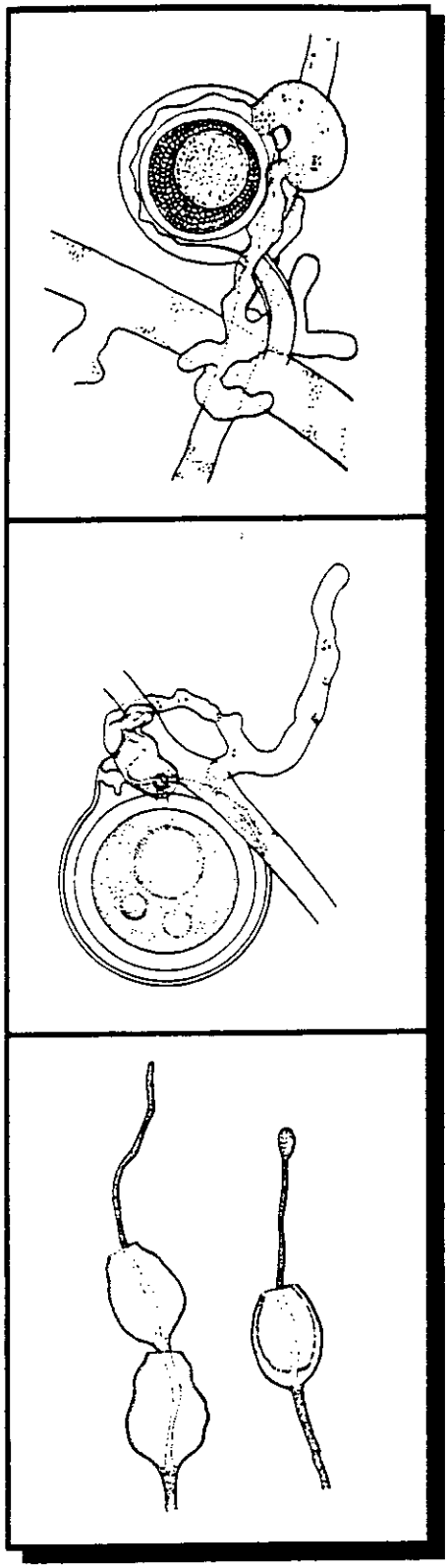

September, 1991
Volume XII, Number 3

PLANT DIAGNOSTICS QUARTERLY

Features

Diagnosing Root Rots of Alfalfa in Kentucky Caused by *Phytophthora megasperma* f. sp. *medicaginis* and *Aphanomyces euteiches*

Regional Reports: End of season wrap-up

Plant Diagnostician's 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. Yearly subscription fees are:

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PLANT DIAGNOSTICIAN'S QUARTERLY

FROM THE EDITOR

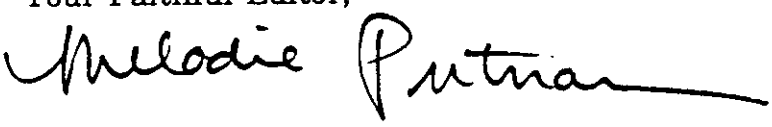
Hello again,

You may have noticed that our cover looks a bit different (and if you haven't, wake up!). The slight name change was recommended and voted on by the Diagnostics Committee of the American Phytopathological Society. The idea was that the name of *PDQ* would more accurately reflect the readership, since not all subscribers are diagnosticians. Now if we can only get people to stop calling it Plant Disease Quarterly.

The December issue will contain the minutes of the Diagnostics Committee meeting, as well as the next batch of diagnostic sheets. Let me know if you have any suggestions for articles for future issues.

(By the way, is it really true that if you set out kerosene and acorns that you'll attract space aliens?)

Your Faithful Editor,



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REGIONAL REPORTS

Northwest Region
Colette Beaupré

Prevalent plant disease problems on ornamentals in Colorado during the early summer included shot hole (*Coccomyces* sp.) of *Prunus* spp., Marssonina leaf spot of aspen, and fireblight. Unusual for the area was a report of Fusicoccum canker of Mountain Ash. Late season rusts and powdery mildews were widespread. In home lawns, both Ascochyta leaf blight and melting-out were most common.

Generally, in commercial horticulture crops, the impatiens serotype of tomato spotted wilt virus is most common, but the lettuce serotype was detected on *Alstromeria* and *Stephanotis* grown at the Colorado State University (CSU) greenhouse facility.

The Colorado State Univ. crops diagnostician position was lost this year; and Dr. Bill Brown, Cooperative Extension Plant Pathologist, is handling the crop disease problems. (Laura Pickett)

This was a wet year in Montana, and as a result, the disease problems which developed there were as expected. One notable disease problem was the occurrence of barley scald (*Rhynchosporium secalis*) on malt barley. (Jack Riesselman)

Though tomato spotted wilt was a serious problem in Oregon last year, the disease was not common this year. The few cases of the Impatiens serotype were from greenhouse crops of begonia, bergenia, impatiens, and verbena. The lettuce serotype of the virus was detected occasionally in fuschia, geranium, impatiens, verbena, and lemon balm in greenhouse culture. It was also found in field-grown dahlia.

In ornamentals, Phytophthora root rot and twig die-back of witch-hazel and heath, respectively, were serious this year. Needle cast disease of conifers was moderately heavy this year in Oregon, with Swiss needle cast and *Rhabdocline* on Douglas fir most severe. Also, Cyclaneusma needle cast of pine is on the increase.

Winter injury was heavy on small fruits. Powdery mildew was a serious problem on grapes in Oregon this year due to the long wet spring. Apple scab, and cherry leaf spot were prevalent, as was red stele on strawberry.

Virus disease in potato, cucurbits and peppers were widespread this year due to high aphid populations. In carrot, celery and cilantro, Cercospora leaf blight was serious; as was Pseudomonas leaf blight of celery. Root rots of snap bean and Rhizoctonia pod blight bean were also heavy. In early spring Mycocentrospora leaf spot was severe on beans, onions and parsley. This resulted in high yield-loss in some areas. There was also heavy loss in the peppermint crop due to rust.

The diagnostic laboratory is currently using Agri-Diagnostics Phytophthora test kit (ELISA multiwell) with reliable results when compared to accompanying culturing. (Stacey Fischer)

Wyoming had a cool, wet spring and a wet summer for most of the state. There were heavy crop losses in dry bean due to Fusarium root rot. This was also an exceptional year for fireblight on all hosts. A single incidence of halo blight of oat was reported in the state (no record of previous reports here). Rust diseases were widespread due to the unusually wet conditions, whereas rusts are normally rare here.

We are developing a state-wide prevention program for winter injury, which is our number-one problem with trees and shrubs.

Our clinic has processed just over 500 samples since October 1990. Greenhouse bioassay for bacterial diseases of bean seed for seed certification (about 200 seed lots anticipated for this year) is underway. (Colette Beaupré)

As of September 30, the Utah Plant Disease Clinic has logged in 270 samples for the year; this is slightly fewer than last year, but rotting potato season is not yet upon us! Potato harvest always brings in a few choice, interestingly-perfumed packages.

Utah may be great for skiing, but we don't have much here to make the plant pathologist's life exciting. As in previous years, the number of non-pathogenic disorders far exceeded those of pathogenic origin; we had many examples of iron deficiency, drought damage, and herbicide injury. This year we had noticeably more winter injury, due to the very harsh cold weather last December.

We had an interesting, yet quite destructive problem in our winter grain crops this summer, whose cause I can only guess at. Around July, when the grain was supposed to be filling, much of it was stunted with white, and/or unfilled heads. Additionally, leaf tips were burned back. This disorder was widespread in Utah, though somewhat capricious; but it seemed to occur more often when growers had been a little behind on irrigation. We have concluded that abnormally heavy springtime rains promoted lush top growth in the grain, without correspondingly lush root growth. When in June the rain spigot was suddenly shut off and temperatures soared, the grain did not have the root system to deal with the different environmental circumstances. Whether or not this guess is on target, I do know that pathogens were not directly involved.

Our major pathogen problems were those we experience frequently: fireblight of apples and pears in the northern part of the state; powdery mildew in apples and sour cherries; some take-all and barley scald; crown rot, Verticillium wilt and spring blackstem in alfalfa; the usual cornucopia of turf difficulties; curly top in tomatoes; and Verticillium and Fusarium wilts in tomatoes and potatoes.

There were a few anomalous disease problems. First, we found a disease in alfalfa called yellow leaf blotch, caused by the fungus *Leptotrochila medicaginis*. We have not seen this problem here before. Apparently it is not common, nor very damaging.

Pink snowmold, which we have almost every year in the early spring, showed up unexpectedly on a golf course in mid-June. It was there because of the heavy spring rains we endured. Another unusual turf problem ought to go down in the annals of amazing things creatures can do when we say they can't do them. I had a call from a turf farmer who had a sever die-out problem; some dead patches were over 10 feet across. I expected a disease; but instead I found alarmingly high populations of Banks grass mites. For reasons unknown, the mites were defying the text books, which put them down as grass feeders but not grass killers; and they were definitely killing the turf. Controlling the mites solved the problem of turf death.

The most unusual problem we encountered was the stem and bulb nematode we found in one of our few garlic plantings. The nematode had come in with seed, and is now a resident of the grower's soil.

In general, we don't have many disease worries in fruit orchards; but this year apple scab appeared again, at low levels. Scab is uncommon here, and used to catch us off guard. But we now know it can occur, and we monitor for it each fall and spring. We have one peach grower, that we know of, who is losing young trees to a very aggressive isolate of *Cytospora*. Don't get fooled into thinking that *Cytospora* is a disease only of the sick and the senior citizens of the tree world. (Karen Shotwell)

Southwest Region

Steven Koike

Oklahoma has confirmed the presence of a number of viruses on cucurbits: zucchini yellow mosaic, watermelon mosaic-2, papaya ringspot, and cucumber mosaic virus. *Sclerotium rolfsii* has been reported on peanut; and *Pythium* and *Rhizoctonia* pod rots have been common. *Colletotrichum coccodes* has been isolated from hydroponically-produced tomatoes. Other samples include pine wilt on Scots pine, glume blotch (*Septoria*) on wheat, Phyllosticta leafspot on oak, *Sclerotium rolfsii* on alfalfa, and Cercospora leafspot on cotton.

In Texas there have been major disease problems with the melon crops. Apparently a group of viruses is significantly reducing crop yields and quality. Researchers are currently trying to identify the virus complex involved. A *Gaeumannomyces* type of patch disease has been frequently identified on turf samples. Commercial Photinia nursery stock has been plagued with a bacterial disease, in part encouraged by overhead sprinkler irrigation. Pathologists working on this project believe the pathogen may be a *Xanthomonas campestris* pathovar.

Overhead sprinkler irrigation is also affecting disease development in areas of California. For several leafy vegetable crops, sprinkler irrigation is used almost exclusively. Under these conditions seed-borne pathogens, if present, can easily take hold. Such has been the case for Septoria leafspot of parsley (*S. petroselini*) and bacterial leafspot of cilantro (caused by a non-fluorescing *Pseudomonas syringae*). For both of these crops, disease control is difficult because in California there are no chemicals registered for use on these "minor" crops.

An unusually wet late summer in New Mexico (150% of annual average rainfall by mid-September) has been responsible for serious outbreaks of several foliar fungal and bacterial disease. Angular leaf spot of cotton (*X. campestris* pv. *malvacearum*) and southwest cotton rust (*Puccinia cacabata*) have been quite severe throughout southern New Mexico. Phytophthora root rot of chile (*P. capsici*) was more severe this

year than usual, in particular the pot rot and aerial phases of the disease. Bacterial spot of chile (*X. campestris* pv. *vesicatoria*) was widespread for the first time in a number of years. Web blotch on peanut (*Phoma arachidicola*) was very severe (>80%) in eastern New Mexico as was southern blight (*Sclerotium rolfsii*) and Pythium pod rot. Various head blight problems on sorghum and maize have been reported, and powdery mildew is widespread throughout the state on numerous crops and ornamentals.

