

# **ABSTRACTS OF PAPERS**

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ABSTRACTS

IDENTIFICATION OF BEAN GERmplasm FOR TOLERANCE TO PYTHIUM ROOT ROT UNDER CONTROLLED CONDITIONS. G. S. Abawi, J. A. Keplinger, and D. J. Pieczarka, Dept. of Plant Pathology, Cornell Univ., Geneva, NY 14456 and Univ. of Florida, Belle Glade, FL 33430.

Reaction of beans to root rot incited by *Pythium ultimum* was determined in a growth chamber at 21°C, 60–80% RH, and 11,000 lux of light for 14 hr/day. Seeds were surface-disinfested for 5 min in 0.25% NaOCl, rinsed in water and planted in sterilized sand at 22–23°C. Eight-day-old seedlings were transplanted into plastic pots filled with pasteurized soil infested with 200 sporangia/g oven-dry soil. Root-rot severity and total dry weight were determined 4 wk later. A large number of bean selections tolerant to seed decay or preemergence damping-off incited by *P. ultimum* were found susceptible to the root-rot phase of this fungus. To date, the most tolerant germplasms identified are Geneva selections (GV) originally obtained from PI 204722 (GV 97), PI 205207 (GV 106), PI 209811 (GV 200), PI 169-787 (GV 396), PI 222738 (GV 209), PI 169912 (GV 388), PI 204718 (GV 90), PI 222819 (GV 212), PI 167349 (GV 488), PI 169716 (GV 491), PI 205211 (GV 110), PI 203958 (GV 606), and PI 125836 (GV 460).

EVALUATION OF THE SUSCEPTIBILITY OF BLOSSOMS OF APPLE CULTIVARS TO ERWINIA AMYLOVORA. H. S. Aldwinckle, J. L. Norelli, and S. V. Beer, Departments of Plant Pathology, New York State Agricultural Experiment Station, Cornell University, Geneva, NY 14456 and Ithaca, NY 14853.

An evaluation of blossom susceptibility to *Erwinia amylovora* was conducted on 5-year-old apple trees on M.7 rootstock of the cultivars: Empire, Honeygold, Idared, Jerseymac, Jonamac, Julyred, Liberty, Macoun, Monroe, Niagara, NY 212, NY 58553-1, Priscilla, Spartan, Summerred, and Virginiagold. Bloom date difference among cultivars was compensated for by recording the exact bloom stage of blossom clusters and by staggering inoculation dates. Individually tagged blossom clusters were inoculated with an aqueous suspension of *E. amylovora* containing  $10^5$  and  $10^7$  cfu/ml using a compressed-air-powered atomizer. No significant differences in percentage of blossoms infected were observed among most of the cultivars, although these cultivars differ in susceptibility to vegetative shoot infection. However, Liberty and NY 212 did show significantly fewer blossom infections than some other cultivars.

REGULATION OF STRESS METABOLITE BIOSYNTHESIS IN POTATO TUBER DURING HYPERSENSITIVITY. Leo M. Alves, Plant Morphogenesis Laboratory, Manhattan College, Bronx, NY 10471; and Edwin B. Kalan and Edward G. Heisler, ERRC, FR, SEA, USDA, Phila., PA 19118.

Ethylene/oxygen ( $E/O_2$ ) elevates stress metabolite (SM) levels in hypersensitive potato tuber tissue. To determine whether  $E/O_2$  is retarding SM turnover, a measured amount of rishitin was applied to tuber tissue which was then incubated in air or  $E/O_2$ , and rishitin disappearance monitored. No difference in the rate of rishitin disappearance was detected between air and  $E/O_2$ . However, tissue treated with rishitin and incubated in  $E/O_2$  synthesized new pools of intermediates from the katahdinone and phytuberin pathways. New synthesis was not detected in rishitin-air treatments. These results suggest the dual involvement of ethylene and SM intermediates in the regulation of the biosynthesis of SMs, compounds which may serve as phytoalexins.

NECROSIS OF ELM TISSUE FOLLOWING CHEMICAL INJECTION FOR DUTCH ELM DISEASE CONTROL. J.L. Andersen, C.W. Murdoch, R.L. Cameron and R.J. Campana, Department of Botany and Plant Pathology, University of Maine, Orono, Maine 04469,

To determine the sequence of changes relative to necrosis, dis-

coloration and microbial colonization, three sets of twin stems 11–15 cm dbh were injected at two sites by gravity flow with Arbotech 20S<sup>R</sup> (thiabendazole). One stem of each pair was cut and split longitudinally after 4 days; and after 50 days. Sapwood pH was determined at 10 cm increments using Hellige-Truog solution. Vitality was determined using a 1% solution of Triphenyl Tetrazolium Chloride (TTC). Electrical resistance was determined with a Shigometer and linear discoloration was measured. Material harvested after 50 days was bioassayed. After four days no discoloration was observed, but TTC indicated dead sapwood above and below the wound. Vitality and pH (max. 6) increased with distance from the wound. After 50 days basic pH readings (8+) were obtained. Data indicate that tissue was killed prior to discoloration and that necrosis occurred from chemical toxicity rather than from microbial invasion.

EFFECT OF METALAXYL (CGA 48988), A SYSTEMIC FUNGICIDE, ON DEVELOPMENT OF PHYTOPHTHORA INFESTANS IN POTATO FOLIAGE. A. E. Apple, R. I. Bruck\* and W. E. Fry, Dept. Plant Path., Cornell Univ., Ithaca, NY 14853 and \*Dept. Plant Path., N.C. State Univ., Raleigh, NC 27650.

In greenhouse experiments, applications of the systemic fungicide metalaxyl (CGA 48988) [Ridomil(R), N-(2,6-dimethylphenyl)-N-(methoxyacetyl)-alanine methyl ester] inhibited growth and development of *Phytophthora infestans* in potato foliage. Lesion expansion was reduced more effectively when metalaxyl was applied before inoculation than after lesions had appeared. Sporulation from metalaxyl-treated lesions decreased as the time interval between fungicide application and inoculation decreased. Sporangia produced by *P. infestans* in lesions in metalaxyl-treated leaves were less able to germinate and infect potato foliage than were sporangia produced by *P. infestans* in untreated leaves. The rapid inhibitory effect of metalaxyl on the development of *P. infestans* in infected tissue explains the efficacy of this fungicide in halting established epidemics.

INCREMENT CORE ANALYSIS OF DECLINING URBAN NORWAY MAPLES. J. D. Apple and P. D. Manion. SUNY College of Environmental Science and Forestry, Syracuse, N.Y. 13210

Filtering techniques which average growth rate over five and seven years were used to determine growth trend information over a 20 year period on declining Norway maples in Syracuse, N.Y. At least two major trends were evident. One growth trend was related to precipitation. A second, decreasing growth trend was time dependent and non-weather in origin. Regression models explained 50 to 90% of the trend variation. The decreasing growth trend was associated primarily with declining trees. In trees that did not show visible decline symptoms, both trends were well represented. Therefore, non-weather dependent, decreasing growth trends may be previsual indicators of future decline.

DETECTION OF SOME PLANT VIRUSES BY AGAROSE GEL ELECTROPHORESIS. A. Asselin, J.G. Parent and G. Bellemare. Dept. of Phytology and Dept. of Biochemistry. Laval University, Quebec, Canada G1K 7P4

Agarose gel electrophoresis in presence of 0,25 M urea was used to detect potato virus X (PVX), some tobacco mosaic virus (TMV) strains ( $U_1$ ,  $U_2$ ,  $U_5$ ,  $C_C$ ) and tomato mosaic virus (ToMV). Homogenates or clarified juices from infected tissue could be subjected directly to gel electrophoresis if urea was added to the gel and to the sample buffer. Virus bands were revealed after staining with Coomassie Blue. Viruses and virus strains could be identified because of their electrophoretic mobilities. Tris-acetate-EDTA buffers gave best results for TMV and ToMV while sodium tetraborate was preferred for PVX. Best results were obtained when horizontal

agarose (0.5 to 1%) slab gels were electrophoresed overnight at 30V. Agarose gel electrophoresis was also tested to separate partially stripped TMV particles and to detect other plant viruses.

**BIODETERMINATION OF FUNGICIDE RESIDUES ON APPLE LEAVES.** Ted R. Bardinelli, Charles W. McCarthy, and William J. Manning, Dept. of Plant Pathology, University of Massachusetts, Amherst, MA 01003.

Reduction of fungicide sprays in Integrated Pest Management Programs requires a knowledge of active fungicide residues on leaves. We have developed a method for the biodetermination of fungicide residues on apple leaves using indicator fungi, such as Aspergillus, Botrytis, Monilinia, and Penicillium. Fungicides commonly used (captan, dodine, maneb, and thiram) in apple disease control were applied to detached apple leaves. Leaf discs were transferred to agar plates seeded with spores of a bioindicator fungus. After 18 hrs, at 22 C, radii of zones of inhibition were recorded and plotted against fungicide concentrations. Dose-response curves were then used to determine active fungicide residues.

**CONTROL OF FIRE BLIGHT BY NON-PATHOGENIC BACTERIA.** S. V. Beer, J. L. Norelli\*, J. R. Rundle, S. S. Hodges, J. R. Palmer, J. I. Stein, and H. S. Aldwinckle\*. Departments of Plant Pathology, Cornell University, Ithaca 14853 and Geneva\* 14456 N. Y.

The ability of non-pathogenic bacteria to reduce the occurrence of fire blight blossom infection incited by Erwinia amylovora was tested in a research orchard. Suspensions of two strains of E. herbicola were introduced separately into Idared apple (Malus pumila) blossoms one day before and three days after inoculation with E. amylovora. Three weeks after inoculation, 76% of water-treated control blossom clusters were infected. When E. herbicola was introduced at  $10^8$  and  $10^6$  colony forming units/ml, only 36% and 57% of the clusters became infected, respectively. Treatment with streptomycin (100 ppm) resulted in 36% blossom cluster infection. The two E. herbicola strains gave similar results; they were comparable, except that one produced a bacteriocin *in vitro* while the other was not known to do so. These results suggest that new controls for fire blight might be developed based on the use of non-pathogenic strains of E. herbicola.

**INHIBITION OF ERWINIA AMYLOVORA BY BACTERIOCIN-LIKE SUBSTANCES.** S. V. Beer and J. R. Rundle, Department of Plant Pathology, Cornell University, Ithaca, NY 14853.

Several strains of Erwinia herbicola, some unidentified strains isolated from pome-fruit trees, and an Erwinia species isolated from infected sugar beet were found to produce bacteriocin-like substances which inhibit growth of E. amylovora. The producer-strains were grouped according to characteristics of the inhibition zones formed in lawns of E. amylovora which had been laid over producer colonies killed with CHCL<sub>3</sub>. Mutants of E. amylovora resistant to substances produced by one strain were also resistant to those produced by other strains within the group, but they were sensitive to substances produced by strains of other groups. These observations indicate that the inhibitory substances differ among the groups of strains that produced them. Some strains also produced in liquid media; culture filtrates from these strains inhibited most E. amylovora strains tested. Most other enterobacteriaceae tested were less sensitive.

**A SAND-PLATE TECHNIQUE FOR DETERMINATION OF PHYTOPATHOGENICITY OF BACTERIA.** M. G. Bookbinder, Dept. of Plant Pathology, The Pennsylvania State University, University Park, PA 16802.

A procedure was developed to determine the pathogenicity of bacterial isolates to plants. Seeds were disinfested, plated on PDA, and incubated at room temperature for 72 hr. After primary roots were punctured with a flamed needle, seedlings were immersed for 10 minutes in a distilled water suspension of bacteria (from 18-24 hr culture on YDCA), aseptically transferred to moist, sterile sand in petri plates, incubated at room temperature for 72 hr, and observed. Several isolates were tested against 'Saranac AR' alfalfa by means of this procedure. Significant levels of root injury were produced by (i) several HR positive pseudomonads and erwinias; (ii) HR negative Bacillus subtilis and B. megaterium; and (iii) HR negative, human-parasitic E. coli, Salmonella typhi-suis, Shigella flexneri, Klebsiella pneumoniae, and Mycobacterium phlei. Results of plate tests were confirmed by root and stem inoculation experiments performed on mature alfalfa plants.

**INTERACTIONS OF NEMATODES AND BACTERIA ON ALFALFA.** M. G. Bookbinder, J. R. Bloom, and F. L. Lukezic, Dept. of Plant Pathology, The Pennsylvania State University, University Park, PA 16802.

Surface-disinfested Meloidogyne hapla (Mh), Pratylenchus penetrans (Pp), Helicotylenchus dihystra (Hd), Tylenchorhynchus claytoni (Tcl), Trichodorus christiei (Tch), and Ditylenchus dipsaci (Dd) reduced the growth of seedlings of 'Saranac AR' alfalfa, grown in sterile sand. Xiphinema americanum (Xa) did not affect seedling growth. Mh, Pp, Hd, Tcl, and Tch interacted synergistically with isolates of Pseudomonas syringae (Ps), Ps. corrugata (Pc), and Ps. marginalis (Pm) in reducing seedling growth; Dd and Xa did not interact with Ps, Pc, or Pm. Results of these studies were confirmed by experiments with mature plants grown under greenhouse conditions. Mh, Pp, Dd, Hd, Tcl, Tch, and a Tylenchus sp. were observed to act as wounding agents, and to vector the isolates into seedling roots. Mh predisposed seedlings to infection by bacteria applied 3 weeks after Mh, in pot tests. Xa did not feed on or probe alfalfa roots.

**A NEW MOSAIC DISEASE OF CORN.** Carl W. Boothroyd and H. W. Israel, Dept. of Plant Pathology, Cornell Univ., Ithaca, NY.

A severe stunting and mosaic of field grown sweet corn was noted June 25, 1979 at Ithaca, NY. The mosaic developed in leaves as a coalescence of elongate chlorotic areas extending laterally from the veins, followed by production of short ( $\leq 2$  cm) white lines within the veins. The name white line mosaic is thus suggested. Early infection resulted in almost total yield reduction. Mechanical transmission to corn and sorghum, aphid transmission to corn, and leaf dip ELISA tests against strains A and B of maize dwarf mosaic virus were all negative. Examination of leaf dip preparations by electron microscopy revealed many isometric particles about 35 nm in diameter. Comparable symptoms and the presence of similar particles were documented for both field and sweet corn in several NY counties, and for field corn from VI. Reports of a similar disease have been received subsequently from OH and WI. Provisionally, this mosaic is believed to be caused by a virus dissimilar from any known viruses in the US.

**OAK WILT FOCI RELATED TO RIDGE BEARING AND ASPECT IN PENNSYLVANIA.** K. L. Bowen, and W. Merrill, Department of Plant Pathology, The Pennsylvania State University, University Park, PA 16802.

