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Abstracts

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Alphabetized by first author's last name

EVALUATION OF FORECASTS TO INITIATE FUNGICIDE APPLICATION IN THE MANAGEMENT OF CERCOSPORA BLIGHT OF CARROT. [1]V. Abraham, [1]A. C. Kushalappa, [2]O. Carisse and [2]G. Bourgeois. [1]Department of Plant Science, Macdonald Campus of McGill University, Ste-Anne-de-Bellevue, Quebec, H9X 3V9; [2]Agriculture Canada, Ste. Jean sur Richelieu, Quebec.

Forecasts for first fungicide application to control carrot blight caused by Cercospora carotae (Pass.) Solheim were evaluated during summers of 1991 and 1992. In the forecasts based on infection, the blight severity values (BSV) were calculated for each day using duration of leaf wetness, relative humidity and temperature. The first fungicide was applied when the cumulative blight severity values reached 14 (CBSV-14) and 18 (CBSV-18). In the integrated pest management program (IPM) the first fungicide was applied when middle leaf of 50% of the plants was diseased whereas in the conventional, the first application was made when the plant height reached 15 cm. The subsequent fungicides were applied at 7-10 day intervals in all forecasts. For forecasts CBSV-14 and CBSV-18, fewer fungicides were applied as compared to conventional and IPM forecasts.

INFECTION OF RED SPRUCE TWIGS BY *PHOMOPSIS* VIA NONLETHAL GALLS OF THE EASTERN SPRUCE GALL ADELGID. Douglas E. Audley and John M. Skelly, Department of Plant Pathology, The Pennsylvania State University, University Park, PA 16802.

A survey of 39 stands of red spruce was conducted in 1990 in West Virginia with branch samples collected for foliar nutrient analysis. On several plots, dying twigs were noted as previously infested by nonkilling attacks of the eastern spruce gall adelgid (*Adelges abietis* L.). Twigs attacked 2 and 3 years prior to the 1990 sampling exhibited dying needles on the underside of branches and cankering of galled twigs. During a follow-up survey for possible causes of twig death, 3-5 symptomatic twigs were removed from 3 trees within each of 3 stands. Isolations were made onto malt extract agar and 14 of 43 sampled twigs yielded *Phomopsis* spp. Inoculum, a mycelial/spore suspension (ca. 6000 spores/cc) or mycelial agar plugs was used to inoculate 20 each of red spruce by pin-prick through a droplet of inoculum suspension or mycelial (agar) inoculation of slit wounds, respectively. In both treatments, 5 of 20 attempts proved positive for symptoms and re-isolation of the pathogen. These studies add further information to explain crown thinning in red spruce.

ROLE OF NEAR-ULTRAVIOLET RADIATION AND MOISTURE STRESS IN CONIDIATION BY *BOTRYTIS SQUAMOSA* IN VITRO AND ON ONION LEAF SEGMENTS. F. J. Balis and J. W. Lorbeer, Department of Plant Pathology, Cornell University, Ithaca, NY 14853.

Increasing photoperiods of exposure to near-ultraviolet (NUV) radiation, from 0 to 24 hours, increased the production of conidia by *B. squamosa* grown on an onion foliar extract medium or detached leaf pieces. Conidial production was greatest with continual exposure to NUV radiation. Although sporulation was induced by drying cultures of *B. squamosa*, there was no significant increase in sporulation on onion foliar extract medium adjusted from -1.5 to -45 bars water potential with KCl, $NaNO_3$, NaCl, sucrose, or PEG 4000. Transient drying of blighted leaf segments did not increase levels of conidiation. Linear growth rate on media adjusted from -1.5 to -45 bars decreased with decreasing water potential below -9 bars, but was significantly greater or unaffected at -9 bars, compared to growth on the unadjusted medium alone at -1.5 bars. NUV radiation stimulated conidial production by *B. squamosa*, while moisture stresses did not.

CONIDIAL AND SCLEROTIAL PRODUCTION BY *BOTRYTIS SQUAMOSA* IN VITRO: ROLE OF CARBON-NITROGEN INTERACTIONS AND THE CATIONS Na^+, K^+, and Ca^+. F. J. Balis and J. W. Lorbeer, Department of Plant Pathology, Cornell University, Ithaca, NY 14853.

Studies were conducted to identify and elucidate those factors affecting the asexual reproductive behavior of *Botrytis squamosa* in vitro. Cultures were grown on a variously supplemented onion foliar extract agar and on a defined medium at 18 C with a 14 hour photoperiod of near-ultraviolet radiation. Carbon and nitrogen, provided as glucose and $NaNO_3$, interacted to increase sporulation by *B. squamosa*. At high carbon:nitrogen ratios, sclerotial production was favored, while at low ratios, conidial production was favored. The Ca^{++} cation specifically interacted with nitrate nitrogen to enhance conidiation. The K^+ cation favored sclerotial formation by *B. squamosa*.

EXTENT OF INJURY AND THE FUNGI ASSOCIATED WITH FEEDING WOUNDS CREATED BY CONIFER SWIFT MOTH LARVAE ON ROOTS OF RED SPRUCE AND BALSAM FIR. D.R. Bergdahl, J.R. Grehan, B.L. Parker, D.R. Tobi and S. Halik, Dept. of Forestry and Dept. of Plant and Soil Science, University of Vermont, Burlington, Vermont 05405.

Feeding wounds created by larvae of the conifer swift moth (Korscheltellus gracilis) on roots of red spruce (Picea rubens) and balsam fir (Abies balsamea) were evaluated to determine relative frequency and extent of injury and to identify associated fungi. Trees were on the windward slope of Whiteface Mountain, New York at 850 and 1050 m elevation. At each elevation, 10 co-dominant trees per species were selected from each of 3 crown categories (healthy, initial decline and advanced decline = <10, 11-50 & >50% dieback, respectively) and their roots were exposed to a distance of 2

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m from the main stem. The mean number of wounds and wound areas were greater near the buttress, and on initial and advanced decline trees. Wood staining fungi (Leptographium spp.) and an unidentified fungus were frequently isolated from wounds. Wood rotting Basidiomycetes, including Armillaria spp. were also isolated.

PERSISTENCE OF BURSAPHELENCHUS XYLOPHILUS IN LIVING PINUS SYLVESTRIS. D.R. BERGDAHL and S. Halik, Department of Forestry, University of Vermont, Burlington, Vermont 05405.

A total of 100, 20-year-old Scots pines (Pinus sylvestris), were inoculated with a Scots pine isolate of Bursaphelenchus xylophilus (pinewood nematode=PWN) to evaluate persistence of the organism in the host tree. Ten trees were inoculated on each of 10 dates between 6/1-9/14, 1987. Two inoculation wounds were made with a drill bit in the main stem of each tree and approximately 30,000 nemas were inoculated per wound. In addition, 10 trees were inoculated on each of 3 dates with a nematode-free solution. All trees were visually evaluated annually and sampled periodically between 1987 and 1992. B. xylophilus was extracted from asymptomatic living trees for up to 5 years after inoculation as well as from dead trees but not from controls. The PWN was most frequently extracted from trees inoculated on 7/7 and 9/14, 1987.

USE OF THE POLYMERASE CHAIN REACTION FOR GENETIC STUDIES OF *NECTRIA COCCINEA* VAR. *FAGINATA* AND *N. GALLIGENA*. Louis Bernier and Richard C. Hamelin, Centre de Recherche en Biologie Forestière, Université Laval, Québec, Qc, Canada G1K 7P4.

We have used the polymerase chain reaction to amplify DNA sequences from the Ascomycetes *Nectria coccinea* var. *faginata* (Ncf), causal agent of beech bark disease (BBD), and *N. galligena* (Ng), causal agent of Nectria canker on northern hardwoods and also associated with BBD. Specific primers were used to amplify the small subunit (18S) of the genes encoding ribosomal RNA (rDNA genes), whereas oligodeoxynucleotide primers allowed the detection of random DNA polymorphisms (RAPD markers). Samples of Ncf and Ng were obtained from various parts of Québec and, in the case of Ng, from different host species. Analysis of rDNA and RAPD patterns confirmed the occurrence of both species of *Nectria* on beech. Two different rDNA patterns occurred among all Ng isolates examined but were not correlated with either host or geographic origin. Genetic segregation of rDNA and RAPD polymorphisms, and of virulence on McIntosh and Golden Delicious apples was observed among the progeny from single perithecia of Ng.

HOST SPECIFICITY OF *CYLINDROCARPON LUCIDUM AND PYTHIUM IRREGULARE*, SUSPECTED CAUSAL AGENTS OF APPLE REPLANT DISEASE, AND THE EFFECT OF COMBINATIONS OF OTHER *PYTHIUM* AND *CYLINDROCARPON* SPECIES ON APPLE. P. G. Braun, Research Station, Agriculture Canada, Kentville, N.S., B4N 1J5.

In a previous experiment, it was demonstrated that the combination of *Cylindrocarpon lucidum* and *Pythium irregulare* on apple roots caused symptoms which resembled those of apple replant disease (Can J. Plant Pathol. 13:291-297. 1991). The present study was conducted to determine if combinations of other *Cylindrocarpon* and *Pythium* species would cause a similar response on apple and to determine if *C. lucidum* and *P. irregulare* are specifically pathogenic to apple. Four species each of *Cylindrocarpon* and *Pythium* were tested alone and in combination on apple. While various combinations of *Cylindrocarpon* and *Pythium* species resulted in a gradation of shoot growth reduction (0-50%), the combination of *C. lucidum* and *P. irregulare* resulted in the greatest reduction (68%) in shoot growth. *P. irregulare* and *C. lucidum* alone and combined were tested on pear, plum, and peach. The fungi individually or combined significantly reduced shoot growth of pear while only *P. irregulare* and *C. lucidum* individually reduced the growth of plum and peach, respectively.

