

The American Phytopathological Society
NORTHEASTERN DIVISION

Annual Meeting

November 1 and 2, 1990

Cromwell, CT

ABSTRACTS

Alphabetized by first author's last name.

ALLEVIATION OF Mg DEFICIENCY INDUCED SYMPTOMS IN NORWAY SPRUCE. A. Adomowicz and J. M. Skelly, Department of Plant Pathology, Pennsylvania State University, University Park, PA 16802.

Yellowing of Norway spruce has been demonstrated to be related to Mg deficiency in several plantations of the NE. Three plantations were chosen for study and a specific forest fertilizer, Kieserite (27% MgO), was applied in late April 1989 at 3 rates, 0, 50, and 100 kg/ha. In addition, K₂O was applied in the most severely symptomatic plantation. Soil and needles were sampled in April 1989 (before treatment), and in June and November 1989 and again in June 1990. Trees were evaluated for defoliation and discoloration at each sampling. Soil concentrations of Mg had increased significantly ($p < .05$) over control plots within 2 months and remained high ($p < .05$) in June 1990. Needle Mg content was likewise increased in treated versus nontreated plots but significant ($p > .05$) differences were not noted. Discoloration and defoliation ratings were similarly improved across all plots at each time of sampling perhaps due to excessive rainfalls and natural increased Mg availability during the 1989 and 1990 growing seasons.

CONTROL OF PYTHIUM ROOT ROT IN GREENHOUSE GROWN CUCUMBERS WITH SOLUBLE SILICON AMENDMENTS. R. R. Bélanger, M. Chérif and J. Tremblay. Dép. de phytologie, Univ. Laval, Québec (Qc), Canada, G1K 7P4.

Two cultivars of long English cucumber, Marillo and Corona, were grown in a NFT system with nutrient solutions amended with 0 (controls), 100, and 200 ppm soluble silicon. After two weeks, the nutrient solutions were inoculated with a virulent strain of Pythium ultimum. Throughout the growing season, fruit yield and size decreased steadily for the controls when compared to the treated plants. Control plants also showed early symptoms of wilting and senescence, and were more prone to insect attacks. At the end of the experiments, silicon treated plants had higher root dry weights and the only cases of mortality were observed on the control plants. Both cultivars responded similarly to the treatments. Investigations are underway to explain the mechanisms by which silicon provides protection against Pythium infections and disease development.

Frequency of infestation of Monochamus notatus and M. scutellatus by Bursaphelenchus xylophilus in Vermont. D. R. Bergdahl, S. Halik, J. Tomminen, and H. Akar, School of Natural Resources, UVM, Burlington, VT 05405

Adult Monochamus notatus (Mn) and M. scutellatus (Ms) were collected from two locations in central and northern Vermont from 6/4-9/1, 1988. On the day of collection, beetles were identified to sex, sectioned and placed in distilled water for 24 hrs to extract dauerlarvae (L_{IV}) of Bursaphelenchus xylophilus (Bx). There was no difference in frequency of infestation of Monochamus sp by Bx (Mn=51% and Ms=56%) but infested Ms carried a greater mean number of L_{IV} (5450 vs 595). Frequency of infestation was independent of sex for each beetle species and there was no difference in mean number of L_{IV} carried

between sexes within each species of Monochamus. Frequency of infestation of male Ms was dependent on time and the mean number of L_{IV} carried by male Ms appeared to decrease after the first month. There was no difference in frequency of infestation or mean number of L_{IV} carried for Ms females.

DEVELOPMENT OF AN ANTIBODY-BASED DIAGNOSTIC KIT TO MONITOR VENTURIA INAEQUALIS ASCOSPORES. L. P. Berkett, A. R. Gottlieb & J. A. Bergdahl, Dept. of Plant & Soil Sci., Univ. of Vermont, Burlington, VT 05405.

To efficiently schedule fungicide applications for apple scab, growers need to know when ascospores are mature and when environmental conditions fulfill infection requirements. Currently, apple growers can easily identify infection periods however, they have no practical way to evaluate the presence of mature ascospores or the potential for ascospore release during a wetting period. We have developed a system to monitor mature ascospores of V. inaequalis that combines 3 features: (1) maturation of ascospores under natural orchard conditions; (2) separation of mature ascospores and capture on an assay medium; and (3) detection of mature ascospores with an immunassay. The system was field tested in 1989. Individual ascospores were immunologically detected. Data were collected on the number of ascospores and other fungal spores released from leaf samples on 15 dates. The number of immunoreactions closely paralleled the number of mature ascospores collected.

SCREENING FOR PARTIAL RESISTANCE TO CROWN RUST Puccinia coronata RACE CR 13 IN 33 OAT CULTIVARS AND BREEDING LINES. S. C. Brière, A. C. Kushalappa, and D. E. Mather, Department of Plant Science, Macdonald College of McGill University, Ste. Anne de Bellevue Québec, Canada, H9X 1C0.

Nineteen cultivars and 14 oat (Avena sativa and A. nuda) breeding lines were sown over two growing seasons in 3.8 x 1.0 m plots with five rows. A hill in the centre of the plot was inoculated with a uredospore suspension of P. coronata race CR 13. Crown rust severity was visually estimated as the percent leaf area diseased at weekly intervals commencing at approximately Zadoks growth stage 37. The parameter used in the analysis was the cumulative proportion of leaf area diseased (CPLAD). An analysis of variance was conducted on the CPLAD value on each sampling date. Data was also submitted to principal component and cluster analyses to obtain specific groupings of cultivars and breeding lines, based on their levels of partial resistance. On the basis of the first year data, six cluster groupings were identified, one of which contained six cv/lines that denoted high levels of partial resistance.

VARIATION IN FEEDING DETERRENCE OF THE CORN LEAF APHID RELATED TO ACREMONIUM ENDOPHYTES IN GRASSES. R. J. Buckley, P. M. Halisky and J. P. Breen, Cook College, Rutgers Univ., New Brunswick, N.J. 08903

Populations of corn leaf aphid (CLA) were subjected to feeding trials on perennial ryegrass and tall fescue. Genetically identical clones of these grasses with (EI) and without (EF) endophyte in-

Camera-ready abstracts are published as they were submitted by the Division. The abstracts are not edited or typed in the APS headquarters office.

fection were tested to determine aphid feeding preference. The results indicated that, given a choice, CLA preferred feeding on EF ryegrass over plants infected with *Acremonium lolii*. In contrast, CLA feeding on tall fescue showed no preference between EF plants and those infected with *A. coenophialum*. These results suggest that some antifeedant component is associated with *A. lolii* but lacking from *A. coenophialum*. In N.J., the CLA is known to vector maize dwarf mosaic virus and barley yellow dwarf virus.