More than 350 oak wilt infection centers were found in south-central Pennsylvania (Bedford, Franklin, Fulton, Huntingdon, and Juniata Counties) between 1964 and 1970. Analysis of data from these foci showed no year-to-year pattern of spread. However, a significantly larger number of infection centers occurred on slopes with a northwest exposure ( $P = 0.05$ ). A significantly larger number of infection centers also occurred on ridges with bearings between 30 and 60 degrees from north ( $P = 0.05$ ). Previous studies showed that the majority of infection centers occurred on the upper third of the slopes and tops of ridges. These patterns of occurrence are consistent with the hypothesis of insect vectors passively carried and impacted onto the ridges by prevailing westerly winds.

**FUNGICIDAL CONTROL OF BREMIA LACTUCAE IN LETTUCE.** G.C. Bruin and L.V. Edgington, Department of Environmental Biology, University of Guelph, Guelph, Ontario, Canada. N1G 2W1.

The systemic fungicides Ridomil, RE20615, RE26745 and propamincarb were evaluated for control of downy mildew of lettuce. A standard treatment of weekly sprays of zineb 1.7 kg ai/ha and an unsprayed check were included. Complete control was obtained with a granular application of Ridomil 5G at a rate of 1 kg ai/ha applied in the seed furrow. Hardly any downy mildew spots could be detected at harvest, 68 days after seeding. Four biweekly sprays of Ridomil 50WP (0.2 kg ai/ha) and RE26745 (0.4 kg ai/ha) also resulted in excellent control, with less than 5% leaf area of lower leaves diseased, as compared with 68.5% of the check. Half rates of Ridomil 5G (0.5 kg ai/ha) and RE26745 (0.2 kg ai/ha) as well as a 24% EC formulation of Ridomil were slightly less effective (8-15% disease).

**INDUCED RESISTANCE TO RIDOMIL OF SOME OOMYCETES.** G.C. Bruin and L.V. Edgington, Department of Environmental Biology, University of Guelph, Guelph, Ontario, Canada. N1G 2W1.

Culturing of 3 isolates of Phytophthora capsici on media containing sub-lethal doses of Ridomil induced quick adaptation to this fungicide. Twelve successive transfers on such media

raised EC50 levels from about 0.1 µg/ml to over 300 µg/ml. The adapted strains simultaneously developed resistance to the related compounds Fongarid and RE26745, but not to thiram and fenaminosulf. Similar results were obtained for *Pythium graminicola*. Resistance to Ridomil could also be induced by irradiating mycelium with UV. Resistant strains of *Pythium ultimum* obtained in this way had about 10 times higher EC50 values while in vivo 10 times more Ridomil was required to control *Pythium* damping off of peas in soil infested with a resistant strain. Characteristics of different resistant strains will be discussed.

**A SELECTIVE MEDIUM FOR THE ISOLATION OF PSEUDOMONAS SYRINGAE.**  
T. J. Burr and B. Hurwitz, Department of Plant Pathology, New York State Agricultural Experiment Station, Cornell University, Geneva, New York 14456.

A modification of King's medium B was used throughout the growing season to determine the epiphytic populations of *Pseudomonas syringae* (Ps) and *P. syringae* pv. *papulans* (Psp) on apple fruits of the cvs. Empire, Mutsu, and Delicious. Isolations were also made from apple buds and leaves and from leaves of various orchard weeds. The medium (KBS) contains: sucrose, 50 g/l; K<sub>2</sub>HPO<sub>4</sub>, 1.5 g/l; MgSO<sub>4</sub>·7H<sub>2</sub>O, 1.5 g/l; proteose peptone #3 (Difco), 20.0 g/l; sodium taurocholate, 3.0 g/l; agar, 15.0 g/l; and tergitol anionic 7, 0.1 ml/l. After autoclaving the following were added aseptically: novobiocin, 50 ppm; cycloheximide, 100 ppm; and penicillin 6, 60 ppm. Both pathogens produced a fluorescent pigment on KBS and developed characteristic colonies after 48-hr incubation at 28°C. Ps developed raised translucent mucoid colonies which were distinguished from the smaller, flat, cream-colored colonies of Psp. Growth of a high (50 to 97%) percentage of other epiphytic bacteria was inhibited on KBS.

**INCREASED DEVELOPMENT OF BACTERIAL WETWOOD ASSOCIATED WITH INJECTION HOLES MADE FOR CONTROL OF DUTCH ELM DISEASE.** R.J. Campana, C.W. Murdoch and J.L. Andersen, Department of Botany and Plant Pathology, University of Maine, Orono, Maine 04469.

Bleeding of elm sap from injection holes made to inject systemic chemicals suggested that bacterial wetwood may limit effective distribution of infused chemicals. The frequency and significance of bleeding from wounds was explored. More than 8000 injection wounds in 500 elms of varying size were examined for bleeding over a three-year period. Data were recorded by nature of wounds, location in tree, type of injection, solution injected and depth of wounds. No significant differences were obtained with the nature of wounds or type of injection. Numbers of bleeding wounds were significantly (P=0.05) more frequent with fungicide solutions than with water, and with increased depth of injection holes. The data show a clear relationship of bleeding to wounding of any kind, and stimulation of bleeding following injection wounds. Since bleeding occurs from pressure, it serves to limit distribution of injected chemicals dependent on a negative pressure system.

**NEW METHOD TO GET HIGH INFECTION OF PYRICULARIA ORYZAE CAV. IN AREAS WITH LOW RELATIVE HUMIDITY.** J. Castano and G. E. Galvez, Centro Internacional de Agricultura Tropical (CIAT), A.A. 67-13, Cali, Colombia.

In the field resistance to rice blast is often evaluated in the seedling stage of plant growth using blast nurseries. The fungus requires 25-28°C and at least 90% RH for normal development. Often these special conditions do not exist in some locations hindering breeding efforts trying to select resistant seedlings. Microclimate modification was successful in getting blast development. Sixty rice varieties were planted in 20 m. long plant beds by 1.20 m. wide at two locations. The first was in the eastern Colombian savanna where optimum environmental conditions for blast exist. The second location was in a central Andes Valley where conditions are often poor for blast development. At the second location the plant beds were sprinkler irrigated each evening and then a plastic sheet was draped over them where it remained during the night. Similar disease severity occurred at both locations, although some cultivars behaved differently perhaps because of the presence of different races of the fungus.

**SOIL APPLICATION OF FUNGICIDES TO CONTROL PYRICULARIA ORYZAE CAV. IN RICE.** J. Castano and G. E. Galvez, Centro Internacional de Agricultura Tropical (CIAT), A.A. 67-13, Cali, Colombia.

In temperate areas where rice is grown chemical control of blast has been emphasized. Although effective chemical control is available for temperate areas, in the tropics the control of the disease is quite difficult due to the frequent and heavy rains. In the absence of blast resistant varieties, the control of the dis-

ease is based on fungicides applied on the foliage. But because of the drastic conditions prevalent in the tropical areas, this practice is not always worthwhile. Thirty-four fungicides were applied to soil at the time the blast susceptible Fanny rice variety was planted in 1 m<sup>2</sup> plots, replicated twice. The fungicide dosages ranged between 2 to 240 kg. a.i./ha. Relative to blast incidence and spike development the most effective fungicides were: Benlate (Methyl-1(butylcarbamoyl)-2-benzimidazole carbamate); NF-44 (1,2, Bis (3, Metoxycarbamoyl)-2-thioureido)benzene); NF-35 (1,2 Bis (3, Metoxycarbamoyl)1,2-benzimidazole carbamate); Duter (Triphenyl hydroxide of tin); Brestan (Triphenyl acetate of tin) and Demosan (1,4-dichloro-2,5-dimethoxybenzene).

**INTERACTION OF CADMIUM AND OZONE ON A WOODY AND HERBACEOUS SPECIES.** Bruce Clarke, Ronald Harkov and Eileen Brennan, Department Plant Pathology, Cook College, P.O. Box 231, New Brunswick, New Jersey 08903

The effect of Cd on growth and foliar ozone toxicity of tomato and quaking aspen was determined in a controlled and ambient environment. Plants were grown in sand culture and received nutrient solution daily. Cadmium treatment levels ranged from 0 to 0.75 µg Cd/ml for tomatoes and 0 to 10 µg Cd/ml for trees. Replicates from each treatment were exposed to 328-478 µg O<sub>3</sub>/m<sup>3</sup> or 574-622 µg O<sub>3</sub>/m<sup>3</sup> for 3 hrs. Cadmium-treated plants were more susceptible to ozone damage than plants not receiving Cd. This response was not evident when O<sub>3</sub> fumigations produced slight or extremely severe foliar injury. Cadmium content generally followed a root > leaf > stem gradient. Tissue concentrations increased with treatment levels. Cadmium did not alter the percent dry weight of plant tissue. The importance of these results will be discussed particularly as it pertains to the alteration of subtle plant processes by cadmium.

**EFFECT OF FOLIAR AND SOIL-BORNE PATHOGENS ON 'BLUEBOY' WHEAT YIELDS IN PENNSYLVANIA.** H. Cole, Jr., J. A. Frank, and H. G. Marshall, Dept., of Plant Pathology and USDA-AR, The Pa. State University, University Park, PA 16802.

Field plots were established for yield loss studies on 'Blueboy' wheat using paired treatment blocks of fumigated and non-fumigated soil. The blocks were further subdivided into foliar fungicide sprayed and non-sprayed subplots. The fumigant was methyl bromide (393 kg/ha) and the fungicide was a tankmix of triadimefon (30 g AI/ha) and captafol (1.1 kg AI/ha). Plots were evaluated for disease severity and lodging during the season and yields were calculated at harvest. The major pathogens in the plot were *Septoria nodorum*, *Helminthosporium sativum*, and *Erysiphe graminis* f. sp. *tritici*. Total disease severity was reduced by more than 50% in the fumigated, fungicide sprayed plots compared to non-treated plots. The average yield in these treated plots was 6296 kg/ha (93.7 bu/A) compared to 3877 kg/ha (57.7 bu/A) in the non-treated plots.

**WINTER INJURY TO APPLE ROOTS CAUSES TREE DECLINE AND DEATH.** Daniel R. Cooley and William J. Manning, Dept. of Plant Pathology, University of Massachusetts, Amherst, MA 01003.

Symptoms similar to collar rot (*Phytophthora cactorum*) and fire blight (*Erwinia amylovora*) appeared in several Massachusetts apple orchards during spring 1979. Affected trees (*Malus domestica* Borkh.) varied in age, cultivar and rootstock. Symptoms developed over 24 to 48 hrs during warm (30°C) weather. These included buds failing to break, stunted leaves, marginal leaf browning, flower browning, and complete wilting and browning of twigs and flowers, either on the whole tree or isolated limbs. Woody tissue became water-soaked or browned. Some roots were rotted, the most severe symptoms occurring near the soil surface. No potential pathogens were isolated from stem or root tissues. Apparently, winter weather produced a combination of cold stress and excess water in the rhizosphere causing symptoms. Whether marginally stressed trees might be more susceptible to root disease in the future is not yet known.

**THE EFFECT OF JAPANESE MILLET (ECHINOCLA FRUMENTACEA) ON THE MACROSPORE GERMINATION, MYCELIAL GROWTH, AND SOIL POPULATION OF FUSARIUM SOLANI COERULEUM.** David N. Costello, Department of Botany and Plant Pathology, University of Maine at Orono, Orono, ME 04469; Simeon S. Leach, USDA-AR, University of Maine at Orono, Orono, ME 04469.

Immature Japanese millet (*Echinochloa frumentacea*) was incorporated into soil inoculated with *Fusarium solani* Coeruleum, causal agent of dry rot of potato, to determine if the millet could reduce the population of the pathogen. Laboratory studies were

conducted to ascertain if sterile root exudates, root extracts, and leaf extracts affect the germination and growth of the pathogen. Results showed a significant decrease in the pathogen population in soil amended with millet. Root exudates and extracts showed no significant effects on germination and mycelial growth of the pathogen. Leaf extracts showed a significant reduction of mycelial growth, but no effect on spore germination. The results indicate the presence of an inhibitory component in the millet leaves.

**A SYSTEMIC APPROACH TO THE CONTROL OF CYTOSPORA KUNZEI IN SPRUCE.** Arthur C. Costonis, Systemic Tree Techniques, Inc., 138 Mill Street, Westwood, MA 02090

A group of 11 spruce trees infected with *C. kunzei* were treated by systemic root flare injection with the MAUGET fungicide (Fungi-Sol, Fungi-Sol PV) alone or in combination with the MAUGET nutrient (Stemix). All treatments significantly reduced the activity of *C. kunzei*. The fungicide nutrient treatment resulted in pronounced deeper green foliage and increased annual growth over the fungicide alone and the control trees. The average *C. kunzei* activity of the treated and untreated trees was 2.3 and 4.0 respectively on a rating scale of 1=Good vigor with up to 5 branchlets infected with *C. kunzei* to 4=Poor vigor with more than 15 branchlets infected with *C. kunzei*.

**ELIMINATION OF FUSARIA FROM ASPARAGUS SEEDS.** John P. Damicone, Daniel R. Cooley, and William J. Manning, Dept. of Plant Pathology, University of Massachusetts, Amherst, MA 01003.

Asparagus seed is often contaminated with *Fusarium moniliforme* and *F. oxysporum*. This complicates both experimental and practical programs that require disease-free seedlings. The usual techniques for disinfecting seeds involve the use of chlorine bleach solutions (e.g. Clorox) for 10-30 minutes at 10-25% concentrations. Using several variations of time and concentration of Clorox, we isolated 6-7% *F. moniliforme* and 1.5-3.8% *F. oxysporum* from commercial lots of 'Mary Washington' seed plated on potato carrot agar. Hot water treatments at 50, 55, and 60 C were either ineffective or reduced germination drastically. Soaking seeds for 24 hrs in 50 mg benomyl/liter water (on a shaker) reduced, but did not eliminate *Fusarium* incidence and seedling infections. Seeds soaked in 2.5% benomyl in acetone for 24 hrs (on a shaker), followed by surface-sterilization in 10% Clorox solution, germinated well and produced seedlings without infections.

**FUSARIUM MONILIFORME VAR. SUBGLUTINANS PATHOGENIC ON CORN AND ASPARAGUS.** John P. Damicone and William J. Manning, Dept. of Plant Pathology, University of Massachusetts, Amherst, MA 01003.