A NEW FAIRY RING FUNGUS IN TURF. P. M. Halisky and R. J. Buckley, NJAES, Cook College, Rutgers University, New Brunswick, NJ, 08903.

Of 16 species of basidiomycetes associated with turfgrass habitats in NJ, 10 formed ring patterns and 6 were scattered. Both mushrooms and puffballs were incriminated as ring formers. Among the ring-forming fungi were three species of Clitocybe viz. hydrogramma, dealbata, and gigantea. In this report we add a fourth species: Clitocybe nuda commonly known as blewit. During 1985-1992 a large (8.7 m dia) ring of C. nuda was carefully observed for sporophore production. These appeared as follows: 1985:50, 86:13, 87:58, 88:0, 89:11, 90:0, and 91:4. The unpredictable appearance or absence of annual sporophores is another phase of the "fugitive phenomenon" in fairy rings. No control of C. nuda was observed after application of flutolanil drenches at various rates.

SILICON-INDUCED REACTIONS IN CUCUMBER PLANTS INFECTED WITH PYTHIUM ULTIMUM. Chérif, M., N. Benhamou, J. G. Menzies, and R. R. Bélanger. Département de phytologie, Faculté des sciences de l'agriculture et de l'alimentation, Université Laval, Qc, Canada G1K 7P4

The effect of the amendment of nutrient solutions with soluble potassium silicate (Si) on the response of cucumber (cv. Corona) root and hypocotyl tissues to an attack by Pythium ultimum was examined by light and electron microscopy as well as energy dispersive X-ray analysis (EDX). Plants were treated with 0 or 1.7 mM Si-amended nutrient solutions and root and hypocotyl samples were collected at different times after inoculation with P. ultimum. By 48 h after infection, striking differences in the expression of defense reactions were observed between Si-amended and Si-free cucumber plants. Treatment of the plants with Si markedly stimulated the accumulation of an electron dense, phenolic-like material in infected host tissues, and significantly increased the percentage of cells filled with this material. Fungal hyphae colonizing such occluded host cells were seriously damaged, and were often reduced to empty hyphal shells. Additionally, Si-treated cucumber plants responded to P. ultimum infection by the formation of electron-dense layers along primary and secondary cell walls, as well as over pit membranes of xylem vessels. EDX analysis did not reveal the presence of silica deposits in P. ultimum infected plants grown in Si supplemented media. The present results suggest that a relationship exists between Si treatment, resistance to P. ultimum attack, and elaboration of plant defense mechanisms.

STUDIES OF SILICON DISTRIBUTION IN WOUNDED AND PYTHIUM ULTIMUM-INFECTED CUCUMBER PLANTS. Chérif, M., J. G. Menzies, N. Benhamou and R. R. Bélanger. Département de phytologie, Faculté des sciences de l'agriculture et de l'alimentation, Université Laval, Qc, Canada G1K 7P4

The objective of this study was to investigate the deposition of silicon (Si) in relation with the ability of Si to reduce the severity of Pythium ultimum infection on cucumber. Roots, hypocotyls and leaves of cucumber plants grown in nutrient solutions unamended (Si-) or amended (Si+) with 1.7 mM (100 ppm) silicate were inoculated with P. ultimum or wounded with a sharp needle. At 24, 48 and 72 h after treatment, the plants were examined for silicon distribution using scanning electron microscopy and energy dispersive X-ray microanalysis. No silicon was detected at sites of fungal penetration or in P. ultimum hyphae, regardless of the plant organ studied. Si was also absent in wounded roots and near absent in wounded leaves and hypocotyls collected from plants maintained under high humidity in a growth chamber. By contrast, a specific and intense deposition of silicon was found in cells surrounding the trichome hairs and in wounded leaves and hypocotyls of uncovered Si+ plants. These results reinforce the idea that accumulation and polymerization of silica at fungal penetration sites or in epidermal cell walls has apparently no role as a physical barrier against fungal attack. As such, Si deposition does not appear to be the mechanism by which fungal growth and penetration of plant tissues are hindered.

DETECTION OF MYCOPLASMALIKE ORGANISM ASSOCIATED WITH GRAPEVINE YELLOWS BY POLYMERASE CHAIN REACTIONS. K. H. Chen, S. Y. Wu, Y. D. Chen, Y. H. Guo and T. A. Chen. Department. of Plant Pathology, Rutgers University, New Brunswick, NJ 08903.

Grapevine yellows(GY) disease has been reported in Europe and USA and is spreading in both continents. The disease agent was found to be a mycoplasmalike organism(MLO), but the titer of MLO in the infected vines is extremely low. Previously, two DNA fragments(GYD-1 and GYD-2) specific to GY-MLO were selected in our laboratory. Based on the partial sequence of the cloned genomic DNA fragment GYD-2, three oligonucleotides(oligo 1, 2 and 3) were designed and synthesized for use as primers in polymerase chain reactions(PCR). Using oligos 1 and 2, a 550-bp DNA fragment was amplified from crude DNA extracts of diseased periwinkles and grapevines (Italy and New York isolates). Using oligos 1 and 3, a 600-bp DNA fragment was amplified only from diseased periwinkle plants, but not from diseased grapevines. No PCR products were detected when DNA from healthy periwinkles or grapevines were used as templates. Results from PCR revealed that the MLO isolates in periwinkles were genetically related but not identical to those from Italy and New York grapevines.

NURSERY-CULTIVATED GERANIUM SPP. AS A POSSIBLE INOCULUM SOURCE FOR XANTHOMONAS CAMPESTRIS PV. PELARGONII CAUSING BACTERIAL BLIGHT DISEASE OF A GREENHOUSE PELARGONIUM CROP. M. Daughtrey and M. Macksel, Cornell University, Long Island Horticultural Research Laboratory, Riverhead, NY 11901.

On 19 August 1991, a culture-indexed geranium crop (*Pelargonium* x *hortorum*) was exposed to hurricane wind and rain in an uncovered greenhouse. Leaf spots and wilt were observed on 10 October, and bacterial strains were identified as *X. campestris* pv. *pelargonii* (*Xcp*). *Geranium maculatum*, *G. platypetalum*, *G. sanguineum* 'Album' and *G. endresii* 'Wargrave Pink' with spotted foliage were collected on 14 November from a herbaceous perennial nursery adjacent to the greenhouse where bacterial blight had been detected. Bacterial strains from *Geranium* spp. were identified to be *Xcp* by Agdia ELISA, Biolog and culture media tests, and were shown to be pathogenic to *Pelargonium* with stab, foliar spray and cut-petiole droplet inoculations.

A COMPARATIVE STUDY OF HOST ROOT CELL REACTIONS INDUCED BY PYTHIUM ULTIMUM OR ITS METABOLITES ON GERANIUM. H. Desilets, N. Benhamou, and R. R. Bélanger. Département de phytologie, Université Laval, Québec, Qc G1K 7P4.

The involvement of Pythium ultimum metabolites in disease development on geranium was studied ultrastructurally. Degradation events induced on the host root cells by the pathogen were compared to those initiated by a treatment of partially purified culture filtrates of the pathogen. In the latter

treatment, early events of root cell response were invagination of plasma membrane, cytoplasmic disorganization, and accumulation of an electron-dense material in both the intercellular spaces and the lumen of xylem vessels. Interestingly, similar host reactions were detected at the early stages of infection by P. ultimum. Despite marked cell wall distortions upon treatments with either the pathogen or its metabolites, cytochemical labelling of pectin and cellulose revealed that these two carbohydrates were not apparently hydrolysed. The present ultrastructural results support the hypothesis that toxic metabolites produced by P. ultimum play an important role in the development of root symptoms during the infection process.

COMPARISON OF DNA AND RNA HYBRIDIZATIONS FOR THE DETECTION OF *CLAVIBACTER MICHIGANENSIS* SUBSP. *SEPEDONICUS* IN FIELD SAMPLES. J. Drennan, A. Westra, *A. Oleson, A. Collmer, *N. Gudmestad, and S. Slack, Cornell University, Ithaca, NY 14853 and *North Dakota State University, Fargo, ND 58105.

Clavibacter michiganensis subsp. *sepedonicus* (*Cms*), the causal agent of bacterial ring rot, was detected in field-grown Russet Burbank and Belrus potatoes given an initial inoculum dose of 0, 10^2, or 10^9 colony forming units of *Cms* strains SS43 or SS13. At 90 days after planting, stem and petiole samples were processed by (i) macerating frozen tissues, (ii) centrifuging stem sections, or (iii), directly blotting tissues on nylon membranes. Membranes were hybridized using a 1.078 kb *Cms* sequence (Mogen et al., Phytopathology 80:90-96) employed as a ^{32}P DNA or RNA probe. Overall, the DNA probe detected *Cms* at a higher rate than the RNA probe (29.9% vs 23.7%), although the differences were not significant by chi-square analysis ($p=0.122$). Similiarly, there were no significant differences between the systems based on cultivar, strain, dose or plant parts ($p \geq 0.368$). Advantages of the DNA probe included lower backgrounds and not requiring chemical treatments for RNase.

ASSOCIATION BETWEEN MANGANESE-REDUCING RHIZOBACTERIA AND NACL APPLICATIONS IN SUPPRESSION OF FUSARIUM CROWN AND ROOT ROT OF ASPARAGUS. W. H. Elmer. The Connecticut Agricultural Experiment Station, New Haven, CT 06504

Applications of NaCl suppressed Fusarium crown and root rot of asparagus without affecting the *Fusarium* spp. in the soil. Rhizobacteria recovered from the NaCl-treated asparagus roots usually differ in species composition when compared to roots from controls. Over 800 strains of rhizobacteria were recovered from NaCl-treated and nontreated asparagus roots in four different fields. Each strain was assayed for fluorescence on King's B medium and for its ability to reduce Mn on a Mn-dioxide medium. Between 2-14% strong Mn-reducers were found in every field. In 3 out of the 4 fields sampled, significantly more strong Mn-reducers were recovered from NaCl-treated roots than from control roots, and the majority (88%) were fluorescent pseudomonads. Mn-reducing rhizobacteria may play a role in suppressing disease by enhancing Mn uptake by roots.

