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ABSTRACTS

INHIBITORY INTERACTIONS BETWEEN *ACREMONIUM* SPP. AND THE MYCOFLORA FROM SEEDS OF *FESTUCA* AND *LOLIUM*. B. O. Bayaa, P. M. Halisky, and J. F. White*, Department of Plant Pathology, NJAES, New Brunswick, NJ, and Department of Botany*, University of Texas, Austin, TX.

Isolates of the grass endophyte, *Acremonium*, were used to study inhibitory interactions with 10 species of fungi isolated from seeds of *Festuca* and *Lolium*. *Acremonium loliae* isolated from perennial ryegrass inhibited the growth of *Anthromycopsis*, *Phoma*, *Alternaria*, *Curvularia*, and two species of *Drechslera*; but not *Colletotrichum*, *Nigrospora*, or *Stachybotrys*. *Acremonium coenophialum* isolated from tall fescue was variable in its reactions. Every isolate of this endophyte suppressed growth in one or more of the 10 test fungi. Reciprocally, growth of the endophyte, *Acremonium typhinum*, isolated from *Elymus*, *Festuca*, and *Sphenopholis* was inhibited by at least four of the test fungi. Inhibition of sporulation in certain of the test fungi by *A. coenophialum* and *A. loliae* also was observed.

TISSUE CULTURE BIOASSAY AS A VARIABLE IN A REGRESSION MODEL TO PREDICT HYPOXYLON CANCKER INCIDENCE IN ASPEN CLONES IN THE FIELD. R. Belanger, S. Falk, P. Manion, and D. Griffin, SUNY College of Environmental Science and Forestry, Syracuse, NY 13210.

Percent hypoxylon infection and site related variables were identified by intensive surveys of 29 naturally occurring aspen clones in Central New York. Ten clones representing the range of variation in infection were tissue cultured from dormant buds and bioassayed using *Hypoxylon mammatum* culture filtrates. Over 91% of the variation in hypoxylon infection was accounted for in these 10 clones with a multiple linear regression model of four independent variables: Average bioassay response, growth rate, transformed aspect and site index. The model is interpreted as expressing the relationship of genetic and environmental variables to predict hypoxylon disease incidence of aspen clones growing in the field.

INFLUENCE OF MAIZE GROWTH STAGE ON FUNGAL MOVEMENT, VIABILITY, AND ROT INDUCTION IN STALKS INOCULATED WITH *COLLETOTRICHUM GRAMINICOLA*. F. B. Bergstrom and G. C. Bergstrom, Department of Plant Pathology, Cornell University, Ithaca, NY 14853.

Stalks of susceptible maize hybrid Pioneer 3901 were injected (into the second internode above the brace roots) with *C. graminicola* conidia at late whorl, silking, kernel blister, or kernel dent stage. At weekly intervals, internodes were rated for symptoms and recovery of viable *C. graminicola*. Acropetal fungal movement followed by symptom development progressed rapidly in plants inoculated at the kernel blister and kernel dent stages, and at a slightly slower rate in plants inoculated at silking. Plants inoculated at late whorl developed few symptoms; the fungus appeared to be restricted in acropetal movement and/or survival until silking, and its survival in upper internodes was greatly reduced prior to kernel blister. Histology and fungal recovery data suggest a vascular mode of transport of *C. graminicola* in maize stalks.

BIOLOGICAL CONTROL OF *SCLEROTINIA SCLEROTIUM* WITH FUNGI ISOLATED FROM PETALS. G.J. Boland, G.D. Inglis and E.A. Smith, Department of Environmental Biology, University of Guelph, Guelph, Ontario N1G 2W1.

The disease cycle of *Sclerotinia sclerotiorum* involves the saprophytic colonization of senescing flower tissues by germinating ascospores. To determine the potential for biological control of *S. sclerotiorum* using fungi from flowers, fungi were isolated from 432 petals of white bean and of canola. More than 18 genera of fungi were recovered. Isolates from *Alternaria* and *Cladosporium* were present on 50-100% of the petals. Fungi were screened for disease control by coinoculating autoclaved petals with spore suspensions of *S. sclerotiorum* and the fungus to be evaluated. The inoculated petals were placed on white bean seedlings in a mist chamber. Twenty-seven isolates from 12 genera were screened at least twice and 7 isolates prevented disease. The best candidates were from the genera *Alternaria*, *Cladosporium*, *Drechslera*, *Fusarium*, *Gliocladium* and *Myrothecium*. The results indicate that such fungi from flowers can prevent infection by *S. sclerotiorum*.

SPORE PRODUCTION BY *BOTRYTIS CINEREA* ON NECROTIC STRAWBERRY LEAVES. P.G. Braun and J.C. Sutton, Department of Environmental Biology, University of Guelph, Guelph, Ontario, Canada N1G 2W1.

Green strawberry leaves inoculated with *B. cinerea*, the cause of gray mold fruit rot of strawberries, remained symptomless and senesced at the same time as uninoculated leaves. The pathogen was quiescent in the green leaves and sporulated after the leaves senesced. Potential sporulation of *B. cinerea* on necrotic strawberry leaves was monitored by incubating leaf samples from the field in humidity chambers. Sporulation incidence oscillated with peaks in April, June, and after crop renovation in July. The sporulation peaks coincided with peaks of production of necrotic leaves. Regression analyses showed strong positive relationships of the numbers of necrotic leaves/m² with incidence of sporulating leaves/m² (r²=0.95) or with conidiophores/m² of field (r²=0.90). Thus, the oscillating patterns of potential sporulation by *B. cinerea* in Ontario strawberries appear to depend on flushes of necrotic host leaves, the principal inoculum source for fruit rot.

CONTROL OF PINK AND GREY SNOW MOLD AND RESIDUAL SUPPRESSION OF DOLLARSPOT OF CREEPING BENTGRASS BY TRIADIMEFON AND PROPICONAZOLE. L.L. Burpee and L.G. Goult, Department of Environmental Biology, University of Guelph, Guelph, Ontario N1G 2W1.