*Fusarium moniliforme* var. *subglutinans* was isolated from sporodochia on overwintered corn stubble. Seedlings of 'Golden Midget' sweet corn (*Zea mays* L.) and 'Mary Washington' asparagus (*Asparagus officinalis* L.) were grown on Hoaglund's Solution agar slants. Inoculated corn seedlings developed severe root and stem lesions after 7 days and died after 14 days. Inoculated asparagus seedlings developed typical root and stem lesions and crown infections after 14 days. Other seedlings were grown in autoclaved soil amended with oat inoculum. Stand counts were reduced for both corn and asparagus seedlings and typical disease symptoms were observed. The fungus was readily reisolated from corn and asparagus seedlings. Corn may serve as a reservoir of inoculum for *Fusarium moniliforme* var. *subglutinans* pathogenic on asparagus.

**THE INFLUENCE OF SAPSTREAM CONTINUITY AND PRESSURE ON DISTRIBUTION OF INJECTED CHEMICALS FOR TREE DISEASE CONTROL** S.J. Day and R.J. Campana, Department of Botany and Plant Pathology, University of Maine, Orono, Maine 04469.

Inadequate distribution of systemic chemicals in elms for disease control has not been explained satisfactorily. To measure the influence of pressure and sapstream continuity, 80 small elms (8-30 cm, dbh) were injected with acid fuchsin dye or Arbotect 20-S (thiabendazole) to evaluate distribution in small twigs. Methods involved: induced pressure under water; and induced pressure without water; gravity infusion under water; and gravity infusion without water. Forty trees were dissected after 7 days to measure dye movement; 40 others were bioassayed for chemical distribution after 21 days. Both linear distribution of dye and percent of positive bioassay were significantly greater ( $P=0.05$ ) with sapstream continuity than without. Dis-

tribution of both dye and chemical appear to be more dependent on sapstream continuity than pressure.

**THE EFFECT OF CADMIUM ON NITRATE REDUCTION IN PHASEOLUS VULGARIS.** Martha Decker and Eileen Brennan, Dept. of Plant Pathology, Cook College, P.O. Box 231, New Brunswick, N.J. 08903.

The hypothesis that cadmium, an increasingly common water and soil pollutant, might interfere with nitrogen metabolism was tested with bush bean. The reduction of nitrate in foliage was the system investigated. Bush beans (*P. vulgaris*) were grown in sand culture with a nutrient solution containing 0.1 ppm Cd, as CdCl<sub>2</sub>. After 15 days, when no Cd-toxicity symptoms were apparent, the third trifoliolate leaf was harvested for an *in vivo* nitrate reductase assay. More nitrite was detected in Cd-treated tissue than in the controls. Further tests were conducted to determine whether the increased nitrite content was a reflection of a stimulation in nitrate reduction or an inhibition of nitrite reduction.

**INTERACTIONS OF FUSARIUM SOLANI F. SP. PISI WITH CHICKPEA (CICER ARIETINUM L.) AND ITS PHYTOALEXINS.** T. Denny and H. D. VanEtten, Dept. Plant Pathology, Cornell Univ., Ithaca, NY 14853.

Seedlings of chickpea developed root rot symptoms 9-13 days after inoculation with *F. solani* f. sp. *pisi* isolate T-30. When compared to healthy tissue, concentrations of the phytoalexins medicarpin and maackiain increased 5 fold (to 260 µg/cc) and 3 fold (to 70 µg/cc), respectively, during pathogenesis. Mycelial growth of T-30 on agar medium was insensitive to either phytoalexin at concentrations up to those found in diseased tissue. *In vitro* spore germination proceeded normally in 55 µg/ml of either phytoalexin after a 1-2 hr delay. Pre-incubation with 12 µg/ml of medicarpin shortened the delay in germination when spores were subsequently challenged with 70 µg/ml of medicarpin. Given 24 hr, T-30 mycelium metabolized medicarpin in culture. However, medicarpin was not metabolized by the spores during the delay period. Thus, the very rapid adaptive tolerance manifested by spores is probably due to a mechanism other than metabolism.

**ENVIRONMENTAL INFLUENCE ON PHENOLOGICAL EVENTS IN NECTRIA HAEMATOCOCCA MP VI.** Margaret F. Dietert and Hans D. VanEtten, Dept. Plant Pathology, Cornell Univ., Ithaca, NY 14853.

The influence of various environmental parameters on certain aspects of fungal development was determined for two field and two ascospore isolates of *N. haematococca* MP VI (*Fusarium solani*). All isolates showed broad pH optima for mycelial growth and sexual fertility. Photoperiod had little effect on mycelial growth; however, conidial size and number increased at longer photoperiods. The light requirement for ascospore production was satisfied in some isolates before as well as after spermatization (crossing). Light intensities examined ranged from 10 to 250 ft-c, and without exception, the higher the intensity, the more fertile the cross. The light requirement was not negated by cold temperature. Temperature optima in all isolates for mycelial growth were 27-30 C, and the size and numbers of conidia produced were isolate- and temperature-dependent. Temperatures of 18-24 C before and 21-24 C after crossing were most favorable for perithecial production and ascospore formation, the exact optima being isolate-dependent.

**PURSLANE (PORTULACA OLERACEA L.) AS A POSSIBLE SOURCE OF CUCUMBER MOSAIC VIRUS INFECTION OF TOBACCO TRANSPLANTS.** J. A. Dodds and G. S. Taylor. Department of Plant Pathology, The Connecticut Agricultural Experiment Station, New Haven, CT 06504.

Plants of a cigar wrapper tobacco cultivar developed systemic mosaic symptoms in field and greenhouse following seedling propagation in trays resting on crushed stone in a hoop-house. In the field, infected plants were sequential within rows and not in groups across rows. Cucumber mosaic virus (CMV) was isolated from field plants with symptoms. The same virus was isolated from plants of purslane (*Portulaca oleracea* L.) and one plant of plantain (*Plantago major* L.) showing mosaic symptoms and growing as weeds in the crushed stone floor of the hoop-house. These observations suggest that the tobacco plants became infected as seedlings with purslane as a probable source of CMV.

**EFFECT OF THE NUMBER OF COMPONENT LINES ON POWDERY MILDEW EPIDEMICS IN A WHEAT MULTILINE.** Vern J. Elliott, D. R. MacKenzie,

R. R. Nelson, Dept. of Plant Pathology, The Pennsylvania State University, University Park, PA 16802.

Field experiments were conducted with isogenic lines of Chancellor wheat to study the effects of the number of component lines in a multiline on epidemics of *Erysiphe graminis* f. sp. *tritici*. Resistant and susceptible isogenic lines were mixed in varying proportions to experimentally simulate 1, 2, 4, 6, 10, 25 and 50 component multilines in which one component was susceptible. Disease assessments were made throughout the season and expressed as disease proportions. A logit transformation and regression analysis were used to calculate r-values for each experimental multiline. The regression of r-values against the natural log of the number of component lines gave the following:  $r\text{-value} = 0.116 - 0.0184 (\ln \# \text{ lines})$ . This non-linear effect of component line number on r-value demonstrates the decreasing effectiveness of each additional component in reducing the r-value of a powdery mildew epidemic.

THE BIOLOGICAL ACTIVITY OF THE O<sub>3</sub> PROTECTANT, DPX. W.A. FEDER, Jane S. Mika, P. Vardaro, & I. Perkins, Sub.Expt.Sta. U.Mass. 240 Beaver St., Waltham, MA 02154

Fronds of *Lemna* sp. bleach and multiply more slowly when exposed to .5ppmhr O<sub>3</sub>. Fronds floated for 24 hr on medium plus 100 ppm DPX, an O<sub>3</sub> protectant, are uninjured by .5ppmhr O<sub>3</sub>. Protection persists for 72 hr 14 days in 100 ppm DPX depressed growth and altered morphology. Leaf cupping and root distortion were evident after 72 hr DPX exposure. Lower concentration of DPX reduced frond injury and O<sub>3</sub> protection. Permanently open stomata in this species suggest that protection against O<sub>3</sub> injury does not result from stomatal regulation. DPX affords maximum protection against O<sub>3</sub> injury when applied 24-48 hr before plant exposure to O<sub>3</sub>. Growth effects from DPX are minimized by keeping plant contact below 72 hr.

ENGLISH OAK DECLINE ON CAPE COD, MA. W.A. Feder, Gary W. Moorman, T.A. Tattar, Un.Ma. Waltham and Amherst, MA and William Clark Barnstable, MA.

Progressive dieback, beginning in the upper crown, led to the decline and eventual death of English oaks (*Quercus robur*) on the north shore of Cape Cod within two years after onset of symptoms. Trees affected were located around homes and in the forest, and ranged from 10-40cm dia. at 1.4 m above ground. Twigs and small branches from many affected trees contained extensive discolored streaks in the outer xylem. Similar vascular discoloration was found in the xylem of stump sprouts and of small seedlings near the affected trees. Many of the declining mature trees also contained injury under the bark from larvae of the two-lined chestnut borer. A fungus was isolated from fresh material on PDA. The young mycelium is hyaline and becomes dark olive-green with age. Hyphae vary in diameter but are mostly narrow. Mycelium is branched, septate, and lacks clamp connections. No spores have been observed in culture. *Ceratocystis fagacearum* has not been isolated to date.

RELATIVE YIELD POTENTIAL OF SIX WHEAT CULTIVARS AS AFFECTED BY SOIL FUMIGATION AND FOLIAR FUNGICIDES. J. A. Frank, H. Cole, Jr., and H. G. Marshall, Dept. of Plant Pathology and USDA-AR, The Pa. State University, University Park, PA 16802.

Periodic evaluations of disease severity and lodging were made on six soft red wheat cultivars planted in paired treatment blocks of fumigated (methyl bromide) and non-fumigated soil. The blocks were further subdivided into foliar fungicide sprayed (tankmix of captan and triadimefon) and non-sprayed sub-plots. All six cultivars exhibited degrees of susceptibility to *Septoria glume blotch* and leaf spot, and also powdery mildew, the major pathogens in this test. Foliar fungicides reduced *Septoria* leaf spot severity and generally eliminated powdery mildew. An average yield improvement of 2083 kg/ha was achieved with the combination of fumigant and fungicides. The Illinois cultivar (IL 72-2218-1) provided the highest average yield (7526 kg/ha) while the commercially grown cultivar 'Redcoat' had the lowest yield (5140 kg/ha) under the same conditions.

WOUND-INDUCED RESISTANCE TO CELLULOSE: THE ROLE OF LIGNIN Gordon T. Geballe and A. W. Galston Dept. of Biology Yale University New Haven, CT 06520

Peeled oat leaves floated on cellulysin and mannitol undergo extensive cellulolytic digestion and release protoplasts from almost every cell. If, however, the peeled segments are preincubated on water for at least 12 hr, few protoplasts are released by the cellulase. Thus wounding induces a resistance to cellulolytic digestion. Ethylene appears to be the effector for the wound response: wounded tissue produces more ethylene than unwounded, and chemicals that interfere with ethylene synthesis or activity inhibit

the development of the resistance.

The cell walls of wounded tissue become autofluorescent. Fluorescence, correlated with resistance, is due to a material insoluble in water or methanol, but soluble in NaOH. It appears that the fluorescence is due to the presence of lignin, which is responsible for at least part of the resistance. Aminooxy acetic acid, an inhibitor of PAL, inhibits the development of resistance.

FUSARIA ASSOCIATED WITH ASPARAGUS FLOWERS, FRUIT AND SEED. Robert L. Gilbertson and William J. Manning, Dept. of Plant Pathology, University of Massachusetts, Amherst, MA 01003.

Asparagus (*Asparagus officinalis* L.) flowers, fruit and seed were collected from local asparagus fields to determine whether they serve as sources of inoculum for *Fusaria* associated with asparagus root and crown rot. *Fusarium moniliforme*, *F. oxysporum*, *F. solani*, and *F. tricinctum* were isolated from washed flowers at pre-open, open and senescent stages, from non-surface-sterilized pulp from green and mature fruit, and from seeds, whether surface-sterilized or not. Isolates of *F. oxysporum* and *F. moniliforme* were pathogenic to asparagus seedlings.

FUSARIUM INCIDENCE IN ASPARAGUS SEEDLINGS GROWN IN AN OLD AND A NEW FIELD. Robert L. Gilbertson and William J. Manning, Dept. of Plant Pathology, University of Massachusetts, Amherst, MA 01003.

Asparagus (*Asparagus officinalis* L.) seedlings of cultivars Mary Washington, Viking 2-K, and Rutgers Beacon were grown in an old asparagus field and one with no known history of asparagus culture. Seeds were pre-soaked in water (PS) or PS + 10% Clorox, or PS + Clorox + 2.5% benomyl in acetone, before planting. Six-week-old seedlings were rated for disease and crowns used for isolations. 80-100% of all seedlings from all treatments and both locations had *Fusarium* symptoms. Rutgers Beacon seedlings had less disease and more vigor in both fields. *F. oxysporum* was isolated most frequently. *F. moniliforme* was not prevalent in seedlings from the new field.

THE EFFECTS OF LANDFILL GASES ON AMERICAN BASSWOOD ROOT DISTRIBUTION. E. Gilman, I. A. Leone, F. Flower. Dept of Plant Pathology, Cook College, New Brunswick, NJ 08903

Root systems of 12 4-year old American basswood (*Tilia americana* L.) trees growing in 2' of cover soil placed over a completed sanitary refuse landfill were excavated and mapped. Elevated levels of soil CO<sub>2</sub> and CH<sub>4</sub> emanating from decomposing refuse, in conjunction with low O<sub>2</sub> concentrations, appear to be partially responsible for causing a decrease in total root length and a reduction in the depth of root penetration. In areas of high landfill gas concentrations (23% CO<sub>2</sub>, 12% CH<sub>4</sub>, 4% O<sub>2</sub>) 30 cm below the soil surface, basswood roots ceased growing; however at moderate gas concentrations (8% CO<sub>2</sub>, 1% CH<sub>4</sub>, 18% O<sub>2</sub>) the roots grew toward the soil surface, away from the source of CO<sub>2</sub> and CH<sub>4</sub>. Multiple regression analysis showed that the concentration of soil carbon dioxide and oxygen together accounted for 84% of the variability in total root length. The results suggest that the ability of woody species to survive in landfill soil may be related to the vertical distribution of the root system.

WHITE LINE MOSAIC AND STUNT OF FIELD AND SWEET CORN IN VERMONT ASSOCIATED WITH POLYHEDRAL VIRUS INFECTION. A. R. Gotlieb and A. L. Liese, Botany Department, University of Vermont, Burlington, VT 05405.