ACTION OF SIDEROPHORES FROM *GLOEOPHYLLUM TRABEUM* ON 2-KETO-4-THIOMETHYL BUTYRIC ACID AND CELLULOSE-AZURE SUBSTRATES. V. Chandhoke, J. Jellison, B. Goodell, and F. Fekete, Dept. of Forest Biology, University of Maine, Orono, ME 04469.

Experiments using purified siderophores from the brown-rot fungus *Gloeophyllum trabeum* suggest that these metabolites have the potential to carry out reactions involved in the process of lignocellulose degradation by wood decaying basidiomycetes. Purified siderophores were able to carry out one-electron oxidation of 2-keto-4-thiomethyl butyric acid (KTBA), the Haber-Weiss reaction. Reaction rate was influenced by siderophore, iron, manganese, oxalate concentration and by pH. Cleavage of cellulose azure in the presence of iron was shown to be directly correlated with siderophore concentration.

UTILIZATION OF MONOCLONAL ANTIBODIES AGAINST ELM YELLOW MYCOPLASMA-LIKE ORGANISMS IN DETECTION OF ELM YELLOW DISEASE. T. J. Chang and T. A. Chen, Department of Plant Pathology, Rutgers University, New Brunswick, NJ 08903.

Two monoclonal antibodies were generated against elm yellows MLO by using partially purified MLO preparations from diseased *Catharanthus roseus* (periwinkle) as antigen. ELISA results indicated both antibodies reacted with preparations from elm yellows infected periwinkle but not with preparations from healthy periwinkle. In immunofluorescence assays (FAs), using freshly prepared sections, one of the monoclonal antibodies reacted with antigens *in situ*. Using ELISA, both antibodies not only reacted with preparations of elm yellows MLO from infected elm trees but also cross reacted with diseased periwinkles infected with ash yellows. Western blotting has also been carried out to locate and characterize specific epitope(s) on both ash and elm yellows MLOs that reacted with our monoclonal antibodies.

PRODUCTION OF MONOCLONAL ANTIBODIES AGAINST THE BACTERIAL-LIKE ORGANISM ASSOCIATED WITH CITRUS GREENING DISEASE. K. H. Chen, S. Ke, and T. A. Chen. Dept. Plant Pathology, Rutgers University, New Brunswick, NJ 08903.

Specific monoclonal antibodies (MABs) were produced against a non-cultivable, phloem-limited bacterial-like organism (BLO) associated with citrus greening disease (CG). Three hybridomas were selected by ELISA; two from a Kwangtung strain and one from a Fujian strain, China. Using partially purified CG-BLO in PAGE, specific protein bands could be recognized in diseased but not in healthy plant preparations. All three MABs reacted positively with diseased plant but not with healthy plant materials on Western blots. There were at least two different epitopes on the Kwangtung strain and one of them was commonly shared with the Fujian strain and a strain from Taiwan. Immunogold Protein A staining in electron microscopy confirmed the results of ELISA and Western blots indicating that these geographic isolates were immunologically different. Other diagnostic methods such as DNA probes and *in situ* blots are now being developed.

RECOVERY OF *ERWINIA AMYLOVORA* FROM EXCISED INFECTED APPLE SHOOTS AND SUBSEQUENT DEVELOPMENT OF SYMPTOMS ON PRUNING STUBS IN THE ORCHARD AS INFLUENCED BY PRUNING METHODS. G. G. Clarke, K. D. Hickey, and J. W. Travis. Dept. of Plant Pathology, Penn State Univ., Univ. Park, PA 16802.

Trees from an orchard of 'Rome Beauty' apple with a long history of fire blight were used to study the effect of removing infected shoots by pruning at various distances from the infection site. A total of 700 shoots were pruned using seven combinations of pruning distances and disinfection methods. Pruned shoots were taken to the lab and assayed for the presence of *Erwinia amylovora* near the cut end. Pruning stubs in the orchard were monitored for development and progression of blight symptoms. When infected shoots were pruned at the base of visible symptoms 87% of the excised shoots assayed positive for *E. amylovora* while only 57% of the corresponding stubs in the orchard showed

visible progression of blight within 55 days. Pruning 8 to 10 inches below visible symptoms resulted in 21% positive *E. amylovora* assays and only 12% infected orchard stubs. When healthy shoots were cut with shears swabbed with virulent *E. amylovora* only 17% of the stubs developed blight symptoms.

SUMMER PRUNING REDUCES FLYSPECK OF APPLE. D. R. Cooley, W. A. Auto and J. Gamble. Dept. of Plant Pathology, Fernald Hall, Univ. of Massachusetts, Amherst, MA 01003

Flyspeck, caused by *Zygothia jamaicensis*, is a summer fungal disease of apples. While damage is primarily cosmetic, and disease pressure is generally low in New England, disease-incidence has increased significantly over the past 3 years. Part of this increase may be attributed to reductions in summer fungicide use and changes in the materials applied. As part of a program to develop sustainable apple production techniques, we wished to find alternatives to reinstating frequent summer fungicide applications. We examined the effect of summer pruning on flyspeck to see whether this recommended cultural practice could also reduce disease incidence. A block of 14 standard McIntosh trees were randomly assigned to 2 groups. One group was summer pruned, while the other was not. No summer fungicides were applied to either treatment. Significant differences occurred. Flyspeck in the summer pruned treatment was 9% compared to 18% in the controls. Of the infected fruit, the control fruit averaged 230 colonies/fruit, and pruned fruit averaged 57 colonies/fruit. Summer pruning could be a valuable cultural disease management tool, at least in areas where flyspeck pressure is low to moderate.

STRAWBERRY CULTIVARS SHOW DIFFERENTIAL FIELD-TOLERANCE TO BINUCLEATE *RHIZOCTONIA*. D. R. Cooley, W. J. Manning, D. J. Marchant and S. G. Schloemann. Dept. of Plant Pathology, Fernald Hall, Univ. of Massachusetts, Amherst, MA 01003

Binucleate *Rhizoctonia* (BR) spp. have been implicated as causal agents in black root rot of strawberry, a disease complex causing death of feeder rootlets resulting in reduced plant productivity and longevity. Cultivar (cv) response to black root rot has not been extensively investigated. We selected 10 commercial June-bearing strawberry cvs representing a range of maturity dates and genetic backgrounds to test their tolerance to a pathogenic isolate of BR (AG I). Randomized blocks were planted in a field which had no strawberry production history. Half of each plot was treated with oat/BR inoculum mixed in soil in the root zone at the time of planting in late June, and half was not inoculated. In mid-August plant survival was evaluated. Survival differences between inoculated and non-inoculated plots, and between cvs, were significant. 'Jewel', 'Earliglo', 'Blomindon' and 'Surecrop' showed the best survival in BR plots, while 'Midway', 'Red Chief', and 'Lester' showed the least. Evaluations of long-term effects on vigor and productivity will continue. These results suggest that cvs vary in their susceptibility to BR, and that it may be possible to use BR-tolerance to manage black root rot in strawberries.