Triadimefon (50WP) and propiconazole (135EC) applied to creeping bentgrass at 3.0, 6.0 and 12.0 kg a.i./ha on 3 December 1985 significantly suppressed the intensity of grey snow mold caused by *Typhula ishikariensis* and pink snow mold caused by *Microdochium nivale* estimated in April 1986. Application of triadimefon at 6.0 and 12.0 kg a.i./ha and propiconazole at 3.0, 6.0 and 12.0 kg a.i./ha resulted in control of grey snow mold (<3% disease) that was equivalent to the disease suppression provided by pentachloronitrobenzene (PCNB) applied at 30 kg a.i./ha. Only propiconazole at 6.0 and 12.0 kg a.i./ha suppressed pink snow mold to a level (<3% disease) that was equal to the suppression provided by PCNB at 30 kg a.i./ha. Seven months after the fungicides were applied, the intensity of dollarspot caused by *Sclerotinia homeocarpa* was significantly suppressed in plots treated with triadimefon or propiconazole at 6.0 and 12.0 kg a.i./ha.

ROOT DECAY OF GRAPE CAUSED BY *AGROBACTERIUM TUMEFACIENS* and *A. RADIOBACTER* BOVAR 3. T. J. Burr, A. L. Bishop, B. H. Katz and C. Bazzi*. Plant Pathology Department, New York State Agricultural Experiment Station, Cornell University, Geneva, NY 14456, *Institute of Plant Pathology, University of Bologna, Italy.

Strains of *Agrobacterium tumefaciens* and *A. radiobacter* biovar 3 were isolated from naturally occurring lesions on roots of

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V. vinifera cultivars in a commercial nursery. Sixty-three biovar 3 strains obtained from root lesions, vineyard soil and from sources in the U.S. and Europe, decayed grape roots. The crown areas of young Concord seedlings were wounded with a pin, inoculated with suspensions (ca. 10^8 cfu/ml) of each strain and incubated on moistened perlite in petri dishes. Water-soaked decay was observed within 48 hr. Decay by all strains was restricted to roots, whereas only tumorigenic strains incited tumors on hypocotyls and shoots. Tumorigenic and nontumorigenic strains of biovar 1 and 2 from grape and other hosts did not cause root decay.

TIMING BRAVO 720 FOR CRANBERRY FRUIT ROT CONTROL. F.L. Caruso and C.C. Kusek, Cranberry Experiment Station, University of Massachusetts, East Wareham, MA 02538, and Ocean Spray Cranberries, Plymouth, MA 02360.

Applications of Bravo during bloom to control fruit rot of cranberries were conducted to obtain an early application label for Bravo 720. Currently, late bloom is the earliest application stage for Bravo. Initial Bravo applications (5.5 pt/A) began at weekly intervals beginning at pre-bloom through out of bloom. Two subsequent sprays were applied at two week intervals. Initial applications at pre-, 10%, 50%, and full bloom gave good control of field rot in the variety "Crowley", especially early rot caused by *Phyllosticta vaccinii*. Later initial applications led to increased rot caused by *P. vaccinii* plus *Glomerella cingulata* and *Physalospora vaccinii*.

DEVELOPMENT OF AN INDIRECT ELISA FOR DETECTION OF MLOS IN ASH AND ELM. C.M. Craft and J.D. Castello, SUNY College of Environmental Science and Forestry, Faculty of Environmental and Forest Biology, Syracuse, N.Y. 13210.

Antisera were produced in rabbits to ash yellows (AY) and elm yellows (EY) antigens partially purified from infected periwinkle (*Catharanthus roseus* Don.). An F (ab')₂-based ELISA (Clark, Barbara, and Davies, 1983, *Annals of Appl. Biol.* 103: 251-259) was developed for each of the AY and EY MLOs. Reciprocal cross reactivity was demonstrated between each antiserum and the heterologous antigen. However, when tested in August, there was no cross reactivity with either antiserum against peach eastern X-disease MLO in celery or the clover phyllody MLO in clover in ELISA tests. Field tests are in progress to determine the effectiveness and reliability of the assays for detection of MLOs in naturally infected ash and elm, and to search for potential vectors and hosts of these pathogens.

A WILT DISEASE OF ANEMONE CORONARIA HORT. CAUSED BY COLLETOTRICHUM GLOEOSPORIOIDES WITH PSEUDOMONAS SP. AS A SYNERGIST. Robert P. d'Ambrosio, Ambrose Laboratories Ltd., Eastchester, N.Y. 10707.

In 1978 15% of 100,000 greenhouse-grown *Anemone coronaria* Hort. developed leaf curl and subsequent wilt symptoms. Pieces of diseased leaves were plated on PDA; the resultant bacterial colonies were streak-plated and colonies of both a *Pseudomonas* sp. and *C. Gloeosporioides* developed. When healthy plants were inoculated with the fungus alone 25% developed typical symptoms while 60% of the plants inoculated with a bacterium-fungus mixture developed typical symptoms. The bacterium alone produced no disease. Control was achieved by chlorination of the irrigation water along with foliar sprays of Fermate and Benomyl at 10 day intervals. Infected mature plants were reclaimed with a soil drench using 400g Captafol, 50g Benomyl/100 L. H. O.

DEMETHYLATION OF PISATIN BY THREE FUNGAL PATHOGENS OF PISUM SATIVUM. L. M. Delserone and H. D. VanEtten, Dept. of Plant Pathology, Cornell University, Ithaca, NY 14853

Several isolates each of the pea pathogens *Ascochyta pisi*, *Mycosphaerella pinodes*, and *Phoma medicaginis* var. *pinodella* were tested for the ability to demethylate and thus detoxify the phytoalexin pisatin. The hypothesis is that the ability to demethylate, which is known to be required by *Nectria haematococca* for high virulence toward pea, is also necessary for high virulence of any fungal pathogen of pea. All isolates of *M. pinodes* and some isolates of *A. pisi* and *P. medicaginis* had rapid rates of demethylation. Some isolates of the latter two species demethylated slowly. For all three

genera, high virulence was correlated with rapid demethylation and tolerance to pisatin *in vitro*, an observation which supports the hypothesis stated above.