From Arizona there have been numerous reports of *Phymatotrichum omnivorum* on woody plant hosts, including *Rhus*, *Brachychiton*, grape, mesquite, wisteria, juniper, and several fruit tree hosts. Diagnosticians have received *Ganoderma lucidum*, *Phelklinus texanus*, and *Ceriporia xylostromatoides* samples from several hosts. Other miscellaneous reports include: *Agrobacterium tumefaciens* on *Myoporum*; *Macrophomina* on elm, *Myopourm*, tomato, eucalyptus, and jacaranda; *Phyllosticta* on *Opuntia*; and psyllid yellows on potato.

An apparently new leaf spot disease of screwbean mesquite (*Prosopis pubescens*) has been found in southern Nevada. The fungus, which belong to the coelomycete group, infects the leaves and petioles. Attempts to identify the fungus are currently underway. Also, an unusually high incidence of olive knot disease (*Pseudomonas savastanoi*) occurred this year on olive trees in southern Nevada. Twigs and stems have extremely high numbers of galls. Freezing damage, which occurred last winter, has been implicated with this problem. There are fewer alfalfa diseases (leaf spots and stem cankers) this year. Reduced irrigations, due to drought concerns, may be a factor in this.

Central Region

Karen Rane

The Central Region experienced widely divergent weather patterns this summer. Conditions ranged from abundant to excessive rainfall throughout the season in Minnesota; to severe summer drought conditions in much of Kansas, Missouri, Illinois, Ohio and Indiana. This variability in environmental conditions is reflected in reports of disease problems from the region's diagnosticians.

Wet spring conditions contributed to seedling blight and root rot problems in corn and soybeans in Minnesota. In Kansas, distortion of corn brace roots was attributed to heavy rains at planting followed by drought, resulting in the development of a hard crust on the soil surface. A significant increase in the incidence of Stewart's wilt in field and/or sweet corn was noted in Michigan, Missouri, Illinois and Indiana. In Ohio, the seedling blight phase of the disease was severe in sweet corn. Virus problems in corn were reported from Indiana, Ohio, and Missouri associated with the use of selective grass herbicides for Johnsongrass control. Symptoms ranged from chlorotic mottling to stunting and red foliar discoloration. Maize dwarf mosaic virus and maize chlorotic dwarf virus were diagnosed in some, but not all symptomatic plants. The possible interactions between the viruses, tolerant and susceptible corn lines, and herbicides have yet to be defined. In Nebraska, a new county record of maize chlorotic mottle virus was reported, bringing to ten the number of counties with this virus disease. Maize chlorotic mottle is a component, along with maize dwarf mosaic virus, of the disease called corn lethal necrosis, and is a serious concern in the region. Additional corn problems in the region this summer include increased incidence of corn borer and stalk rot (Minnesota, Indiana) and Diplodia ear rot (Nebraska).

Charcoal root rot was prevalent in soybeans wherever drought conditions existed in the Central Region. In Minnesota, wet weather at planting time caused more fields to be planted to soybeans rather than corn, and there is concern that the soybean cyst nematode may become more of a problem due to lack of crop rotation. An increase in the number of soybean seed problems (*Phomopsis*, purple seed stain caused by *Cercospora*, and bleeding hilum caused by soybean mosaic virus) has been observed in Iowa. In wheat, an increase in head scab was noted in Minnesota and Indiana.

For much of the region, drought stress was the most common problem diagnosed on woody ornamentals. In addition, death of white pines after 8 to 15 years at a site continues to be a common occurrence in several states. Adverse conditions such as high soil pH, clay soils and site disturbances are believed to contribute to this decline. *Sphaeropsis sapinea* was diagnosed on white and Colorado blue spruce in Christmas tree plantations in Michigan, on Frasier fir in Ohio, and also found to cause a basal canker on white pine in Missouri. Increased incidence of pine wilt, caused by the pine wood nematode, was reported from Kansas and Missouri. A canker disease of spruce caused by a *Phomopsis* species was found in nurseries in Michigan. The symptoms resemble those of Cytospora canker in that lower branches are affected, but entire trees can also be killed. Oak wilt continues to be a problem in Iowa, Nebraska and Missouri. Ash yellows infection of green ash was confirmed in several areas of Minnesota this summer.

Pothos was found to be an asymptomatic host for tomato spotted wilt virus in Minnesota, and was believed responsible for a chronic TSWV problem in one commercial greenhouse in the state. Other

diseases of note in herbaceous ornamentals include Verticillium wilt in garden phlox (Ohio) and foliar nematode on creeping phlox (Missouri).

Fire blight, apple scab, cedar-apple rust and sooty blotch were significant problems in Minnesota this season. In Ohio, active fire blight infections were observed in July, which is later in the summer than in previous years. Wet conditions in portions of Wisconsin contributed to increased incidence of stem and root rot and leaf blight of ginseng, caused by *Phytophthora* and *Rhizoctonia* spp.

Northeast Region

Anne Bird Sindermann

Money was not the only thing drying up in the Northeast this summer. In Maryland, a very hot dry early summer resulted in transplant failure of southern grown processing tomatoes. Alerted by media coverage of dogwood anthracnose, people diligently called with observations of drooping leaves and twig dieback of flowering dogwood. The dogwoods were not suffering from Discula; heat and drought were the culprits. Oaks, maples, and other shade trees suffered drought stress. Small grains were senescent 10 days ahead of schedule, and Phytophthora on ericaceous plants arrived in the lab earlier than in recent years. Southern blight of white potatoes, rarely seen in Maryland, was reported in late May after unseasonably hot weather. Stewart's wilt of corn was widespread, possibly due to reduced uptake of Furidan applied to control high vector populations.

An interesting and challenging problem described as watermelon internal rind necrosis was reported in Maryland and in Indiana. I first suspected to be bacterial, the problem was determined to be physiological in nature after no pathogen was detected after repeated attempts at recovery. In Maryland, the problem was first noticed in the variety 'Royal Majesty' then observed in other varieties examined form a Fusarium wilt trial at the University vegetable farm. It is believed long periods of high temperatures caused rind necrosis. A hardening or woodiness of the cores of tomato fruit was also believed to be caused by the heat.

Verticillium wilt of okra was reported in New Jersey. Plants were stunted and yielded poorly. Also in New Jersey, zucchini yellow mosaic virus was reported in pumpkins and other cucurbits. Other aphid-vectored viruses were prevalent and noticed early in the season throughout the region. In Pennsylvania, prunus necrotic ringspot virus was detected in hybrid tea roses. A new race of soybean cyst nematode (SCN, Heterodera glycines) was confirmed in Delaware; races 1,3, and 4 are now present. Control of this serious pest of soybeans relies on resistant cultivars so studies to determine which soybean varieties are resistant to one or more races of SCN will continue.

Southeast Region

Jackie Mullen

Most of the Southeast experienced an extremely wet spring which set the stage for a wide variety of diseases in the spring and early summer. But drought developed in some southeastern areas as the summer progressed.

Not surprisingly, there were a number of problems that showed up throughout the region. Southern blight (*Sclerotium rolfsii*) was common on a wide variety of plants in Arkansas, North Carolina, South Carolina (especially on ajuga and pachysandra), and Alabama. *Phytophthora* root rots and blights were also abundant (identified on 308 samples in the clinic at NC), with reports coming in from Florida, Tennessee, NC, SC, and Alabama. *Phytophthora*.caused foliar blight of Madagascar periwinkle (*Catharanthus roseus*) in TN, NC, and FL (identified in FL as *P. nicotiana* var *parasitica*); and peppers were hit hard by *Phythophthora* in Louisiana.

Leaf spots on shade trees and shrubs were abundant in the region (*When will people give up on photinia? MP*), particularly dogwood anthracnose (*Discula destructiva*) in home landscapes (TN), *Tubakia* (formerly *Actinopelte*) on sweet gum (NC) and oaks, and various anthracnoses.

Wet feet of ornamentals and other water related stresses were common in Georgia,

James Mitchell (Arkansas) reports take-all (*Gaeumannomyces*) in zoysia and bermuda grass earlier this summer.

Bacterial fruit blotch (*Pseudomonas*) of watermelon caused 100% loss in the fields where it was detected. The water-soaked fruit blotch appeared initially as quarter-sized spots but quickly (7-10 days) spread to involve the whole fruit. Small (1/16-1/8 inch) black spots on the leaves often did not cause

significant damage to the foliage. In the two locations in one county where this disease was detected, 'Prince Charles' seed was believed to be the source of the bacteria.

The diagnostic facility received about 25 samples of oak ring spot virus which appeared as yellow irregular rings on some oak species and solid yellow spots on other species. It is suspected that the increased incidence of this disease may relate to the drought stress of this past summer.

Aside from the above information, I regret to report that reliable sources indicate the Arkansas Disease Clinic will no longer be funded as of next June.

This past summer western Kentucky was hot and dry, and charcoal rot was a noticeable problem on soybeans. State-wide, bacterial leaf spot (*Xanthomonas*) was a problem on pepper and tomato. Also, tip blight (*Sphaeropsis*) on Austrian and Scots pine continue to be a problem. For the most part in June and July, Kentucky was dry with rains coming in August (B. Eshenaur).

In Georgia, the summer was fairly wet with only a short dry period. Some of the problems include Rhizoctonia aerial blight, Rhizoctonia stem rot on poinsettias, Helminthosporium leaf spot on poinsettia, anthracnose on southern pea, and Septoria leaf spot on dogwoods. Many shrubs with minor leaf spots and environmental stresses (wet feet) were received. A new angular leaf spot of rhododendron is currently being investigated. Cucurbits were especially hard hit this past summer with anthracnose and gummy stem. (White flies - not exactly in the disease category - have caused significant widespread damage in all vegetables.)

The Florida Department of Agriculture & Consumer Services reported a busy summer as usual with hot, wet weather. A new *Xanthomonas* bacterial leaf spot problem on ponytail palm (*Beaucarnea recurvata*) was detected in several different nurseries around southern and central Florida. The recently described *Pseudomonas andropogonis*-induced foliar disease on bougainvillea was plentiful. A limited outbreak of Asian citrus canker reappeared in September in a citrus grove in which a very limited infection on only five leaves had been detected about six months previously. Two acres containing 236 mature citrus trees were cleared out after the initial spring detection in this grove; the grove had been under a 30-day inspection. More tree destruction is pending following this latest outbreak in a continuing effort to eradicate this disease.

An unusually high frequency of Rhizoctonia web blights and *Erythricium* (*Corticium*) *salmonicolor* limb blights were diagnosed, mostly on *Ilex* spp. with compact crowns. Bidens mottle virus was confirmed on *Cosmos sulphureus* for the first time in Florida. This virus is common on many other hosts in the state. Turnip mosaic virus was detected in watercress (*Nasturtium officinale*) for the first time in Florida. Symptoms include leaf mosaic, stunting, and reduced flowering. Neither bidens mottle on cosmos or turnip mosaic on watercress are present at economic levels at the present time.

The Florida Extension Plant Disease Clinic (Simone and Cullen) reported that the sweet potato whitefly (*Bemisia tabaci*) has persisted throughout Florida causing damaging silver leaf symptoms. The population of this geminivirus vector is increasing in north Florida. States to the north of Florida should be on the lookout for the tomato geminivirus (present in north Florida) and such disorders as silvering of squash and irregular ripening of tomato fruit. In addition, two new geminivirus diseases were reported from pigeon pea exhibiting stunting and mosaic, and jatropha (exhibiting leaf distortion and mottling). The specific identity of these gemini diseases is not known at present. New or unusual reports include a leaf spot of redbud (*Cercis canadensis*) caused by a *Cylindrocladium* sp., dasheen mosaic virus from the ornamental aroid *Rimusatia vivipara*, and oleander knot disease caused by *Pseudomonas syringae* pv. *savastanoi*. A *Phytophthora* fruit rot of beauty-berry (*Callicarpa americana*) - a native woody ornamental - in nursery production was found in north central Florida. Speciation of this pathogen is in progress.