INFLUENCE OF N-FORM ON VERTICILLIUM WILT OF EGGPLANT W. H. Elmer, F. J. Ferrandino, and M. P. N. Gent. Connecticut Agricultural Experiment Station, New Haven, CT 06504.

Eggplants were grown in the field in fumigated soil or soil infested with *Verticillium dahliae*, fertilized with $(NH_4)_2SO_4$ or $Ca(NO_3)_2$ at 112 kg N/ha, and sampled during the 1990-1992 growing seasons. Plants sampled before anthesis were always asymptomatic and had no stem colonization by *V. dahliae*. In addition, NH_4-N fertilized plants had leaves with more carbohydrates, chlorophyll, Cu, P, Mn, Zn, but less K per g tissue than plants treated with NO_3-N. After symptoms appeared, NH_4-N treated plants were usually larger, had larger leaves, more yield, and less *V. dahliae* stem colonization than plants fed NO_3-N. However, leaf concentrations of minerals, carbohydrates and chlorophyll in NH_4-N treated plants did not differ from plants fertilized with NO_3-N later in the season. NH_4-N nutrition may suppress Verticillium wilt by increasing nutrient uptake and encouraging vegetative growth before the onset of symptoms.

INFLUENCE OF GROWTH REGULATORS ON FUSARIUM SCAB OF WHEAT. T. Fauzi and T. Paulitz, Plant Science, Macdonald Campus, McGill University, Ste. Anne de Bellevue, Que., Canada, H9X 3V9.

The effect of the growth regulators ethaphon (cerone) and chlormequat (CCC) on head blight of spring wheat cv. Max was tested in irrigated field trials inoculated with *Fusarium graminearum* in 1991 and 1992 in Quebec and Ontario. In 1991, a dry year, there were no symptoms of head blight, but the incidence of seed infection ranged from 2-20% in treatments where heads were inoculated with macroconidia. CCC treatments had the highest incidence of infection, but were not significantly different from the non-treated control ($P=0.06$). In 1992, plots were inoculated with macroconidia or with Fusarium-colonized corn applied in the rows. Three weeks after application, mature perithecia were found on the colonized corn. Incidence of spikelet infection ranged from 2-4% in the non-inoculated treatments to 15-23% in the inoculated treatments. CCC significantly increased disease only in treatments inoculated with colonized corn.

A MATHEMATICAL MODEL FOR FOCUS EXPANSION WITHIN A LINEAR PLANTING. F. J. Ferrandino, Dept. of Plant Pathology and Ecology, Conn. Agric. Expt. Stat., New Haven, CT, 06504.

Turbulent dispersal of airborne spores yields epidemiological contact distributions characterized by a length scale which increases with downwind distance due to the escape of spores from the plant canopy into the faster moving air above. Such contact distributions approach an inverse power law of distance at large distances. Simulated epidemics based on this type of spore dispersal exhibit isopathic velocities which increase with distance from the focus of disease irrespective of disease severity. The leading edge of this dispersive epidemic wave propagates more quickly than the trailing edge and the wave spreads out in space with increasing time. This behavior contrasts with the constant isopathic velocities characteristic of the traveling wave description predicted using spatial contact distributions of exponential order. Results suggest that a traveling wave description is appropriate if the spatial coordinate is first log-transformed.

SEPTORIA LEAF EPIDEMICS WITHIN LINEAR PLANTINGS OF TOMATOES. F. J. Ferrandino and W. H. Elmer, Dept of Plant Pathology and Ecology, Conn. Agric. Expt. Stat., New Haven, CT, 06504.

Field experiments were conducted over three years to examine the epidemiological behavior of Septoria leaf spot (*Septoria lycopersicum*) on tomato. Rows of tomatoes were artificially inoculated and the resultant temporal development and spatial spread of disease were followed. In addition, trap plant experiments were conducted to determine the spatial distribution of secondary lesions about foci. Secondary spread was described well by an inverse power law of distance. Predictions of a mathematical model based on this contact distribution described the observed disease development and spread of Septoria leaf spot within a row of tomato plants. The observed epidemics were characterized by isopathic velocities which increased with distance from disease foci and accelerated with each successive generation.

A LABORATORY TECHNIQUE TO DETERMINE COLD TOLERANCE OF ALFALFA (MEDICAGO SATIVA L.) CULTIVARS. A. R. Gotlieb and N. J. Sullivan. Plant and Soil Science Department, University of Vermont, Burlington, Vermont 05405.

Experiments were performed in order to develop a laboratory technique which could determine cold tolerance of alfalfa (Medicago sativa L.) cultivars. Four alfalfa cultivars (Apollo, Saranac, Shenandoah, and Maverick) were grown hydroponically using a slant board system (ten seedlings laid on capillary matting and held between two Plexiglas pieces), cold acclimated for one week at 7°C and two weeks at 0°C, frozen at 0, -2, -4, and -6°C, then regrown for three weeks. Cold tolerance was determined by percent mortality following freezing and expressed as a T50 value. Regrowth, internal crown Horsfall rating, number of living crown buds, and root diameter following freezing were also examined. Significant differences in T50 values among cultivars were detected in two out of five experiments. This technique has potential in future research examining relationships between cold temperature and pathogen infection in alfalfa.

ISOLATION OF BACTERIAL ANTAGONISTS FOR THE CONTROL OF *MAGNAPORTHE POAE* IN TURFGRASS. Mirta B. Guglielmoni, Donald Y. Kobayashi and Bruce B. Clarke. Department of Plant Pathology, Rutgers University, New Brunswick, NJ 08903.

Mycelium of *Magnaporthe poae*, the causal agent of summer patch in cool season turfgrasses, was used to develop a baiting technique for the isolation of antagonistic bacteria from soil naturally infested with the pathogen. Isolates of bacteria obtained using this method were tested for their ability to utilize chitin as the sole source of carbon in minimal media. Approximately 20% of the recovered isolates, including *Serratia marcescens*, were identified as chitinase producers. Several chitinase producers inhibited the growth of *M. poae* in vitro. Current studies indicate that certain of these isolates reduce the severity of summer patch symptoms in the growth chamber.

MONOCLONAL ANTIBODIES AGAINST ASH YELLOWS AGENT. Y. H. Guo and T. A. Chen, Dept. of Plant Pathology, Rutgers University, New Brunswick, N.J. 08903.

Three monoclonal antibodies (McAb), 6F11-1B1, 2A11-3F11 and 7D7-3F4, against the ash yellows mycoplasma-like organism (Ash-MLO) were produced by using partially purified preparations from periwinkle plants experimentally infected with the Ash-MLO as immunogen. Splenocytes from immunized BALB/c mice were fused with P3-NSI/1-Ag4-1 murine myeloma cells and were screened using indirect ELISA. The isotypes of all three McAbs belonged to the subclass IgM. The ash-MLO was easily detected in infected periwinkle and ash using these McAbs in ELISA and Immunofluorescence tests. Specificity of these McAbs was observed when they did not react with healthy periwinkle, ash, and eight other MLO or spiroplasma-infected periwinkles.

IDENTIFICATION OF GREMMENIELLA ABIETINA RACES USING RAPD MARKERS. Richard C. Hamelin, Guillemond B. Ouellette* and Louis Bernier. C.R.B.F., Université Laval, Québec, Qc G1K 7P4 and *Laurentian Forestry Centre, 1055 Rue du PEPS, Ste-Foy, Qc, G1V 4C7.

Two races of *Gremmeniella abietina*, causal agent of the scleroderris canker of conifers, have been identified in North America based on symptoms, virulence and serological and soluble protein surveys. However, due to problems related to intraracial variability, speed of the assays, and the difficulty to clearly assign some samples to a race (including putative hybrids) we have used Randomly Amplified Polymorphic DNA (R.A.P.D.) markers to provide fast and accurate identification with very small amounts of tissue. Six DNA fragments amplified with 4 primers unequivocally distinguished the North American (NA) from the European (EU) race when tested with 32 isolates of *G. abietina* isolated from seven conifer species from eastern and western Canada, eastern U.S., Italy, The Netherlands, Switzerland and Finland. In all cases the race designation using the R.A.P.D. assay was the same as determined with the soluble protein assay. We did not identify any interracial hybrids in our sample. In one case, however, an isolate that could not be assigned to either race using the protein assay was clearly identified as a NA isolate using the R.A.P.D. assay.

OCCURRENCE AND SEVERITY OF FOLIAR OZONE SYMPTOMS ON SENSITIVE HARDWOOD SPECIES IN SHENANDOAH NATIONAL PARK, VA. Elisabeth Hildebrand and John M. Skelly, Department of Plant Pathology, The Pennsylvania State University, University Park, PA 16802.