In early July of 1979, stunt of early planted corn accompanied by white lines 1 to 2 mm wide by 1 to 4 cm long on older leaves was noted. Stunt became apparent by mid-July as symptomless plants continued growth. Stunted plants produced small or no ears. Survey revealed approximately 50% of the fields in Addison and Franklin counties were affected. Plants affected within fields ranged from as low as 5% to a high of 40%. Mechanical transmission was unsuccessful. Virus was purified from field collected plants by clarification with hydrated calcium phosphate combined with differential centrifugation. Density gradient fractionation resulted in two major particle fractions with A 260/280 ratios of 1.6 to 1.7. Electron microscope examination revealed a polyhedral particle 24 nm in diameter. A specific antiserum was produced to purified virus. This virus may be previously undescribed in corn.

INTERACTIONS BETWEEN RHIZOBIUM LEGUMINOSARUM AND FUSARIUM SOLANI F. SP. PISI IN VITRO AND IN VIVO. A. Bruce Gray and

W.E. Sackston. Dept. of Plant Science, Macdonald Campus of McGill University, Ste. Anne de Bellevue, Que., Canada H9X 1C0

Ten strains of *Rhizobium leguminosarum* from peas were grown on yeast extract mannitol agar in petri plates with *Fusarium solani* f. sp. *pisi*, the major pathogen associated with root rot of processing peas in Quebec. All 10 strains inhibited the growth of *F. solani*, some more than others. Peas were grown in controlled environment cabinets in sterilized soil infested to various degrees with *F. solani*, and with the respective *Rhizobium* strains in peat culture placed at seed level. Nodulation was reduced progressively by increasing concentrations of *F. solani* inoculum and resulting greater root rot intensity. Least effect was observed on nodulation by those *Rhizobium* strains least inhibitory to *F. solani* *in vitro*.

THE INFLUENCE OF MAIZE DWARF MOSAIC VIRUS ON YIELD OF SWEET CORN. L. V. Gregory and J. E. Ayers, Department of Plant Pathology, The Pennsylvania State University, University Park, PA 16802.

Experiments were conducted to investigate the influence of maize dwarf mosaic virus (MDMV) on yield of sweet corn using 2 cultivars (Bonanza and Stylepak) at Rock Springs and Landisville, Pennsylvania. Treatments consisted of inoculations with MDMV strain A at different growth stages beginning with the 3-4 leaf stage and continuing at weekly intervals. Yield was expressed as the number and fresh weight of marketable and unmarketable primary ears. There were no significant differences in either total number of ears or total fresh weight in any treatments. In most cases, inoculated plots had statistically fewer marketable ears in comparison with the uninoculated control. The greatest reduction in marketable ears occurred in plots inoculated at the 8-9 leaf stage at Landisville and Rock Springs. It appears that MDMV-A may have a more pronounced effect on yield when infection and subsequent disease development coincides with ear development.

IS AMBIENT OXIDANT DETRIMENTAL TO HYBRID POPLAR? Ronald Harkov, Bruce Clarke, Ann Rhoads and Eileen Brennan. Dept. of Plant Pathology, P.O. Box 231, Cook College, New Brunswick, New Jersey 08903.

In an effort to answer the question of whether oxidant pollution affects the growth of urban woody vegetation, we have used an ozone sensitive clone of hybrid poplar (Clone #388) in a four-year open-top chamber study. Rooted cuttings of Clone #388 were planted in one-gallon plastic containers filled with a greenhouse potting mix (loam:vermiculite:peat). All plants were cut back to a single bud and were placed in either an open-top chamber with charcoal-filtered air or in an unfiltered chamber. Linear growth (cm) was recorded at various time intervals. Ambient oxidant levels were continuously monitored using a Mast meter equipped with a chromium trioxide scrubber. No linear growth effects were noted during the four-year study even though ambient oxidant levels frequently exceeded 0.10 ppm and significant growth effects were noted on plantings of bean, potato, and alfalfa.

ROLE OF PLANT BREEDING IN FORAGE PEST MANAGEMENT SYSTEMS. R. R. Hill, Jr. and K. T. Leath. U.S. Regional Pasture Research Laboratory, University Park, PA 16802

Integrated pest management systems are less well developed for forages than for many other crop species. Host plant resistance, pesticides, and various cropping practices have been used alone and in combinations to reduce losses from disease and insect pests. Little has been done to determine optimum combinations of different pest control strategies for forages. With few exceptions, forage cultivars are heterogenous mixtures of heterozygous genotypes. Most breeding for pest resistance has been done with population improvement methods. Epidemiological investigations to determine frequencies of resistant plants needed in forage cultivars to provide practical levels of protection are needed to make maximum use of plant breeding expertise in development of sound integrated pest management systems.

EFFECTS OF A BACTERIOCIN PRODUCED BY ERWINIA HERBICOLA ON ERWINIA AMYLOVORA. S.S. Hodges, S. V. Beer, and J. R. Rundle. Department of Plant Pathology, Cornell University, Ithaca, N.Y. 14853.

Culture filtrate (CF) prepared from *Erwinia herbicola* (strain 112Y), grown in a potato extract-glucose-asparagine broth, contained a soluble, bacteriocin-like substance(s) that

inhibited *E. amylovora* (strain 273) *in vitro*. Concentrations of CF as low as 0.5% (v/v) inhibited growth of early log-phase cultures of *E. amylovora* growing in nutrient-yeast extract-glucose broth. *E. amylovora* cells were sensitive only when actively growing. Growth was monitored by determining number of colony forming units per ml (cfu/ml) and by measuring optical density at 620 nm ( $OD_{620}$ ), relative to cultures without added CF. Decreases in cfu/ml occurred 30 to 45 min after addition of CF, whereas decreases in  $OD_{620}$  occurred 90 min after addition. Gross morphological changes of treated cells, including the development of protuberances, were observed with phase contrast microscopy by 90 min after treatment with CF.

CELL WALL APPPOSITIONS AND PLANT DISEASE RESISTANCE: ACOUSTIC MICROSCOPY OF PAPILLAE THAT BLOCK FUNGAL INGRESS. H. W. Israel\*, R. G. Wilson†, J. R. Aist\*, and H. Kunoh‡. \*Department of Plant Pathology, Cornell University, Ithaca, NY 14853; †Hughes Research Laboratories, Malibu, CA 90265; and ‡Laboratory of Plant Pathology, Mie University, Tsu-city 514, Japan.

Preformed oversized papillae, experimentally produced in coleoptile cells of compatible barley, *Hordeum vulgare*, can prevent direct entry of *Erysiphe graminis* f. sp. *hordei* that ordinarily penetrates and causes disease. To discover how these papillae may function, acoustic microscopy was used to contrast their *in vivo* elastic properties with those of ineffective normal papillae and contiguous cell wall. Raster and line scans showed intense acoustic activity at sites of preformed papillae; scans in selected focal planes identified this activity with the papillae, not with subtending cell wall. Minimal acoustic activity was found in normal papillae. It is suggested that some wall appositions could serve in disease resistance as visco-elastic barriers to mechanical forces exerted by the special penetration structures of encroaching pathogenic fungi.

PYTHIAECIOUS FUNGI ASSOCIATED WITH THE CROWN ROT SYNDROME IN WESTERN NEW YORK APPLE ORCHARDS. S. N. Jeffers, H. S. Aldwinckle\*, T. J. Burr\*, P. A. Arneson. Departments of Plant Pathology, Cornell University, Ithaca, New York 14853 and \*NY State Agric. Expt. Sta., Geneva, New York 14456.

Recently, species of *Phytophthora* other than *P. cactorum* have been implicated as pathogens in crown rot of apple trees. A pimaricin-vancomycin-PCNB medium was used to isolate pythiaecious fungi from apple trees in NY with typical crown rot symptoms. Occasionally *P. cactorum* was found, but more commonly a species tentatively identified as *P. megasperma* was found in necrotic tissues. A heterothallic species of *Phytophthora* was isolated once. This is the first report of *Phytophthora* sp. other than *P. cactorum* isolated from apple trees suffering from crown rot in New York. Three species of *Pythium* were found in the woody tissues sampled but each was found only once. Pathogenicity of these isolates has been determined by a modification of the Borecki & Millikan dormant twig assay, by a seedling assay, and by a green fruit assay. *P. cactorum* is consistently more pathogenic than the other species.

LEAF GROWTH OF SILVER MAPLE SEEDLINGS FUMIGATED WITH SO<sub>2</sub> AND OZONE. Keith F. Jensen and Roy L. Patton, USDA Forest Service, Northeastern Forest Experiment Station, P.O. Box 365, Delaware, OH 43015.

Silver maple seedlings were fumigated for 12 hours per day for 30 days with either 25 ppm O<sub>3</sub>, 50 ppm SO<sub>2</sub>, or both. Leaf length was measured three times a week throughout the study. At the end of the treatment period, leaf length, leaf width, leaf area and leaf dry weight were measured. Fumigation with SO<sub>2</sub>, O<sub>3</sub>, or both gases tended to retard leaf initiation, while fumigation with O<sub>3</sub> and O<sub>3</sub> plus SO<sub>2</sub> markedly reduced leaf length, width, area, and dry weight. Leaf shape and the leaf weight area ratio were not affected by fumigation. The reduction in leaf size of photosynthetic area caused by air pollutants may reduce the amount of photosynthate available for plant growth and result in slower growth of the entire plant.

ETIOLOGY OF BOTRYTIS BLOSSOM AND STEM BLIGHT OF LOWBUSH BLUEBERRIES. Steven B. Johnson, Department of Botany and Plant Pathology, University of Maine at Orono, Orono, ME 04469; Simeon S. Leach, USDA-SEA, University of Maine at Orono, Orono, ME 04469.

Field and controlled environment chamber studies were conducted to investigate primary inoculum sources, infection period identification and characterization, and timing of fungicide

application for control of Botrytis blossom and stem blight of lowbush blueberries. The primary inoculum source was identified as the duff and leaf debris from the previous years noncrop growth. Noncrop year application of benomyl was ineffective in reducing the *B. cinerea* field populations. Botrytis cinerea infected the prebloom and the full bloom stages of the floral bud in less than 12 hours under optimum conditions of 18 to 20 C, 100% relative humidity with free moisture at the infection site. Benomyl was ineffective in controlling the disease when applied six hours after inoculation.

NEW FUNGICIDES FOR THE CONTROL OF ONION WHITE ROT. Johnston, S. A., Rutgers Res. & Dev. Center, Bridgeton, N.J. 08302

Fungicide trials for the control of onion white rot (*Sclerotium cepivorum*) were conducted during the 1977-78 and 1978-79 growing seasons for overwintering green bunching onions. Onion white rot was severe in both seasons. Fungicides were applied as in-furrow sprays at the time of seeding in both tests. In the 1978-79 test, a foliar application of each fungicide treatment was applied to half of each plot in early spring. Rovral (1.12 kg/ha) and Ronilan (1.12 kg/ha) provided significant control of onion white rot in 1978, while Rovral (0.56 and 1.12 kg/ha), Ronilan (1.12 and 2.24 kg/ha) and DPX-4424 (0.56 and 1.12 kg/ha) provided significant control in 1979. A spring application of Rovral and DPX-4424, in addition to the fall application, improved control of onion white rot compared to only a fall application; while control with Ronilan was not enhanced with the spring application. In a separate test in 1979, Rovral (7.84 kg/ha) provided complete control of onion white rot when applied in the spring, either as a single foliar spray or as a single basal drench without a fall application at seeding.

DETOXIFICATION OF PHASEOLLIN BY FUSARIUM SOLANI F. SP. PHASEOLI. H.C. Kistler and H.D. VanEtten, Dept. Plant Pathology, Cornell Univ., Ithaca, NY. 14853.

The bean root rot pathogen, *F. solani* f. sp. *phaseoli*, metabolizes phaseollin, a phytoalexin from *Phaseolus vulgaris*, to the less fungitoxic compound 1a-hydroxyphaseollone (Phytochemistry 13:1129). Pretreatment of the fungus with non-toxic concentrations of phaseollin increases the rate of subsequent phaseollin detoxification (Physiol. Plant Path. 3:327). Further study of phaseollin detoxification by *F. solani* f. sp. *phaseoli* revealed that: 1)  $^{18}O$  from  $^{18}O_2$  but not  $H_2^{18}O$  is incorporated into 1a-hydroxyphaseollone, during the metabolism of phaseollin, and 2) pretreatment with other selected isoflavonoid and non-isoflavonoid polyphenolic compounds enhances the ability of the fungus to metabolize phaseollin. These results suggest that phaseollin is detoxified by *F. solani* f. sp. *phaseoli* by means of a nonspecifically induced, oxygenase enzyme system.

PHOTOSYNTHESIS IN CHLOROPLASTS ISOLATED FROM BARLEY INFECTED WITH HELMINTHOSPORIUM SATIVUM. L.J. Laber and G.A. Strobel, Department of Botany and Plant Pathology, University of Maine, Orono, Maine 04469, and Department of Plant Pathology, Montana State University, Bozeman, Montana 59717, respectively.

The interactions between chlorosis and photosynthesis in barley infected by *Helminthosporium sativum* are not well understood. Barley seedlings (8 days old) were sprayed with spores and placed in a chamber at 100% humidity. Chloroplasts were isolated every 12 hours for 3 days and their activities compared with those from uninfected seedlings. After 3 days the chlorophyll content of diseased leaves was 30% of the control leaves. However, the isolated chloroplasts carried out Hill reaction (ferricyanide reduction), noncyclic photophosphorylation and cyclic photophosphorylation at the same rates as control chloroplasts. Yields of protoplasts were low 12 hours after inoculation and none were obtained at later times. Therefore, the primary locus of action of this fungus is not the inner (chlorophyll containing) membranes of chloroplasts. We suggest that the plasma membrane is more likely to be a primary site.

CALCULATION OF CROP LOSSES DUE TO MYCOPLASMA DISEASES: PEACH X-DISEASE AND PEAR DECLINE. George H. Lacy and John L. McIntyre, Department of Plant Pathology and Botany, The Connecticut Agricultural Experiment Station, New Haven, CT 06504.

Losses were determined for two mycoplasma diseases, peach X-disease, a dramatic disease, and pear decline of scions on *Pyrus communis* rootstock, an insidious disease. The major parameters of crop losses were reduced fruit set for X-disease and loss of fruit weight for pear decline. In X-disease the trees die, but in pear decline, the trees live and produce fruit for years. For X-disease, % loss =  $100 \left[ \frac{S_t Y_0 - (S_1 Y_1 + S_2 Y_2 + S_3 Y_3 + S_4 Y_4)}{S_t Y_0} \right]$

where  $Y_0$  = fruit yield (kg/cm<sup>2</sup>) from symptomless scaffolds,  $Y_{1-4}$  = yield of scaffolds with specific symptoms (1 = mild, to 4 = dead),  $S_t$  = total number of scaffolds and  $S_{1-4}$  = number of scaffolds with specific symptoms. For pear decline, the % loss =  $100 \left[ \frac{T_t Y_s - (T_t - T_d) Y_s + T_d Y_d}{T_t Y_s} \right]$  where  $T_t$  = total number of trees,  $T_d$  = trees with symptoms,  $Y_s$  = yield (kg/cm<sup>2</sup>) of symptomless trees, and  $Y_d$  = yield of diseased trees.