At the Plant and Pest Diagnostic Center of Tennessee, B. Long reports an unusual occurrence of black root rot (*Thielaviopsis*) of English holly.

With fruits/vegetables, Beth reported Alternaria leaf blotch on apple (esp. 'Red Delicious') as a new problem this year; necrotic leaf blotch disorder on 'Golden Delicious' apple; a widespread and heavy occurrence of strawberry anthracnose; a frequent and unusual incidence of Phytophthora late blight of tomato; and an unusually severe incidence of downy mildew of cucurbits.

With field crops there was a high incidence of black shank on tobacco due to ideal disease conditions. Even those varieties with some resistance to the disease had black shank. Blue mold was a problem in tobacco for the first time in several years. Incidence occurred primarily in east Tennessee. No

Ridomil tolerant strains of blue mold were detected. Fusarium scab (head blight) was extremely severe on wheat, especially on 'Saluda' and 'Pioneer 2555' varieties. Those varieties that were in bloom during prolonged periods of rain and high humidity were more heavily infected. Extension wheat specialists said this was the worst epidemic of wheat scab in 30 years. Early planted (before June 15) soybeans were hit hard with soybean stem canker. Many fields in middle Tennessee had 100% infection, and fields with susceptible varieties may lose more than 50% of the crop. Sudden, late (Sept. 1) and heavy occurrence of Southern corn leaf rust on corn (field and sweet) was also noted.

T. Cresswell (North Carolina) reported an unusually wet July and August. Rhizoctonia (web blight, root/stem rots) were prevalent, as were downy and powdery mildews. Other noteworthy occurrences were frogeye leaf spot (*Cercospora nicotianae*) and blue mold (*Peronospora tabacina*) on tobacco; and web blight (*R. solani*) on blue hollies (*Ilex* x *meservae*). The holly web blight occurred in field production beds and the pathogen splashed onto the foliage. Severe damage was noted in two situations.

M. V. Patel (Mississippi) reports a very wet spring followed by a dry June and July. Fireblight on apple and pear was severe and common during the late spring and early summer. Fusarium wheat scab was also a serious problem during the early summer. Other diseases that were particularly severe included oak leaf blister, aerial web blight of snap beans, southern corn leaf rust where whole fields were effected at damaging levels, and an unusual find of downy mildew on watermelon. TSWV was found on greenhouse tomatoes. In addition, M. V. reported a number of southern pea samples with anthracnose.

In Louisiana, C. Overstreet noted that the very wet weather early in the season was followed by a damaging dry spell late in the summer. An unidentified pod drop disorder (seen previously in 1986) was a problem in a number of soybean fields; root-knot and reniform nematodes on cotton are a problem on some farms. On rice, the white tip nematode has been a problem on one variety - 'Mercury'. Also with rice, C. Hollier reported that rice blast (*Pyricularia*) reached epidemic proportions in some areas with 10-50% destruction in some fields.

Pecans were hit hard by scab; many large ornamental trees gave up and died as a result of accumulated stresses over the past several years;

Diseases were frequent in South Carolina also. J. Blake reports brown patch, ring nematode and gray leaf spot on warm season grasses; and Pythium root rot and brown patch on cool season turf. Anthracnose and gummy stem were common on cucurbits. James also noted Seiridium canker on Leyland cypress.

Alabama experienced a very wet spring and early summer. The southern sections of the state stayed wet throughout the summer, but the northern parts dried out in July such that the cotton crop suffered from severe drought stress. Fireblight was severe and widespread on apple and pear; even resistant and tolerant ornamental pears showed evidence of the disease. Diseases of note included abundant problems with bacterial wilt on tomato; Rhizoctonia stem rot and aerial blights of beans and peas; field peas with problems of mosaic virus, anthracnose, *Pythium* and *Rhizoctonia*; aerial (*Rhizoctonia*) blights of viburnum and vinca; and Helminthosporium-type leaf spots on all types of bermuda (turf and field types). Cylindrocladium black root and crown rot was identified on a limited area of peanuts. Also with peanuts, early leaf spot was widespread and severe with late leaf spot showing a lower incidence and severity. This is the reverse of the typical peanut leaf spot situation in Alabama. *Rhizosphaeria* needle/twig blight and *Ploioderma* (*Lophodermium*) on Virginia pine caused some damage in a couple of locations in the central section of the state.

Pecans were severely affected by scab. Varieties that normally show some resistance to the disease were covered with it despite regular spray schedules. Those growers who did control the disease had tightened up on their spray schedules, some applying as many as 14 sprays during the season. Also on pecan, *Glomerella* has been tentatively identified as the cause of a late season severe shuck blight. This is a relatively new problem and exact details and knowledge of the disease agent are not available. It appears that this is a late season problem which can be controlled by early fungicide spray treatments. The problem also exists in Georgia.

Sudden death syndrome of soybean was reported in one northern location of the state. Some of our most trouble-some problems this past summer involved possible patch diseases (*Gaeumannomyces*-type) on turfgrass (St. Augustine, bermuda, zoysia). *Gaeumannomyces* patch disease on St. Augustine was confirmed (M. Elliott, Florida) in the central part of the state.

DIFFUSION

Dyes as fungal inhibitors: Effect on colony diameter. Radial growth of three zygomycetes (*Absidia corymbifera*, *Mucor racemosus*, *Rhizopus stolonifer*) and six deuteromycetes was compared against thirteen dyes incorporated into malt extract agar. M.R. Bragulat *et al.* (Univ. Autónoma de Barcelona, Spain) found that auramine (50 µg/ml), methylene blue (500 µg/ml), gentian violet (5 µg/ml), and phenol red (50 µg/ml) worked as well as 2 µg/ml dichloran and 50 µg/ml rose bengal. These concentrations allowed adequate colony growth while controlling rapidly spreading fungi. The authors also found that 10 µg/ml malachite green inhibited all organisms tested except *Fusarium oxysporum*, which may indicate usefulness of this dye in a medium selective for this fungus. Applied and Environmental Microbiology 1991, **57**:2777-2780.

Species concepts of *Phytophthora cryptogea* and *P. drechsleri*. Another attempt has been made, this time by H. H. Ho and S. C. Jong (State Univ. of NY-New Paltz and ATCC, Rockville, MD respectively) to clear up the *Phytophthora cryptogea* - *P. drechsleri* confusion. These two species have been under dispute for decades; in 1986 the two authors even merged the two species and called them *P. drechsleri*. Now after comparing multiple isolates of all *Phytophthora* species producing nonpapillate sporangia and amphigynous antheridia, the authors feel better able to address the situation. Using morphological and cultural characters, *P. cryptogea* has been broadened to include "the 'typical' forms and most isolates that have characteristics intermediate between *P. cryptogea* and *P. drechsleri*. Only isolates that grow well at 35° C. are assigned to *P. drechsleri*...." *P. drechsleri*. has been redescribed to include five additional species formerly thought to be separate and distinct. Several isolates from the ATCC have been re-classified. Mycotaxon 1991, Vol. **XL**:35-39.

Media for selective isolation of hymenomycetes. J.J. Worrall (SUNY- Syracuse) tested growth of 32 wood-decay hymenomycetes and wood-inhabiting non-hymenomycetes on five semi-selective media. The author found that "for general isolation of hymenomycetes, benomyl is the closest to an ideal ingredient...best used at concentrations below 5 ppm." Also discovered was that media containing PCNB was not good for inhibiting Mucorales. For general isolation of hymenomycetes, BDS (benomyl-dichloran-streptomycin) is recommended. Make a stock solution of 40 mg. Benlate 50% WP in 50 ml warm 95% ethanol; dilute to 100 ml with water, and add 20 mg dichloran. Ten ml of the stock solution is added to one liter of malt extract agar before autoclaving, after which 100 mg streptomycin is added. Mycologia 1991, 8:296-302.

Species of the *Phytophthora megasperma* complex. E. M. Hansen and D. P. Maxwell (Oregon State Univ., and Univ. Wisconsin-Madison respectively) have combined the fruits of their individual efforts to address speciation of *P. megasperma*. This article is a re-evaluation of the *P. megasperma* complex based on previously published data. Distinctions between species are made on the basis of host specificity, morphology, colony characteristics, isoenzyme patterns, total protein pattern obtained by polyacrylamide gel electrophoresis, and mitochondrial DNA restriction fragment length polymorphisms. Their conclusions: *P. sojae* is the name for the species which has relatively small cogonia and which is pathogenic only on soybeans. The new species *P. medicaginis* is proposed to accommodate those isolates primarily pathogenic on alfalfa and with oogonia similar in size to *P. sojae*, but with shorter sporangia. *P. medicaginis* includes those isolates called *P. megasperma* var. *sojae* by Waterhouse. Another new species *P. trifolii* is proposed for isolates with larger oogonia (37-46 µm) and primarily pathogenic on *Trifolium* spp. *P. megasperma* is considered to have a broad host range, widely varying oogonial sizes, and faster growth rate than the species listed above. It is also "readily recognized by its electrophoretic protein pattern...although this is more variable than in other species of the complex." Mycologia 1991, **83**:376-381.

INDUSTRY NEWS

DuPont Deletes Ornamentals and Selected Other Crops From Benomyl/Benlate Label

[This item was received from Walker Miller (Clemson) through the e-mail reflector described on page 110.]

For economic reasons DuPont Agricultural Products has deleted all ornamental and bulb uses from all benomyl labels including Tersan. Existing products in market channels may be sold and used as labeled. Products that remains under DuPont control have already been re-labeled. At this time negotiations are on-going concerning dates of last sale and last use of un-re-labeled products. Other crop and use patterns eliminated include: asparagus dip, avocado dip, blueberry container drench, conifer (greenhouse) drench, cucumber greenhouse spray, eggplant drench, garlic dip, ginger dip, pepper drench, strawberry drench and dip, sugarcane dip, sweet potato and yam dip, and tomato greenhouse spray. Use on turf, sometimes considered an ornamental, will be continued.

The decision by DuPont will include all third party labels. A third party label is product which is sold to other companies for resale. Generally it is sold in smaller containers. Ordinarily it takes longer for these products to clear market channels.

The decision is not prompted by environmental or health risks. It was voluntary on the part of DuPont. Economic considerations may have included cost of re-registration as well as small market potential. A possible other factor is the wide spread occurrence of resistance in the fungus Botrytis to benomyl and closely related chemical compounds in the ornamental industry. Resistance in some other organisms has also been documented.

Benlate was available as a dry flowable (DF formulation) and is under a total product recall because of possible herbicide (atrazine) contamination. The DF formulation according DuPont will not be back in the market place, only the 50 W (wettable powder) will be sold. The wettable formulation is made in DuPont's own facilities.

Alternative products with similar mode of action as well as different modes of action are available in the market place. No immediate disruption in production or impact on grower industries is anticipated. Two products remain with similar modes of action. They are thiophanate methyl sold under trade names such as Topsin M, Fungo and Clearys 3336 (discontinued 1989, but still in market channels) and thiabendazole sold under such trade names as Mertect, TBZ and Arbotect. Because of the potential for fungal resistance developing, the strategies for resistance management used with Benlate or Tersan should be applied to these products. If the companies who manufacture these products also opt not to re-register these uses (some have followed DuPont's lead in the past) it will reduce the number of resistance management strategies to the ornamental industry. Some alternative products are already experiencing resistance problems. A further complication is possible in that the broad spectrum product mancozeb is anticipated to become a restricted use material based on the EPA's last position document on that compound. This may further reduce resistance management strategies.

