 - Diagnostic Procedures - Florida's rough draft as a model for diagnostics committee procedures manual. C. Semer

II. Committee Bylaws

I want to keep rules flexible and preserve the broad participation which characterizes our group.

A) Purpose of Diagnostics Committee.

The diagnostics committee will represent those APS members concerned with diagnosis of plant diseases including diagnostic labs and industries which develop and market diagnostic tools. The committee will sponsor workshops, symposia, discussions and other events on diagnostics at national APS meetings, regional APS meetings and at other times. The committee will sponsor other projects which will improve diagnostic plant pathology.

B) Structure of Committee.

The committee will be composed of 5 to 20 members serving three-year terms. Officers will be the chairperson, chair-elect and immediate past chair. Terms of office will be one year in each post. All must be APS members.

1 - Chairperson. Candidates for chair may be nominated by any APS member. Elections will be held at national APS meetings. Only committee members may vote for committee officers. Members may vote in advance by mail or by proxy. The newly elected chair will serve as chair-elect for one year, serving as secretary for the meeting and working closely with the chair. After serving one year as chair, the person will be immediate-past-chair, assisting the chair as needed.

2 - Selection of Committee Members. The chair will select members as vacancies on the committee arise. Prospective member's names will be submitted for final approval to APS Council. The membership should represent a broad range of geographic regions and types of laboratory and include representatives from companies involved in plant disease diagnostics. Any APS member interested in serving on the committee should notify the chair or chair-elect.

3 - Editor of PDQ. The editor need not be a committee member, but the PDQ editor(s) will have a space on the agenda of each committee meeting.

The committee chair will publish agendas and minutes of all diagnostics committee meetings in PDQ.

4 - Committee meetings will be conducted in an orderly manner using "Robert's Rules of Order." An agenda will be sent in advance to all members and published in PDQ. Minutes will be prepared by the chair-elect and approved by voice vote of all present. Objections and additions to minutes may be made by any APS member present.

Activities to be sponsored by the committee may be proposed by any APS member. Decisions on activities to sponsor will be made by voice vote of APS members attending meetings. Consideration will be given proxy votes by committee members. Activities that do not have clear support will not be undertaken.

The committee may set up subcommittees as needed for specific activities.

III. Nominations for the New Chair

Send me the name of your choice for chair after you obtain consent of the person. I will be mailing ballots to all members prior to the August 10 meeting. Final voting will be done at the meeting to allow for last minute write-in candidates.

JOBS

Plant Disease Specialist. The Maryland Department of Agriculture seeks experienced, technically proficient person with Ph.D. in plant pathology, or M.S. in plant pathology with two years of experience in plant pathology, entomology, pest management, pesticide regulation or related field. Duties include the supervision of a plant disease diagnostic lab, conducting inspections/surveys for plant pests, and representing the department on matters such as acid rain, sludge utilization and power plant siting. Salary range: $20,885 - $27,479. Application deadline is June 20, 1986. Contact Dr. W. F. Gimpel, Jr., Chief, Plant Protection, Maryland Department of Agriculture, Annapolis, Maryland 21401 (301-841-5920) for additional information and job application. The department is an equal opportunity/affirmative action employer.

FACT SHEETS

Ohio - New Fact Sheets

Six new Know and Control Plant Disease Fact Sheets have recently been prepared and are available, single copies free, bulk orders at $10.00 per hundred. The following titles are available:

1) Bacterial Wilt of Cucurbits
2) Powdery Mildew of Wheat
3) Controlling Rose Diseases
4) Scab of Apple and Crabapple
5) Leaf Spot and Melting out of Kentucky Bluegrass
6) Early Blight of Potato

To order single copies contact Chuck Powell Jr., Department of Plant Pathology, The Ohio State University, 2021 Coffey Road, Columbus, OH 43210. For bulk orders contact Irene Lam, Publications Office, OCES, 2120 Fyffe Road, Columbus, OH 43210-1099.

American
Type Culture
Collection

12301 PARKLAWN DRIVE · ROCKVILLE, MARYLAND 20852-1776 USA (301) 881-2600 TELEX: ATCCROVE 908-768

N E W S R E L E A S E

For immediate release
Contact: Susan Stephenson

OVER 2,200 VIRUSES AND ANTISERA NOW AVAILABLE FROM ATCC

ROCKVILLE, MD, April 28, 1986 - - American Type Culture Collection has just published the 5th edition of its Catalogue of Animal and Plant Viruses, Chlamydiae, Rickettsiae and Virus Antisera.

The 193-page catalogue describes over 2,200 strains, including molecularly cloned viruses. A subject index is provided.

Copies of the catalogue are available free of charge in the United States. Shipments outside the U.S. will be charged $6.50 for air mail postage. To receive a copy, contact the Sales Department, American Type Culture Collection, 12301 Parklawn Drive, Rockville, Maryland 20852.