To assess the extent of foliar symptoms due to ozone on sensitive hardwoods in the Shenandoah National Park in Virginia, three species were sampled and evaluated at sites of differing elevations adjacent to 3 ozone monitors in 1991 and 1992: black cherry, yellow poplar, and white ash. All foliar samples were evaluated for percent of symptomatic leaves on each branch and average percent leaf area affected. The Horsfall-Barratt rating scale was used to estimate the percent leaf area symptomatic. Ozone symptoms were manifested as stipple on the adaxial leaf surface. In the preliminary 1991 sampling, 40, 87, and 7% of black cherry trees sampled were found to be symptomatic at the 3 sites; 63 and 67% of yellow poplar trees sampled were found to be symptomatic at sites 1 and 3, as were 43 and 63% of the white ash at sites 1 and 2 (3 complete sets were not found in 1991). In 1992, the sampling and rating of injury were repeated. Symptoms of ozone injury appeared on 23, 88, and 10% of black cherry, on 17, 7, and 80% of yellow poplar, and 27, 40, and 40% of white ash. Elevation and ozone exposure will be discussed.

COMPARISON OF dsRNAS ASSOCIATED WITH TWO STRAINS OF THE CHESTNUT BLIGHT FUNGUS IN NEW JERSEY. B. I. Hillman, B. T. Halpern, and J. J. Polashock, Dept. of Plant Pathology, Rutgers University, New Brunswick, NJ 08903.

We have characterized the dsRNAs associated with two hypovirulent strains of the chestnut blight fungus, *Cryphonectria parasitica,* from New Jersey. The dsRNAs of each of these have been cloned and mapped. One of these, from strain NB58, has been sequenced in its entirety. The 12,501 bp dsRNA of strain NB58 is organized similarly to the dsRNA of the well-characterized French-derived strain EP713 and shares approximately 50% sequence identity with the EP713 dsRNA. NB58 dsRNA is associated with greatly reduced fungal virulence. The other dsRNA, from New Jersey strain NB631, is considerably smaller, approximately 2.8 kbp and is associated with only slightly reduced fungal virulence. In northern blot analysis, NB631 dsRNA did not cross-hybridize with a similar sized dsRNA from the hypovirulent Michigan strain RC1.

CONTROL OF POWDERY MILDEW OF ROSE WITH BICARBONATES: I. A QUALITATIVE MICROSCOPIC STUDY OF ERADICATION. H. W. Israel, S. J. Ingalls, L. L. Porter, and R. K. Horst, Department of Plant Pathology, Cornell University, Ithaca, NY 14853.

To learn how bicarbonates adversely affect established powdery mildew infections of rose by *Sphaerotheca pannosa* var. *rosae*, the causal agent, we contrasted paired leaflets, attached or detached, of the susceptible rose cultivar Sonia after one postinoculation adaxial runoff spray of .08 M $KHCO_3$ or of water. Both intact and sectioned samples were examined by light and electron microscopy. Superficial parasite structures and haustoria disappeared within four days on adaxial surfaces where penetrated host epidermal cells recovered but, with contiguous cells, exhibited phenolic-rich contents. Because abaxial infection sites on the same leaflets flourished, as did all sites on water sprayed leaflets, we infer that bicarbonate impacts the fungus directly, and is not mediated by host tissues. (The series, I.-IV., supported in part by Church and Dwight Co., Inc., Princeton, NJ 08540.)

CONTROL OF POWDERY MILDEW OF ROSE WITH BICARBONATES: III. A MICROSCOPIC STUDY OF PROTECTION. H. W. Israel, S. J. Ingalls, L. L. Porter, and R. K. Horst, Department of Plant Pathology, Cornell University, Ithaca, NY 14853.

To discover whether bicarbonates can prevent primary infections of rose by the powdery mildew fungus, *Sphaerotheca pannosa* var. *rosae*, we compared germination percentages of ≤24 h-old conidia incubated in near-saturated atmospheres on agar/collodion coated glass microscope slides that received one preinoculation runoff spray of .08 M $KHCO_3$ versus water. We also microscopically evaluated structural integrity, indicative of viability, of conidia 1 h following submersion in $KHCO_3$ solutions of 0.00 up to 0.64 M. Sprays reduced germination by 22%, and higher percentages of conidia exhibited injury with increasing molarity of the $KHCO_3$ solutions. We infer that sprays applied at *very low* concentrations become virtually 100% efficacious at the *very high* concentrations that result from cyclic dehydration/rehydration of their residues during changing atmospheric water vapor pressures.

IONIC MODIFICATION OF WOOD DURING BIODEGRADATION. J. Jellison and J. Connolly, Dept. of Plant Biology and Pathology, Univ. of Maine, Orono, ME 04469; K. Smith and W. Shortle, USDA Forest Service, Durham, NH 03824.

The effect of colonization by the decay fungi Postia placenta, Gloeophyllum trabeum, Phanerochaete chrysosporium and Trametes versicolor on the cation concentrations of oak and poplar wood was monitored using plasma emission spectrophotometry. Significant increases in the concentrations of calcium, potassium, magnesium, and manganese were seen in all degraded wood samples and elevated levels of aluminum and iron were associated with colonization by the brown-rot fungus P. placenta. The modification of the ionic environment that is associated with the metabolism of the decay fungi may also influence the mineral cycling of woody debris and the forest floor.

TRANSITION METALS AND THEIR ROLE IN FUNGAL BIODEGRADATION. J. Jellison, B. Goodell, V. Easwaran, Y. Chen, V. Chandhoke and F. Fekete, Univ. of Maine, Orono, ME 04469; M. Ishihara and N. Hayashi, FFPRI, Tsukuba, Japan.

Wood degrading fungi were shown to produce tri-substituted phenolates similar to bacterial siderophores. These compounds were purified from the filtrate of fungal cultures low in transition metals and were shown by electron paramagnetic resonance spectrometry to chelate iron. Immuno-TEM studies demonstrated the production of these compounds during the decay process and the penetration of the chelators into the degrading cell wall. Transition metal availability also influenced fungal glycan sheath formation and the electrophoretic profile of the fungal proteins. X-ray diffraction analysis and other assays were used to demonstrate the ability of the biochelator, in the presence of iron, to directly influence wood cellulose crystallinity.

CONTROL OF ROOT-KNOT NEMATODE ON PROCESSING CARROT WITH SOIL FUMIGATION. S.A. Johnston, P.R. Probasco and J.R. Phillips. Rutgers Research & Development Center, Bridgeton, NJ 08302.

The experiment was conducted in a root-knot nematode (*Meloidogyne hapla*)-infested field in Woodstown, NJ in 1991. On 9 Apr, soil fumigants (Telone II and metham sodium, Vapam) were applied with a small plot fumigator. On 20 Apr, oxamyl (Vydate L) treatments were surface applied and incorporated. On 29 Apr, carrots (cv. Danver's 126) were

seeded into the field. Treatments were replicated 4 times in a randomized complete block design. Foliar applications of oxamyl (4 pt/A) were applied to selected plots on 11 Jun, 8 Jul, 13 Aug and 20 Sep. Plots were harvested on 12 Nov. All soil fumigant treatments resulted in significantly greater plant stands and marketable yield, and significantly lower galling indices than the untreated check. Oxamyl did not control root-knot nematode damage to carrots when applied preplant or foliarly but did significantly reduce root-knot nematode levels in the soil at harvest when applied as a foliar treatment.

EFFECTS OF RELATIVE HUMIDITY AND WET PERIOD ON BLOSSOM BLIGHT INFECTIONS OF SOUR CHERRY. D.C. Koball, W.F. Wilcox, and R.C. Seem. NY State Ag. Experiment Station, Cornell University, Geneva, 14456.

Excised sour cherry blossoms (cv. 'Montmorency') were inoculated with Monilinia fructicola (Wint.) Honey at 500 conidia/ml (c/ml), subjected to an 8 hr wetting period at 20°C, and then exposed to five different relative humidity (RH) levels from 55-93%. After 7 days, blossom blight incidence ranged from 0-20% at the 55% RH treatment to 100% at the 93% RH treatment. Sporulation on blighted blossoms ranged from zero to 61,000 conidia/blossom respectively. Water potentials of stamen tissue from uninoculated blossoms ranged from -11.8 to -21.7 bars for the 55% treatment and -8.1 to -13 bars for the 93% treatment. In an outdoor experiment, blossoms were inoculated to runoff at either 5,000 or 50,000 c/ml and exposed to wet periods of 8, 24, or 48 hr using a controlled misting system. Two trees inoculated with 5,000 c/ml from each wet period were then brought into a chamber at 20°C and 90-95% RH for the ensuing incubation period, while two trees at each inoculum level remained at ambient outdoor conditions. The incidence of blight on trees incubated in the chamber was consistently high, whereas large differences occurred between replications on trees incubated under variable conditions. No difference was observed for wetness period treatments, although the number of blossoms blighted at 50,000 c/ml was consistently higher than those blighted at 5,000 c/ml.

GENETIC ANALYSIS OF THE PRODUCTION OF AN ANTIFUNGAL COMPOUND IN *PSEUDOMONAS CEPACIA* STRAIN M53R2. D. Kobayashi, J. Palumbo and M. Murillo. Rutgers University, Department of Plant Pathology, New Brunswick, NJ 08903.

Pseudomonas cepacia strain M53R2 was previously shown to prevent gray mold, caused by *Botrytis cinerea*, on apples and pears. Production of an unidentified antifungal substance (AFS) by M53R2 was proposed as the primary mechanism of antagonism (Mao and Cappellini, Phytopathology 79:1153). Mutants of strain M53R2 were generated using the transposon *Tn5*, and several isolates defective in the ability to produce ASF were obtained. Apple fruit assays indicated that at least two isolated mutants no longer prevented the occurrence of gray mold on apples. Southern blot analyses indicated that *Tn5* insertions in mutants defective in AFS production mapped to one of at least 8 different *EcoRI*-digested DNA fragments. Characterization of corresponding wild-type DNA in cosmid clones indicate that several of these *EcoRI* fragments are physically linked but may comprise different complementation groups.