Topsin M is available from Atochem North America. Fungo along with combination products Banrot and Duasan are available from Grace Sierra Horticultural Products Co. and thiabendazole is available from Merck and Co. Inc.

APS UPDATE

Following is the financial report for *Plant Diagnostics Quarterly* (formerly *Plant Diagnostician's Quarterly*) presented to the Diagnostics Committee in St. Louis. The next issue will have the minutes from this meeting.

PLANT DIAGNOSTICIAN'S QUARTERLY (P.D.Q.)
1991 Financial Report - 1/1/91 thru 6/30/91
Submitted by Gail E. Ruhl
Managing Editor
August 18, 1991

Total Subscribers - 119

United States	100
Canada	14
England	1
Peru	1
France	1
India	1
Republic of Korea	1

Beginning Balance (as of 1/1/91)	$1,745.34
Printing Cost For December 1990 Issue (Billed in January)	$ 228.00
Actual Beginning Operating Budget for 1991	$1,517.34
Income Received from 1/1/91 thru 6/30/91	$1,305.00
Expenses Incurred From 1/1/91 thru 6/30/91 (not including the December 1991 issue)	
•Printing of March/June issues and misc. duplicating	$424.60
•Postage	$525.68
Total Expenses	$950.28
Ending Balance As Of 6/30/91	$1,872.06
Porjected Additional 1991 Expenses	
For September/December Issues	*$1,000.00*
Projected Ending Balance	*$872.06*

Charge Policies:

Back issues in stock - $2.50 each + postage - USA/Canada
$2.50 + airmail postage - overseas

Back issues or articles not in stock - $.05/pg. xerox chg. + postage cost

Yearly Subscription Fee - $10.00
Yearly Overseas Airmail Subscription Fee - $25.00

PDQ Subscribers

This is a reorganized list of our subscribers. Instead of listing people by zipcode, this list is alphabetical by last name (first name is still listed first) according to region. Please let me know if there are any errors.
- Editor

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International Extension Plant Pathology E-mail Reflector

Walker Miller, Clemson University

What is an E-mail (electronic mail) reflector? It is a single address which, when it receives mail, immediately sends it to a list of addresses contained in the reflector. It is not a bulletin board, which must be actively accessed to obtain its information. Any mail sent to the reflector will show up in the e-mail of subscribers to the reflector. It is similar to a distribution list used in local university or industry e-mail systems but is different in that the distribution list does not have to reside in the local system. Anyone anywhere can mail to a single address and every one in the reflector gets an individual response in their mail.

Why an e-mail reflector? There can be many reasons. A few are listed here.

Many Extension Plant Pathologists subscribe to other pathologists' news letters to learn what is going on elsewhere in the country or the world. The reflector could assist in this. Further, this material can be re-released in state and local letters, with adaptive local editing, where it is timely and appropriate.

The current budget restrictions in many states have often resulted in a subscription fee for newsletters to cover postage and perhaps make a little money. E-mail is essentially free. The business world and other e-mail node supporters provide the service as an enabling fee. We can continue to share information for free without cost to our individual extension services.

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-Editor

Diagnosing Root Rots of Alfalfa in Kentucky Caused by *Phytophthora megasperma* f. sp. *medicaginis* and *Aphanomyces euteiches*

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Root diseases and disorders are sometimes a limiting factor in alfalfa production in Kentucky. *Phytophthora megasperma* f. sp. *medicaginis* and *Aphanomyces euteiches* are two fungal pathogens of alfalfa often found in our soils. *P. megasperma* f. sp. *medicaginis* has been widely recognized for years as a major alfalfa pathogen. However, the importance of *A. euteiches* in some poorly drained soils has become evident only recently, based on work by Dr. Craig Grau and associates at the University of Wisconsin (Delwiche et al., 1987; Holub and Grau, 1990).

Characteristic symptoms of Phytophthora root rot sometimes appear on taproots, thus obviating the need for more sophisticated laboratory diagnostic techniques in some cases. Even in these cases, however, laboratory confirmation can be useful. In other cases, we have observed where infection by these fungi only resulted in necrosis of "feeder" (tertiary) roots with few or no distinctive symptoms on taproots. Clearly, if necrosis of feeder roots is extensive, the plant will be greatly debilitated.

In our experience, alfalfa with extensive feeder root necrosis often exhibits only stunting and non-uniform growth, and perhaps stand decline over time. Because of the lack of other typically pathological symptoms such as chlorosis or wilt, it is often easy for growers to overlook the infectious nature of the problem.

As with any disease, diagnosing the cause of feeder root necrosis of alfalfa is the first step towards providing disease control recommendations. We have recently developed and refined techniques for diagnosing several alfalfa root rot diseases common in Kentucky. Our current diagnostic procedures are described below, with annotations.

The procedures described use healthy alfalfa seedlings as bait to detect *P. megasperma* f. sp. *medicaginis* and *A. euteiches* in root tissues and soil. It is often possible to observe abundant asexual sporulation of these fungi directly on necrotic tissue with a recent, active infection. However, sporulation is often reduced in older, less active infections. The use of a bait helps to amplify the presence of these pathogens, thus facilitating detection. Our assumption in using these diagnostic techniques is that the presence of a large enough thallus to support sporulation by these pathogens in symptomatic tissues is indicative of their causal involvement in the symptoms observed.

I. ROOT TISSUE ASSAY

1. **Carefully wash soil off roots. Select and remove necrotic tissues, including feeder roots and decayed portions of taproots if available.** [Because necrotic feeder roots can be very fragile, we ask Extension agents to send alfalfa plants with small spadefuls of intact soil surrounding the taproot. Shaking soil off the roots to facilitate shipment of the sample may break off many of the symptomatic feeder roots. We have had success in the following assays without surface-sterilizing tissues. If tissues are surface-sterilized, such treatment should be minimal, as *A. euteiches* may be sensitive to the treatment.]

2. **To detect *P. megasperma* f. sp *medicaginis*, place 15 ml sterile deionized water into a 9 cm sterile petri dish. Add at least 3-4 pieces of necrotic tissue, selecting freshly decayed tissue when possible. Include three or four healthy, 4-10 day-old whole alfalfa seedlings as a bait. Incubate on a laboratory bench for up to 7 days. During that time, examine the symptomatic tissues daily under a compound microscope for sporangia of *P. megasperma* f. sp. *medicaginis*. As the bait seedlings decay, examine them daily for sporangia, also.** [We use seedlings of the cultivar 'Arc', widely planted in Kentucky, although any cultivar with no resistance to Phytophthora root rot should work well. We grow seedlings in sterilized perlite in small paper cups under a grow light. Perlite works well because very little material adheres to the seedlings, thus permitting easy microscopic examination of root surfaces for sporulation; however, any convenient means of propagation will do. Seedlings keep well for a week or so under refrigeration, so they can be kept on hand easily. In an attempt to increase the selectivity of the assay, we have experimented with adding hymexazol to the assay to inhibit *Pythium* spp. However, we have found that *P. megasperma* f. sp *medicaginis* is somewhat sensitive to hymexazol. Including the compound in the assay usually doubles the necessary incubation time, and can prevent detection of *P. megasperma* f. sp *medicaginis* within a reasonable period of incubation. Also, *Pythium* spp. are reported to cause feeder root necrosis of alfalfa in California (Hancock, 1985; Hancock & Grimes, 1990). We have never issued a diagnosis of feeder root necrosis caused by *Pythium* spp., as we do not have the research base for Kentucky soils to make such a diagnosis. However, it may be of value to know whether *Pythium* spp. are associated with the necrotic tissues. Thus, we use unamended sterile distilled water, so that *Pythium* spp. are not excluded from the assay. One more note concerning *Pythium* spp. This assay works very well for detecting fungi that produce zoospores. *Pythium irregulare*, one of the most common causes of feeder root necrosis of alfalfa in California (Hancock, 1985), does not produce zoospores readily, and thus may not be detected efficiently using this technique.]

3. **To detect *A. euteiches*, add 15 ml of a 5 ppm metalaxyl solution to a separate petri dish. We prepare a 50 ppm stock solution by adding 0.1 ml of Ridomil 2E to 500 ml distilled water, and then prepare a 5 ppm metalaxyl solution by making a 1:9 dilution of the stock solution (both solutions keep well if refrigerated). Add at least 3-4 pieces of necrotic tissue to the petri dish, selecting freshly decayed tissue when possible. Include three or four healthy, 4-10 day-old whole alfalfa seedlings as a bait. Incubate on a laboratory bench for up to 7 days. During that time, examine**

the symptomatic tissues daily under a compound microscope for sporangia of *A. euteiches*. As the bait seedlings begin to decay, examine them for sporangia, also. [We use a 5 ppm metalaxyl solution to make detection of *A. euteiches* easier and more reliable by minimizing growth of *Pythium* spp. *A. euteiches* can be detected using just distilled water if a metalaxyl solution is not on hand. However, use of a sample with a 5 ppm metalaxyl solution is recommended, since overgrowth of the bait seedlings by *Pythium* spp. could prevent detection of *A. euteiches*. Although some species of *Pythium* are known to be insensitive to metalaxyl, we have found these to be uncommon in our samples in either the root assay or the soil assay (below). We use 'Arc' seedlings for this assay, also, although any variety without resistance to Aphanomyces root rot should work well.]

II. SOIL ASSAY

At times, detection of fungal pathogens directly from necrotic tissues may be difficult. If feeder roots have become highly decayed, pathogens such as *P. megasperma* f. sp *medicaginis* and *A. euteiches* may form oospores and the tissue may be colonized by saprophytes. This complicates detection from symptomatic tissue in several ways. Identification of oomycetes based on oospore morphology is risky for all but the most highly trained individuals. In some cases, the presence of saprophytes and/or dormancy of oospores may prevent direct isolation of the pathogen. Also, we have seen cases where feeder roots have been lost to decay and are no longer present, leaving a "rat-tail" taproot. In these cases, there may be little or no freshly decayed tissue to work with.

For samples where feeder roots have decayed and sloughed off, and for samples where fungal root rot is suspected but not confirmed using the root tissue assay, we test soil from the sample using the assay described below. This procedure is a modification of the "extended bioassay" reported by Stack & Millar (1985). If a pathogen is detected using this indirect diagnostic technique, we inform the grower that root rot symptoms were present in the sample, and that *X* pathogen was detected in the soil and may be responsible for the symptoms.

DAY 1. **Mix soil sample thoroughly and spread approx. 50 cc of soil on a paper towel to air-dry. Wash hands well between samples if handling several samples.** [Be sure to have alfalfa seedlings on hand. If not, plant some in perlite. We use the cultivar 'Arc', although any variety without resistance to *P. megasperma* f. sp *medicaginis* and *A. euteiches* should work well.]

DAY 3. **Add 20-25 g air-dried soil to each of two sterile petri dishes. To detect *P. megasperma* f. sp *medicaginis*, dampen one sample with sterile, distilled water. To detect *A. euteiches*, dampen the other sample with 5 ppm metalaxyl solution.** [Be

sure to include this step, as going straight from air-drying to flooding the soil (Day 6 instructions) has prevented detection of *P. megasperma* f. sp *medicaginis* in some of our tests. Avoid overwatering by adding water or metalaxyl solution dropwise until about 95% of the soil appears damp but not wet. The moisture will equilibrate overnight, dampening the remaining soil. As in the direct tissue assay described above, using a single soil sample with water alone will work for detecting both *P. megasperma* f. sp *medicaginis* and *A. euteiches*. However, we prefer to run paired samples with both distilled water and a 5 ppm metalaxyl solution since detection of *A. euteiches* is sometimes enhanced when *Pythium* spp. are inhibited.]

DAY 6. Flood samples by adding sterile, distilled water or 5 ppm metalaxyl solution to detect *P. megasperma* f. sp *medicaginis* or *A. euteiches* sample, respectively. Add three or four healthy, 4-10 day-old whole alfalfa seedlings to each petri dish.