PATHOLOGICAL ANATOMY OF PHAEOCRYPTOPUS GAUMANNI IN DOUGLAS-FIR. T. Dreisbach and W. Merrill, The Pennsylvania State University, University Park, PA 16802.

Phaeocryptopus gaumanni infects succulent first-year needles of Douglas-fir during shoot elongation and sporulates one or sometimes two years later. Needles may remain green and appear healthy even through perithecial formation, raising questions concerning the location and extent of colonization by the pathogen. Douglas-fir needles infected in June 1985 were collected in June 1986 and examined histologically. Hyphae generally were sparse, occurring only in the mesophyll of the adaxial half of the needle. Most hyphae were intercellular, although some intracellular hyphae appeared to penetrate directly through the cell walls. Host cell walls remained intact. No haustoria or appressoria were noted. No hyphae were found penetrating or surrounding endodermal cells or resin ducts. Hyphae aggregated directly beneath stomata, giving rise to stalked perithecia which protruded through the stomata to the outer needle surface.

ISOLATION OF BINUCLEATE RHIZOCTONIA-LIKE FUNGI FROM ROOT SYSTEMS OF COMMERCIAL AND WILD STRAWBERRY PLANTS IN MASSACHUSETTS. J. L. Drozdowski, P. J. Sullivan and W. J. Manning, Department of Plant Pathology, University of Massachusetts, Amherst, MA. 01003.

Binucleate Rhizoctonia-like fungi (BRLF) were consistently isolated from strawberry root systems from commercial fields during the 1984, 1985, and 1986 growing seasons. Root systems of apparently healthy and declining plants were collected and isolations were made from crown, primary and secondary perennial roots, and transient rootlets. The highest percentage of BRLF were recovered from secondary perennial roots of commercial cultivars. Healthy appearing wild strawberry plants were collected during the 1986 growing season from perimeters of previously sampled commercial fields. BRLF were consistently and predominantly isolated from crown tissue of all healthy, wild plants.

A PERSPECTIVE ON THE RESPONSE OF WHITE PINE TO AMBIENT OZONE POLLUTION. J. Eberhardt, E. Brennan, J. Kuser, Depts. of Plant Pathology and Forestry, Cook College-NJAES, Rutgers University, New Brunswick, NJ 08903.

For the past 30 years white pine has been generally classified as an O₃-sensitive species. Research with young trees at New Brunswick, New Jersey, and observations of more mature trees throughout the state do not support that conclusion. In a field planting of over 1000 trees from 58 seed sources, no O₃ symptoms occurred on current year needles in 1984 and 1985. By contrast certain varieties of honeylocust, linden, and many herbaceous crops developed typical O₃ symptoms. Periodic foliar application of the antioxidant EDU (500 ppm) did not improve their appearance, chlorophyll content, candle or needle length, cambial electrical resistance, or stomatal resistance. Replicate plantings in Connecticut and New York also exhibited no O₃-related tip burn or mottle on current year needles. Surveys of mature trees throughout New Jersey revealed little injury that could be attributed to ozone. New Jersey Agricultural Experiment Station, Publication Number K-11353-2-86.

REDUCTION IN POTATO YIELD DUE TO PHYTOPHTHORA INFESTANS INFECTATION. F. J. Ferrandino, The Connecticut Agricultural Experiment Station, P. O. Box 1106, New Haven, CT 06504.

A number of foci in two 15m x 15m potato cv. 'Superior' fields were inoculated with a suspension of *Phytophthora infestans* sporangia (10^4 /ml) twenty days after shoot emergence. Late blight incidence and severity was monitored biweekly until harvest. Potato yield was reduced 10% when disease severity reached one-half by 60 days after emergence and reduced 70% when the same severity occurred 34 days after emergence. A model describing these observations in terms of cumulative light intercepted by healthy potato leaves will be presented.

SYMPTOM DEVELOPMENT ON WHITE ASH AND GREEN ASH SEEDLINGS INOCULATED WITH VIRUSES AND A MYCOPLASMA-LIKE ORGANISM. M. A. Ferris, J. D. Castello, and W. A. Sinclair, SUNY College of Environmental Science and Forestry, Faculty of Environmental and Forest Biology, Syracuse, NY 13210, and Department of Plant Pathology, Cornell University, Ithaca, NY 14853.

Two hundred white ash (*Fraxinus americana* L.) and 200 green ash (*F. pennsylvanica* Marsh) seedlings were inoculated in the greenhouse with tobacco mosaic, tobacco ringspot, and tomato ringspot viruses and the ash yellows mycoplasma-like organism (MLO) in all possible combinations. After one three-month vernalization treatment, foliar symptoms characteristic of virus infection have been observed on many of the inoculated trees. All virus infections have been confirmed by ELISA. Most symptoms appear to be associated with infection by tobacco ringspot virus and are similar to foliar symptoms observed on both declining and non-declining white ash trees in the field. In addition, transmission of MLO was confirmed by DAPI staining and by observation of yellowing and witches' brooms on several inoculated trees.

EFFECTS OF NITROGEN, STRAW MULCH, AND CHLOROTHALONIL ON EARLY BLIGHT OF TOMATOES AND TOMATO YIELD. S. L. Fischer, S. P. Pennypacker, and A. A. MacNab, Dept. of Plant Pathology, The Pennsylvania State University, University Park, PA 16802.