ANTIBIOTIC PRODUCTION BY STRAINS OF *Erwinia herbicola* AND THEIR INTERACTIONS WITH *Erwinia amylovora* IN IMMATURE PEAR FRUITS. M. A. El-Goorani and S. V. Beer, Department of Plant Pathology, Cornell University, Ithaca, NY 14853.

Fifty-one of 301 authentic or putative strains of *Erwinia herbicola* (Eh) produced antibiotic(s) inhibitory to *E. amylovora*, strain Ea273. Thirty-seven antibiotic-producers fell into the following five groups according to the effect of amino acids on the sensitivity of Ea273 to the antibiotic(s): not inhibitory in presence of histidine (19 strains), arginine (3 strains), asparagine (5 strains), lysine (1 strain), little or no effect of casein hydrolysate (9 strains). Based on inhibition patterns of strains of Ea273 that initially exhibited resistance to one antibiotic, and other biological and physical criteria, several different antibiotics were produced by E.h. Ten strains from the first group suppressed fire blight symptoms more than 90% in immature pear fruits. One strain that does not produce antibiotic under the conditions used suppressed development about 80%. Strains from all groups that gave larger inhibition zones provided poor protection against Ea273. These results suggest that in addition to antibiosis other mechanisms also may be involved in disease reduction.

EFFECT OF NaCl APPLICATIONS ON ASPARAGUS FERN WATER POTENTIAL AND FUSARIUM CROWN AND ROOT ROT. W. H. Elmer, The Connecticut Agricultural Experiment Station, Box 1106, New Haven, CT 06504.

Using a pressure bomb in the greenhouse, fern water potential (WP) was measured on asparagus plants inoculated with both *Fusarium oxysporum* and *F. moniliforme*. All plants had received 100 ml of Hoagland's solution amended with 0, 1.0, 2.5, 5.0, or 10.0 g/l of NaCl twice a week for 3 mo before sampling began. Measurements recorded at predawn revealed that WP decreased linearly from -0.3 to -0.6 MPa as NaCl rate increased. Midday WP in plants grown without NaCl was significantly higher (-0.6 MPa) than in plants treated with NaCl (-1.2 to -1.5 MPa). Applying NaCl also suppressed root colonization by both *F. oxysporum* and *F. moniliforme*, and increased plant fresh weights. These findings agree with repeated field experiments that have shown rock salt applications lower fern WP, increase marketable yields and suppress *Fusarium* crown and root rot.

THE EFFECT OF DEFOLIATION DUE TO SEPTORIA LEAF SPOT ON TOMATO YIELD. Francis J. Ferrandino and Wade Elmer, The Connecticut Agricultural Experiment Station, Box 1106, New Haven, CT 06504.

In 1988 and 1989, tomatoes (cv. Better Boy) were planted in a 0.9 m X 0.9 m grid on black plastic. During the first week of July in each year, plots were infested with tomato residues colonized by *Septoria lycopersici*. Other plots sprayed weekly with Manzate 200 (2 lb A⁻¹) served as controls. The number of infected leaflets, the number of lesions/leaflet, defoliation, total leaf area and fruit yield were measured throughout the season. The early harvest of marketable fruit (prior to 20 August) was significantly greater in diseased plots than in sprayed controls, possibly due to plant stress, increased light penetration and/or increased fruit temperature caused by defoliation. The final cumulative yield from diseased plots varied from 40% to 95% of the yields obtained from healthy controls. Final yield was negatively correlated with AUDPC (1988: $r^2 = 0.64$; 1989: $r^2 = 0.79$) and positively correlated with cumulative healthy leaf area (1988: $r^2 = 0.76$; 1989: $r^2 = 0.93$) in both years.

REDUCTION OF THE INCIDENCE AND SEVERITY OF GRAPE POWDERY MILDEW BY *AMPELOMYCES QUISQUALIS*. David M. Gadoury, R.C. Pearson, and R.C. Seem, Dept. Plant Pathology, Cornell Univ., N.Y. State Agricultural Experiment Station, Geneva, 14456.

Ampelomyces quisqualis normally infects senescent colonies of *Uncinula necator* in late summer. Our objective was to introduce the mycoparasite earlier, at the start of an epidemic, and thereby reduce the rate of disease increase. Pycnidia of *A. quisqualis* were produced on cotton twine saturated with malt extract agar. The twine was suspended in the trellis above grapevines of *Vitis vinifera* 'Riesling' either when shoots were 15 cm long; at bloom; or at 15 cm of shoot growth and at bloom. Pycnidia of *A. quisqualis* survived in twine, and released conidia onto plants at the onset of rain, which was necessary for infection of mildew colonies. Release of conidia from pycnidia in twine continued for 3 months after placement of the twine in the trellis. Early infection by the mycoparasite was important in control of powdery mildew. The mean percentage of fruit surface infection was 38% on controls vs 12% on vines exposed to cultures at 15 cm of shoot growth. Delaying treatment until bloom resulted in no reduction of fruit infection. Treatment at bloom of vines previously treated at 15 cm of shoot growth did not reduce fruit infection below levels achieved by a single treatment at 15 cm of shoot growth.

ISOLATE-SPECIFIC RESISTANCE TO BARLEY YELLOW DWARF VIRUS IN SPRING OATS. S. M. Gray, D. M. Smith and M. E. Sorrells, USDA/ARS and Cornell University, Ithaca, NY 14853.

A breeding line of oats developed in Illinois (IL86-5262) and identified as resistant to barley yellow dwarf virus (BYDV) was tested using 5 distinct BYDV isolates in greenhouse and field studies. Virus titer was quantified by ELISA over 6 weeks and compared with titers in similarly treated plants of a resistant ('Ogle') and susceptible ('Astro') oat genotypes. In addition, the effects of the resistance on aphid transmission efficiency and disease epidemiology were examined. Relative to the susceptible genotypes, titers of the PAV, MAV and SGV isolates were suppressed in IL86-5262 by 30-50%. Titer of the RMV isolate was suppressed by 70-80%. There was no suppression of RPV titer. Vector transmission efficiency was reduced for RMV only. In field trials, final RMV incidence was zero in IL86-5262 test plots despite heavy aphid pressure. RMV incidence in 'Astro' and 'Ogle' plots was 42 and 90%, respectively. Final MAV incidence was similar for the 3 genotypes. These results emphasize the need to use multiple BYDV isolates when screening for resistance.