DAY 8-11. Check daily for decay of seedlings. As they begin to decay, examine seedlings using a compound microscope. Return seedlings to soil sample until diagnosis is made. [For most soils, *P. megasperma* f. sp *medicaginis* and *A. euteiches* are readily detected within this time frame. If *A. euteiches* is present at very low levels, incubation for an even longer time in a metalaxyl solution may be required to detect it's presence.]

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We thank Craig Grau for critically reviewing the manuscript.

Cooperative Extension Service

report on

PLANT DISEASES

DEPARTMENT OF PLANT PATHOLOGY
UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN

RPD 614
(Revised 5/90)

COMMON VIRUS DISEASES OF ORCHIDS

M.C. Shurtleff and C. J. D'Arcy

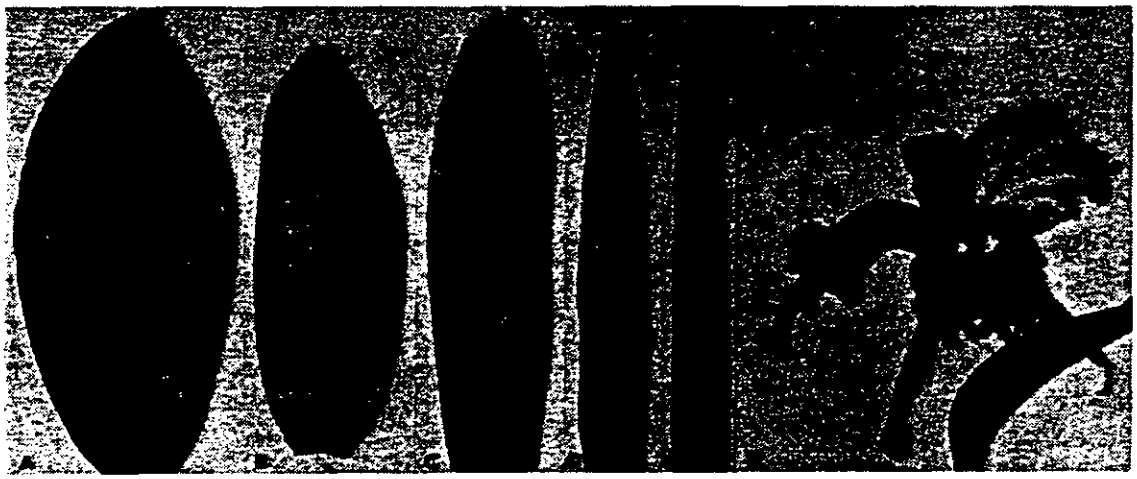

Fig. 1. Virus diseases of orchids. A. Ringspot symptoms occurring on the underside of a *Phalaenopsis* leaf infected with tobacco mosaic virus strain 06 and Cymbidium. B. *Cattleya* leaf infected by tobacco mosaic virus strain 03. C. Upper surface of a *Cattleya* leaf infected with *Cymbidium* mosaic virus. D. *Zygopetalum* leaf infected by cymbidium mosaic virus. E. *Cymbidium* leaf infected with tobacco mosaic strain 01 virus. F. *Cattleya* flower with streaks or "breaks" in pigmentation and distortion in floral symmetry. Flower breaks in orchids are produced by several viruses. (Photograph courtesy of Dr. C.I. Kado, Dept. of Plant Pathology, University of California at Davis)

Most orchid genera are affected by one or more virus diseases. With the increasing importation and rapid exchange of plants by both commercial and amateur growers, the introduction and spread of viruses among orchid plants in a grower's or florist's greenhouse is highly probable. Virus-infected plants bloom less efficiently, lack vigor, and produce flowers of lesser quality than healthy plants. The introduction of virus-infected stock not only costs the grower and florist in terms of greenhouse space, but also presents a dangerous virus reservoir that may serve to contaminate other orchid plants and seedlings.

The efficient control of orchid virus diseases depends on rapid and accurate diagnosis, followed by the destruction of diseased plants. The symptoms produced by orchid viruses depend on the particular viruses and strains involved; the hybrid, species, and genera of orchids infected; the age of the leaves; the time of year; and the environmental conditions. The same virus may cause widely different symptoms

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on different genera, e.g., a flower breaking on the blossoms of one genus, a bar mottle or other symptoms on another genus. Virus-like symptoms also may be produced by thrips on *Vanda* and by scales and mites feeding on *Cymbidium* leaves. Abnormal nutrition and fungal infections also produce virus-like symptoms.

Symptoms in flowers may also be mistaken for those caused by a virus. Aphids and thrips have been reported to damage *Cymbidium* and *Vanda* flowers, respectively. Thrips injury is very similar to a virus disease in *Vanda* orchids.

Some virus-infected plants may show NO symptoms. Such symptomless plants are excellent virus "carriers" for they go unnoticed in the greenhouse. Under adverse conditions, these symptomless plants may develop strong symptoms.

Virus symptoms also may vary between plants that are grown under different conditions. Plants infected with more than one virus also express variable symptoms.

Growers should be familiar with the common orchid virus diseases. Much worry can be overcome by isolating suspect plants and employing stringent control measures. These factors make the diagnosis of orchid diseases difficult.

SYMPTOMS

1. LEAF NECROSIS, BLACK STREAK. Leaf necrosis, caused by the cymbidium mosaic virus, is probably the most common virus disease of many kinds of orchids. Infected plants have irregular, brown-to-black, elongated spots and streaks of dead tissue on both surfaces of older leaves (Figure 1C and 1D). Infected leaves that show symptoms tend to age quickly and dry up. Flowers from such plants are usually symptomless, but they may open in an unthrifty manner. If the leaves die prematurely, the flowers are usually fewer in number and of smaller size. Diseased plants are usually less vigorous; however, not all infected plants show symptoms. Spread of the virus is usually via contaminated pruning tools. No insect vector is known.

   Leaf necrosis affects *Cattleya* and its hybrids as well as many species of *Angraceum*, *Cymbidium*, *Epidendrum*, *Laelia*, *Oncidium*, *Spathoglottis*, and *Zygopetalum*.

   Certain strains of the tobacco mosaic virus also produce leaf necrosis on *Cattleya* (Figure 1B), *Cymbidium* (Figure 1E), and other orchids that closely resembles symptoms produced by the cymbidium mosaic virus.

2. MILD FLOWER BREAK. This is caused by a strain of tobacco mosaic virus. Mild flower breaking is much more common in *Cattleya* than is severe flower breaking. Affected plants have much less variegation in the flowers than plants infected with severe flower break. The flowers are not malformed, and the leaves have only mild mosaic symptoms. The means of transmission of this virus is unknown.

   Mild flower breaking has been reported on about 30 species and hybrids of *Cattleya*. This virus also produces spots and rings of dead tissue on the leaves of *Odontoglossum* and diamond mottle on *Cattleya*, *Cymbidium*, *Odontoglossum*, and *Phalaenopsis*. Diamond mottle is distinguished by elongate chlorotic areas that are often diamond-shaped. Older leaves sometimes develop brown to black flecks and streaks.

3. SEVERE FLOWER BREAK. This conspicuous virus disease of *Cattleya* and its hybrids is characterized by rolling and twisting of the sepals and petals and variegation in the flowers (Figure 1F). The normal pigment of the petals, sepals, and petioles is replaced by irregular streaks, blotches, ring and line patterns which are either more or less intense than the normal color. Leaves that develop after infection are sometimes twisted and mottled with streaks of light and dark green. (Leaves formed earlier may be symptomless.) The dark-green areas are somewhat raised, producing ridges and bumps. The severe flower-breaking virus is transmitted by the green peach aphid (*Myzus persicae*), by grafting, or by juice inoculation. The time between the infection of the flower buds and the expression of flower-breaking symptoms ranges from 12 to 19 days. If conditions are right, the time needed for leaf infections to appear in plants inoculated through the flower buds varies from 2-1/2 to 4-1/2 months.

   In addition to *Cattleya* and its hybrids, the severe flower break virus infects *Cymbidium* and *Oncidium* and possibly other genera. In *Cymbidium*, the symptoms consist of numerous, severely chlorotic, rectangular areas on the leaves, giving the disease the name "Bar mottle."

4. SYMMETRICAL FLOWER BREAK. In addition to severe and mild flower streaking, where the variegation is irregular, a symmetrical variegation occurs in *Cattleya*. The pigment occurs along the sepal margins and over most of the petals except in middle areas that have little or no pigment. The leaves develop an inconspicuous mottle. The means by which the virus causing symmetrical flower break disease is transmitted in the greenhouse is unknown, but it can be experimentally transmitted by juice inoculation.

5. BLOSSOM NECROTIC STREAK. A strain of cymbidium mosaic virus causes latent streaks or spots on orchid blossoms. The blossoms first appear symptomless but brown (necrotic) spots and streaks become visible after one or more weeks. Delay in the appearance of flower symptoms after the blossoms open creates a problem for growers who sell their blooms. Infected flowers may develop necrotic symptoms 3 to 5 days after they are cut from the plant. Long, yellowish, irregular streaks may develop in the leaves. Transmission of this strain of cymbidium mosaic virus occurs on contaminated pruning tools. *Cattleya* and its hybrids are affected, plus species of *Angraceum*, *Cymbidium*, *Epidendrum*, *Laelia*, *Oncidium*, *Spathoglottis*, and *Zygopetalum*.

6. RINGSPOT. Cymbidium ringspot virus also causes single or concentric ringspot patterns on old and young leaves. The rings may later be brown to purple-black and enclose a central light green or yellow "island." Rings may overlap or merge to form large compound patterns. Ringspot may cause death of young shoots and often of the entire plant. Species of *Cattleya*, *Cymbidium*, *Spathoglottis*, and *Trichosma* are affected.

   Ringspot symptoms may also result from double virus infections such as a strain of tobacco mosaic virus and cymbidium mosaic virus (Figure 1A).

VIRUS INDEXING

Under certain conditions, some diseased orchid plants do not show distinct symptoms and control measures cannot be effectively carried out. In such instances, a simple

diagnostic test is required to determine whether a plant is infected with a virus or whether symptoms are due to other causes. Biological tests can be performed on young indicator plants outside the Orchidaceae[1]. Useful indicator plants include Coffee senna (*Cassia occidentalis*), Jimson-weed (*Datura stramonium*), Globe-amaranth (*Gomphrena globosa*), and *Chenopodium amaranticolor*. These tests are called indexing. They provide a means of detecting mild flower break, leaf necrosis, and other viruses.

CONTROL

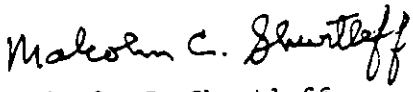
Cultural practices offer the most effective means of control.

1. EXCLUDE AND ERADICATE DISEASED PLANTS. Prompt removal and burning (or burying) all infected plants is an excellent control measure. Once virus-infected, plants NEVER recover although symptoms may disappear at least temporarily. Economically, it may be necessary to first destroy only poorly producing plants and those showing flower breaking. Other infected plants should be removed and isolated, preferably in a separate greenhouse section since they might serve as a source of infection to other plants. Seedlings from older or newly traded and purchased plants should be isolated until known to be virus-free.

2. START WITH VIRUS-FREE PROPAGATING STOCK AND SEEDLINGS. Care should be taken when securing plants to ensure that they are virus-free. Seedlings can be considered free of viruses since these disease agents are NOT known to invade orchid seed. Virus-free meristematic tissue can be removed from diseased plants and cultured. This technique is time-consuming and expensive to set up, but can be undertaken to save valuable stock.

3. STRINGENT SANITARY MEASURES ARE NEEDED. When pruning, dividing, or harvesting flowers, sterilize tools after EACH plant. Tools can be dipped in 70 percent rubbing alcohol and then flamed or soaked for 20 to 30 seconds in liquid household bleach (Clorox, Purex, or Sunny Sol) solution, using 1 part of bleach in 5 parts of water. All fragments of plant material should be wiped off the knife. When the solution turns green from plant juices, discard it and make up a fresh solution. Use clean pots and new potting media. Avoid handling plants except when necessary. Carefully wash hands with soap and hot, running water after handling diseased plants and tools. Keep down all weeds around growing orchids. They may harbor one or more viruses.