In 1984 and 1985, effects of nitrogen, mulch, and fungicide on development of early blight (caused by *Alternaria solani*) and fruit yield of processing tomato cultivar "Merit" were evaluated in a complete factorial experiment. The factors were: 3 levels of nitrogen (0, 112, and 224 kg N/ha), 2 levels of straw mulch (with and without), and 2 levels of fungicide (chlorothalonil applied as scheduled by the forecasting system FAST and no fungicide). With fungicide treatment, defoliation by early blight was reduced and yields generally were increased. In most cases, early blight severity was lower and yields were greater with the presence of nitrogen, with little response difference between 112 and 224 kg N/ha. Mulch did not significantly influence early blight development but had variable effects on yield.

INITIATION AND DEVELOPMENT OF CLEISTOTHECIA OF *UNCINULA NECATOR*. D.M. Gadoury and R.C. Pearson, Plant Pathology Dept., N.Y. State Agr. Expt. Station, Geneva, NY 14456.

A collection of 20 *U. necator* isolates consisted of two mating types that occurred with equal frequency. Ascocarp initiation required only that compatible isolates be paired and was not affected by light, temp., leaf age or host resistance. However, subsequent growth was affected by temp. and host resistance. At 20 C, ascocarps first appeared 8-10 da after inoculation as hyaline spheres 40 μ m in diam. Basal hyphae grew outward from the ascocarp wall at this stage and secured the ascocarp to the vegetative hyphae, but did not anastomose. During the next 10 da the ascocarps first yellowed as intra- and extracellular lipids accumulated, and then became brown as the outer wall darkened and hardened, while diam. increased to 100 μ m and an equatorial band of uncinata, upwardly directed appendages formed. Association with the host was terminated within 30 da of inoculation when connections to the vegetative hyphae necrosed and the ascocarp became basally convex, tearing the basal anchorage hyphae free of the vegetative hyphae.

CONTROL OF LETTUCE DAMPING-OFF WITH SELECTIVE FUNGICIDES. L.E. Carrabrandt and S.A. Johnston, Plant Pathology Department, Cook College, Rutgers University, New Brunswick, NJ 08903.

NTN 19701, CGA 448, SN 84364 and NC 28410 soil drench and seed treatment applications were evaluated for control of *Pythium* and *Rhizoctonia* damping-off of lettuce. In greenhouse tests, where fungicides were applied at various rates, alone, or with metalaxyl (Apron (A) or Ridomil (R)), the following treatments significantly increased plant vigor, stand and dry weight: all seed treatments of NTN, CGA, SN and NC alone or combined with A and drench applications of NTN + R and SN + R. In the field, where just metalaxyl combinations were tested, only drenches of NTN + R were effective. In greenhouse studies conducted with *Rhizoctonia solani* anastomosis groups (AG) -1, -2-2, -3 and -4, the efficacy of NTN, CGA, SN and NC, applied alone as seed treatments or soil drenches, was not found to be influenced by AG of *R. solani*. Results of laboratory tests, in which radial growth of *R. solani* AGs on soil plates treated with NTN, CGA, SN and NC was measured, were consistent with greenhouse AG test results. NJAES, Publication Number K-11140-1-87.

ISOLATION AND CHARACTERIZATION OF PECTOLYTIC ENZYMES FROM *ERWINIA CAROTOVORA* SUBSP. *ATROSEPTICA*. H. L. George and M. S. Mount, Dept. of Plant Pathology, Univ. of Mass., Amherst, MA. 01003.

Enzymes with pectate lyase (PL) and polygalacturonase (PG) activities were isolated from the extracellular, periplasmic, and cytoplasmic fractions of *Erwinia carotovora* subsp. *atro-*

septica strain SR8. The predominant activity in all fractions was from 2 endoPL's with pI's of 9.5 and 9.6. Additional extracellular enzymes included 2 endoPL's of pI 9.7 and 10.2 and 2 PG's of approximate pI 3.75 and 10.3. The periplasm contained an exoPL of pI 6.9 that generated unsaturated dimers, and the cytoplasm contained the PG of approximate pI 3.75. Trace amounts of PL enzymes of pI 8.0 and 8.9 were found extracellularly and in the periplasm. Enzymes were characterized as to mode of action, ion requirement, pH for optimal activity, and metabolic products generated.

CHLOROPHYLL CONTENT OF SOYBEAN IN RELATION TO AMBIENT OZONE POLLUTION. B. Greenhalgh, G. Smith, I. Leone and E. Brennan, Department of Plant Pathology, NJAES-Cook College, Rutgers University, New Brunswick, New Jersey 08903.

On the basis of controlled chamber studies with Hodgson soybean, researchers have suggested that O₃ pollution is causing decreased net photosynthesis (Pn) in field-grown beans which can lead to significant yield loss. Because Pn was correlated with chlorophyll content in these experiments, we reexamined chlorophyll data for 9 soybean cultivars grown in ozone polluted air in New Jersey over a 3-year period to test the validity of the prediction. Chlorophyll content was compared in EDU-treated and untreated plants exposed to ambient O₃ concentrations of 0.065, 0.062 and 0.065 ppm (7 hr mean) in 1983, 1984 and 1985, respectively. Under these conditions chlorophyll reduction was the exception rather than the rule. Chlorophyll content in soybean was dependent on cultivar, growth stage, and on many environmental factors in addition to ozone concentrations. New Jersey Agricultural Experiment Station, Publication No. K-11353-3-86.

CONTRIBUTION OF APOTHECIA IN THE FIELD TO WHITE MOLD OF WHITE BEAN. R. Hall, Department of Environmental Biology, University of Guelph, Guelph, Ontario, Canada. N1G 2W1.

The contribution of apothecia within the field to epidemics of white mold, caused by *Sclerotinia sclerotiorum*, was examined in commercial fields of white bean (*Phaseolus vulgaris*) in southwestern Ontario. The mean incidence (m.i.) of white mold was 13.5% in 1984 and 1.1% in 1985. Apothecia were more numerous in fields with white mold and usually preceded or coincided with the first appearance of white mold in fields where both occurred. Among 47 fields examined in 1984, 18 contained both apothecia and white mold (m.i. 27.0%), 13 contained white mold (m.i. 11.5%) and no apothecia and 16 lacked both white mold and apothecia. The incidence of the disease regressed significantly on the number of apothecia observed in the field. In 1985, of 58 fields, 13 contained both apothecia and white mold (m.i. 4.0%), 2 had white mold (m.i. 6.0%) but lacked apothecia, 19 contained apothecia but no white mold and 24 lacked both apothecia and white mold. Counts of apothecia in the field may help in predicting white mold.