OXYTETRACYCLINE DAMAGE TO TRUNKS OF X-DISEASED PEACH TREES TREATED BY VARIOUS METHODS. George H. Lacy, Department of Plant Pathology and Botany, The Connecticut Agricultural Experiment Station, New Haven, CT 06504.

Trunks of peach trees treated with oxytetracycline (OTC) solutions became necrotic in vertical elongated patterns around the application sites. Damage was worst when OTC was infused after frost had occurred and was more damaging to trees with severe symptoms than trees with moderate or mild symptoms. Trunk damage varied with the method of OTC application. Trees infused with large volumes (1000 ml containing 500 mg OTC/infusion site), 10 ml pipets (10 ml containing 100 mg OTC/infusion site), 15 ml pipets (15 ml containing 300 mg/infusion site), Mauget cups (50 ml containing 500 mg/infusion site) concentrated OTC (1.0 ml containing 100 mg/infusion site), or injected with pneumatic pressure (2.1 kg/cm<sup>2</sup>) apparatus (1333 ml containing 333 mg/infusion site) caused 13, 14-19, 30, 44, 69, 42-93, and 69 cm<sup>2</sup> trunk damage, respectively. The 10 ml pipet application was least damaging, least expensive, and most rapid.

DNA HOMOLOGIES AMONG SPIROPLASMA STRAINS REPRESENTING DIFFERENT SEROLOGICAL GROUPS. I.-M. Lee and R. E. Davis, Dept. of Plant Path., Rutgers Univ., New Brunswick, NJ 08903; & Plant Virol. Lab., USDA, Beltsville, MD 20705.

DNA homology among 10 strains of *Spiroplasma* spp. representing 3 serogroups (Davis et al., 1979. Can. J. Microbiol. 25:861) was assessed after digestion of DNA-DNA duplexes in liquid with single-strand specific S<sub>1</sub> nuclease. Two strains representing each serogroup (and subgroup) were examined. DNA homology between the two strains of each pair was 77% or greater. DNA homology between the serogroup I, subgroup A (IA) strain *S. citri* Maroc R8A2 (as <sup>3</sup>H-labeled DNA probe) and honey bee spiroplasmas AS 576 and G 1 (group IB) was 45-48%; that between Maroc R8A2 and corn stunt spiroplasmas I-747 and PU 8-17 (group IC) was 32-33%; that between Maroc R8A2 and nectar spiroplasma strains 23-6 and 27-31 (group II) or between Maroc R8A2 and other nectar strains SR 3 and SR 9 (group III) was 5%. Results from reciprocal hybridizations were in good agreement. DNA homology between the 3 serogroups was never more than 5%. The data agree with divisions based on serological criteria and strengthen the hypothesis that each serogroup represents at least one *Spiroplasma* species.

MORPHOLOGY AND MODE OF MULTIPLICATION OF *SPIROPLASMA CITRI* UNDER OPTIMAL GROWTH CONDITIONS IN VITRO. Ing-Ming Lee, E. C. Calavan, and D. J. Gumpf, 1st author, USDA/SEA, Beltsville, MD 20705, 2nd and 3rd authors, Department of Plant Pathology, University of California, Riverside, CA 92521.

Helical filaments were the only morphotypes observed during logarithmic increase in titer. The smallest viable cell was a helical filament with approximately 1.5-2 gyres having one tapered or pointed end, and one rather blunt end from which cell elongation appeared to occur. Constrictions developed near the middle of helical filaments when cell length reached 2-4 gyres. Further constriction resulted in separation of the two cells, often unequal in size and shape. If cells elongated before young cells completely separated, long helical and branched helical filaments with 2-3 constrictions resulted. Long, branched helical cells eventually divided by constrictions giving rise to short helical cells. The principal mode of multiplication of *S. citri* under optimal conditions thus appears to be cell elongation with new, short helical cells formed by cycles of constriction and cell separation.

A COMPARISON OF OZONE AND PEROXYACETYLNITRATE LEVELS IN AMBIENT AIR IN NEW JERSEY. Timothy E. Lewis and Eileen Brennan, Dept. Plant Pathology, Cook College, P.O. Box 231 New Brunswick, N.J. 08903.

An air monitoring station for O<sub>3</sub> and PAN has been in operation in New Brunswick, N.J. for one year. Total oxidant has been measured with a Mast sensor, O<sub>3</sub> by a chemiluminescent method, and PAN by gas chromatography. O<sub>3</sub> and PAN concentrations were



associated with daily and seasonal trends for incident solar radiation. During the course of a photochemically active day, the PAN maximum generally preceded the O<sub>3</sub> maximum, a sequence that is unlike that found in other cities where the two pollutants have been monitored simultaneously. This phenomenon appears inconsistent with the chemical mechanism by which PAN is formed. Long range transport may be involved in the explanation.

DEOXYRIBONUCLEIC ACID HYBRIDIZATION BETWEEN *SPIROPLASMA CITRI* AND CORN STUNT SPIROPLASMA. C. H. Liao and T. A. Chen, Dept. of Plant Pathol., Rutgers Univ., New Brunswick, NJ 08903.

Deoxyribonucleic acids (DNA) were extracted from the Morocco strain of *Spiroplasma citri* and two isolates (ATCC 29051 and the Mississippi isolate) of corn stunt spiroplasma by the method of Marmur except that pronase at the final concentration of 100 µg per ml was used. To prepare [<sup>3</sup>H] DNA, cells were cultivated in a modified C-3G medium containing agamma horse serum 15%, sucrose 8%, PPLO broth 1.5%, and 0.5 µCi of [methyl-<sup>3</sup>H] thymine per ml (20 Ci/mmol). The DNA-DNA hybridization was carried out on nitrocellulose membrane filters by the method of Denhardt (Biochem. Biophys. Res. Comm. 23:641). The DNA homology between *S. citri* and two isolates of corn stunt spiroplasma was determined to be 57%, an average value of 5 independent experiments (standard error ± 4). This method was compared with the liquid method using S-1 single strand specific nuclease.

A PLANT BREEDER'S VIEW OF CROP PROTECTION. D. R. MacKenzie, Department of Plant Pathology, The Pennsylvania State University, University Park, PA 16802.

The decade of the 1970's was one of converging concepts and an exciting time for crop protection. I am hopeful that the trend will continue. Prior to this period, pest control was an "or-strategy" representing sub-discipline adherents who chose only one method as a control practice, e.g. host resistance or chemicals. Today, with the birth of quantitative epidemiology, "and-strategies" or more integrated approaches can be explored for what is hoped to be more dependable methods of crop protection. Innovations in computers, crop and pest modeling, statistics, breeding methodology, basic epidemiology, etc. will open new areas for efforts and hopefully provide more stability to crop production. These advances will have impact worldwide and at all levels of agricultural production. Examples of recent developments will be given.

APPARENT CONTROL OF POTATO EARLY BLIGHT ASSOCIATED WITH RATE OF NITROGEN FERTILIZER APPLICATION. D. R. MacKenzie, Dept. of Plant Pathology, The Pa. State University, University Park, PA 16802.

Recommended nitrogen (N) fertilizer rates are often exceeded in commercial potato crop practices with assumed negative effects on crop quality and profits. Investigations into why growers would "squander" resources unnecessarily focused on the obvious effects of N on delayed crop senescence. Potato early blight (caused by *Alternaria solani*) was used as a representative late season pest to test the hypothesis that, in commercial practice, N is used to control "senescent type diseases." The quantity of N applied (ranging from 0 to 200 kg/ha) significantly lowered apparent infection rates and reduced terminal disease severity. Significant yield losses were associated with increased early blight. Yield response curves to N applied shifted upwards from an optimum of 133 kg/ha in the absence of early blight to 160 kg/ha in the presence of the disease. Given present prices for N fertilizer and the current value of potatoes, and when faced with the need to control early blight, net profits are maximum at N rates higher than previously recommended.

GENETIC RECOMBINATION IN *FUSARIUM OXYSPORUM* F.SP. *LYCOPERSICI* IN VIVO AND IN VITRO. B.H. MacNeill, F. Romero-Munoz and Sue Chilton, Department of Environmental Biology, University of Guelph, Guelph, Ontario, Canada.

Two strains of *F. oxysporum* f.sp. *lycopersici* which could be distinguished on the basis of morphology, virulence and sensitivity to certain fungicidal toxophores were used to doubly infect a susceptible tomato cultivar. Subsequently, isolations from the stem yielded the parental strains as well as recombinants of the three genetic markers. Recombination also occurred in petri plate culture when mixtures of the two strains were used as inoculum. The significance of the parasexual cycle as a mechanism of genetic exchange both *in vitro* and during host passage is discussed.

IDENTIFICATION, ETIOLOGY, AND CONTROL OF *EUONYMUS FORTUNEI* ANTHRACNOSE CAUSED BY *COLLETOTRICHUM GLEOSPORIOIDES*. M. J. Mahoney and T. A. Tattar, Shade Tree Laboratories, Dept. of Plant Pathology, University of Massachusetts, Amherst, MA 01003.

A leaf and stem spotting disease on field and container-grown *Euonymus fortunei* 'Emerald 'n Gold' and 'Gaiety' was found at several nurseries in New England. *Colletotrichum gloeosporioides* Penz. was consistently isolated from diseased leaves and stems. Leaf and stem lesions are discrete, circular, dark-brown and 0.5-3.0 mm dia. with light tan necrotic centers. Initial infection occurs during late May in Mass. and repeated infections occur throughout the growing season. Under laboratory conditions lesion development is most severe after 24 hrs. or more of leaf wetness, and the optimum temperature range for vegetative growth and spore germination is 25-30°C. All *E. fortunei* cultivars tested under laboratory conditions were susceptible to infection. Under these conditions Maneb, Manzate 200, and Daconil 2787 completely protected leaves from lesion development.

CARBOHYDRATE UTILIZATION OF FIVE *SPIROPLASMA*. K. M. Malloy and T. A. Chen, Department of Plant Pathology, Rutgers University, New Brunswick, N.J. 08903.

Carbohydrate utilization was used to partially characterize 5 spiroplasmas: corn stunt (C.S.), honeybee (H.B.), leaf blotch (LB-12) and suckling mouse cataract associated (SMCA) spiroplasmas, and *S. citri*. Eleven filter sterilized carbohydrates were separately tested in autoclaved stock medium containing 1.5% PPLO broth, 0.02% phenol red in a balanced salt solution plus 15% horse serum. Monosaccharides were added at a rate of 0.2%, all others at 0.4%. A positive result was determined by an increase in cell numbers and sufficient acid production to change the pH indicator to yellow. The results showed C.S. was positive for fructose. *S. citri* and H.B. were positive for glucose, fructose, maltose, starch, and trehalose. SMCA and LB-12 were positive for glucose, fructose, maltose, and starch but negative for trehalose. *S. citri*, H.B., LB-12, and SMCA could be maintained in sucrose; after 2 mos. sufficient acid was produced to change the color of the medium but the number of cells did not increase.

USE OF PORTABLE TELEVISION FOR AERIAL INFRARED DETECTION OF POTATO DISEASES. F.E. Manzer and G.R. Cooper, Department of Botany and Plant Pathology, University of Maine, Orono, Maine 04469.

A portable black and white television camera was modified and filtered to record imagery in the near-infrared (700-900 nm). Test imagery to date shows that early and late blight of potato foliage can be detected in a manner similar to that shown previously by the authors using black and white infrared photography. Advantages of television over photography include elimination of delay in film development and direct viewing through the camera of subjects as they appear in infrared. The latter advantage allows the camera operator to "zoom in" on any area showing evidence of foliage damage.

A SELECTIVE MEDIUM FOR *VERTICILLADIELLA PROCERA*. K. A. McCall, and W. Merrill, Department of Plant Pathology, The Pennsylvania State University, University Park, PA 16802.

*Verticilladiella procera* causes a root decline of *Pinus strobus*. This disease is suspected to occur in scattered localities throughout PA, but this has not been confirmed due to difficulty in isolating the pathogen. *In vitro* studies showed that 500 mg/liter cycloheximide in acid malt agar (AMA) prevented the growth of some commonly occurring contaminants such as *Trichoderma viride* and *Fusarium solani*, but not the growth of *V. procera*. In subsequent field studies, chips from the roots and stems of white pines suspected or known to be infected by the pathogen were plated on AMA containing 500 mg/liter cycloheximide. The pathogen was recovered in pure culture from trees in various stages of decline. It was recovered in small percentages from chips from dead trees (1.7% and 3.3%) and chips from a tree just beginning to show symptoms (20%). It was recovered in high percentages from chips of trees in an active state of decline (82% and 100%).

*ARMILLARIELLA MELEA* IS ASSOCIATED WITH A DISEASE OF BLUEBERRY BUSHES IN CONNECTICUT. John L. McIntyre and George H. Lacy, Department of Plant Pathology, The Connecticut Agricultural Experiment Station, New Haven, CT 06504.

*Armillariella mellea* is associated with diseased blueberry bushes (*Vaccinium corymbosum*) in Connecticut that were

planted in a field 1- or 2-yrs after it was cleared of a hardwood forest. *A. mellea* is not reported to cause disease on this plant, but rhizomorphs of *A. mellea* were present, and mycelial fans were observed, on roots and stems of all diseased plants that were removed from the soil. Foliage on diseased bushes turns red prematurely and affected plants weaken and die. The disease occurred on each of 13 varieties, with 8 varieties having greater than 5% incidence. The most severely affected variety was Weymouth (34%). Since varieties were not replicated this high incidence may result from either inoculum abundance or varietal susceptibility. Although Koch's postulates have yet to be satisfied, these observations indicate caution when planting blueberry bushes on land recently cleared of hosts of *A. mellea*.

INDUCED RESISTANCE OF TOBACCO: A GENERALIZED RESPONSE AGAINST SEVERAL DIFFERENT PATHOGENS. John L. McIntyre, J. Allan Dodds, and J. Daniel Hare. Departments of Plant Pathology and Entomology, The Connecticut Agricultural Experiment Station, New Haven, CT 06504.