APHID TRANSMISSION OF SEROLOGICALLY SIMILAR BARLEY YELLOW DWARF VIRUS ISOLATES FROM NEW YORK AND MONTANA. D. Hazelwood, S. M. Gray, USDA/ARS, Cornell University, Ithaca, NY 14853, and T. W. Carroll, Montana State University, Bozeman, MT 59717.

Barley yellow dwarf virus isolates from Montana (MT), serologically identified as RMV, were transmitted efficiently by *Rhopalosiphum maidis* and *Schizaphis graminum*. Normally *R. maidis* is a vector of the RMV isolate and *S. graminum* is a vector of the SGV isolate but occasionally transmits RMV. Based on aphid transmission characteristics, we suspected a mixed infection of RMV and SGV in MT RMV-like isolates. Serological detection of SGV could have been masked by environmental factors or RMV infection. Serial aphid transmission experiments using both aphids in an attempt to separate SGV and RMV were unsuccessful. In contrast, mixed infections of NY RMV and NY SGV were separable by single aphid transfer. *R. maidis* transmitted only RMV, and *S. graminum* transmitted RMV only 3% of the time, both RMV and SGV 6%, and SGV 87% of the time. Aphid transmission patterns from these plants almost always followed those predicted by ELISA. These results suggest that the MT RMV-like isolates may not be a mixture of RMV and SGV, and represent new isolates of RMV that have a wider vector range.

THE DEMISE OF THE NON-AGGRESSIVE STRAIN OF *OPHIOSTOMA ULMI* WITHIN POPULATIONS OF *ULMUS AMERICANA* IN VERMONT AND MILLINOCKET, MAINE. David R. Houston, USDA Forest Service, 51 Mill Pond Road, Hamden, CT 06514.

Previous systematic surveys of elms with Dutch elm disease in 1977, 1980 and 1983 in Vermont and Millinocket, Maine, revealed a progressive decrease in the proportion of *Ophiostoma ulmi* isolates belonging to the non-aggressive (NA) subgroup. Surveys of these elm populations conducted again in 1986 (Millinocket) and 1989 (Millinocket and Vermont) show that the decrease of the NA subgroup has continued. This subgroup is now virtually absent in Vermont where only 2 of 200 (1%) isolates were NA (50% in 1977). The trend is similar for the isolated elm population in Millinocket where in 1989, 10% of isolates were NA (85% in 1977). In Vermont, the pattern of spread of the aggressive subgroup appears to have been from the west and south along elm-rich valleys. Since 1980, the size class distribution of the diseased elm population (reflecting the population as a whole) has shifted from scattered, large trees to abundant small trees and saplings.

SPREAD OF THE SUGAR MAPLE SAPSTREAK DISEASE PATHOGEN, *CERATOCYSTIS COERULESCENS*, VIA ROOT GRAFTS BETWEEN *ACER SACCHARUM*. David R. Houston, USDA Forest Service, 51 Mill Pond Road, Hamden, CT 06514.

Wounds to roots and root collars comprise the main infection courts for *Ceratocystis coerulea* (Cc). Observations suggest that limited spread also occurs by root grafts. To test this, one tree of each of 10 pairs connected by root grafts was inoculated with a benomyl resistant isolate of Cc. After 2 or 4 yrs. all infected trees were harvested to determine patterns and extent of infection. Eight of 10 inoculated trees were infected (determined by electrical resistance measurements, stain, and/or reisolation). Cc moved across root grafts in 3 pairs. Trees of these pairs were the only ones with crown symptoms. Of the 5 other infected pairs, 3 had non-functional grafts, and in 2, infections were strongly contained. Disease development within trees varied greatly, e.g., stain columns extended a few cm in one; over 9 m in another. In 2 pairs, infection within inoculated trees was less extensive than within the trees to which it spread.

EVALUATION OF FUNGICIDES, SOIL FUMIGANTS, AND A SURFACTANT TRANSPLANT WATER TREATMENT ON THE CONTROL OF PHYTOPHTHORA BLIGHT OF PEPPERS. S.A. Johnston, Rutgers Univ., RD #5, Box 232, Bridgeton, NJ 08302

The experiment was conducted in a Phytophthora-infested field and arranged in a split-plot design with 4 replications. Whole plots included soil fumigants, either applied through drip irrigation or chisel injection prior to bedding and a surfactant transplant water solution. Half of each plot received 3 applications of metalaxyl (4.7 l/ha) through drip irrigation 21, 54, and 85 days after transplanting, followed by 3 foliar applications of Tencop 5E (3.5 l/ha) beginning 111 days after transplanting and continued every 7 days. The application of metalaxyl, followed by foliar applications of Tencop 5E, resulted in a significant decrease in disease incidence compared to the nontreated control. There were no significant differences in disease incidence among the whole plots. Vorlex (1,3-dichloropropene+methylisothiocyanate) resulted in a significant yield increase at the first harvest and the surfactant transplant water treatment resulted in a significant yield decrease.

POTENTIAL BENEFITS OF MANAGING EYESPOT IN WINTER WHEAT IN NEW YORK. D. W. Kalb and G. C. Bergstrom, Department of Plant Pathology, Cornell University, Ithaca, NY 14853-5908.

Eyespot, incited by *Pseudocercospora herpotrichoides*, was controlled by varying degrees by delayed planting, seed treatment with triadimenol (40 ml Baytan 30F/45 kg), or foliar application of benomyl (2.2 kg Benlate 50WP/ha, fall or spring) in order to assess the potential yield benefits of eyespot control in New York. Plots were established in 1989 and 1990 in an area with a history of severe eyespot. Disease ratings taken at tillering, flag leaf emergence, and soft dough are summarized for both years. Delayed planting significantly reduced disease at all three rating periods but did not affect yield significantly. Seed treatment with triadimenol significantly reduced disease at tillering and flag leaf emergence but not at soft dough; it did not affect yield significantly. Fall or spring application of benomyl greatly reduced disease at all rating periods. In 1989, yields were increased significantly by fall application of benomyl and, in 1990, by fall or spring application of benomyl.

IDENTIFICATION OF A VIRUS INFECTING RHOPALOSIPHUM MAIDIS, A VECTOR OF THE RMV ISOLATE OF BARLEY YELLOW DWARF VIRUS. M. L. Krumrine and F. E. Gildow, Department of Plant Pathology, 211 Buckhout Lab, The Pennsylvania State University, University Park, PA 16802.