4. SPRAY OR FUMIGATE REGULARLY TO CONTROL VIRUS-CARRYING INSECTS. Timely applications of recommended insecticides will control aphids, thrips, scales, and other insects. Insect feeding is known to damage flower buds and leaves. Follow the current suggestions of the University of Illinois Extension Entomologists.



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Extension Plant Pathologist

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Cooperative Extension Service

PLANT DISEASES

DEPARTMENT OF PLANT PATHOLOGY
UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN

RPD No. 1008
(Revised 10/89)

SCLEROTINIA DISEASE, WHITE MOLD OR WATERY SOFT ROT

M.C. Shurtleff and G.S. Abawi

Sclerotinia disease (also known as white mold, watery soft rot and cottony rot) is caused by three fungi in the genus *Sclerotinia: S. sclerotiorum*, *S. minor*, and *S. trifoliorum*. These fungi attack over 370 species of plants in 64 plant families (Table 1).

These widespread fungi infect plants grown outdoors and in greenhouses throughout the United States. Sclerotinia disease is most serious in the cool, wet regions of the world.

Depending on the crop or weed host, the *Sclerotinia* fungi can cause a blighting or rotting of any above- or below-ground part of the plant (Figures 1-10). Initially, disease outbreaks are usually patchy and spasmodic. But if favorable temperature and moisture conditions prevail during the growing season, the incidence of the disease can be high and its development can be extensive.

In addition to direct losses in the field, detection of a very small percentage of diseased beans, carrots, peas, pumpkins, or other vegetables in a truckload at the processing plant may result in rejection of the whole load. Even a low incidence of this disease may lower the grade or raise the cost of processing.

Sclerotinia disease generally becomes most prevalent in areas where the plant population is high, vegetative growth is dense, air movement is restricted, and the soil is quite wet for an extended period.

Fig. 1. Sclerotinia stem rot and wilt of larkspur. (Illinois Natural History Survey photograph.)

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Fig. 2. Sclerotinia wilt and stem rot of larkspur. Sclerotia of the causal fungus have formed in the stem pith of the two plants on the left, and on the outside of the crown of the plant at the right. (Illinois Natural History Survey photograph.)

Fig. 3. A lettuce head infected with *Sclerotinia*, showing symptoms of watery soft rot.

Fig. 4. Wilting of leaves, canker formation, and dieback associated with Sclerotinia wilt and stem rot of larkspur. (Illinois Natural History Survey photograph.)

Fig. 5. Sclerotinia stem cankers on a peony shoot. (Illinois Natural History Survey photograph.)

Fig. 6. Sclerotinia stem rot of soybeans. Note the sclerotia on the surface of the stems.

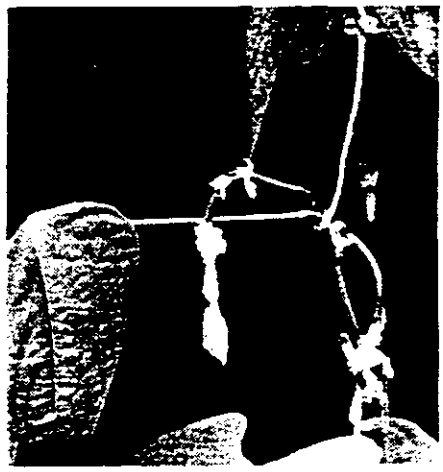

Fig. 7. Blossom blight of snap bean caused by *Sclerotinia sclerotiorum*.

Table 1. Plants Susceptible to *Sclerotinia sclerotiorum*[a]

Aconite
Acrodium
Alfalfa or lucerne
Alkanet
Almond
Amaranthus
Anemone (poppy)
Angelica
Anise
Apple
Apple-of-Peru
Apricot
Artichoke
Asparagus
Asphodel
Aster
Avocado
Babysbreath
Bachelors-button
Banana (Cavendish, common)
Barberry
Barley
Basil
Bean (Adzuki, black gram, civet, kidney, or dwarf, lima, mung, scarlet, runner)
Bedstraw (Catchweed)
Beet (garden, sugar)
Begonia
Bellflower (chimney and willow)
Birdsfoot-trefoil
Bittercress
Black-salsify
Bleedingheart
Bluebells
Bristlegrass (green)
Broadbean or vetch
Broccoli
Broomrape
Brussels sprout
Buckhorn
Buckwheat
Burclover or toothed medic
Buttercup (Persian, wild)
Butterfly-flower
Cabbage
Calendula
Camellia
Candytuft
Cantaloupe
Canterbury-bell
Cape-gooseberry
Cape-marigold
Caraway
Carnation
Carrot
Castorbean
Cauliflower
Celeriac
Celery
Chamomile
Charlock
Chickpea or garbanzo bean
Chickweed (common)
Chicory
China-aster
Chinese cabbage
Chinese gooseberry
Chokeberry (red)
Chrysanthemum
Cineraria (florists')
Citron
Clover (alsike, crimson, Egyptian, holy, least hop, red, sierra, subterranean, white, zigzag)
Cockscomb
Columbine
Colza
Coriander
Cornflower
Corn salad
Cosmos (common)
Cow-parsnip
Cowpea or black-eyed pea
Crabapple
Crabgrass
Crownvetch
Cryptomeria
Cucumber
Cynoglossum
Cypress or white-cedar (lawson)
Dahlia
Daisy (African, English, oxeye, Shasta, Swan river, Transvaal)
Dandelion (common, Russian)
Deadnettle (red)
Delphinium
Dill
Dock (yellow or curled)
Dutchman's-pipe
Eggplant
Endive
Escarole
Eucalyptus or gum
Euonymus
Evening-primrose
False-dragonhead
Fennel
Fenugreek
Fig (cultivated, magnolia-leaf)
Fireweed
Firewheel
Flax (common, flowering)
Forget-me-not
Forsythia
Foxglove
Freesia
Fuchsia
Gaillardia
Galinsoga (small-flowered)
Garden cress
Garlic
Gayfeather
Gazania
Gentian
Geranium (fish, florists')
Gerbera
Gherkin (West Indian)
Ginseng (American)
Gladiolus
Globeflower
Gloxinia
Goldenbell
Goldenglow
Goldenrod
Gourd (yellow-flowered)
Goutweed
Granadilla (purple-flowered)
Grape (European wine)
Grapefruit
Groundnut or wildbean
Groundsel (ragwort)
Guayule
Hebe
Hedgemustard (tall)
Hemp
Henbane
Heuchera
Hibiscus (Chinese)
Hollyhock (Antwerp, common)
Hop (common or European)
Horsechestnut
Horseradish
Houndstongue
Hyacinth
Hydrangea
Iris (English, German, Siberian)
Jamaica sorrel
Jerusalem-artichoke
Jute
Kale
Kale (tree)
Kenaf
Kohlrabi
Lambsquarter (common)
Larch (Japanese)
Larkspur (bouquet, candle, garland, rocket)
Lawson cypress
Lemon
Lentil
Lettuce (head, leaf, prickly Romaine)
Lilac (common)
Lily (Easter, Madonna)
Lime
Lobelia (edging)
Lotus species
Lupine (blue, European blue, sundial, Washington)
Malvaviscus
Mangel
Marigold
Matilija-poppy
Medic (black)
Milk-thistle
Milkvetch
Milkweed
Monarch of the veld
Monkshood (azure)
Mountain-bluet
Mouse-ear cress
Mulberry (white)
Mullein (moth)
Muskmelon
Mustard (black, leaf, white, wild)
Myoporum
Narcissus
Nasturtium (garden, wild)
Nemesia
Nettle
New Zealand spinach
Nightshade (beaked or buffalo-bur, silverleaf)
Oak
Oats
Okra
Onion
Orange (common or sweet, Mandarin, sour or Seville)
Pak-choi
Pansy
Parsley
Parsnip
Papaw
Pea (field, garden)
Peach
Peanut
Pear
Pelargonium
Pennycress (field)
Peony
Pepper (chili, red or sweet)
Peppergrass
Peppermint
Periwinkle (common, Madagascar)
Pe-tsai
Petunia (garden,wild)
Phlox
Pigeonpea
Pigweed (rough, redroot)
Pine (Japanese red)
Plantain (broadleaf)
Plum (American, garden or prune)
Poinsettia
Poison-hemlock
Poppy (California, opium, wild)
Potato
Primrose
Proboscis flower
Pummelo
Pumpkin
Pursland (common)
Pyrethrum (common, dalmatian)

Quickweed
Radish (garden, wild)
Ragweed
Rape
Rape (bird)
Raspberry (red)
Rhubarb
Rice
Rocket-salad
Rock melon
Rose
Roselle
Rutabaga (swede)
Rye
Safflower
Sage
Salsify
Scabious (sweet)
Shepherds-purse
Slipperwort
Snapdragon
Soybean
Sowthistle
Spiderflower
Spikenard
Spinach
Spurge (thyme-leaved, toothed)
Squash (summer, winter)
Stephanotis
Stock (common, intermediate)
Strawberry
Strawflower
Sugar-apple
Sunflower
Sunn-hemp
Sweet alyssum
Sweetclover (annual yellow, yellow, white)
Sweetpea
Sweetpotato
Sweet sultan
Swiss chard
Tansymustard
Teasel (common, Fuller's)
Thistles
Tickseed
Toadflax
Tobacco (common, flowering, wild)
Tomato
Tree-tomato
Tulip
Turnip
Udo
Valerian (common or garden-heliotrope)
Vetch (common, hairy)
Wallflower
Watercress
Watermelon
Wheat
Wildginger
Wintercress
Yardlongbean
Yellow rocket
Zinnia

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*Much of the host range of *Sclerotinia sclerotiorum* was compiled from a literature search (1938-1974) by Dr. Howard F. Schwartz.

SIGNS AND SYMPTOMS

The first symptom of the disease is a brown lesion shortly followed by a characteristic fluffy, white growth (mycelium) of the *Sclerotinia* fungus on infected host plants. Resting bodies (globular, flattened, elongated, or irregular in shape) called sclerotia are produced in the white mycelial growth. The sclerotia are white at first, but later become hard and black and are usually about 1/16 to 1/2 of an inch (2 to 10 millimeters) in diameter (Figures 2, 6, 10, 11, and 12). Droplets of water are often present on young sclerotia. In the later stages of the disease the fluffy mycelial growth may disappear but the black sclerotia are still visible either inside the stems of affected plants or on the surface of the lesions.

Symptoms vary according to the type of plant tissue involved. Leaves, stems, fruits, and storage organs may all be attacked.

STEM AND CROWN (COLLAR) ROT, WILT (e.g., ASTER, BEGONIA, CABBAGE, COLUMBINE, DAHLIA, DELPHINIUM, LARKSPUR, LETTUCE, PEONY, POTATO, SNAPDRAGON, STRAWBERRY, TOMATO). Pale or dark brown and water-soaked areas or cankers (lesions) usually develop on the stem at or near the soil line. Under cool and moist conditions, the lesions on the stem become quickly covered by cottony webs of mycelium (Figure 3). The lesions continue to enlarge and may completely girdle the stem. Infected plants may not show symptoms other than the lesions during the early stages of infection. Symptoms at later stages of infection may include a slow or rapid wilting, withering, and death of the foliage beyond the lesion (Figures 1, 4, and 5) which may result in wilting and the collapse of the plant. Infection may also occur through the blossom, leaf, or petiole, then progressing into the stem. Sclerotia are formed internally in the stem pith or on the outside of the stem.