PROPERTIES OF PIGMENT PRODUCED BY A YELLOW MUTANT OF *ERWINIA CAROTOVORA* SUBSP. *CAROTOVORA*. R. L. Hammell, C. H. Liao and J. M. Wells, USDA-ARS, Rutgers Univ., New Brunswick, NJ 08903

After mutagenesis of an overnight culture of *E. carotovora* subsp. *carotovora* with N-methyl-N'-nitrosoguanine (100 μ g/ml, 2h), two of the 593 colonies screened (0.3%) displayed yellow pigment. The carbohydrate source and lighting conditions affect the pigmentation of a yellow mutant (YP3) tested. Under fluorescent light, YP3 is yellow on fructose, galactose, galacturonic acid, glucose, lactose, and sucrose. YP3 is darker yellow on these and is also yellow on trehalose, xylose, and polygalacturonic acid in the dark. Using boiling methanol, pigment was extracted from YP3 plus five other strains of yellow bacteria: 2 strains of *Xan. campestris*, *Ps. viridiflava*, *E. ananas*, and *Cytophaga johnsonae*. The absorbance spectra of pigment from all strains except YP3 showed peaks ranging from 335-445nm. Preliminary spectrophotometric and thin layer chromatographic results indicate that YP3 pigment is unique requiring further study.

COMPATIBILITY OF NEW HAMPSHIRE SPRUCE AND FIR ISOLATES OF *ARMILLARIA* WITH *A. OBSCURA*. T. C. Harrington, Dept. of Botany and Plant Pathology, Univ. of New Hampshire, Durham, NH 03824.

Isolations were made from decayed roots, mycelial fans, rhizomorphs, and basidiocarps of *Armillaria* growing on various hardwoods and conifers in the state, but mostly on spruce (*Picea rubens*) and fir (*Abies balsamea*). Haploid-haploid and haploid-diploid pairings were made and compatibility evaluated based on morphological changes in haploid testers. Nine isolates from spruce, 10 from fir, and 5 from other species fell into a

single intersterility group, apparently Group I of Anderson and Ullrich. Most haploid-haploid pairings of these isolates with isolates of *A. obscura* (Pers.) Herink from Europe showed compatibility. In contrast, haploid-diploid pairings between the two groups were much less frequently successful than within-group pairings. Partial compatibility and morphological differences (scaliness of caps) preclude unqualified assignment of the New Hampshire isolates to *A. obscura*. A second intersterility group from hardwood forests was partially compatible with a Group VI isolate and European isolates of *A. mellea*.

COINCIDENCE OF LILAC WITCHES'-BROOM AND ASH YELLOWS IN TWO ARBORETA. C.R. Hibben and L.M. Franzen. Brooklyn Botanic Garden Research Center, Ossining, NY 10562.

Witches'-brooms, deliquescent branching, and premature elongation of buds developed in *Syringa diversifolia*, *S. x henryi*, *S. x josiflexa*, *S. josikaea*, *S. x nanceiana*, *S. x prestoniae*, *S. tomentella* var. *rosea*, *S. villosa*, and *S. vulgaris* in lilac collections at the Arnold Arboretum, Jamaica Plain, MA and the Royal Botanical Gardens, Hamilton, Ontario, Canada. Mycoplasma-like organisms (MLO) were detected in phloem sieve tubes of stems by the fluorescent stain DAPI, (4', 6-diamidino-2-phenylindole · 2HCl). Ash yellows (AY) was identified, by symptoms and the DAPI stain, in the following ash located near the lilacs: *Fraxinus americana*, *F. americana* f. *asciata*, *F. americana* x *quadrangulata*, *F. angustifolia* f. *monophylla*, *F. bungeana*, *F. excelsior* f. *aurea*, *F. oregona*, *F. ornus* var. *juglandifolia*, *F. oxycarpa*, and *F. potamophila*. This provides circumstantial evidence that the same MLO are causing both diseases.

CHRYSANTHEMUM PHLOEM NECROSIS: IV. FLORAL SYMPTOMOLOGY AND PHLOEM ANATOMY. R. K. Horst, H. W. Israel, R. J. McGovern, S. J. Bucci, and W. Jessel. Department of Plant Pathology, Cornell University, Ithaca, NY 14853; and California-Florida Plant Corporation, Fremont, CA 94538.

The severity of chrysanthemum phloem necrosis (CPN) as judged by symptomatology has increased in recent years in *Chrysanthemum morifolium* 'Marble' cultivars. Recent observations of CPN affected plants have revealed markedly symptomatic inflorescences; they are distorted, have partial petal development, and their disk flowers are chlorophyllous with no stamens or pistils. Transmission electron microscopy of reproductive shoot apices of symptomatic 'Pink Marble' revealed hypertrophied phloem sieve cells, invaginations of the walls of phloem parenchyma and companion cells, and wall appositions (2-20 μ m in diameter) resembling papillae in phloem parenchyma. Moreover, mycoplasma-like organisms bounded by a unit membrane and containing DNA-like fibrils and ribosome-like structures were found in phloem parenchyma and in immature sieve cells.

BEECH BARK DISEASE: PATTERNS OF CANKER DEVELOPMENT IN AFTERMATH FORESTS IN MAINE. David R. Houston and Harry T. Valentine, USDA Forest Service, 51 Mill Pond Road, Hamden, CT 06514.