Using antibody to *Rhopalosiphum padi* virus (RhPV), 2 of 10 Montana clones of *R. maidis* tested positive for virus via immuno-specific electron microscopy. Because RhPV is not known to infect *R. maidis*, this may be a new isolate of RhPV. In chronically infected colonies of *R. maidis*, 9 of 10 adult aphids tested positive for the virus. Purified virus at 10 µg/ml in 20% sucrose was membrane fed to virus-free New York clones of *Sitobion avenae*, *R. maidis*, *R. padi*, and *Schizaphis graminum*. *R. maidis*, *R. padi*, and *S. graminum* became infected, but *S. avenae* did not. In sections of infected *R. maidis* observed via transmission electron microscopy, isometric particles 28 nm in diameter were observed in large crystalline arrays in both midgut and hindgut cells. Virus was not observed in muscle or nerve tissue. This is the first virus purified from *R. maidis*.

PREDISPOSITION OF BROADLEAF TOBACCO TO FUSARIUM WILT BY EARLY SEASON NEMATODE INFECTION. James A. LaMondia, The Connecticut Agricultural Experiment Station, Box 248, Windsor, CT 06095.

In greenhouse experiments, broadleaf tobacco plants were infected with cyst (*Globodera tabacum*) or root-knot (*Meloidogyne hapla*) nematodes 2 wk before, 1 wk before or at the same time as *Fusarium oxysporum*. Plants infected with nematodes 1 or 2 wk prior to fungal infection had greater wilt symptom severity and *F. oxysporum* colonization of the stalk than simultaneously inoculated plants. In field experiments, early season *G. tabacum* control by preplant soil oxamyl application to soil infested with *G. tabacum* and *F. oxysporum* indirectly reduced the incidence of Fusarium wilt and increased fresh weight of broadleaf tobacco. Wilt incidence was 47.9, 23.0 and 7.9% and fresh weights were 1.6, 1.7 and 1.8 kg per marketable plant for 0.0, 2.2 and 6.7 kg ha⁻¹ oxamyl, respectively. Early infection of tobacco by *G. tabacum* predisposes broadleaf tobacco to severe wilt.

TWENTY-THREE YEAR SPREAD OF AN OAK WILT INFECTION CENTER. W. Merrill, Dept. of Plant Pathology, Penn State University, University Park, PA 16802

The State-Federal Oak Wilt Post-Control Appraisal Study found most oak wilt (*Ceratocystis fagacearum*) foci in Pennsylvania, Maryland and West Virginia died out naturally within 3 yr of establishment, and none survived more than 5 yr. In Perry County, PA, from 1965 to 1984, spread occurred from only three of hundreds of inoculated trees in several areas at 410-763 m elevation. However, a single focus of 31 trees inoculated in the winter of 1966-67 spread annually, involving 139 trees by 1990. The focus extends along the northeast and north sides of a low hill between 430-445 m elevation. Oak wilt has not occurred lower or higher on the hillside although red oaks are plentiful, and no spread occurred from 100 inoculated trees along the same contours on the west side nor from 50 at 467 m along the top of the hill. No wilting tree occurred within root-graft distance of trees which died less than 3 yr previously. Spread appeared to be random within the focus. Reasons for the record longevity of this focus are unknown.

INHERITANCE AND LOCALIZATION OF RESISTANCE TO *Meloidogyne* spp. IN *Phaseolus vulgaris*. B. A. Mullin,¹ G. S. Abawi,¹ J. L. Kornegay,² and M. A. Pastor-Corrales.² ¹Dept. Plant Pathology,¹ NYS AES, Cornell Univ., Geneva, NY and Bean Program,² CIAT, Cali, Colombia.

Resistance to root galling and nematode reproduction caused by root-knot nematodes (*Meloidogyne incognita* and *M. javanica*) in bean line A 211 segregated independently. Chi-square analysis of the resistance segregation ratios of the F₂ generation suggested that a dominant and a recessive gene conferred resistance to root galling, whereas a single recessive gene conferred resistance to nematode reproduction. Stem grafts were prepared between bean lines susceptible (Canario Divex) and resistant (A 211 and Nemasnap) to *M. incognita* in all scion/rootstock combinations. Successful graft combinations were each inoculated with 10,000 eggs of *M. incognita* 10 days later, and host response was assessed 8 weeks later. All graft combinations with a resistant rootstock expressed a resistant reaction to *M. incognita*, whereas all combinations with a susceptible rootstock exhibited a susceptible reaction, regardless of the scion component.

ASSOCIATION OF A FUNGUS WITH OVERSTORY SUGAR MAPLE LEAVES INJURED BY PEAR THRIPS IN PENNSYLVANIA. B. Nash,¹ G. Stanosz,² G. Taylor,¹ and D. Davis.¹ ¹Dept. of Plant Pathology, Penn State University, University Park, PA 16802; ²Penna. Bureau of Forestry, 34 Airport Drive, Middletown, PA 17057.

Fruiting bodies in necrotic areas of *Acer saccharum* Marsh. leaves collected in 1989 suggested a fungal association with symptoms attributed to the pear thrips, *Taeniothrips inconsequens* (Uzel). Overstory foliage was collected in May and June 1990 from 5 trees in each of 3 thrips-infested stands. For each tree/month, 80 randomly-selected leaves were evaluated for symptoms and 20 additional leaves were incubated in moist chambers. Two incubated leaves with fruiting bodies were selected for spore examination and isolations. Each mo., 92% of the leaves had necrotic areas. Of the leaves with necrosis, ≤5% of the surface area was affected on 82% and 99% of the May and June leaves, respectively. Acervuli were observed in necrotic areas of incubated leaves. Conidia and cultures of one fungus were obtained from 29/30 leaves collected in May. This fungus has also been recovered from symptomatic leaves from ME, VT, and NH. This fungus, tentatively identified as a *Discula* sp., is a potential cause of necrosis of thrips-infested leaves and is identical to a pathogen associated with mortality of sugar maple seedlings in thrips-infested stands.

EGGPLANT YIELD INCREASE OBTAINED BY NEMATOCIDES FOR OCN CONTROL. W.W. Osborne, International Agriculture, Institute (IAI), Inc., South Boston, VA 24592.

Replicated on-farm tests were conducted utilizing four chemical soil treatments on naturally infested *Globodera solanacearum* (OCN) infested soil to determine the yield response of eggplant (cultivar millionaire). Fruit yield increased 44%, 39%, and 38% respectively, following single preplant soil incorporation treatments of Mocap (Bthoprop), Furadan (Carbofuran) and Temik (Aldicarb) nematocides applied this spring. A 32% fruit yield increase occurred where methylbromide was applied the previous spring. This OCN control study followed tobacco in the crop rotation sequence. Data are an average of 4 replications and two harvests.