Tobacco mosaic virus (TMV) inoculation of a hypersensitive tobacco cultivar induced systemic and long-lived resistance against TMV, *Phytophthora parasitica* var. *nicotianae* (Ppn), and *Pseudomonas tabaci* (Pt). Reproduction of the aphid, *Myzus persicae*, is also reduced on TMV-induced plants, and aphid mortality may be increased. Resistance to Ppn, Pt, and TMV was also induced by localized infections of tobacco necrosis virus, but not by systemic infections of cucumber mosaic virus. Levels of protection and the time resistance develops in a given leaf, however, are not the same for the different challengers. These results suggest that induced resistance of tobacco is a generalized response and that different protection mechanisms develop against different pathogens following the initial induction response.

CHEMICAL CONTROL OF NAEMACYCLUS NEEDLECAST OF SCOTS PINE. W. Merrill, B. R. Kistler, and K. Bowen, Department of Plant Pathology, The Pennsylvania State University, University Park, PA 16802.

There are three infection periods in *Naemacyclus minor* needlecast of Scots pine in PA. First year needles are infected in mid to late summer, late fall, and the following spring. Therefore in 1977-78 we studied the effectiveness of Manzate 200 80W in controlling this disease. The chemical was applied with a back-pack mist blower at the rate of 1.5 lb f.p. plus 4 oz of Pinolene sticker per 100 gal per acre. All combinations of summer, fall and spring applications were used. Percentage of foliar infection was established by direct isolations from needles in Sept. 1978. Unsprayed trees averaged 60 percent foliar infection. Summer and/or fall applications reduced infection to 21 to 34 percent, significant at  $P=0.01$ . Any schedule including spring applications reduced infection to less than 4 percent, significantly different from all other treatments at  $P=0.01$ . This spring spray schedule is being field tested in 1979 by five commercial growers.

INFECTION PERIODS FOR NAEMACYCLUS NEEDLECAST OF SCOTS PINE. W. Merrill, B. R. Kistler, and L. Zang, Department of Plant Pathology, The Pennsylvania State University, University Park, PA 16802

*Naemacyclus minor* causes a serious needlecast of Scots pine Christmas trees in PA. Previously we reported that inoculum of the pathogen was present throughout the year and that infection of first-year needles occurred in summer and fall. Isolations suggested that the first year needles also became infected the following spring. Therefore we isolated from 5 year's complements of needles from emergence from the fascicle sheaths to casting up to 18 months later. The trees studied were 5 to 12 years old, of French and Spanish provenances, and were growing in commercial Christmas tree plantations in three different climatic regimes in the state. Up to 10 percent of the first-year needles were infected in late summer. The level of infection increased to about 15 percent during the fall and to 60 to 90 percent the following spring. Thus in PA the major infection period is in the spring, usually from mid-April to mid-June. Preliminary data suggest that infection during this period is closely related to rainfall.

INFLUENCE OF MULCHING ON VERTICILLIUM WILT INFECTION RATE AND YIELD IN EGGPLANT. G.W. Moorman, University of Massachusetts, Suburban Experiment Station, 240 Beaver Street, Waltham, MA. 02154.

Four eggplant varieties were grown in a field artificially infested with *Verticillium dahliae*. Certain plants were mulched

with black polyethylene film while other plants were not mulched. The apparent infection rates in mulched 'Black Beauty', 'Beauty Hybrid', and 'Black Jack' were approximately half the apparent infection rates in plants grown on bare ground. Mulching did not greatly reduce the apparent infection rate in 'Satin Beauty' plants. The apparent infection rates in mulched plants and non-mulched plants remained relatively constant during the first 70 days after transplanting after which the rates increased sharply. Eighty-four days after transplanting, 96%-100% of all the plants had *Verticillium* wilt. Mulched plants of each variety produced more than twice as many fruit as the plants grown on bare ground.

EFFECT OF TEMPERATURE ON THE PREDISPOSITION OF TOMATO TO FUSARIUM WILT BY ROOT KNOT NEMATODE. J. J. Morrell and J. R. Bloom, Dept. of Plant Pathology, The Pennsylvania State University, University Park, PA 16802

'Bonny Best' tomato plants were grown in soil infested with combinations of *Fusarium oxysporum* f. s. *lycopersici* Race 1 and *Meloidogyne incognita*. Two different isolates of the fungus were used. Plants were maintained in Cornell-type soil temperature tanks at 16, 21, 24, or 28 C for a period of 28 days after infestation with the fungus. Significant levels of infection were found at all temperatures tested, including 16 C, which had not been reported previously. The first isolate had highest levels of infection at 21 and 24 C in the presence of root knot nematodes, and at 24 and 28 C in the presence of the fungus alone. At 16 C there was no significant difference in the number of plants infected with the second isolate alone or in combination with the root knot nematodes, although the presence of nematodes caused a significant increase in the percent incidence and vessel infection at 21 C.

PRESSURE AND COMPOSITION OF INTRASTEM GASES PRODUCED IN WETWOOD INFECTED AMERICAN ELM (*ULMUS AMERICANA* L.) TREES. C.W. Murdoch, C.J. Biermann and R.J. Campana, Department of Botany and Plant Pathology, University of Maine, Orono, Maine 04469

Wetwood in elm is characterized by high intrastem gas pressure, but preliminary data indicate a need for reassessment of the relative proportion of the gases involved. Intrastem gas pressures of wetwood-infected elm trees and the composition of the gases present were monitored. Gaugecocks were installed on ten elm stems ranging in dbh from 20-61 cm. Pressures were recorded at weekly intervals to one year. Five trees were analyzed for oxygen, nitrogen, methane and carbon dioxide content using gas chromatography. From November-April no pressure was observed in infected trees. Highest values were recorded in August. Pressures up to 1.41 kg/cm<sup>2</sup> were recorded. Gas composition averaged 7.2% oxygen (0-13), 32.8% nitrogen (4-55), 47.2% methane (24-83) and 8.8% carbon dioxide (6-10). Three different bacteria have been isolated from infected trees, suggesting that wide differences in gaseous content may reflect varying bacterial populations.

PROTOCOL FOR THE DETECTION OF TOBACCO RINGSPOT VIRUS IN GERANIUM BY ELISA. S. R. Newhart and C. P. Romaine, Dept. of Plant Pathology, The Pa. State University, University Park, PA 16802.

The protocol for indexing florist's geranium (*Pelargonium x hortorum*) for tobacco ringspot virus (TRSV) by the enzyme-linked immunosorbent assay (ELISA) was investigated. Alkaline phosphatase-labeled antibodies to TRSV were used to detect purified antigen that was diluted in either geranium leaf extracts subjected to successive levels of clarification or PBS-T-PVP (phosphate-buffered saline, 0.02 M phosphate, pH 7.4, 0.15 M NaCl containing 0.05% Tween-20 and 2% polyvinyl pyrrolidone). Extracts were filtered through Miracloth, diluted in PBS-T-PVP, clarified by centrifugation at 12,000 g for 10 min., and lastly, precipitated by 6% polyethylene glycol and 0.3 M NaCl. Each succeeding clarification step improved antigen detection to levels as low as 300 ng/ml. The results indicated that clarification of the test sample was required for reliable indexing of geranium for TRSV by ELISA.

HISTOPATHOLOGICAL STUDY OF ALFALFA ROOT INFECTED BY HOPLALAIMUS GALEATUS. O. C. Ng and T. A. Chen, Department of Plant Pathology, Rutgers University, New Brunswick, New Jersey 08903.

Pathological changes in axenically cultured alfalfa roots infected by a single *Hoplalaimus galeatus* were studied with light and electron microscopes. Longitudinally, cell damage could be traced 105  $\mu$ m from the point of nematode penetration. Damaged cells picked up more stain than healthy cells. Formation of passageway and feeding cavities by the nematode caused mechani-

cal damage to cortex. However, cells with dense tonoplast or darkened granular contents were also observed; these changes were apparently not due to mechanical damage. Hypertrophy and hyperplasia were found in the pericycle. As the pericycle cells increased in size and number, the endodermis was flattened and collapsed. Electron dense materials accumulated along the tonoplast membrane of the endodermis and pericycle. Vascular damage included feeding cavities, lysed phloem tissue and the association of electron dense materials with the xylem elements. Thus, both mechanical and chemical injuries are involved in the pathogenesis of *Hoplostaimus galeatus*.

**PARTIAL CHARACTERIZATION OF A MEMBRANE-ASSOCIATED RNA-DEPENDENT-RNA POLYMERASE IN TOBACCO RINGSPOT VIRUS-INFECTED CUCUMBER.**  
B.L. Molt, C.P. Romaine, S.H. Smith, Dept. of Plant Pathology, The Pennsylvania State University, University Park, PA 16802.

Infection of cucumber cotyledons with tobacco ringspot virus (TRSV) results in up to a 9-fold increase in actinomycin D insensitive RNA polymerase activity in a membrane-rich subcellular fraction (31,000 g pellet). The increase in RNA polymerase activity precedes the log-phase in the virus growth curve, becomes maximal at 4 days post-inoculation, and then rapidly declines. The kinetics of <sup>3</sup>H-UTP incorporation into an acid-insoluble product is linear for 30 minutes. Enzyme activity is dependent upon the presence of the other three nucleoside triphosphates, is stimulated 25% by the addition of exogenous TRSV-RNA, and is reduced 80% by the addition of RNase, but only negligibly by DNase. The predominant <sup>3</sup>H-labeled products synthesized *in vitro* are high molecular weight and double-stranded and presumably intermediates in TRSV replication. The properties of this RNA polymerase are characteristic of the membrane-associated virus-specific RNA-dependent-RNA polymerase (bound replicase).

**CHEMICAL CONTROL OF APPLE BLOSSOM INFECTION BY ERWINIA AMYLOVORA.** J. L. Norelli, J. D. Gilpatrick, and H. S. Aldwinckle, Dept. of Plant Pathology, New York State Agricultural Experiment Station, Cornell University, Geneva, NY 14456.

Experimental and registered compounds were evaluated for control of apple blossom infection by *Erwinia amylovora* on 5-year-old Idared/M.7 trees. Test materials were applied as dilute sprays to runoff at 25-50% bloom and at early petal fall. Blossom clusters were inoculated at 50-80% bloom with an aqueous suspension of *E. amylovora* (10<sup>7</sup> cfu/ml). Greatest disease control (68%) was obtained with streptomycin, 100 mg/l. The level of disease control obtained by the following compounds did not differ significantly from that of streptomycin, 100 mg/l: cupric hydroxide, 1500 mg/l; MBR-10995, 300 mg a.i./l; oxytetracycline, 200 mg/l; and streptomycin, 50 mg/l. Disease control obtained with the following compounds did not differ significantly from that with water: benomyl, 225 mg/l; triadimefon, 300 mg/l; captan, 1200 mg/l; iprodione, 2100 mg/l; mancozeb, 1400 mg/l; KL-490-04-79, 10 mg/l; KL-496-04-79, 50 mg/l; and oxytetracycline, 100 mg/l.

**PRELIMINARY RESULTS CONCERNING THE FEASIBILITY OF DEVELOPING A FORECASTING PROGRAM FOR CHEMICAL CONTROL OF PYTHIUM BLIGHT.**  
F. W. Nutter, Jr. and H. Cole, Jr., Department of Plant Pathology, The Pennsylvania State University, University Park, PA 16802.

The arbitrary scheduling of fungicide applications to control Pythium blight is often cost-prohibitive; hence, protective control measures are rarely applied. Cost-effectiveness and efficacy might be increased were a forecasting program available to schedule fungicide applications. In 1978, the microclimate of 3 locations within each of 4 golf courses was monitored to determine if there are differences in the microclimate within a course, and if these differences are related to the appearance or non-appearance of Pythium blight. Two variables which were positively correlated with Pythium outbreaks were max daily temp (T) > 30 C, and the number of hours relative humidity was > 90% coincident with T > 20 C. These variables were reliable in forecasting disease appearance in 1979 and may allow sufficient warning to apply protective control measures that are cost-effective.

**THE EFFICACY OF COPPER COMPOUNDS FOR CONTROL OF BACTERIAL SPECK IN ONTARIO.** I.M. Parsons and L.V. Edgington, Department of Environmental Biology, University of Guelph, Guelph, Ontario. N1G 2W1.

Bacterial speck of tomato caused by *Pseudomonas tomatum* has become a serious problem in the 8000 hectares of processing tomatoes in Ontario. The bacteria infect pedicels causing flower drop, and delay of harvest. Also fruit infection interferes with skin removal in the processing of the

tomatoes. Field plots in Southern Ontario were sprayed with various copper fungicides, dithiocarbamate fungicides and combinations thereof. Untreated check plants developed 20% infected foliage by July 12th. Plants treated 7 times with fixed coppers beginning June 14th on a 7 to 10 day cycle receiving 15.2 and 30.8 kg/ha per season developed 15% and 10% infected foliage respectively. Neither of the dithiocarbamate fungicides maneb and mancozeb had an effect on disease when used alone but each enhanced the control when used in combination with the fixed coppers.

**EFFECTS OF AIR POLLUTANTS ON STEM CHARACTERISTICS OF HYBRID POPLAR.** Roy L. Patton and Keith F. Jensen, USDA Forest Service, Northeastern Forest Experiment Station, P.O. Box 365, Delaware, OH 43015.

Hybrid poplars (*Populus* spp.) grown in clean chambers were compared with poplars of the same nine clones grown in chambers fumigated with 15 ppm O<sub>3</sub>, 25 ppm SO<sub>2</sub>, or both. After 102 days, fumigated seedlings of all nine clones had lower specific gravity; those of six clones had lower dry weight/fresh weight ratios; and those of three clones had lower height, fresh weight, and dry weight. To test the effect of the chambers, seedlings of six clones grown in open-topped field chambers were compared with seedlings of the same clones grown in the open. Significant differences were found in stem fresh weight and dry weight in four clones; height in five clones; and specific gravity in one clone. There were no differences in dry weight/fresh weight ratio. These results suggest that dry weight/fresh weight ratio and specific gravity may be useful measures of the impact of air pollution on forests.

**OCCURRENCE OF BENOMYL-RESISTANT STRAINS OF UNICINULA NECATOR ON GRAPES IN NEW YORK.** R. C. Pearson, Dept. of Plant Pathology, New York State Agricultural Experiment Station, Geneva 14456.