LEAF AND PETIOLE ROT, FLOWER OR BLOSSOM BLIGHT (e.g., BEAN, BEET, CABBAGE, CAULIFLOWER, CELERY, CHRYSANTHEMUM, ENDIVE, LETTUCE, STEPHANOTIS). The leaves and petioles of such plants as beet, cabbage, cauliflower, celery, Chinese cabbage, endive, and lettuce suddenly collapse (drop) following infection of the oldest leaves and stem base (Figure 3). A slimy, wet, bacterial rot usually follows (caused by species of *Pseudomonas*, *Erwinia carotovora*, or both). The dense, cottony mycelium and sclerotia of the fungus are often visible on the lower surface of the outer infected leaves.

In celery and celeriac, a characteristic area that is pink to reddish brown and water-soaked develops at the base of the affected petioles. This is often followed by the production of an abundant cottony mycelium. When infection is severe, the entire plant may collapse.

In some plants (such as garden beans, soybeans, and stephanotis), symptoms often become visible about a week after flowering. This happens because the blossoms are generally the first part of the host to become colonized by the fungus (Figure 7). The leaves, petioles, stems, and pods that are in contact with the invaded blossoms can then become infected when moisture is present (Figure 8).

Fig. 8. Rot on a snap bean leaf. Infection started when an infected blossom fell on the leaf.

Diseased tissue is pale and water-soaked at first. The enlarging lesions become covered with the white, cottony mycelium. Within a few days, the leaves of severely diseased plants gradually turn yellow, then brown, and drop early. As the disease progresses, infected plants wilt. if the disease continues to progress, all plant parts that are above the ground may be killed.

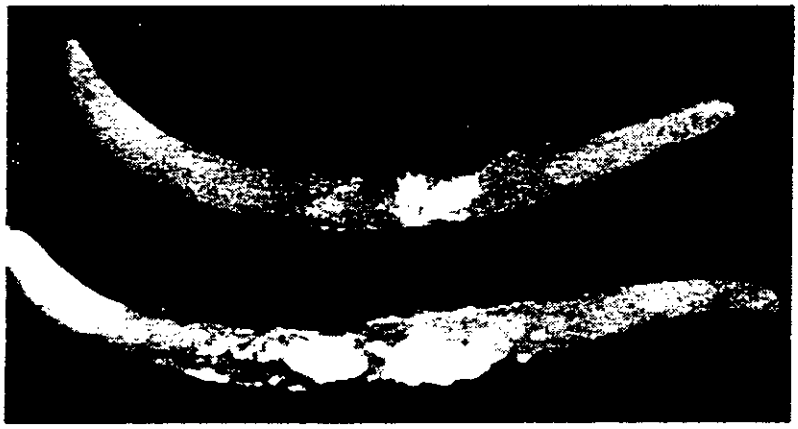

Fig.9. Snap bean pods infect by *Sclerotinia sclerotiorum* showing symptoms of watery soft rot.

Flower or blossom blight begins as small, tan to light brown spots in the petals. In wet weather, the spots rapidly enlarge and merge, blighting the entire petal. Eventually, the whole flower may become a dark brown; and when moist, covered with abundant, white mycelium (Figure 7). The fungus may grow from the blossom into the adjoining fruit, shoot, or twig and kill them for some distance (fruit, shoot, or twig blight).

FRUIT ROT (e.g., BEAN, CUCUMBER, EGGPLANT, MUSKMELON, PEA, SQUASH). The tips of pods and other fruits growing on or near the soil may become infected and start to rot, although infection commonly spreads from diseased flower parts. Eventually, a wet rot results in complete decay. The white mycelium and black sclerotia are usually evident externally as well as within diseased pods and fruits.

ROT OF FLESH STORAGE ORGANS (e.g., BEAN, BLEEDINGHEART, CABBAGE, CARROT, CELERY, PUMPKIN, SQUASH). The typical white, cottony growth develops on any part of the plant in the field, in transit, or in storage (Figure 9). The sclerotia form externally (Figure 10). In stored plant parts, a secondary spread occurs from a single infected root,

Fig. 10. A carrot infected with white mold or watery soft rot. Note the clusters of black sclerotia on the surface.

bulb, rhizome, or tuber which can produce cottony pockets or "nests" of rotted storage organs. Diseased tissue tends to collapse and produces a dark, watery, soft rot that is colonized by secondary bacteria (usually species of *Pseudomonas* and *Erwinia*).

DAMPING-OFF OR BED ROT (e.g., CELERY, CELERIAC, ENDIVE, LETTUCE, STOCK, TOBACCO). Patches of seedlings wilt and collapse from a water-soaked rot at or near the soil line. The typical cottony mold growth is sometimes evident on the soil surface. Seedlings may also rot before emergence resulting in poor, patchy stands.

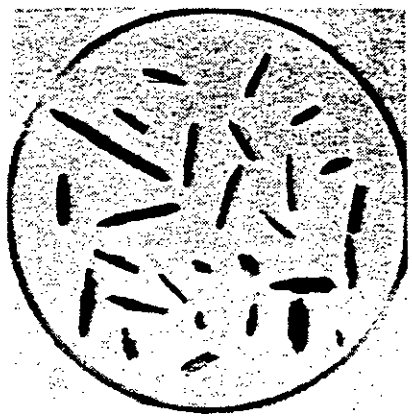

Fig. 11. Sclerotia of *Sclerotinia sclerotiorum* taken from within a rotted peony stem. These hard, black bodies serve to carry the fungus through unfavorable conditions. (Illinois Natural History Survey photograph.)

DISEASE CYCLE (Figure 12)

The *Sclerotinia* fungi survive between crop seasons as sclerotia in or on the soil. The sclerotia have a black rind and a dense gray center thus distinguishing them from seeds. After they mature, the sclerotia become dry and fall to the soil surface or remain within diseased plant tissue. The sclerotia are distributed between fields on plant material, by machinery and vehicles, animals, flowing water, and with seeds. Sclerotia that overseason on the surface or in the top inch or two of the soil germinate, usually in the spring or early summer, at temperatures of 40° to 85°F (4.4° to 29.4°C).

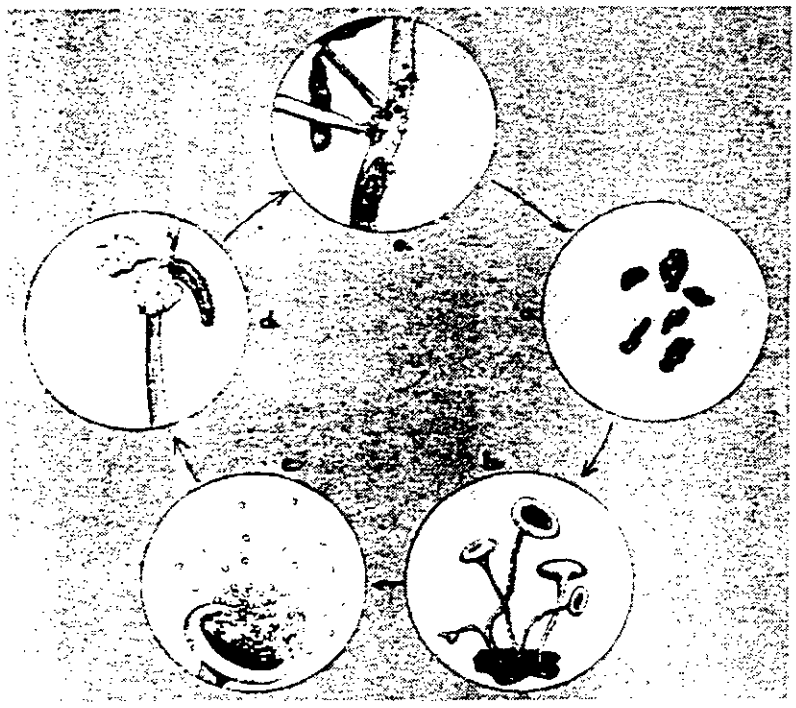

Fig. 12. Disease cycle of *Sclerotinia sclerotiorum*. The fungus survives in or on soil and crop debris as black sclerotia *(a)*. The sclerotia germinate to form trumpetlike apothecia *(b)* which discharge large numbers of ascospores *(c)*. The microscopic spores are blown to susceptible plants where infection occurs that results in white, cottony fungal growth *(d)*. Sclerotia later form in the cottony mycelial growth, both on and in infected tissues *(e)*, thus completing the disease cycle.

The optimum range is 55° to 60°F (12.7° to 15.5°C). Germination results in one to many slender stalks that terminate in small (1/4 to 1/2 of an inch), disc- or trumpet-shaped structures called apothecia.

The pale, brownish yellow apothecia appear on or just above the soil surface following a damp period when the soil remains wet (between saturation and field capacity) for about 10 days. When mature, the apothecia forcibly discharge large numbers of microscopic spores (ascospores) into the air as a cloud to a distance of 1 to 2 centimeters for a period of 2 or 3 weeks.

The ascospores are blown about by air currents up to a mile or more. Some of the sticky spores land on susceptible plant parts. If a film of water is maintained for 48 to 72 hours on host

tissues, the spores germinate and invade the host tissue at temperatures of 40° to 85°F (4.4° to 29.4°C). The optimum range is 68° to 76°F (20° to 24.4°C). White, cottony fungal growth develops in and on the infected tissues within a few days. The production of sclerotia becomes evident in about 10 to 14 days, thus completing the disease cycle (Figure 12).

The sclerotia of the *Sclerotinia* fungi can also undergo a hyphal, or eruptive, mycelial germination. Hyphal germination is characterized by the production of a few short hyphal strands. These can colonize dying and dead plant materials that come in contact with them. Using the colonized material as an energy source, the fungus can then invade healthy host tissue. Eruptive mycelial germination is characterized by the production of a massive and dense mycelium that can directly infect healthy host tissue. In either case, more sclerotia are produced within a few days after infection, thus completing the cycle.

Research in New York has resulted in accurate monitoring of environmental conditions favorable to the production of apothecia combined with scouting for apothecia. The system is based on daily measurements in the growing crop of rainfall, tensiometer readings, and blossom development stage. Such a system permits snap bean growers to make fungicide applications only when needed. For more information obtain a copy of IPM Circular No. 105, Snap Bean Pest Management. A Guide to Regular Field Monitoring in New York, Cornell Cooperative Extension Office, Cornell University, Ithaca, NY 14850.

CONTROL

1. Pasteurize the soil in greenhouses and plant beds using steam (180°F or 82°C for 30 minutes or 160°F or 71°C for an hour at the coolest spot). Where only a small patch of plants is infected in an outdoor bed, drench moist soil with formaldehyde. Mix 1 pint of 38- to 40-percent commercial formaldehyde in 6 gallons of water. Apply slowly using a watering can, 1/2 gallon per square foot of bed. After the treatment, cover the soil with canvas or plastic for 48 hours to hold in the fumes. After 2 to 4 days, remove the cover, work the soil, and plant when all odor is gone. WARNING: Do NOT use formaldehyde in a greenhouse where plants are growing. Formaldehyde is irritating to the skin, eyes, nose, and mouth. Wear protective gloves and a respirator when handling the commercial concentrate. Avoid inhaling the fumes. Wash the chemical from the skin or eyes immediately.

   Once partial sterilization is completed, every precaution must be taken to avoid recontamination of the soil by introducing sclerotia on dirty boots or uncleaned tools and farm equipment.

2. Plant in well-prepared, well-drained soil on raised ridges or beds. Where feasible, cultivate the soil around the stems so it will dry rapidly. If mulching with an organic material is needed, avoid contact with the stems. Manure should also be kept away from the crowns of plants where stem rot is a problem.

3. In a small flower or vegetable garden, lighten heavy clayey topsoil by blending in sand, peatmoss, or well-decomposed organic matter; or replace the top inch or more of heavy topsoil with sand. Removing the infested soil and replacing it with new soil before seeding or setting out other plants in the vacant spot is another alternative.