DAMAGE CAUSED BY *GREMMENIELLA LARICINA* ON *LARIX* SPP. G. Laflamme. Forestry Canada, Quebec Region, 1055 du P.E.P.S., Sainte-Foy, Quebec, Canada, G1V 4C7

A recent taxonomic study of the genus *Gremmeniella* distinguished two species: *G. abietina* and *G. laricina*. In the Swiss Alps, these two species have been found on the same trees in a larch plantation. The pathogenicity of *G. abietina* was questioned as only *G. abietina* was said to be pathogenic. However in Canada, *G. laricina* has been reported in the provinces of British Columbia and Quebec, and was once tested to be pathogenic on larch. In Quebec, we have observed a shoot blight in natural regeneration of *Larix laricina,* which is constantly associated with *G. laricina*. However, the disease was always at an endemic level. On *L. decidua* and on *L. leptolepis*, the disease reached the epidemic level and again it was associated with *G. laricina*. Tree mortality was recorded on trees less than 2 m high. Branches on larger trees below the snow line, were killed, much like the pines infected with the North American species of *G. abietina*.

CLONING OF DOUBLE-STRANDED RNA (DSRNA) ELEMENTS ASSOCIATED WITH HYPOVIRULENCE IN RHIZOCTONIA SOLANI. D. K. Lakshman and S. M. Tavantzis. Department of Plant Biology and Pathology, University of Maine, Orono, ME 04469.

We have reported previously that specific dsRNA elements may regulate expression of virulence in R. solani. The hypovirulent isolate Rhs 1A1 originated as a mycelial sector of the virulent AG 3 isolate Rhs 1AP. The dsRNA content of Rhs 1AP is stable and consists of two dsRNAs of 23 kb and 6.5 kb. Rhs 1A1 has 3 dsRNAs in addition to the 2 dsRNAs found in Rhs 1AP. The apparent sizes of the novel dsRNAs are 25 kb, 3.7 kb, and 1.1 kb. We have constructed cDNA libraries of these dsRNAs, and initiated sequencing projects. Northern blot hybridization analyses suggest that elements with corresponding sizes (23 kb or 6.5 kb) occurring in both cultures are genetically identical, but the 23-kb dsRNA is not related to the 6.5-kb element. The 25-kb dsRNA of Rhs 1A1 is unrelated to the 23-kb dsRNA found in either culture. Work is under way to determine whether the 3.7 kb and 1.1-kb dsRNA elements are related to each other, to any of the other dsRNAs, or to chromosomal or extrachromosomal DNA.

JUVENILE EMERGENCE AND REPRODUCTION OF GLOBODERA TABACUM TABACUM IN RESPONSE TO TOBACCO, TOMATO, AND BLACK NIGHTSHADE. James A. LaMondia, Dept. of Plant Pathology and Ecology, Conn. Agric. Expt. Sta., Valley Laboratory, Windsor, CT 06095.

The effects of broadleaf tobacco, Rutgers tomato, and black nightshade on juvenile hatch and reproduction of Globodera tabacum tabacum (GTT) were determined in lab and greenhouse experiments. GTT cysts were exposed to distilled water (dH20) or 1:0, 1:1, 1:10, 1:100, and 1:1000 dilutions of root exudates in an in vitro assay. Exudates were prepared by soaking 2g root in 100 ml dH20 for 2 hr. GTT hatch after 6 wk was greater in undiluted exudates from nightshade than tomato or tobacco (83% vs. 28% and 16%). Hatch in dH20 was 2.4%. Exudate dilutions of 1:100 or greater for nightshade and 1:10 or more for tomato or tobacco did not increase hatch over dH20. GTT hatch from cysts in nylon mesh bags in soil under nightshade, tomato, tobacco, or fallow was 96%, 97%, 82%, or 79%, respectively, after 12 wk in the greenhouse. Numbers of new cysts produced on roots were greater for nightshade than for tomato or tobacco.

MOLECULAR CLONING AND DETECTION OF GRAPEVINE LEAFROLL VIRUS BY NUCLEIC ACID HYBRIDIZATION AND POLYMERASE CHAIN REACTION. Kaishu Ling, John Hu* and Dennis Gonsalves. Department of Plant Pathology, Cornell University, Geneva, NY 14456. *Department of Plant Pathology, University of Hawaii, Honolulu, HI 96822.

Grapevine leafroll virus (GLRV) is one of the most widespread and economically important virus diseases of grapes. There are at least four distinct serotypes of this closterovirus which make serological diagnosis of leaf roll more complicated. Thus, development of nucleic acid probes which can be used for detection of all isolates of GLRV is desirable. We have successfully established a cDNA library from dsRNA of GLRV-NY1 (serotype III). Cloned fragments were used in Northern blot hybridizations to specifically detect dsRNA isolated from GLRV infected vines. Reverse Transcriptase-Polymerase Chain Reaction (RT-PCR) with specific synthesized primers was successfully applied for detection.

"HERB'S SYNDROME": AN UNEXPLAINED CROWN DETERIORATION, DIEBACK AND MORTALITY OF *PINUS STROBUS*. J. H. McDonald, W. Merrill, and N. G. Wenner, Penn State, 211 Buckhout Lab, University Park, PA. 16802

An unexplained crown deterioration, dieback and mortality was found in four 75- to 105-year-old stands of *Pinus strobus* in northwestern PA, one stand each in Clarion, Forest, Jefferson, and Venango counties. The syndrome, named for its discover, Herb Landes, appears unrelated to site, soil type, aspect, elevation or age. About 180 acres of trees are affected. Symptoms are distinctive: major scaffolding branches die and are replaced by aggregations of short-lived epicormic branches at the nodes which often form small, loose witches' brooms. Foliage on such branches often is tufted and chlorotic. Radial growth of affected trees has been negligible for at least 20 years. Internodes of many of the epicormic branches are distinctively spindle-shaped due to a significant thickening of the bark. Lesions of various sizes occur in the bark and xylem of such twigs. *Leucocytospora kunzei*, two unidentified discomycetes, an unidentified sporodochial fungus, and at least two unidentified species of mites have been found on some epicormic branches of these trees.

PATHOLOGICAL ANATOMY OF EPICORMIC BRANCHES OF *PINUS STROBUS* WITH "HERB'S SYNDROME". J. H. McDonald, W. Merrill, and N. G. Wenner, Penn State, 211 Buckhout Lab, University Park, PA 16802.

Three 105- to 120-year-old *Pinus strobus* with "Herb's Syndrome" were felled in Cook Forest State Park, Clarion Co., PA in March 1992. Histological sections of epicormic branches processed through Johansen's Quadruple Stain were examined. Small lesions develop in the outer bark around what appears to be damage caused by an insect with piercing-sucking mouthparts. These lesions continue to enlarge, overcoming multiple attempts of the host to wall

them out. Epithelial cells of cortical resin ducts are hypertrophied, occluding the ducts. Red-brown lesions develop in the xylem. Xylem often also contains included bark. Xylem rays are hypertrophied. Tracheid orientation is distorted, often at 90° from normal. Tracheids exhibit spiral thickenings which are rare in healthy wood. The overall pathological anatomy is similar to the "rotholz" of *Abies balsamea* caused by *Adelges piceae*.

EVALUATION OF VINEYARD SPRAYERS FOR COVERAGE AND DRIFT. W. McFadden-Smith[1], K. Ker[2], G. Walker[2], and S. Paul[3], [1]Horticultural Research Institute of Ontario and [2]Advisory Services, OMAF, Vineland Station, Ontario, L0R 2E0, and [3]Dept. of Engineering, U. of Guelph, Guelph, Ontario, N1A 2W1

Four types of vineyard sprayers were evaluated for efficacy in deposition of spray material on foliage and clusters and for amount of drift away from the target rows. A conventional air-blast sprayer, a modified air-blast sprayer, a low volume sprayer and a recycling sprayer were evaluated on grape vines, cv. Riesling, at cluster closure (mid-July) using a fluorescent dye (Calcofluor) (0.67 g/L). Wind speed and direction were recorded during the operation of each sprayer. The amount of drift in the air and on the ground was greater from the air-blast sprayer than the others at 2.74 m from the sprayed row. These differences were not significant at greater distances. Detectable residues (0.01-0.03 ppm) were found in the air and on the ground as far as 21.8 m from sprayed rows. The air-blast and modified air-blast sprayers gave superior coverage of leaves and clusters. The recycling sprayer gave good coverage of leaves and intermediate coverage of clusters. The low volume sprayer gave the poorest coverage overall.

MANAGEMENT OF BLACK ROT IN CABBAGE WITH HOST RESISTANCE AND A COPPER BACTERICIDE. M. T. McGrath, M. S. Ghemawat and H. Staniszewska, Dept. of Plant Pathology, Long Island Horticultural Research Laboratory, Cornell University, Riverhead, NY 11901.

The objectives were 1) to compare the efficacy of genetic control (resistant cultivars SuperElite (SE) and Bravo (B)) and chemical control (the copper bactericide Champ F applied weekly to the susceptible cultivar Market Prize (MP)) for managing *Xanthomonas campestris* pv. *campestris*, 2) to determine if black rot can be controlled successfully with Champ F applications initiated after disease detection and 3) to evaluate the integrated use of genetic and chemical controls. For each cultivar there was a nontreated control, a 'preventive' spray program initiated immediately after transplanting an infected plant to the middle of each plot (17 July), and an 'IPM' spray program initiated after symptoms were observed on noninoculated plants (14 Aug for MP and SE or 27 Aug for B). Black rot severity at crop maturity in 1991 was significantly lower for both SE (1.0%) and B (1.6%) than for either nontreated MP (5.6%) or MP treated preventively (3.6%). Therefore genetic control was more effective than chemical control. Black rot development was suppressed by each spray program in each of the 3 cultivars. The 'preventive' spray program was more effective. Similar trends were obtained in 1992.