IMPACT OF VERTICILLIUM ALBO-ATRUM ON THE VAPOR PRESSURE DEFICIT RESPONSE OF ALFALFA STOMATES. B.W. Pennypacker, D.P. Knievel and K.T. Leath, Penn State University and USDA-ARS, U.S. Pasture Research Lab., Univ. Park, PA 16802.

Stomates have a direct or feedforward response to vapor pressure deficit (VPD) that allows reduction of conductance when VPD is high. The stomatal response increases water use efficiency. Resistant and susceptible alfalfa clones were inoculated with *V. albo-atrum* and stomatal conductance was measured at 1 kPa and 2.4 kPa vapor pressure (VP) with a LI-6200 Photosynthesis System. Quantum flux was approx. 1050 µmol m⁻²s⁻¹ during all measurements. Only young fully-expanded symptomless leaves were measured. Stomates of both resistant and susceptible non-inoculated leaves increased conductance at 2.4 kPa VP, whereas, the stomates of infected susceptible leaves failed to respond to the more favorable VPD. Malfunction of the feedforward stomatal response will restrict transpirational water loss at the expense of CO₂ influx and may contribute to reduced net photosynthesis.

CORRELATION BETWEEN BARLEY YELLOW DWARF VIRUS CONCENTRATION AND SYMPTOM SEVERITY IN FIVE WINTER BARLEY CULTIVARS. D. Phayre, F. E. Gildow, and M. L. Risius, Department of Plant Pathology and Department of Agronomy, Pennsylvania State University, University Park, PA 16802.

Under greenhouse conditions, five barley cultivars, Barsoy, Maury, Venus, Pennco and Wysor, were grown in either pots of soil or in a hydroponic system and infested with viruliferous aphids carrying the PAV isolate of barley yellow dwarf virus. At two, four, and six weeks after inoculation individual plants were evaluated for virus content using ELISA, symptom severity and fresh weight. Barsoy and Maury showed the highest virus concentration and symptom severity. Venus, Pennco, and Wysor had significantly lower levels of virus. Barsoy was the only cultivar to show a significant reduction in fresh weight (28%). Based on viral content and symptom severity, all cultivars ranked similarly for both growing conditions with Barsoy and Maury exhibiting susceptibility and Venus, Pennco, and Wysor exhibiting levels of resistance. The ranking of cultivars based on virus concentration correlated well to yield data obtained from field studies.

OZONE-INDUCED CHANGES IN Cu/Zn SUPEROXIDE DISMUTASE GENE EXPRESSION IN PEA. L. Pitcher,¹ B. Zilinskas,¹ E. Brennan,¹ ¹Dept. of Biochemistry and Microbiology and ²Dept. of Plant Pathology, Cook College, Rutgers Univ., New Brunswick, NJ

Superoxide dismutases (SODs) are metalloenzymes which rid cells of toxic superoxide radicals. Using monospecific antibodies and cloned cDNAs for pea chloroplastic and cytosolic SODs, we examined the expression of Cu/Zn SOD genes in pea leaves after a 1.5 h exposure to 0.3 ppm ozone. Immediately after ozonation, there were small changes in the levels of the cytosolic SOD isozyme and its transcript, while at 24 h both tripled in abundance. Only minor changes were evident in the abundance of the chloroplastic SOD and its

transcript immediately and 24 h after ozonation. This is the first report, to our knowledge, which shows that the expression of the cytosolic Cu/Zn SOD gene is dramatically increased by ozone, while that encoding the chloroplastic isozyme is not, suggesting differential regulation of this family of closely related genes. Supported by USDA CSRS Grant 89-3471-4502.

EVALUATION OF FUNGICIDES FOR THE CONTROL OF SUMMER PATCH IN ANNUAL BLUEGRASS. K.A. Plumley, B.B. Clarke and P.J. Landschoot, Rutgers University, New Brunswick, NJ 08903 and Pennsylvania State University, University Park, PA 16802.

Registered fungicides previously shown to be effective against summer patch (*Magnaporthe poae* Landschoot and Jackson) were evaluated on two central New Jersey golf courses with a history of the disease. Over the past three seasons, a gallage study was conducted on an annual bluegrass fairway (*Poa annua* L.). Plots received benomyl, fenarimol, iprodione, propiconazole, or triadimefon at the same rate (active ingredient/100 m²), but in different volumes of water (800, 2000, or 4000 L/ha). A positive correlation between efficacy and the amount of water used to apply the fungicides was observed each year. In a similar study, the influence of fungicide timing on efficacy was evaluated on a bentgrass/annual bluegrass putting green. Propiconazole was applied according to four spray schedules based on the calendar and/or mean soil temperature (18°C) at a 5 cm depth. The late May, June, and July treatment regime was most effective in controlling this disease.

SUPPRESSION OF DOLLAR SPOT (*Sclerotinia homeocarpa*) AND BROWN PATCH (*Rhizoctonia solani*) ON CREEPING BENTGRASS BY AN ISOLATE OF *STREPTOMYCES*. H. M. Reuter, G. L. Schumann, M. L. Matheny* and R. T. Hatch*, Dept. of Plant Pathology, University of Massachusetts, Amherst, MA 01003 and *BioTechnica International, Inc., Cambridge, MA 02140.

Results of 1990 field trials suggest that a *Streptomyces* isolate may suppress dollar spot and brown patch on creeping bentgrass. Inoculum was grown in liquid culture and applied in two formulations: 1) a topdressing mixture with sand and corn meal or 2) the culture diluted with water and applied at a total volume of 3.4 L/m². The topdressing was applied as a single pre-season treatment. The liquid applications contained either 36 or 360 ml/m² of culture and were applied at 7 and 21 day intervals. An additional treatment for dollar spot included nitrogen (0.25 lb/100 ft²) in conjunction with the liquid culture. Dollar spot was suppressed by the 36 ml rate of culture plus nitrogen applied at 21 day intervals. The culture medium itself appeared to be conducive to dollar spot. Brown patch was suppressed by the topdressing treatment and the application of 360 ml/m² of the culture at 7 day intervals.

METHODS FOR ASSESSMENT OF RELATIVE RESISTANCE SELECTIVITY AMONG FUNGICIDES TO CONTROL CEREAL POWDERY MILDEW. P. L. Sanders, Department of Plant Pathology, 211 Buckhout Lab, The Pennsylvania State University, University Park, PA 16802.