Beech bark disease occurs when bark of *Fagus grandifolia* is infested by the beech scale (*Cryptococcus fagisuga*), then infected and killed by *Nectria* spp. In long-affected stands, internal defect results as trees are cankered over time. The amount of defect, patterns of its development, and the relationship of climate to these patterns were studied in 50 trees from two stands in Maine. Two cross sections from each of five 1-m-long bolts from each tree were selected by importance sampling. The total area of canker on the outside surface of each growth sheath of each bolt was estimated from the arc lengths of cankers on the annual rings of the sampled cross sections. Cankering began in stems 12-37 years old and 2-11 cm diameter. Rates of cankering increased over time; years of high or low cankering were synchronous between trees and stands. Cankering in year $N+1$ was negatively correlated ($R^2=.803$) with the product of Oct. rainfall (yr. N) and number of severely cold days (Dec., yr. $N-1$ through Mar., yr. N).

TRANSPOSON (Tn5) MUTAGENESIS IN A SOFT-ROTTING STRAIN OF PSEUDOMONAS FLUORESCENS. S. Y. Hung, C. H. Liao, and J. M. Wells, USDA-ARS, Rutgers Univ., New Brunswick, NJ 08903

Bacterial conjugations were performed by mating *E. coli* SM10 (pSUP1011) (the donor) with *P. fluorescens* (ATCC 17816) (the recipient), according to the procedures previously described (M. K. Morgan and A. K. Chatterjee. 1985 J. Bacteriol. 164:14-18). Km^r -transconjugants occurred at frequencies ranging from 3.1×10^{-6} to 8.4×10^{-6} per donor cell. Approximately 0.7% of 2,425 Km^r Cm^s -transconjugants

examined were auxotrophs requiring the following amino acids for growth: arginine, histidine, leucine, methionine, proline, serine, or tryptophan. The auxotrophs reverted to prototrophs at the frequency of about 10^{-7} and all revertants tested were Km^s . The Southern blot techniques are presently used to analyze the site of insertion and preliminary results suggest that the transposition is random and single-sited.

CHRYSANTHEMUM PHLOEM NECROSIS: II. VASCULAR CYTOPATHOLOGY. H. W. Israel, R. K. Horst, R. J. McGovern, S. J. Bucci, S. O. Kawamoto, and K. F. Weaber. Department of Plant Pathology, Cornell University, Ithaca, NY 14853.

Vascular tissues in root and shoot apices, lateral buds, leaves, and petioles, of *Chrysanthemum morifolium* 'Pink Marble' affected by chrysanthemum phloem necrosis (CPN) were studied over the past five years by transmission electron microscopy. Specimens were taken from field-, greenhouse-, growth chamber-, and axenically-grown plants. Additionally, graft transmission of CPN was examined in vascular tissues from scions of reciprocal grafts of affected 'Pink Marble' and unaffected 'Fanfare' or 'Bonnie Jean'. Ubiquitous ultrastructural features of diseased tissues included: i) severely hypertrophied or collapsed sieve cells; ii) prominent wall ingrowths of phloem parenchyma and companion cells; and, iii) mycoplasma-like profiles, which were always seen in affected plants but not always in affected cells. These results confirm and extend earlier studies using light and fluorescence microscopy of veinal tissues affected by CPN.

CHRYSANTHEMUM PHLOEM NECROSIS: III. MICROSCOPY OF THE PUTATIVE PATHOGEN. H. W. Israel, R. K. Horst, R. J. McGovern, S. O. Kawamoto, S. J. Bucci, and K. F. Weaber. Department of Plant Pathology, Cornell University, Ithaca, NY 14853.

Combined light and electron microscopy were used to localize and describe the putative causal agent of chrysanthemum phloem necrosis (CPN) in vascular tissues from symptomatic *Chrysanthemum morifolium* 'Pink Marble' and 'Showoff' and from scions of unaffected 'Fanfare' and 'Bonnie Jean' grafted to diseased 'Pink Marble' stocks. The observations clearly implicate three different structures in the etiology of CPN: i) bodies, seen exclusively in immature sieve cells and phloem and xylem parenchyma, that closely resemble spheroid mycoplasmas bearing internal structures similar to ribosomes and DNA fibrils; ii) bodies, seen only in root and shoot apices, that resemble certain spheroid animal mycoplasmas bearing dense cores; and, iii) bodies, seen in a variety of cell types, that resemble filamentoid mycoplasmas in maintenance culture. The possibility that the three classes of bodies are functionally related is being explored.

PATHOGENICITY TO ALFALFA OF APHANOMYCES SP. ISOLATES FROM NEW YORK SOILS. D. W. Kalb and R. L. Mitter, Dept. of Plant Pathology, Cornell University, Ithaca, NY 14853.

Isolates of *Aphanomyces* sp. were obtained from New York State soils cropped to alfalfa. A selective medium was used to recover the fungus from infected seedlings in a baiting assay and from seedling roots grown in field soil. Pathogenicity was demonstrated using fragmented mycelium or zoospores. All isolates tested caused severe plant stunting, often accompanied by chlorosis and necrosis. These symptoms developed in plants inoculated at 1, 2 and 5 wks after germination or when the inoculum was incorporated into the growth medium prior to planting. Incidence of pre- and post-emergence damping-off was high in the preplant inoculations. Consistent disease development was obtained from fragmented mycelium at 1.0 gm dry weight/liter applied to 1-wk-old plants grown in vermiculite with a flood/drain cycle or added prior to seeding. These procedures should be useful for selecting resistant alfalfa germplasm.

SUCCESSIONAL PATTERNS OF FUNGI IN RED OAKS KILLED FOLLOWING GYPSY MOTH DEFOLIATION IN PENNSYLVANIA. D. Karasevic and W. Merrill, Dept. of Plant Pathology, The Pennsylvania State University, University Park, PA 16802.