DIAPORTHE LOKOYAE ON *PICEA PUNGENS* IN PENNSYLVANIA. W. Merrill and N. G. Wenner, Penn State, 211 Buckhout Laboratory, University Park, PA 16802.

In September 1991, *Diaporthe lokoyae* Funk was discovered on 1-1.5 m tall *Picea pungens* in a Chester Co., PA Christmas tree plantation. The trees, planted in 1984 on clay soil of low fertility, became increasingly symptomatic beginning in 1988. Scattered branches or groups of branches were chlorotic and declining on many trees. Perithecia occurred on discolored branches 5-8 mm in diameter. A *Phomopsis* sp. was isolated from cortical tissues of these branches. Numerous isolates of *Phomopsis* have been recovered from chlorotic or dying conifers in PA, but have been unidentifiable because of overlap in sizes of the conidia of the various species. This is the first time we have found the sexual stage of one of these fungi. *Diaporthe lokoyae* has been reported from the western US and Canada causing cankers and dieback in Douglas-fir, usually associated with stress. This is the first report of *D. lokoyae* from eastern North America, and the first report of it attacking *Picea pungens*.

IMMUNODETECTION OF BEAN YELLOW MOSAIC VIRUS IN WHITE LUPIN. C. Piche, J. Peterson, M.G. Fortin. Dept. of Plant Science, McGill University, Macdonald Campus, 21,111 Lakeshore Road, Ste-Anne-de-Bellevue, Quebec, Canada H9X 3V9.

Virus-like symptoms were observed in fields of white lupin (*Lupinus albus* L.) in Eastern Canada. Affected plants displayed mosaic, leaf stunting and deformation, and bunchy growth habit symptoms. The disease was reproduced in the greenhouse by mechanical inoculation on lupin. Bean yellow mosaic virus (BYMV) and cucumber mosaic virus (CMV) are the two most common virus diseases of lupin reported. Symptomatology on diagnostic species, electron microscopy, Enzyme Linked Immunosorbent Assay (ELISA) and immunodetection after Western blotting were used to identify the virus present. CMV was not detected but a potyvirus, later identified as BYMV, was found. This is the first report of a viral disease of lupin in Canada. The distribution and occurrence of plants showing symptoms in the field suggest seed-borne infections as a possible virus source.

NB58F: AN ISOLATE OF *CRYPHONECTRIA PARASITICA* THAT APPEARS TO BE RESISTANT TO VIRUS INFECTION. J. J. Polashock and B. I. Hillman, Dept. of Plant Pathology, Rutgers University, New Brunswick, NJ 08903.

Virulence of *Cryphonectria parasitica*, the causal agent of chestnut blight, may be reduced by any of several dsRNA viruses that are transmitted primarily through anastomosis of compatible hyphae and via conidia. A phenotypically distinct sector subcultured from a virus-containing isolate, NB58, was found to be dsRNA free. Repeated attempts to infect this isolate, termed NB58F, by anastomosis with several dsRNA-containing strains have been unsuccessful. DNA fingerprint analysis indicated that the nuclear background of NB58F is the same as that of parent strain NB58 and of a dsRNA-free single conidial isolate of NB58, NB58-19. NB58F is intermediate between NB58 and NB58-19 in pigmentation, growth rate, and sporulation in culture, and in virulence. Sexual crosses suggest that the NB58F phenotype is associated with a single nuclear gene.

CONTROL OF POWDERY MILDEW OF ROSE WITH BICARBONATES: II. QUANTITATIVE INFLUENCE ON FUNGAL STRUCTURES. Porter, L.L., Horst, R.K. and Israel, H.W., Department of Plant Pathology, Cornell University, Ithaca, NY 14853.

Detached leaves were used to monitor the development and morphology of fungal structures in the rose-*Sphaerotheca pannosa* var. *rosae* pathosystem affected by one post-inoculation application of bicarbonates. The numbers of conidia, conidiophores and hyphal branches were determined from measured adaxial lesions of naturally infected leaves of four rose cultivars. Leaves were sprayed with treatments, allowed to dry, and were maintained in Petri dishes containing moistened filter paper. After three days, fungal structures were counted in the same lesions. A reduction in the number of conidiophores and hyphal branches occurred in lesions sprayed with (0.08M) potassium bicarbonate- oil (0.5% v/v). Reduction in number of conidia varied by cultivar. Sprayed bicarbonate-oil solutions appear to impact fungal development beyond the conidial stage.

CONTROL OF POWDERY MILDEW OF ROSE WITH BICARBONATES: IV. TEMPORAL INFLUENCE ON CONIDIAL GERMINATION. Porter, L.L., Horst, R.K. and Israel, H.W., Department of Plant Pathology, Cornell University, Ithaca, NY 14853.

Conidial germination, a component of parasitic fitness, is critical for pathogen ingress of the host plant. The influence of one postinoculation application of bicarbonate solutions against *Sphaerotheca pannosa* var. *rosae* condial germination was evaluated at selected intervals using a detached leaf bioassay. Naturally infected leaves of the rose cultivar Samantha were shaken 24 h in advance to remove older conidia. Leaf tissue disks, 4 mm dia., were removed and placed in Petri dishes containing 2% water agar. Treatments were applied to the disks, which were allowed to dry. Disk samples were collected at 9, 24, 48 and 72 h post-treatment, cleared in chloral hydrate 24 h, and stained in acid fuschin/lactophenol. Microscopic examination and counts indicated consistent reduction of conidial germination with bicarbonate-oil solutions. The adversarial action of bicarbonates thereby involves interference with an aspect of parasitic fitness.

DISCHARGE OF ASCOSPORES OF LEPTOSPHAERIA MACULANS IN AUTUMN FROM STUBBLE OF THE CURRENT YEAR'S CROP OF SPRING RAPESEED. C.B. Rempel and R. Hall, Dept. Environmental Biology, University of Guelph, Guelph, Ontario, Canada N1G 2W1

Blackleg of rapeseed (Brassica napus) is initiated by ascospores of Leptosphaeria maculans from infested crop stubble. We examined whether ascospores are discharged soon after harvest. Stubble from the current-year's crop of spring rapeseed was collected from two locations in 1990 and one location in 1991 at 2-wk intervals between mid-September and mid-November. Twenty asci were examined in each of 50 pseudothecia in each sample. Immature, mature, and discharged asci occurred throughout the period and their respective proportions were 60-76%, 17-26%, and 2-14% in mid-September and 35-41%, 35-49%, and 16-25% in mid-November. We conclude that maturation of pseudothecia of L. maculans does not require an over-wintering period and that stubble from the current year's crop of spring rapeseed can serve as a source of inoculum for fall-planted winter rapeseed.

DISEASE INCIDENCE AND SEVERITY RELATIONSHIPS IN BLACKLEG OF RAPESEED. C.B. Rempel and R. Hall, Dept. Environmental Biology, University of Guelph, Guelph, Ontario, Canada N1G 2W1

The relationship between incidence (I, proportion of plant units diseased) and severity (DS, area of stem tissue affected) of blackleg (caused by Leptosphaeria maculans) was examined in 7 genotypes of rapeseed (Brassica napus) grown at 7 locations in Ontario and Manitoba over two years. The regression equation based on all data was Log (DS) = 0.53 + 0.01 (I) ($R2 = 0.89$, $p = 0.01$). Regression equations of this form explained 67-92% of the variability in DS among plant genotypes. Slopes were similar among regression equations for different locations but differed widely among equations for different plant genotypes. The results suggest that the DS-I relationship was affected more by plant genotype than by location and that disease incidence may be unsatisfactory as a criterion for selection of resistant genotypes.

BIOLOGICAL CONTROL OF DOWNY MILDEW OF SUNFLOWER. W.E. Sackston, O. Anas, T. Paulitz. Plant Science, Macdonald Campus, McGill University, Ste. Anne de Bellevue, Que., Canada, H9X 3V9

Sunflower seeds of downy mildew susceptible line IS 003 were bacterized with Pseudomonas putida isolate N1R by soaking in bacterial suspension or by infiltrating under vacuum, then sown in pots in a soil:peat mixture. Inoculation was by drenching pots with zoosporangial suspension (500/mL) of Plasmopara halstedii (PH) race 1, 75 mL/pot, 1 or 2 days after sowing. Sporulation was induced 13 days later. Plants in untreated controls or bacterized but not inoculated with PH were tall and healthy. Inoculation with PH without bacterization gave 35/35 plants stunted, with sporulation. Bacterization by soaking, and inoculation, gave 7/38 healthy plants, 31/38 stunted, with sporulation. Bacterization by infiltration, and inoculation, gave 16/33 plants tall and healthy, 17/33 stunted, with sporulation. Bacterization by infiltration might give better protection in soil naturally infested with the pathogen.

ACQUISITION OF METALAXYL RESISTANCE IN *PYTHIUM APHANIDERMATUM*. Patricia L. Sanders, Department of Plant Pathology, The Pennsylvania State University, University Park, PA 16802.

Hybridization was attempted between isolates of *Pythium aphanidermatum* with mutagen-induced resistance to 6-fluoro-tryptophan (FTP) and natural or mutagen-induced resistance to metalaxyl. Protoplast fusion and in-culture and in-planta hybridization were attempted to obtain double-resistant progeny. The presence of nuclear hybridization in double-resistant progeny was evaluated by evidence of heterozygosity at the genetic locus determining phosphoglucose isomerase. Phosphoglucose isomerase isozyme studies revealed no evidence of nuclear hybridization in 43 recovered double-resistant progeny, hence, spontaneous mutation appeared to be the source of this variation. The recovery from FTP-resistant parents of seven double-resistant progeny with intermediate levels of resistance to metalaxyl suggests that metalaxyl resistance may be controlled by a single gene and incompletely dominant in *P. aphanidermatum*.