A diverse population of *Erysiphe graminis* f. sp. *hordei* isolates was contrived and assayed to determine ethirimol and flutriafol resistance frequencies. The experimental population was repeatedly cycled on fungicide-treated and non-treated winter barley seedlings until effects of fungicide regimes were evident. The population was cycled under five treatment regimes: non-treated, continuous ethirimol, continuous flutriafol, continuous ethirimol plus flutriafol (Ferrax), and ethirimol alternating in sequential cycles with flutriafol. Two inoculation methods were compared: one in which inoculum was transferred via a settling tower onto barley seedlings, and a second wherein conidia were collected, suspended in standardized quantities in Fluorinert, and sprayed onto barley foliage. Both methods are suitable for determinations of relative resistance selectivity with powdery mildew populations; however, the second method eliminated much of the variability associated with the settling tower method.

LABORATORY-INDUCED RESISTANCE TO FOSETYL ALUMINUM IN A METALAXYL-RESISTANT FIELD ISOLATE OF *PYTHIUM APHANIDERMATUM*. P. L. Sanders, M. D. Coffey, G. D. Greer, and M. D. Soika, Departments of Plant Pathology, The Pennsylvania State University, University Park, PA, 16802, and The University of California, Riverside, CA, 92621.

Mutants of *Pythium aphanidermatum* resistant to both metalaxyl and fosetyl aluminum were obtained following exposure of a metalaxyl-resistant field isolate to the chemical mutagen, N-methyl-N'-nitro-N-nitrosoguanidine. Selected mutants were resistant to metalaxyl and phosphorus acid *in vitro* and exhibited *in vitro* growth rates and zoospore production that differed little from the metalaxyl-resistant parent. Mutants were resistant to metalaxyl and fosetyl aluminum on greenhouse-grown 'Penncross' creeping bentgrass and showed virulence equal to that of the parent isolate.

SENSITIVITY OF WILDTYPE AND HALF-SIB FAMILIES OF BLACK CHERRY TO AMBIENT DOSES OF OZONE IN NORTHCENTRAL PENNSYLVANIA. M. Simini, J. M. Skelly, and J. E. Savage, Dept. of Plant Pathology, The Pennsylvania State University, University Park, PA 16802.

Wildtype black cherry, *Prunus serotina* L., has been previously identified as being sensitive to ozone (O₃) at ambient exposures realized in much of the NE-USA. The objectives of these studies were to determine: 1) the sensitivity of wildtype seedlings at three locations in northcentral PA; 2) the O₃ sensitivity expressed by five half-sib families of black cherry. Half sib seedlings were exposed within open-top chambers receiving approx. 40%, 60%, and 95% of ambient aid and within open plots in Clearfield Co., PA. Additionally, 75 wildtype seedlings were evaluated at this site as well as at each of two other open sites in northcentral PA. Seasonal 12 h mean O₃ exposures (5/1-8/16) were 41ppb, 45ppb, and 37ppb, respectively, at the three sites. Percent foliar surface area of wildtype seedlings showing typical O₃ induced stipple on 9/16/90 were 14.0%, 14.2%, and 8.5% at the three sites. Family R12 had the greatest O₃ injury among families grown in 95% of ambient air.

A CRITIQUE OF FOREST HEALTH SURVEYS IN THE BLACK FOREST, FEDERAL REPUBLIC OF GERMANY. J. M. Skelly, Department of Plant Pathology, Pennsylvania State University, University Park, PA 16802.

Surveys to determine the health of forest trees are conducted annually within the Black Forest, State of Baden-Wuerttemberg, FRG. Silver fir (*Abies alba*), Norway spruce (*Picea abies*), European beech (*Fagus sylvatica*), and several oaks (*Quercus* spp.) are the species evaluated at the present time. The ECE system for crown yellowing and defoliation occurrence is employed. Critical errors were noted in the survey procedures as observed in the fall of 1989, including nonuse of site specific reference trees, inclusion of previous years of dead branches in defoliation estimates, and nonidentification and/or nonrecording of obvious causes of observed yellowing and crown thinning. Such survey data should be considered suspect when it is used to explain the recent phenomena of "waldsterben" or "neuartige waldschäden" commonly accepted as induced by air pollutants or site acidification.

ASCOSPORE PRODUCTIVITY OF *VENTURIA INAEQUALIS* AND THE BUILDUP OF SCAB ON NINE APPLE CULTIVARS. C. A. Smith and W. E. MacHardy, Department of Plant Biology, Univ. of New Hampshire, Durham, 03824.

Nine apple cultivars were assessed for scab development on cluster and extension shoot leaves and on fruit from early June through harvest in 1988, 1989, and 1990 to compare levels of resistance to *Venturia inaequalis* (Cke.) Wint. The most resistant cultivars, based on fruit scab incidence and severity, were 'Paula Red' and 'Ida Red'; the least resistant cultivars were 'Stayman', 'Rome', and 'McIntosh'. The number of asci/pseudothecium and the rate of maturation of ascospores on leaves from each cultivar that had overwintered in the orchard was determined by examining squash mounts of pseudothecia excised at five dates during the primary scab season in 1990. Preliminary data indicate that pseudothecia from 'Ida Red' matured at the slowest rate and had the lowest number of asci/pseudothecium. Ascospore productivity on leaves of each cultivar was determined in 1990 by trapping spores at weekly intervals from sets of overwintered 10 cm² leaf disks. The relationship between ascospore productivity and scab buildup on each cultivar will be discussed.

Symptoms, incidence, and pathogenicity of an anthracnose fungus from sugar maple seedlings in pear thrips-infested stands. G. Stanosz, PA Bur. For., 34 Airport Dr., Middletown, PA 17057.

Mortality of new *Acer saccharum* Marsh. seedlings in stands infested with *Taeniothrips inconsequens* (Uzel) occurred in 1989 and 1990 in northern Pennsylvania. Leaves became spotted and water-soaked, then collapsed or dropped, and upper portions of stems became necrotic. Ten samples, each of 5 symptomatic seedlings, were collected in June from each of 5 stands (1 in 1989, 4 in 1990) and incubated for 3-4 days in moist chambers. Acervuli and conidia of one fungus were observed from leaves of 247/250 seedlings. The fungus was isolated from one seedling of each sample (50/50 attempts). Mechanical wounding of leaves followed by inoculation with a conidial suspension resulted in collapse of leaves and mortality of laboratory-grown seedlings. Unwounded, inoculated seedlings did not die, and leaf symptoms were less frequent and less severe. This fungus, tentatively identified as a *Discula* sp., should be considered among causes of foliage symptoms and mortality of sugar maple seedlings, especially those damaged by pear thrips.

THE INFLUENCE OF SOIL FERTILITY ON NIGROSPORA BLIGHT OF KENTUCKY BLUEGRASS. D. C. Thompson¹, J. R. Heckman² and B. B. Clarke¹, Dept. of Plant Pathology¹ and Dept. of Crop and Soil Science², Rutgers University, New Brunswick, NJ 08903.