Successional patterns of fungi were evident in the degradation of oaks (*Quercus rubra* & *Q. velutina*) that died following defoliation by the gypsy moth. Species of *Phialophora*, *Cephalosporium*, *Fusarium*, and *Pithomyces*, with populations peaking in trees dead 1 growing season (GS), were the pioneering nondecay fungi. Species of *Cytospora*, *Penicillium*, *Stachylidium*, *Graphium*, and *Rhinochloidiella*, with populations peaking in trees dead 2 and 3 GS, were an intermediate group. *Trichoderma viride*, *Paecilomyces varioti*, and *Bispora* sp., prominent in trees dead 6 GS, were a third "clean up" group. Species of *Hypoxylon*

the pioneer decay fungi, succeeded during the 2nd and 3rd GS by *Stereum complicatum*. *Merulius tremulosus* and *Polyporus tulipiferae* comprised a third group, fruiting on trees dead 3 GS then declining, and *P. gilvus* and *P. pargamensis* comprised a fourth group, accounting for an increasing percentage of the fruiting bodies on tree dead 3 to 6 GS.

EFFECTS OF OZONE AND SULFUR DIOXIDE ON MYCORRHIZAL AND NON-MYCORRHIZAL PAPER BIRCH AND WHITE PINE SEEDLINGS. K. D. Keane, R. E. Leete, and W. J. Manning. Dept. of Plant Pathology, Univ. of Massachusetts, Amherst, MA. 01003.

Four-week old seedlings of paper birch (*Betula papyrifera*) and white pine (*Pinus strobus*) were transplanted into non-steamed (NS) or steamed (S) soil, with and without *Pisolithus tinctorius* (PT), and exposed to carbon-filtered air (CF), CF + O₃ (0.06-0.08 ppm), CF + SO₂ (0.05 ppm), or CF + O₃ + SO₂ (5 days/week, 7 hours/day) for 12 weeks. In birch, shoot height (SHT) was influenced by air, soil and PT. A soil x PT interaction affected % mycorrhizal infection (MI), no. of leaves (NL), shoot wt. (SW) and leaf wt. (LW). An air x soil interaction also influenced LA, NL, and root weight (RW). In white pine, PT significantly affected MI, new needle weight (NNW) and SW. New needle area (NNA) and old needle weight (ONW) were influenced by a two-way interaction between soil and PT. An air x soil interaction significantly affected SHT, NNA, NNW, ONW, SWT and RWT.

PHYTOALEXINS IN QUAKING ASPEN. B. Kuntz and D. Walton, Illick Hall, Department of Environmental and Forest Biology, SUNY College of Environmental Science and Forestry, Syracuse, NY 13210.

Methanol extracts of Quaking Aspen, *Populus tremuloides*, wood, infected with *Hyphoxylon mammatum*, showed antifungal activity in a modified tlc/*Cladosporium* spore bioassay. Uninfected controls showed no activity. Antifungal activity is due to at least three compounds which appear to be phenolic acids. Techniques used to purify and identify the phytoalexins include: thin layer, gas, and high pressure liquid chromatography. P-coumaric acid has been tentatively identified using GCMS as one of the antifungal compounds.

INTERACTIONS BETWEEN THE TOBACCO CYST NEMATODE AND FUSARIUM WILT ON CONNECTICUT BROADLEAF TOBACCO. J. A. LaMondia, The Connecticut Agricultural Experiment Station, P. O. Box 1106, New Haven, CT 06450.

The effect of the tobacco cyst nematode (TCN), *Globodera tabacum*, on fusarium wilt incidence was determined for one wilt susceptible and two wilt resistant tobacco lines. Two-liter pots infested with 30-cm³ straw culture of *Fusarium oxysporum* f. sp. *nicotianae* were inoculated with 0, 3200, 16000, or 56000 TCN juveniles immediately after transplanting tobacco seedlings. Each TCN level was replicated four times for each tobacco line. Fusarium wilt incidence increased with increasing TCN levels for all lines. The effect of TCN level on wilt incidence was greatest for the susceptible line. Dry shoot weights and stem necrosis ratings were negatively correlated with TCN population levels. *Fusarium oxysporum* was isolated from stems of all susceptible plants and from 81 and 88% of the resistant lines.

THE PHIALOPHORA STATE OF A MAGNAPORTHE SP. CAUSES SUMMER PATCH DISEASE OF *POA PRATENSIS* L. AND *P. ANNUA* L. P.J. Landschoot and Noel Jackson, University of Rhode Island, Kingston, RI 02881.

Poa pratensis L. and *P. annua* L. exhibiting symptoms of summer patch disease in Rhode Island, Michigan, Nebraska, Maryland and New York consistently yielded a *Phialophora* fungus from infected roots. The isolates from all sources were similar in colony morphology and growth characteristics in culture. All fruited in culture to produce the same teleomorph. According to Mr. John Walker of the Biological and Chemical Research Institute Rydalmere, Australia, the fungus is a member of the genus *Magnaporthe* Krause and Webster with a *Phialophora* anamorph, similar to *M. rhizophila* Scott and Deacon. *P. pratensis* sod inoculated with the *Magnaporthe* sp. resulted in symptoms identical to summer patch. The fungus was reisolated from infected roots via a selective medium. Thus, a causal relationship between this *Magnaporthe* sp. and summer patch of *P. pratensis* and *P. annua* has been established.

INFLUENCE OF SEVERAL FACTORS ON THE BIOCONTROL OF GRAY SNOW MOLD OF TURFGRASS BY *TYPHULA PHACORRHIZA*. M.B. Lawton, L.L. Burpee and L.G. Goulet, Department of Environmental Biology, University of Guelph, Guelph, Ontario N1G 2W1.

Applications of grain inoculum of *T. phacorrhiza* isolate T011 at 50 g/m² and 200 g/m² in December resulted in suppression of gray snow mold (*T. ishikariensis*) in April that was not significantly different from suppression induced by quintozone (30 kg a.i./ha). Disease was suppressed at 5 months, but not at 17 months, after treatment with 200g inoculum/m². Cellulose amendments did not enhance disease suppression. After snow-melt, growth of new foliage was more rapid in plots treated with 200 g/m² than 50 g/m². Isolates T011 and T016 of *T. phacorrhiza* did not differ in their disease suppression potential when applied at the same concentrations. An increase in the concentration of isolate T016 significantly reduced the time required for growth of new foliage but it did not increase disease suppression. Sclerotia of *T. ishikariensis* present in untreated plots were not observed in plots treated with quintozone or with grain inoculum of isolate T011 or T016.