INFLUENCE OF ASSESSMENT TIME AND MODEL CHOICE ON THE RELATIONSHIP BETWEEN TEMPERATURE/LEAF WETNESS PERIODS AND DISEASE PARAMETERS OF *SEPTORIA GLYCINES* ON SOYBEANS. W. Schuh and A. Adamowicz, Department of Plant Pathology, The Pennsylvania State University, University Park, PA 16802.

The disease severity and number of lesions of *Septoria glycines* were significantly influenced by temperature and leaf wetness period. The three assessment dates (7, 14, 21 days after inoculation) had a strong influence on the choice of modeling approach (linear regression analysis and nonlinear regression analysis (Richards model)). Disease severity was modelled successfully as a function of temperature and leaf wetness period using linear regression analysis at assessment days 14 and 21, whereas the Richards function was only applicable on day 14. Lesion number could be modelled only on day 7 because of lesion merger, especially at higher disease severities. In general, both modelling approaches described the data satisfactorily when comparison was based on the R^2-value (>0.85). However, the shape of the curves based on the two models led to different interpretations. Results from this study show the influence of time of assessment and modelling approach on the interpretation of the data set.

HYPOXYLON MAMMATUM ASCOSPORE INFECTION OF DROUGHT-STRESSED *POPULUS TREMULOIDES* CLONES: INTERACTION OF HOST-PRODUCED FUNGAL STIMULATORS AND INHIBITORS. M. R. Searles, B. M. Kruger, and P. D. Manion, SUNY College of Environmental Science and Forestry, Syracuse, NY. 13210

With increasing drought stress on tissue-cultured plantlets of aspen, there is an increase in proline and susceptibility of aspen to Hypoxylon canker. Proline stimulates *H. mammatum* in culture, but we hypothesize that a reduction in fungal inhibitors may also account for infection. Four aspen clones were inoculated with *H. mammatum* ascospores and grown on medium amended with proline. No lesions were produced on plantlets with proline levels similar to those in drought-stressed tissues. Lesions were produced on 3 of 4 clones only when proline tissue levels were 35 to 45 times that of drought-stressed tissues. Fungal inhibitory compounds of 8 aspen clones (stressed and non stressed) were identified and quantified by using a thin layer chromatography bioassay. The phenolic compounds catechol, salicin, and salicortin decreased in drought-stressed plants. These results suggest that *H. mammatum* ascospore infection of aspen is controlled by the interaction of stimulators and inhibitors.

THE PRODUCTION OF CONIDIA BY VENTURIA INAEQUALIS ON 7 APPLE CULTIVARS. C. A. Smith and W. E. MacHardy, Deptartment of Plant Biology, University of New Hampshire, Durham, NH 03824

Conidium production was quantified on 7 apple cultivars in 1989 and 1990 using a non-destructive method that allowed a scab lesion to be sampled repeatedly until conidium production ceased. Conidium productivty was significantly greater ($P = 0.05$) from lesions on 'Golden Delicious,' 'Mutsu,' 'Rome,' and 'Stayman' compared to productivity on 'McIntosh,' 'Spartan,' and 'Delicious' lesions, and ranged from approximately 15,000-29,534 conidia/lesion in the 'Golden Delicious' group and from 5,379-9,732 conidia/lesion in the 'McIntosh' group. In 1990, productivity/lesion was significantly greater from lesions on 'Golden Delicious,' 'Rome,' and 'Spartan' than on 'Stayman,' 'McIntosh,' and 'Mutsu' lesions, and productivity on 'Delicious' lesions was significantly less than on any other cultivar. Productivity ranged from 15,300-30,700 conidia/lesion in the 'Golden Delicious' group, 10,000-13,000 in the 'McIntosh' group, and was 3,500 on 'Delicious.' The infectious period (period from the appearance of a lesion to the last sampling day conidia were collected) ranged from 94 days on 'Golden Delicious' to 51 days on 'McIntosh' and 'Spartan' in 1989, and from 68 days on 'Golden Delicious' to 52 days on 'McIntosh' in 1990. The rate at which conidia were produced did not differ among the 7 cultivars in either year, but the number of conidia produced during the first 10 days after a lesion appeared did differ among the cultivars.

LACK OF DEFOLIATION DUE TO ANTHRACNOSE IN LANDSCAPE AND WOODLAND DOGWOOD TREES. V. L. Smith, Dept. Plant Pathology & Ecology, CT. Agr. Exp. Stn., New Haven, CT 06504

Defoliation due to anthracnose (*Discula destructiva*) has been considered to be a primary cause of dogwood (*Cornus florida*) mortality in the eastern U. S. Number of leaves and number of anthracnose lesions were counted on branches on 5 landscape trees and 2 forest trees in Connecticut at weekly intervals. Concurrently, anthracnose severity and incidence were quantitatively assessed on surrounding trees. Disease severity and incidence were higher in landscape trees than in forest trees, but none suffered defoliation due to anthracnose. Results indicate that defoliation caused by anthracnose is not a major factor in tree mortality in Connecticut.

THE REDUCTION OF ASCOSPORIC INOCULUM OF *VENTURIA INAEQUALIS* BY ORCHARD SANITATION. D. K. Sutton and W. M. MacHardy, Dept. of Plant Biology, Univ. of New Hampshire, Durham, NH. 03824-3597.

Two sanitation practices, shredding fallen apple leaves with a flail mower and applying urea to apple leaf litter, were evaluated in orchard trials from 1986-90 for their potential to reduce ascosporic inoculum of *Venturia inaequalis*. Autumn leaf-shredding reduced ($P=0.05$) the leaf litter density a mean of 55% at 7 sites, and the 'relative ascospore dose' (RAD) by a mean of 55% at two sites where ascospore discharge was monitored. The severity of primary foliar scab was reduced ($P<0.1$) a mean of 62% at 5 of the 7 sites. A spring leaf-shredding and spring urea application reduced ($P=0.05$) RAD by 89 and 74%, respectively; the severity of primary scab was reduced ($P<0.1$) 80% by each treatment. In small plot studies in 1990 and 1992, pre-leaf-fall urea, spring urea, autumn leaf-shredding, spring leaf-shredding and autumn plus spring leaf-shredding treatments reduced ($P<0.1$) ascospore productivity 97, 82, 50, 65, and 83%, respectively.

A METHOD OF EVALUATING BACTERIA FOR SUPPRESSION OF SUMMER PATCH AND ROOT COLONIZATION ABILITY ON TURFGRASS. D. C. Thompson, D. Y. Kobayashi and B. B. Clarke, Dept. of Plant Pathology, Rutgers University, New Brunswick, NJ 08903.

Summer patch of bluegrasses and fine fescues is caused by an ectotrophic root-colonizing fungus, *Magnaporthe poae*. A system was developed to evaluate bacteria, obtained from agronomic biocontrol programs, for suppression of summer patch and turf root-colonization ability (RCA). This system was then modified and improved to allow large scale

screening of bacteria isolated from turf roots. The Kentucky bluegrass cultivar Baron was grown in an 80:20 mix of sand:peat in 164 cm^3 conetainers. Tall fescue seed colonized by *M. poae* was placed 1.3 cm below the Baron seed. Bacterial suspensions (50 ml of 10^9 to 10^{11} cfu) were applied to 4 to 5 wk old turf grown in a greenhouse at 24 C. RCA was determined 2 wk later on rhizosphere soil and roots. Remaining plants were then moved to a 28 C growth chamber. Symptoms developed in 2 to 4 wk and were reduced by some bacteria. Populations of selected bacteria applied in the field were correlated with RCA in controlled environments.

EFFECT OF INITIAL POPULATION DENSITIES OF MELOIDOGYNE HAPLA ON GROWTH OF LETTUCE IN ORGANIC SOIL. N. M. M. Viaene and G. S. Abawi. Dept. of Plant Pathology, Cornell Univ., Geneva, N.Y. 14456.

Lettuce cv. 'Montello' was direct-seeded in 500 cc pots and 15,000 cc microplots in greenhouse and field tests, respectively. Pots and microplots were filled with nontreated or methylbromide-treated organic soil that was infested with *Meloidogyne hapla* at initial population densities (Pi) of 0, 1, 2, 4, 6, 8, 16, and 32 eggs/cc soil. Plant weight, root galling severity (RGS), and number of eggs per root system (Pf) were determined after 8 weeks. Plant weight declined linearly as Pi increased. In fumigated soil, the tolerance limits (T), calculated by fitting the data to the Seinhorst equation, were 3.75 eggs/cc soil in the microplot tests and 7.75 eggs/cc soil in the greenhouse tests. The T value was lower in nontreated soils. The RGS increased with increasing Pi's and reached a maximum (>80% roots with galls) at Pi's of 8 and 32 eggs/cc soil in greenhouse and microplot tests, resp. The reproduction rate (Pf/Pi) of *M. hapla* was highest at the lowest Pi's. Total egg production was greater in fumigated than in nontreated soil.

SPECIES OF ARMILLARIA CAUSING ROOT DISEASE OF BLUEBERRY IN MASSACHUSETTS. Philip M. Wargo, USDA Forest Service, Hamden, CT 06514, Frank L. Caruso, U.MA, East Wareham, MA 02538 and James W. Blodgett, U.WI, Madison, WI 53706.