The severity of *Nigrospora* blight, caused by *N. sphaerica*, was measured in a field trial designed to evaluate the influence of soil fertility on diseases of Kentucky bluegrass. The cultivars Nassau and Baron were planted in 1988 where three levels of soil pH, phosphorus and potassium had been maintained for 16 years. During 1990, four levels of chloride (0, 56, 112, 224 kg/ha) were applied every three weeks to each plot using mixtures of ammonium chloride and ammonium sulfate. Soil pH was the most important factor in determining the severity of blight with pH values in the range of 4.5 being more conducive than 4.9 or 5.6. Lower chloride, phosphorus and potassium levels were more conducive to blight, but to a much lower magnitude than soil pH. Nassau was more susceptible than Baron.

PRELIMINARY MODEL FOR PREDICTING BROWN PATCH (*Rhizoctonia* spp.) ON CREEPING BENTGRASS. L. Vallencourt and G. L. Schumann, Dept. of Plant Pathology, University of Massachusetts, Amherst, MA 01003.

A model for predicting brown patch outbreaks has been developed based on data from field and growth chamber experiments done in 1989-90. Key environmental parameters include precipitation, relative humidity (RH), and soil and air temperatures within a 24 hr period. Severe disease outbreaks occur when: 1) air temperature exceeds 16 C and the average is greater than 21 C; 2) RH remains higher than 95% for at least 12 hr; 3) soil temperatures exceed 20 C and the average is greater than 21 C; and 4) precipitation and/or irrigation deposition is greater than 4 mm. Less severe disease, such as "smoke rings" without foliar blighting, may occur under the same conditions when precipitation is less than 4 mm or absent. A low risk of infection remains at temperatures to a minimum of 12 C if the average temperature remains greater than 21 C and the period of high RH exceeds 14 hr.

SUSTAINING ASSOCIATES

- ABBOTT AGRIC. RES. CTR., Long Grove, IL
AGRI-DIAGNOSTICS ASSOCIATES, Cinnaminson, NJ
AGRICULTURE CANADA, Vineland Station, Ontario
AGRIGENETICS COMPANY, Madison, WI
ALF. CHRISTIANSON SEED CO., Mt. Vernon, WA
AMERICAN CYANAMID CO., Agriculture Center, Princeton, NJ
ATOCHEM NORTH AMERICA, Philadelphia, PA
BASF CORPORATION, Research Triangle Park, NC
BUCKMAN LABORATORIES, Memphis, TN
CALGENE, INC., Davis, CA
CARGILL HYBRID SEEDS, Aurora, IL
CHEVRON CHEMICAL CO., San Ramon, CA
CIBA-GEIGY CORPORATION, Agric. Div., Greensboro, NC
DEKALB-PLANT GENETICS, DeKalb, IL
DEL MONTE FOODS USA, Walnut Creek, CA
DNA PLANT TECHNOLOGIES, INC., Oakland, CA
E. I. DUPONT DE NEMOURS & CO., INC., Agric. Chem. Dept., Newark, DE
ELI LILLY & CO., Lilly Res. Labs, Greenfield, IN
FERMENTA ASC CORPORATION, Mentor, OH
FERRY MORSE SEED CO., San Juan Bautista, CA
FUNDACAO EDUCACIONAL ITUIUTABA, Ituiutaba MG, Brasil
FUNK SEEDS INTERNATIONAL, INC., Bloomington, IL
GEORGE J. BALL INC., West Chicago, IL
GREAT LAKES CHEMICAL CORPORATION, West Lafayette, IN
GRIFFIN CORPORATION, Valdosta, GA
GUSTAFSON, INC., Des Moines, IA
HARRIS MORAN SEED CO., Hayward, CA
H. J. HEINZ CO., Bowling Green, OH
HOECHST ROUSSEL AGRIC. VET. CO., Somerville, NJ
ICI AMERICAS, INC., Mountain View, CA
ICI AMERICAS, INC., Richmond, CA
ILLINOIS CROP IMPROVEMENT ASSOCIATION, Urbana, IL
ILLINOIS FOUNDATION SEEDS, INC., Champaign, IL
ISTITUTO DI FITOVIROLOGIA, Torino, Italy
JANSSEN PHARMACEUTICA, Piscataway, NJ
LANDIS INTERNATIONAL, Valdosta, GA
LOXTON RESEARCH CENTRE, Loxton, Australia
MERCK & CO., INC., Rahway, NJ
MOBAY CORPORATION, Kansas City, MO
MONSANTO CO., St. Louis, MO
NOR-AM CHEMICAL CO., Wilmington, DE
NORTHFIELD LAB—DEPT. OF AGRICULTURE, Adelaide, Australia
NORTHROP KING CO., Woodland, CA
PEST PROS, INC., Plainfield, WI
PETOSEED CO., INC., Woodland, CA
PIONEER HI-BRED INTERNATIONAL INC., Johnston, IA
RHONE-POULENC AG COMPANY, Research Triangle Park, NC
RICERCA, INC., Painesville, OH
RJR NABISCO INC., Winston-Salem, NC
ROGERS BROTHERS SEED COMPANY, Nampa, ID
ROHM & HAAS CO., Philadelphia, PA
ROTHAMSTED EXPERIMENT STATION, Herts, England
SAKATA SEED AMERICA, INC., Salinas, CA
SANDOZ CROP PROTECTION CORP., Des Plaines, IL
O. M. SCOTT & SONS, Marysville, OH
TRICAL INC., Hollister, CA
TWYFORD INTERNATIONAL, INC., Sebring, FL
UNIROYAL CHEMICAL CROP PROT. R&D, Bethany, CT
UNOCAL CHEMICALS, West Sacramento, CA
VALENT USA CORPORATION, Tallahassee, FL
W-L RESEARCH, INC., Evansville, WI

You could be receiving *Phytopathology* every month as a benefit of APS Membership.

Better yet, two or all three journals can be yours at substantial member savings.

Choose *Plant Disease*, *Phytopathology*, or *Molecular Plant-Microbe Interactions* when you join APS. See membership application near the back of this issue.

APS... More Than Ever Before Your Professional Resource.

Call Now for an Application:
☎ Toll-Free 1-800-328-7560 (MN) 1-612-454-7250

Other Member Benefits Include:

- Monthly Newsletter. *Phytopathology News* keeps you informed about APS happenings.
- FREE Job Placement Service.
- Discounts to 25% on APS Press Publications. Receive Free book catalogs and new title announcements.

The American Phytopathological Society,
3340 Pilot Knob Road, St. Paul, MN 55121 U.S.A.