4. Make every effort to prevent the fungus from forming sclerotia that will later contaminate the soil. Wherever feasible, collect and remove all diseased plant material promptly when infection is first detected. This refuse should be burned immediately, far away from the growing crop. Do NOT place the debris in a refuse dump or compost pile. The sclerotia can remain viable for 2 or 3 years, possibly longer.

5. Keep infested soils as weed-free as possible. Numerous common weeds are susceptible (Table 1), allowing the *Sclerotinia* fungi to build up to high levels in the soil in the absence of a susceptible crop plant.

6. Make a clean and deep plowdown of infested soil in gardens or fields immediately after harvest. This buries most of the sclerotia to a depth of several inches where they will decompose and cease to be a source of infection for future crops.

7. Place root and other crops in storage immediately after harvest. Dipping or spraying the produce with a suggested fungicide at the time of cleaning will often sharply reduce losses in harvest and storage. A fungicide should be used only when labeled. The manufacturer's directions should be carefully followed. Refer to University of Illinois Cooperative Extension Service Circular 1184, Disease Management Guide for Commercial Vegetable Growers, Illinois Extension Circular 1259, Plant Disease Control Guide: Flowers and Nonwoody Ornamentals, and Illinois Extension Circular 1260, Plant Disease Control Guide: Woody Ornamentals, as regards suggested fungicides. These publications are all revised annually and should be available at your county Extension office.

   The storage area should be clean, cool, and dry without free moisture on the walls, ceiling, or floor and with a humidity of 90 to 95% to prevent shriveling and shrinking. Store only fully mature, blemish-free plant material without bruises or cuts. The temperature should be as close to freezing as possible, while still maintaining good eating quality.

8. Follow other cultural practices that promote the drying of soil and plant surfaces. Wherever possible: (1) avoid small fields surrounded by dense woods that restrict air circulation; (2) plant row crops in the direction of prevailing winds; (3) avoid excessively high plant populations and narrow-row spacing; (4) rotate with nonsusceptible crops, such as corn, grasses, and cereals, for at least a year; (5) avoid excessive watering that would keep the soil near the saturation level for 10 days.

9. There is no cure for the disease once plants are infected. Where chemical control is needed, apply a suggested fungicide as a soil drench to ornamentals and certain vegetables before planting or apply to the base of established plants as new growth appears. Spray the stems and soil surface of ornamentals and certain vegetables at 1- to 4-week intervals during cool, rainy periods in spring and early summer. Suggested fungicides are listed in University of Illinois Cooperative Extension Service Circulars 1184, 1259, and 1260. The timing and placement of fungicide applications will vary with the crop.

   When using any fungicide, carefully follow the directions and precautions as printed on the container label. The application of fungicides is difficult. Foliar sprays require more or less complete coverage of all above-ground plant parts, especially within the plant canopy. Thorough coverage and the proper timing of the first spray are essential in obtaining effective control.

10. There is no known commercial plant resistance to these Sclerotinia fungi so control measures depend on disease avoidance. It is vital to reduce the population of sclerotia surviving from one crop to the next to the smallest possible number.

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Cooperative Extension Service

report on

PLANT DISEASES

DEPARTMENT OF PLANT PATHOLOGY
UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN

RPD No. 663
New 9/90

OAK LEAF BLISTER

M.C. Shurtleff and R.D. Neely

Leaf blister or leaf curl of oaks is caused by the fungus *Taphrina caerulescens*. This common disease occurs worldwide on about 50 species of oaks (*Quercus* spp.) mainly in the red and white oak groups. Ten species of oaks are known to become infected in the Midwest (Table 1). Red oak is especially susceptible.

In Illinois, the disease usually appears only during cool wet springs. Leaf blister seldom causes serious damage. Heavy infections of red and other oaks may be unsightly but does **not** endanger the life of the trees.

Fig. 1. Leaf blisters on a red oak leaf; *left*, upper surface and *right*, lower surface. (Courtesy Purdue University)

Scientists believe that the causal fungus is actually a group of biologically distinct organisms that have become specialized in the oak species which they infect.

The genus *Taphrina* is also responsible for leaf blisters or leaf curls on many plants (Table 2). The disease is only of economic importance on peaches, plums and cherries (see Report on Plant Diseases No. 805, "Peach Leaf Curl and Plum Pockets").

SYMPTOMS

In late spring or early summer, young partially grown leaves develop circular, raised, wrinkled, yellowish white spots on their upper surfaces with yellowish brown to gray depressions of the same size on the corresponding lower surfaces (Figure 1). The blisters are 3 to 30 millimeters in diameter and scattered over the leaf surface.

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Fig. 2. Leaf blister is conspicuous due to the raised and wrinkled appearance of the diseased areas which turn brownish with age. (Illinois Natural History Survey photograph)

The lesions later turn reddish brown with pale yellow margins and finally become a dull brown with age. Several blisters may merge which involve much or all of a leaf causing it to curl (Figure 2). Severe disease may cause some premature defoliation.

DISEASE CYCLE

In the Midwest the *Taphrina* fungus overwinters as microscopic ascospores lodged under the bud scales. The spores germinate in the spring as the buds break open and the young leaves are expanding. The germ tubes of the spores penetrate young leaves directly through the cuticle. The resulting hyphae grow intercellularly mainly between the epidermal cells. A layer of asci forms in late spring or early summer between the outer epidermal wall and the cuticle. The asci, which contain the ascospores, push through the cuticle and rupture releasing tremendous numbers of ascospores (Figure 3). The expelled spores cover the surfaces of the blisters giving them a white to light tan, powdery appearance. The spores are spread about by air currents, splashing rains and insects to the buds, where they become lodged under the bud scales, thus completing the disease cycle.

The causal fungus may occasionally cause one or more secondary cycles of disease when buds open unseasonably in late spring or summer. Mature leaves are resistant to infection.

In the southern states the *Taphrina* fungus overwinters as resting ascospores on the buds, twigs and branches of oaks. The disease is more common and severe in the southeastern and Gulf states, especially on the southern red oak, than it is in the Midwest, perhaps because populations of ascospores remain higher throughout the winter.

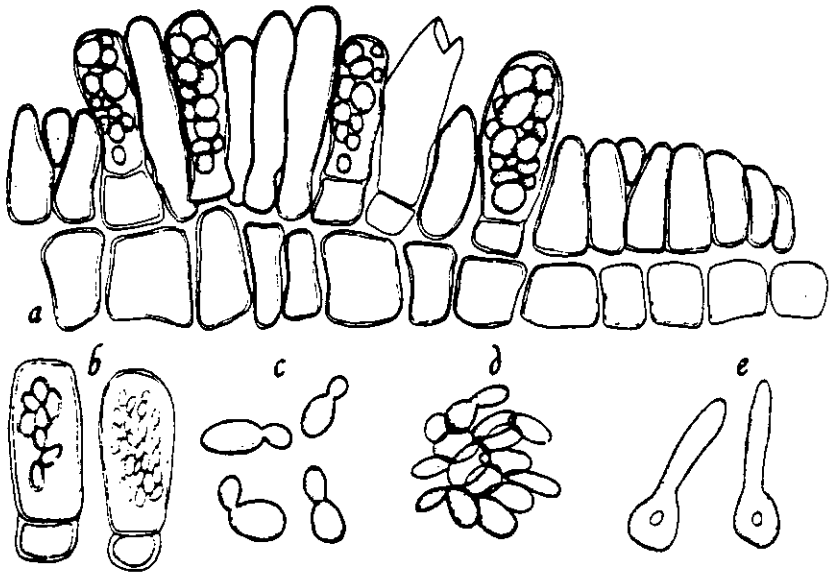

Fig. 3. *Taphrina caerulescens*, the cause of leaf blister or leaf curl of oaks, as it would be seen under a high-power microscope: (*a*) vertical section of the upper surface of an oak leaf showing a layer of epidermal cells and a compact, palisade layer of asci, some containing ascospores, which have ruptured the leaf cuticle; (*b*) two asci, one with 8 ascospores, the other in which the ascospores are budding; (*c*) ascospores budding (forming secondary spores or conidia); (*d*) late budding of an ascospore; (*e*) two ascospores germinating.

CONTROL

1. Since this disease is much more unsightly than harmful to oak trees, no control measures are usually suggested.

2. Collecting and composting or burning the leaves as they drop may be of some benefit in reducing the inoculum for the following spring.

3. A single **dormant** fungicide spray, applied **before** the buds begin to swell in early spring, will control the disease but is not commonly recommended. Fungicide sprays applied **after** budbreak are ineffective. Suggested fungicides to use are given in University of Illinois Cooperative Extension Circular 1260, Plant Disease Control Guide: Woody Ornamentals. This circular is revised annually.

Table 1. Oaks grown in the Midwest which are susceptible to leaf blister caused by *Taphrina caerulescens*

Common name	Scientific name
White oak	*Quercus alba*
Scarlet oak	*Q. bushii*
Jack or northern pin oak	*Q. ellipsoidalis*
Laurel or single oak	*Q. imbricaria*
Bur or mossy-cup oak	*Q. macrocarpa*
Blackjack or jack oak	*Q. marilandica*
Pin or Spanish oak	*Q. palustris*
Chinquapin or dwarf chestnut oak	*Q. prinoides*
Post oak	*Q. stellata*
Black or yellow-barked oak	*Q. velutina*

Table 2. Other plants grown in the Midwest which are infected by species of *Taphrina* causing leaf blister, leaf curl (or other disease)

Common name	Scientific name	Taphrina species
River, silver or soft maple	*Acer saccharinum*	*T. carveri*
Red maple (black leaf blister)	*A. rubrum*	*T. dearnessii*
(leaf blight)	*A. rubrum*	*T. letifera*
Hard or sugar maple (brown leaf blister)	*A. saccharum*	*T. sacchari*
Four-speckled or white alder (catkin deformity)	*Alnus incana*	*T. robinsoniana*
Mountain or water birch (witches' broom)	*Betula occidentalis*	*T. americana*
Canoe, paper or white birch	*B. papyrifera*	*T. carnea*
(red leaf blister or leaf curl)	*B. papyrifera* var. *cordifolia*	*T. carnea*
American hornbeam	*Carpinus caroliniana*	*T. australis*
American filbert or hazelnut	*Corylus americana*	*T. coryli*
Brittle or fragile fern (leaf gall)	*Cystopteris fragilis*	*T. cystopteridis*
Fern, no common name (leaf gall)	*Matteuccia pensylvanica* = *Pteretis nodulosa*, *P. pensylvanica*	*T. hiratsuka*
American hophornbeam	*Ostrya virginiana*	*T. virginica*
Bigtooth or large-toothed aspen (catkin deformity)	*Populus grandifolia*	*T. johansonii*
Populus x *berolinensis*, *P. laurifolia* x *P. nigra* cv. 'italica'		*T. populina*
Black poplar	*Populus nigra*	*T. populina*

Table 2 (concluded)

Common name	Scientific name	Taphrina species
Black or Lombardy poplar	*P. nigra* cv. 'italica'	*T. populina*
	P. petrowskiana, *P. deltoides* x *P. laurifolia*	*T. populina*
Quaking or trembling aspen	*P. tremuloides*	*T. johansonii*
Tall cinquefoil	*Potentilla arguta*	*T. potentillae*
Common cinquefoil	*P. canadensis* = *P. pumila*	*T. potentillae*
Dwarf sumac	*Rhus copallina*	*T. purpurescens*
Skunkbush	*R. trilobata*	*T. purpurescens*
Marsh or meadow fern (leaf gall)	*Thelypteris palustris* = *Dryopteris thelypteris*, *T. thelypteris*	*T. lutescens*
American elm	*Ulmus americana*	*T. ulmi*
Cork or rock elm	*U. thomasii* = *U. racemosa*	*T. ulmi*
Red or slippery elm	*U. rubra* = *U. fulva*, *U. pubescens*	*T. ulmi*

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