Dieback and mortality of blueberry bushes, planted on former mixed oak-pitch pine forested areas in two locations in eastern MA, was attributed to Armillaria root disease. Most cultivars were susceptible to the fungus. Diploid (dip) isolates captured from blueberry bushes in one field and from oak and pine trees in the adjacent forest were paired on malt agar (MA) with haploid tester strains (HTSs) from known Eastern species of Armillaria. Isolates from both oak and pine trees were compatible with HTSs of A. mellea (Vahl:Fr) Kummer, Biospecies (BS) VI. Isolates from blueberry were not compatible with any HTSs of any species. Compatibility testing (dip x dip) of these isolates among themselves and with the forest isolates compatible with A. mellea indicated that the blueberry isolates are of the same genus but not genotype and are most closely related to BS VI. Mycelial and rhizomorph morphology formed on MA also are similar to A. mellea.

COMPARATIVE EFFICACY OF BRAVO® 825 AND BRAVO ® 720 IN CONTROLLING CYCLANEUSMA NEEDLECAST. N. G. Wenner and W. Merrill, Penn State, 211 Buckhout Laboratory, University Park, PA 16802.

In 1992 the efficacy of Bravo® 825 WDG was compared with that of Bravo® 720 F in a Christmas tree plantation in Clearfield Co., PA. The trees were 1.5-2 m Scots pine of Spanish seed source. Sprays were applied by Solo® backpack mist blower on 10 April and 12 May 1992 during the spring infection period. Application rates were 4620 g a.i. /h and 2304 g a.i.../h for the two products, respectively. Levels of *Cyclaneusma minus* infection were determined by direct isolation before the sprays on 10 April and 12 May, and on 16 June 1992, and recorded as the percentage of the 1991 needle complement infected. Details of isolation techniques have been previously reported. Bravo® 720 and 825 prevented infection throughout the study with increases of infection of 0.25% and 7.0%, respectively, as compared to 72.2% in the unsprayed check trees (significant at $P < 0.0005$). However, Bravo® 720 provided significantly better protection than Bravo® 825 ($P = 0.018$).

BANNER® AND RUBIGAN® FUNGICIDES INEFFECTIVE IN CONTROLLING RHABDOCLINE NEEDLECAST. N. G. Wenner and W. Merrill, Penn State, 211 Buckhout Laboratory, University Park, PA 16802.

In 1991-92, two sterol-biosynthesis-inhibiting fungicides were compared to chlorothalonil in controlling *Rhabdocline pseudotsugae* in a Christmas tree plantation of 2-3 m severely infected "Coconino" Douglas-fir in Columbia Co., PA. Applications were made with a Solo® backpack mist blower at the following rates: Bravo® 720 at 3.26 liter f.p./h, Banner® 1.1 EC at 1.19 liter f.p./h, and Rubigan® at 0.44 and 0.89 liter f.p./h. The first scheduled spray (at 10% budbreak) was missed due to poor weather; the second and third sprays were applied on 8 and 22 May, 1991. The study was evaluated on 13 April 1992 during peak symptom expression. From each of 10 permanently tagged samples trees per treatment, one 1991 shoot was removed at each cardinal direction 1.4 m from the ground. The percentage of infected needles was determined for each shoot. Bravo 720® gave significant control, permitting 13% infection, compared to 65% in the unsprayed check ($P = 0.05$). Banner® and Rubigan® treatments did not differ significantly from the check.

DISCOSIA PINI SEEDLING BLIGHT OF *PSEUDOTSUGA MENZIESII* IN PENNSYLVANIA. N. G. Wenner and W. Merrill, Penn State, 211 Buckhout Laboratory, University Park, PA 16802.

In September 1991, a Carbon Co., PA nursery bed of *Pseudotsuga menziesii*, fall-sown in 1990, was examined. The seedlings were severely stunted, chlorotic, and dead or dying. The lower stems frequently were crooked and/or had spindle-shaped swellings and stem cracking. Primary needles were stunted or lacking. The distinctive pycnidia and conidia of *Discosia pini* Heald were abundant on the stems and cotyledons. By comparison, seedlings spring-sown in 1991 from the same seed lot in an adjacent nursery bed were healthy, with well-developed primary needles. All seedbeds had been tilled, formed, and fumigated in the same manner in early fall 1990. The fungus apparently attacked the dormant fall-sown seed during the winter months. This fungus has been reported causing seedling blight of *Pinus ponderosa* in Nebraska, *P. banksiana* in Ontario, *P. sylvestris* in Romania, and *P. densiflora*, *P. thunbergii* and *Cunninghamia lanceolata* in Japan. This is the first report of this pathogen causing mortality to *Pseudotsuga menziesii* seedlings.

IN VITRO MORPHOLOGICAL CHANGES IN TREE PATHOGENIC FUNGI AFTER EXPOSURE TO A FUNGAL ANTAGONIST, *PHAEOTHECA* SP., AND ITS EXTRACTS. D. Yang, L. Bernier, Y. Piché and M. Dessureault. Centre de Recherche en Biologie Forestière, Université Laval, Québec, Qc, Canada, G1K 7P4.

In vitro screening and evaluation of the antagonistic ability of a *Phaeotheca* sp. against several major tree pathogens was conducted by a variation of the agar layer techniques. Results showed that this *Phaeotheca* species produces antifungal metabolites which are strongly inhibitory against a wide range of tree pathogens. Light and interferential microscopy were used to detect the occurrence of hyphal changes in test fungi exposed to colonies of *Phaeotheca* sp. or to their metabolites. Four types of morphological changes were observed in the pathogens tested: swelling of hyphae, production of resting spores, extrusion of cytoplasm from hyphal tips, and bursting and destruction of mycelium. Microscopic observation of the interaction between this *Phaeotheca* and various phytopathogenic fungi confirmed that *Phaeotheca* sp. possessed both fungistatic and fungitoxic activities depending on the fungal species used.

DROUGHT PREDISPOSES BLACK SPRUCE SEEDLINGS TO INFECTION BY *BOTRYTIS CINEREA*. P.G. Zhang and J.C. Sutton, Dept. of Environmental Biology, University of Guelph, Ontario, Canada N1G 2W1.

Seedlings of black spruce (*Picea mariana*) were kept in a growth-room (16 h photoperiod, 20 C, 40-60% RH) and in a greenhouse (16-28 C, 25-80% RH) without watering for periods ranging from 0 to 16 d. Some of seedlings were used to estimate chlorophyll content (YC), and others were inoculated with *B. cinerea* and incubated in high humidity at 20 C for 36 h. Incidence of needles infected (YI) and spores produced per needle (YS) were estimated. In 3- and 4-month-old seedlings, YI was zero following drought periods of < 12 and 8 d, but 2-3% following drought periods of ≥ 13 and 10 d in growth-room and greenhouse environments, respectively. Generally, YI and YS increased, while YC of seedlings decreased with extension of the drought period (D) in seedlings of various ages (A). Regression models using the logits of YI, YS and YC as dependent variables described the levels of infection, sporulation and chlorophyll as a function of D and A. Terms in the model were A, AD, AD^2, and AD^3, and all estimated parameters were significant. Coefficients of determination for combined data from two repetitions of the experiment were 0.45 - 0.77.

EFFECTS OF INOCULUM CONCENTRATION AND NEEDLE AGE ON INFECTION CYCLES OF *BOTRYTIS CINEREA* IN BLACK SPRUCE SEEDLINGS. P.G. Zhang and J.C. Sutton, Dept. of Environmental Biology, University of Guelph, Ontario, Canada N1G 2W1.

Seedlings of black spruce (*Picea mariana*) were kept in the dark at 34-36 C for 96 h to predispose them to *B. cinerea*, then inoculated at 20 C with spore suspensions of the pathogen containing 0, 10^2, 10^3, 10^4, 10^5, 10^6, $3.3*10^6$, $6.7*10^6$, and 10^7 conidia/ml. Incidence of infected needles (YI) was estimated after incubation on an agar medium containing paraquat. YI increased sigmoidally with inoculum concentration to a maximum of 91.7% in needles treated with 10^7 conidia/ml. Effects of needle age on infection were examined using nonpredisposed seedlings that were surface sterilized, or autoclaved, or untreated. The seedlings were inoculated with 10^6 conidia/ml and needles of different developmental stages were detached and incubated on water agar at 20 C. YI and cumulative number of conidia (YC) were estimated daily. YI values for partially expanded, fully expanded, and early senescing needles of the surface-

sterilized and untreated seedlings were < 5%. YI in surface-sterilized needles was not significantly different from that in untreated needles, but was substantially less than that in autoclaved needles. Latent periods ranged from 7.34 to 9.50 d. YC increased progressively with days after inoculation. Regression models were fitted to the data. A logistic model and a polynomial model were respectively chosen to accurately describe YI as a function of inoculum concentration (IC), and YC as a function of days after inoculation (ID, ID^2, and ID^3). Coefficients of determination for combined data of the experiment were 0.96 in the logistic model, and between 0.66 and 0.91 for various treatments in the polynomial model.

CLONING OF A *BACILLUS THURINGIENSIS* CRYSTAL PROTEIN GENE INTO *CLAVIBACTOR XYLI* SUBSP. *CYNODONTIS* Y.P. Zhang, M.C. Meztler and T.A. Chen, Dept. of Plant Pathology, Rutgers Univ., New Brunswick, NJ08903

A transformation system for *Clavibactor xyli* subsp. *cynodontis*(Cxc) was successfully developed using pLAFR3 as a vector. A gene encoding an insecticidal crystal protein, cryIA(a), from *Bacillus thuringiensis* subsp. *kurstaki* Hd1-Dipel, was cloned into pLAFR3. The recombinant plasmid, pLABT7, was transformed by electroporation into Cxc, and it was stable in the transformants. However, neither mRNA nor protein product for the crystal protein gene could be detected using Northern and Western blotting. Subsequently, another recombinant plasmid was constructed which contained a larger portion of the upstream regions of the gene. This construct gave protein expression in *E. coli*, as confirmed by Western blotting. Cxc has also been transformed with this plasmid, and expression studies are ongoing.