Benomyl sprays gave good control of grape powdery mildew, *Uncinula necator*, in vineyards in western New York from 1974 to 1976, but poor control in some in 1977 and 1978. Isolates of *U. necator* were collected in 1978 and maintained on potted grapevines at 24°C in growth chambers. Resistance was determined by dipping the foliage of potted Riesling vines in a 600 µg/ml suspension of benomyl, allowing it to dry, and inoculating with a spore suspension (1.8-3.0 x 10<sup>4</sup> conidia/ml) of the test isolate. Disease control on plants inoculated with a known sensitive isolate was 100 and 99%, 2 and 3 wk after treatment, respectively, whereas control of disease from resistant isolates ranged from 51 to 86% at 2 wk; 50 to 73% after 3 wk. Field tests were conducted during 1979 in a Delaware vineyard from which benomyl-resistant isolates had been collected previously. Four applications of Benlate 50W at 1.12 Kg/ha provided 26 and 33% control of powdery mildew on leaves and clusters, respectively; whereas dinocap (Karathane 18.25W) at 1.4 Kg/ha provided 80% control of mildew on both leaves and clusters.

**THE EXPRESSION OF THE BUFFERING EFFECTS OF A MULTILINE ON DISEASE SEVERITY AND YIELD LOSS.** W. L. Pedersen, D. R. Mackenzie and R. R. Nelson, Dept. of Plant Pathology, The Pennsylvania State University, University Park, PA 16802

A four component multiline of winter wheat was compared to each component line and the variety Chancellor for total disease severity for powdery mildew and yield loss. The multiline consisted of equal proportions of four near-isogenic lines, in a Chancellor background, having the powdery mildew resistance genes Pm2, Pm3c, Pm4, and Michigan Amber (MA). Less than 1.0% total disease was observed on the multiline, Pm3c, Pm4, and MA and no significant differences in yield were observed among them. Chancellor sustained 27% total disease and a 17% reduction in yield. Pm2 sustained 15% total disease and 7% yield loss indicating Pm2 has some capacity, relative to Chancellor, to reduce disease severity and yield loss. It is hypothesized that the capacity of Pm2 to reduce disease and yield loss is enhanced in a buffered background of a multiline, since the multiline should have theoretically sustained approximately 4.0% total disease if the only effect was one of dilution.

**INADEQUATE POLLINATION OF ONION AND THE FLOWER BLIGHT COMPLEX.** G. R. Ramsey and J. W. Lorbeer, Department of Plant Pathology, Cornell University, Ithaca, NY 14853.

Poor seed set of onion in New York results from a flower disease complex caused by *Botrytis squamosa*, *B. cinerea* and *B. allii* and/or inadequate pollination precipitated by low populations of honey bees and syrphid flies. These two disorders cause similar symptoms and thus may be confused. Chlorothalonil which controls the pathogens in the disease complex did not reduce the level of honey bees and syrphid flies.

Ethephon reduced seed yield significantly but did not appear to affect pollination. Pollination was increased slightly by interplanting onions with *Brassica campestris* var. *parachinensis*. Since disease, unlike inadequate pollination, dictates fungicide control, proper diagnosis of the two disorders is essential.

SEED BORNE FUNGI OF ONION IN NEW YORK. G. R. Ramsey and J. W. Lorbeer, Department of Plant Pathology, Cornell University, Ithaca, NY 14853.

Onion seed produced in Orange County, New York during 1976-78 differed each year with respect to the internally borne fungal flora. *Alternaria* species were the predominant fungi isolated from seed produced during the relatively wet growing season of 1976, while *Fusarium* species were dominant in the relatively dry growing seasons of 1977-78. Onion seed lots harvested in 1978 had up to 84% of the seed internally infested with *Fusarium* species. *Fusarium oxysporum* and *F. moniliforme* were the most prevalent species in several seed lots. Those lots with high *Fusarium* infestation characteristically produced the lowest seedling stands when planted in either natural organic soil or autoclaved greenhouse soil. Seed lots with low *Fusarium* infestation characteristically produced the highest stands. All *F. oxysporum* and most *F. moniliforme* isolates from the seed were pathogenic in tests with onion seedlings, but virulence differed. Both fungi were isolated from seedlings (naturally infested seed) exhibiting post-emergence damping-off symptoms.

#### TREES RELATIVELY INSENSITIVE TO AMBIENT OZONE LEVELS.

A. Rhoads, R. Harkov, and E. Brennan, Plant Pathologist, Morris Arboretum of the University of Pennsylvania, 9414 Meadowbrook Ave., Philadelphia, Pa. 19118; Graduate Student and Professor respectively, Dept. of Plant Pathology, Rutgers University, New Brunswick, N.J. 08902.

For six years, 1973 through 1978, we made systematic field inspections for symptoms of ozone injury on trees in New Jersey and southeastern Pennsylvania. Included in the study were rural and urban locations and both native stands and horticultural plantings. Although our observations included a number of species cited as ozone-sensitive by various researchers, we noted only a few isolated cases of visible ozone injury. According to New Jersey air monitoring data ambient ozone levels exceeded the standard of 0.08 ppm numerous times during this period. Concurrent studies of herbaceous plants demonstrated frequent episodes of phytotoxicity to sensitive species. Using visible symptoms as the criterion for damage, we concluded that trees as a group are relatively insensitive to the photochemical air pollutant ozone.

CHLORINATED WATER: BROWN BLOTCH CONTROL BY REDUCTION OF PSEUDOMONAS TOLAASI POPULATIONS ON MUSHROOM PILEI. D.J. Royse & P. J. Wuest, Department of Plant Pathology, The Pennsylvania State University, University Park, PA 16802.

Brown blotch severity and incidence on the cultivated mushroom (*Agaricus bisporus*) caused by *Pseudomonas tolaasi* were significantly ( $P=0.05$ ) reduced by routine waterings of a 175 ug/ml solution of calcium hypochlorite (HTH® dry chlorinator) when compared to regular (control) waterings. Casing soil samples and mushroom pilei harvested at the peak of each break from each treatment were assayed for the presence of the blotch bacterium using an antibiotic selective medium (King's B basal medium, plus: 75,000 units penicillin G, 45 mg novobiocin, and 75 mg cycloheximide per liter added after autoclaving). Disease incidence and severity were positively correlated with bacterial populations on mushroom pilei but not with *P. tolaasi* populations in casing soil. Bacterial populations occurring on mushroom pilei and in casing soil were not correlated.

THE EFFECT OF HOST RESISTANCE ON RELATIVE PARASITIC FITNESS. M. H. Royer and R. R. Nelson, The Pennsylvania State University, Department of Plant Pathology, University Park, PA. 16802.

Eight isolates of *Helminthosporium maydis* race T were serially passed on a resistant normal cytoplasm corn hybrid for up to ten transfer generations. The original isolates were compared to the serially passed isolates on a susceptible Texas male-sterile corn hybrid for their infection efficiency, sporulation efficiency, and virulence (lesion size). Significant decreases in one or more of the fitness attributes occurred for each serially passed isolate. Reduced parasitic fitness occurred after only two serial transfers for some isolates. Two isolates which had been serially

passed on the resistant host for ten generations showed a significant increase in infection efficiency after two serial passages on the susceptible host.

CONTROL OF DOWNY MILDEW OF SUNFLOWER BY TREATMENT WITH RIDOMIL. W.E. Sackston. Dept. of Plant Science, Macdonald Campus of McGill University, Ste. Anne de Bellevue, Que., Canada H9X 1C0.

Systemic infection of sunflower seedlings by soil borne *Plasmodium halstedii* occurs during germination and emergence. Seed dressing with the systemic fungicide Ridomil (CGA 48988: N-(2,6-Dimethylphenyl)-N-(methoxyacetyl)-alanine methyl ester) at 2 g of active ingredient per 1000 g seed completely prevented infection of pre-germinated seeds soaked in zoospore suspension before sowing. Untreated inoculated seedlings developed 100% infection. Seed dressing also prevented infection by inoculum added as a soil drench at intervals after sowing. (Protection during the critical short infection period may reduce the danger of introducing the pathogen on seed and of building up inoculum levels in the soil.) Treatment with standard broad spectrum fungicides was ineffective, and with the systemic Propamocarb (SN 66752: Propyl (3-(dimethylamino)propyl) carbamate monohydrochloride) was only partially effective.

CONTROL OF PYTHIUM BLIGHT OF TURFGRASS WITH SN66752. P. L. Sanders, F. W. Nutter, Jr., and H. Cole, Jr., Dept. of Plant Pathology, The Pa. State University, University Park, PA 16802.

The efficacy of the experimental systemic fungicide propamocarb (Previcur N), was tested in vitro against *Pythium* sp., and in the field and greenhouse against *Pythium* foliar blight on creeping bentgrass and perennial ryegrass. In vitro activity against 32 isolates of *Pythium* was assessed by determining radial growth of each isolate on potato dextrose agar amended with 0, 1, 10, 100, and 1000 ug propamocarb/ml. Ten test isolates had  $ED_{50} > 10$  but  $< 100$  ug/ml, and 22 isolates had  $ED_{50} > 1$  but  $< 10$  ug/ml. In the field, one spray at 28, 56, or 112 g propamocarb/93 m<sup>2</sup> provided excellent disease control for 5 wk after treatment. In greenhouse experiments, the fungicide was applied at 56 g/93 m<sup>2</sup> as a foliar spray or as a drench to mature bentgrass. Disease control was excellent at 2 wk after treatment, regardless of application method. However, when seedling bentgrass and ryegrass were sprayed or drenched at 28, 56, or 112 g/93 m<sup>2</sup>, only the foliar sprays suppressed *Pythium* blight, and the chemical behaved as a contact fungicide, with little evidence of disease suppression beyond 1 wk after treatment.

HISTOLOGICAL STUDY OF 'MERION' KENTUCKY BLUEGRASS SHOWING SYMPTOMS OF FUSARIUM BLIGHT. P. L. Sanders, B. W. Pennypacker, and H. Cole, Jr., Dept. of Plant Pathology, The Pennsylvania State University, University Park, PA 16802.

Leaves, crowns, and roots of 'Merion' Kentucky bluegrass from field infection centers of *Fusarium* blight were examined histologically. Similar specimens were cultured for *Fusarium*. *F. roseum* 'Acuminatum' comprised 56% of the *Fusaria* isolated, *F. roseum* 'Crookwell' 26%, and *F. roseum* 'Equiseti' 18%. Specimens from the 'frog-eye', dead ring, and periphery of the dead ring exhibited varying degrees of vascular plugging in roots and crowns. A coarse, septate mycelium atypical of *Fusarium* was noted in the cortex of the crowns and in the cortex, endodermis, pericycle, and xylem vessels of roots from the 'frog-eye' and dead ring. The fungus was most prevalent in specimens from the dead ring and was never found in crowns from symptomless grass. The *Fusarium* cultivars isolated were inoculated into hydroponically-grown, seedling 'Merion' Kentucky bluegrass. Histological study showed that these fungi colonized the cortex of the root exclusively, frequently growing in a digitate manner. Following cortical colonization, they often sporulated externally.

SPATIAL AND TEMPORAL ANALYSES OF MAPLE DECLINE SYMPTOMS ON URBAN TREES. B. D. Schultz and P. D. Manion. SUNY College of Environmental Science and Forestry, Syracuse, N.Y. 13210

Fourteen hundred Norway, sugar, and silver maples in Syracuse, N.Y. were studied between 1975 and 1977 to detect spatial patterns and changes in decline symptoms. The occurrence and changing patterns of general foliage symptoms, scorch, chlorosis, and small and large dead limbs were noted. Foliage symptoms occurred on approximately 90% of the trees. All symptoms, except scorch, increased in the population. Symptomatic trees occurred in aggregates as indicated by both a 2x2 table and a modified doublet method analysis. Two patterns of aggregation were observed. Trees with large or small dead limbs, extensive foliage symptoms, or scorch were grouped in a linear pattern. These were primarily on one side of a street, and extended the length of one or more blocks. Trees with only

chlorotic foliage, however, were grouped in a more concentrated, circular pattern. Temporal analyses indicated no evidence for tree to tree spread or change in the degree of aggregation over time.

CLUSTERED TUBULES ASSOCIATED WITH CELL WALLS OF LEAFROLL-INFECTED AND LEAFROLL-FREE POTATO PLANTS. Sally Shephardson and R. C. McCrum, Dept. Anatomical Sciences, State Univ. of New York, Buffalo, NY 14214 and Dept. of Botany and Pl. Path., Univ. of Maine, Orono, ME 04469.

Unusual clustered tubular structures were found in leaf tissue cells of potato leafroll virus (PLRV)-infected and PLRV-free *Solanum tuberosum* L., cultivar Russet Burbank. Associated with cell walls external to the plasmalemma they were most numerous in parenchyma cells in or near phloem. Individual tubules 22-25 nm in diameter varied in length. In highly vacuolated cells, groups extended through the plasmalemma and dispersed inside vacuoles. Resembling cytoplasmic microtubules they were colchicine sensitive but cold resistant. The presence of clustered tubules in both PLRV-infected and PLRV-free potato plants signified that they were not specific to potato leafroll disease and thus may be only normal functional or residual aggregates of somewhat atypical plant microtubules.

SOME ENVIRONMENTAL FACTORS AFFECTING CHLORIDE UPTAKE IN PLANTS EXPOSED TO SALT SPRAY. M. Simini, I. A. Leone. Dept of Plant Pathology, Cook College, New Jersey, 08903

Various types of plants were exposed to salt spray in chambers designed to simulate salt deposition rates within 600 meters of the seacoast. Rapidly growing species generally absorbed more chloride than did slow growing woody species. After salting, the plants were exposed to various levels of temperature, relative humidity and photoperiod. Leaf tissues from these plants were analyzed for chloride. Chloride uptake was favored by high relative humidity and low temperatures. High relative humidity is believed to alter the physical and chemical properties of both the salt particles and the plant tissues. Increased temperature may induce structural changes in the cuticle and epicuticular waxes of leaves, decreasing their permeability. Information on environmental variables affecting chloride uptake in plants as well as studies on morphological features affecting uptake will help us to grow plants more successfully in areas where airborne salt is a problem.

CONDUCTIVITY CHANGES IN PEA LEAVES AFTER INFILTRATION WITH HOMOLOGOUS OR HETEROLOGOUS BACTERIA TREATED WITH CHLORAMPHENICOL OR ETHIDIUM BROMIDE. Michael G. Sinclair, Department of Biology, Norwich University, Northfield, Vermont 05663

Exponentially growing cells of *Pseudomonas pisi* (Pp) and *Pseudomonas tomato* (Pt) were transferred from nutrient broth shake cultures to flasks containing either 0.1 ug/ml chloramphenicol or 1.6 ug/ml ethidium bromide in nutrient broth. At the end of the log growth phase the bacteria were sedimented by centrifugation, adjusted to ca.  $10^8$  cfu/ml, and infiltrated into the abaxial side of 3 week old pea leaves. Comparable leaves were also infiltrated with distilled water or bacteria grown in nutrient broth. Leaf disks were removed with a cork borer, shaken in distilled water, and the conductivity measured. At 24 and 48 hours after inoculation the chloramphenicol-treated Pt caused a highly significant increase in conductivity compared to Pt grown in nutrient broth. Pp caused a conductivity increase that was significantly less than that of the Pp grown in nutrient broth. The Pp caused a greater increase in conductivity than Pt and it occurred earlier.

THE EFFECT OF THERMAL UNIT ACCUMULATION AND VIRUS RESERVOIR ON THE INCIDENCE OF POTATO LEAFROLL VIRUS IN MAINE. O.P. Smith, R.H. Storch, P.R. Heppler and F.E. Manzer, Department of Botany and Plant Pathology, University of Maine, Orono, Maine 04469.

The objective of this study was to analyse the yearly incidence of potato leafroll virus (PLRV) in Maine from 1939 to 1976 to determine whether variations were associated with temperature and/or virus reservoir. Results of the Maine-Florida Test were used to estimate PLRV incidence. These data were grouped by area and averaged to produce one annual observation per area. Three areas corresponding to NOAA weather station locations were considered. Temperature variables studied were thermal unit accumulation and air frost days. Virus reservoir was defined as the annual observation of PLRV from the previous year. High correlations of PLRV with thermal unit accumulation above a threshold of 21 C from August 1

to August 10 and with virus reservoir were found. Analysis of covariance indicates that area difference is a function of difference in virus reservoir.

IRRADIATED, DIGESTED SEWAGE SLUDGE: EFFECTS ON RHIZOBIUM SYMBIOSES IN FOUR LEGUMES. Roberta A. Spitko and William J. Manning, Dept. of Plant Pathology, University of Massachusetts, Amherst, MA 01003.

Irradiated digested sewage sludge was applied to field plots at 0, 4.7, and 9.4 metric tonnes/hectare. 10-10-10 fertilizer, at 110 kg/hectare, was applied to other plots. All plots were seeded 2 weeks later with green bean (*Phaseolus vulgaris* L. 'Green Ruler'), alfalfa (*Medicago sativa* L. 'Vernal'), white clover (*Trifolium repens* L.) and soybean (*Glycine max* L. Merr. 'Traverse'). Seeds were inoculated with appropriate Rhizobia at planting. Nodule numbers and weights were determined at flowering. Both sludge rates inhibited nodulation in green bean, alfalfa and clover. Soybeans did not nodulate. Alfalfa and green bean grew well, while clover and soybean grew poorly.

PARTIAL PURIFICATION OF A BACTERIOICIN FROM *ERWINIA HERBICOLA*. J. I. Stein and S. V. Beer. Department of Plant Pathology, Cornell University, Ithaca, NY 14853.

A bacteriocin affecting *Erwinia amylovora*, the causal agent of fire blight, has been partially purified from culture filtrates of *E. herbicola* (strain 112Y). Filtrates from early stationary phase broth cultures contained 114 units/mg dry weight. One unit of activity is defined as the smallest quantity of a preparation that inhibits growth of *E. amylovora* when applied in a volume of 5  $\mu$ l to an agar lawn of the bacteria. The bacteriocin bound to activated charcoal and was eluted with 50% (v/v) ethanol. After removing the ethanol by rotary evaporation, the bacteriocin was bound to a column of QAE Sephadex and was eluted with 0.06M NaCl. Following concentration, the preparation was purified further by Bio-Gel P-2 gel filtration chromatography. The final preparation had an activity of 4925 units/mg dry weight. The partially purified bacteriocin is insensitive to autoclaving, acidic conditions, nucleolytic and proteolytic enzymes, but is labile to base. The molecular weight, as determined by gel filtration, is 800.

CONTROL OF APPLE POWDERY MILDEW BY VAPOR FROM A NEW TRIAZOLE FUNGICIDE. Michael Szkolnik, Dept. of Plant Pathology, New York State Agricultural Experiment Station, Geneva 14456.

A new fungicide, 1-[2-(2,4-dichlorophenyl)-4-ethyl-1,3-dioxolan-2-yl]methyl]-1H-1,2,4-triazole (Ciba-Geigy CGA64251) applied to McIntosh apple foliage controlled powdery mildew (*Podosphaera leucotricha*) on untreated apple seedlings in the same greenhouse fumigation chamber. In the center of each round fiberglass chamber (287 l) were 3 pots, each with 5 untreated seedlings of 16 cm height and 11 leaves. Surrounding these were 7 pots of trees whose 3100 cm<sup>2</sup> leaf area was sprayed with 90 ml of dilute fungicide, and 2 pots of mildewed trees for inoculum. In one test untreated trees in the presence of those sprayed with 30 or 45 ppm active CGA64251 for 4 days developed only 1 mildew lesion per leaf compared with 30 lesions in an adjacent chamber without the chemical. In a second test untreated trees in the chambers 4 days with trees sprayed with 7.5 or 30 ppm CGA64251 developed 1 lesion per leaf compared with 18 lesions in the control chamber. A 2-day exposure at these rates gave nearly as good control. Vapor from CGA64251-treated cheesecloth suspended on wire above untreated trees also gave excellent control.

IN VITRO TRANSLATION OF THE SINGLE-STRANDED RNA OF THE BACILLIFORM VIRUS FROM *AGARICUS BISPORUS*. S. M. Tavantzis, C. P. Romaine, S. H. Smith, Department of Plant Pathology, The Pennsylvania State University, University Park, PA 16802.

The genome of the bacilliform virus that infects the cultivated mushroom, *Agaricus bisporus*, was shown previously to be a single-stranded RNA with a molecular weight of  $1.4 \times 10^6$  d. This RNA has now been found to stimulate polypeptide synthesis in a cell-free, messenger RNA-dependent, rabbit reticulocyte lysate translation system. Protein synthesis is optimal at pH 7.2, with 2.5 mM Mg<sup>++</sup>, and 70-75 mM K<sup>+</sup>. Under these ionic conditions, the efficiency of [<sup>3</sup>H] leucine or [<sup>35</sup>S] methionine incorporation into an acid precipitable product is approximately 50%. The virion RNA codes for the synthesis of at least five polypeptides, detectable by fluorography, with molecular weights ranging from 21,000 d to 77,000 d. The demonstrated messenger activity of the virion RNA of this mycovirus indicates that it is "plus" stranded, and therefore, similar in this respect to the majority of the single-stranded RNA viruses found infecting chlorophyllous plants.

THE ROLE OF AN ECTOMYCORRHIZAL FUNGUS, PISOLITHUS TINCTORIUS IN THE SURVIVAL AND GROWTH OF SCOTS PINE SUBJECTED TO LANDFILL CONDITIONS. M. Telson, I. A. Leone, F. B. Flower. Dept. of Plant Pathology, Cook College, New Brunswick, NJ 08903

P. tinctorius was evaluated for beneficial effects on the survival and growth of Pinus sylvestris under landfill conditions. Pine seedlings were planted in 5-l plastic pots with control, spore infested, or mycelial infested soil. The bottoms of the pots had been partially removed to permit gas exchange as well as support the soil. Pots of the 3 treatments (21 replicates) were buried to the rim at varying sites on a landfill and in a control area. Growth and gas measurements were made during the growing season for two years. Where soil CO<sub>2</sub> was elevated above ambient concentrations, growth of pines in the mycelial treatment was superior to that in the control or spore treatment. Greenhouse experiments in which root systems of pines were fumigated with simulated landfill gas mixtures (20% CO<sub>2</sub>, 5% O<sub>2</sub>, 30% CH<sub>4</sub>) produced results similar to those in the field. Higher than normal CO<sub>2</sub> and temperature also appeared to have a beneficial effect on the fungus in pure culture.

SOME PROPERTIES OF THE PISATIN DEMETHYLASE ACTIVITY OF NECTRIA HAEMATOCOCCA (FUSARIUM SOLANI) MATING POPULATION VI. Hans D. VanEtten and Wolfgang Barz, Dept. Plant Pathology, Cornell Univ., Ithaca, NY 14853 and Lehrstuhl für Biochemie der Pflanze, Hindenburgplatz 55, Münster 4400, Germany.

N. haematococca MP VI has the ability to 0-demethylate pisatin; this ability appears to be needed for a high level of virulence on pea. With glucose (2%) as the carbon source, a mycelial suspension (30 mg, fresh wt/ml) of an isolate (T-36), that is virulent on pea did not demethylate pisatin (.1 mM) in 6 hr while 100% demethylation occurred in 2 hr in glucose-free medium. Prior exposure to pisatin in glucose-free medium markedly enhanced the level of whole-cell pisatin demethylase activity (pda) and maximal stimulation was detected 5-9 hr after the initial exposure. The stimulation of pda was substrate concentration dependent and substrate-specific. The only compounds other than pisatin that stimulated significant activity were pterocarpan or isoflavan derivatives. Protoplasts with pda could be isolated from pisatin-treated mycelium but all attempts to obtain a cell-free system with pda failed.

INTERACTION OF GLUCOSE, ETHANOL, PHENOLICS, AND ISOLATE OF ARMILLARIA MELLEAE. Philip M. Wargo, USDA Forest Service, 151 Sanford Street, Hamden, Conn. 06514.

Hydrolyzable tannin (HT), from oak bark, stimulates or inhibits certain isolates (ISOL) of A. melleae. Gallic acid (GA), released as HT is hydrolyzed, is the inhibitor. To determine the conditions under which HT or GA inhibits or stimulates A. melleae, 15 ISOL were challenged with HT or GA, with or without EtOH, at 3 levels of glucose (GLU). One ISOL was stimulated and one was inhibited by both HT and GA in all GLU and EtOH treatments. HT stimulated the other 13 ISOL at all GLU levels when EtOH was present, and 9 were stimulated when EtOH was absent. GA stimulated 6 and inhibited 5 ISOL when EtOH was present but not at all GLU levels. Three ISOL were inhibited at the lower GLU levels and stimulated at the high level. In the absence of EtOH, GA inhibited all 13 ISOL but not at all GLU levels. Three ISOL were stimulated at the high GLU level. This interaction of ISOL, phenol, GLU, and EtOH helps explain how stresses predispose trees to attack by aggressive isolates of A. melleae.

THE EFFECT OF CUCUMBER POWDERY MILDEW AND APPLE SCAB ON TRANSLOCATION OF FUNGICIDES IN LEAVES. J.T. Warner and L.V. Edgington, Department of Environmental Biology, University of Guelph, N1G 2W1.

Foliar diseases influence the uptake and acropetal translocation of fungicides in leaves. In a controlled environment, portions of cucumber leaves infected with powdery mildew transpired 1.8 times as fast and accumulated up to twice as much radioactivity from basally-applied <sup>14</sup>C-carbendazim as did healthy portions of the same leaf. Under field conditions, portions of apple leaves infected with scab transpired 1.16 times as fast (measured at mid-day) and

accumulated 1.56 times as much radioactivity from benomyl applied to the base of leaves as did healthy areas of the same leaf. In both cucumber and apple, uptake and subsequent translocation were similar whether the fungicides were applied to diseased or healthy areas of leaves.

A SEROLOGICAL INTERMEDIATE OF GREMMENIELLA ABIETINA. P. B. Wendler, A. R. Gottlieb, Botany Department, and D. R. Bergdahl, Forestry Department, University of Vermont, Burlington, VT 05405.

The Asian, European, and North American serotypes of Gremmeniella abietina were compared to 27 Vermont isolates using gel double diffusion and intragel cross absorption tests. An intermediate, between the North American and European serotypes, was shown by means of cross absorption with antiserum prepared in response to a Vermont isolate. The majority of Vermont isolates resembled the Vermont intermediate in serological reaction, three resembled the European serotype, and two were of unknown serotypes. The serological data support possible hybridization between G. abietina isolates in Vermont as well as the identification of a new serotype in Vermont.

XANTHOMONAS PHASEOLI MULTIPLICATION AND ACCUMULATION OF KNOWN PHYTOALEXINS IN SUSCEPTIBLE AND RESISTANT BEANS. J. G. Wyman and H. D. VanEtten, Dept. Plant Pathology, Cornell University, Ithaca, NY 14853.

The bean phytoalexins (PA) phaseollin (PIF) and kievitone strongly inhibit X. phaseoli (Xp) *in vitro* whereas phaseollin and coumestrol do not. Xp (inoculum conc. 10<sup>8</sup>, 10<sup>6</sup> and 10<sup>4</sup> CFU/ml) multiplied readily in primary leaves of Phaseolus vulgaris cv. Dark Red Kidney (susceptible), and none of the characterized PA were detected. Primary leaves of cv. Tara inoculated with 10<sup>8</sup> CFU/ml reacted hypersensitively and accumulated significant amounts of phaseollin, PIF and a coumestan other than coumestrol. Multiplication of the lower inoculum conc. of Xp in Tara suggested that an induced resistance developed without visible symptoms, but none of the known PA were detected by spectrophotometric or sensitive bioassay methods. The known bean PA appear unlikely to play a significant role in nonhypersensitive resistance to common blight.

CONTROL OF NAEMACYCLUS MINOR NEEDLECAST WITH DIFOLATAN. L. E. Zang and W. Merrill, Department of Plant Pathology, The Pennsylvania State University, University Park, PA 16802.

Naemacyclus minor causes a severe needlecast of Scots pine (P. sylvestris) in Pa. Christmas tree plantations. Most infection occurs between mid-April and late June. Current control measures require 2-3 fungicide applications per season. One spray of Difolatan 4F (captafol) was applied on 20 April at a rate of 5.0 lbs. a.i./100 gal/acre using a backpack mistblower. Trials were evaluated on 11 July 1979. The level of infection was determined by needle isolation. The infection level of 17 April was 10%. On 11 July the level of infection was 57% in the check plot and 14% in the spray plot. Thus, one application of Difolatan 4W gave excellent control of Naemacyclus needlecast.

GIBBERELLIN A4 PRODUCTION BY SPHACELOMA MANIHOTICOLA, CAUSAL AGENT OF CASSAVA SUPERELONGATION DISEASE. R. Zeigler, M. Powell and H. Thurston, Department of Plant Pathology and \*Department of Pomology, Cornell University, Ithaca, NY 14853.

Symptoms of superelongation disease of cassava, caused by Sphaceloma manihoticola Bitancourt and Jenkins, include striking internode elongation. This suggests a hormonal role in the disease. Gibberellin A4 was purified from culture filtrate of pathogenic isolates by base-acid partitioning with ethyl acetate followed by silica gel column chromatography. Biologically active fractions were identified using lettuce seedling hypocotyl elongation bioassay. The fungal product was identified as gibberellin A4 using combined gas-liquid chromatography-mass spectrometry. Treatment of plants with known gibberellin A4 and that purified from pathogen filtrate reproduced hypertrophic symptoms.