SYNTHESIS AND CLONING OF A DNA COMPLEMENTARY TO A MILD MUTANT OF PAPAYA RINGSPOT VIRUS. Brigitte L. Hostis, M. Kyle and D. Gonsalves. Dept. of Plant Pathology, Cornell University, New York State Agricultural Experiment Station, Geneva, NY 14456.

A mild mutant of papaya ringspot virus (PRV) was selected following nitrous acid treatment of a severe Hawaiian strain of the virus (Yeh and Gonsalves, *Phytopathology* 74: 1086-1091, 1984). An apparently full-length DNA complementary to the RNA of the mutant (10 Kb) was synthesized using an oligodT primer with Avian myeloblastosis virus reverse transcriptase. The hybrid cDNA-RNAs were inserted at the PstI site of the plasmid pUC18 after A:T tailing and the recombinant plasmids introduced in *E. coli* JM83 following standard protocols. This method yielded clones containing PRV specific sequences of 2kbp and under as shown by hybridisation analyses involving autoradiography and electron microscopy. The hybrid cDNA-RNAs were also used to synthesize an apparently full-length (10 Kb) second-strand with RNAase H and DNA polymerase I. The cloning of this full-length cDNA is now in progress.

ARMILLARIA ROOT DISEASE OF SPRUCE PLANTATIONS IN NORTH-CENTRAL MAINE. William H. Livingston, Dept. Bot. & Plant Path., Univ. Maine, Orono, ME 04469.

Twenty-seven plantations of black (*Picea mariana*) and white (*P. glauca*) spruce in Piscataquis Co., Maine, were surveyed in 1986 for trees in the process of dying from root diseases. These former spruce-fir sites were planted 4-10 yr earlier with containerized seedlings. The highest incidence of dying trees (9.25 trees/ac) occurred in a white spruce stand planted in 1976. Most other plantations had low numbers of dying trees (0.2-3.35 trees/ac), with the highest incidence occurring in these stands 5-7 yr after planting. *Armillaria* root disease was the primary cause of mortality in all stands. Root deformities appear to predispose seedlings to root disease development. Haploid isolates of known biological species of *Armillaria* are being tested for compatibility with diploid cultures of *Armillaria* isolated from diseased seedlings collected in the plantations.

SPATIAL AND TEMPORAL CHANGES IN ELEMENT CONCENTRATIONS OF WHITE OAK (*Quercus alba* L.) XYLEM NEAR A COAL-FIRED POWER PLANT. R. Long and D. D. Davis, Dept. of Plant Pathology, The Pennsylvania State University, University Park, PA 16802.

Increment core samples of 24 white oak trees (≥ 100 yrs.) were taken at 4 distances (0.25, 1.2, 2.0, 10.3 km) from a 623 megawatt electric generating station. Core samples were crossdated and divided into sections. Each section corresponded to a time period associated with different operating conditions and emission stack heights: 1) 1940-53: pre-plant operation, 2) 1954-61: 76 and 99 m stacks, 3) 1962-76: 99 and 183 m stacks, 4) 1977-85: 183 and 259 m stacks. ICP-atomic emission spectrometric analysis revealed no significant correlation (P ≤ 0.05) between element concentrations and distance in the 4 time periods examined for P, Ca, Mg, Fe, Mn, Cu, Al, Co, Cr, Ni, and Pb. Analysis of covariance indicated Sr concentration was inversely related to distance from the source in all 4 time periods. However, Sr concentration increased by 17, 28, 92, and 81% at 10.3, 2.0, 1.2, and 0.25 km during 1954-1976, coincident with maximum fly ash deposition.

Survey and Control Of Red Stele Of Strawberries In Ontario. F.J. Louws*, B.D. Ripley**, and L.V. Edgington*. Department of Environmental Biology* and Pesticide Residue Lab**, University of Guelph, Guelph, ONT N1G 2W1.

Field symptoms of red stele caused by *Phytophthora fragariae*

were observed in 13 of 51 fields surveyed in south-central Ontario. Microscopic examinations of root vascular tissue for the presence of oospores verified infection of plants in 11 of the 13 fields. Experiments were initiated to investigate the potential of chemical control of red stele in established plantings. Metalaxyl (Ridomil 240 EC at 1.01 kg ai/ha), oxadixyl (SAN371F 325.9 g/l at 1.37 kg ai/ha) and water (control) were applied as soil drenches in May of 1984 followed by two fall applications at two farm locations. Fungicide treated plants significantly increased in density, vigour and yield as recorded in the spring of 1985. Residue levels of metalaxyl were 0.01-0.08 ug/g (July 1984) and undetectable (June 1985) in the fruit and 0.07-0.21 ug/g in the soil (June 1985). Oxadixyl levels were 0.20-0.62 ug/g (July 1984) and 0.15-0.20 ug/g (June 1985) in the fruit and 1.00-1.10 ug/g in the soil (June 1985).

Evaluation of phenylamides for the control of cavity spot of carrots. M.R. McDonald, E.N. Knibbe, and L. V. Edgington. University of Guelph, Guelph, Ontario, N1G 2W1.

Cavity spot of carrots has been attributed to a number of species of *Pythium*. In 1985, two susceptible carrot cultivars (Chanton and Tahoe) were treated with metalaxyl as a seed dressing (0.012 kg ai/ha), furrow treatment (1.0 kg ai/ha) or drench at seeding, or as a foliar spray (1.2 kg ai/ha) one month after seeding. Treatments were applied alone and combination. At harvest, 74% of the check carrots had cavity spots that rendered them unmarketable; 58% of carrots produced from treated seed, developed mild symptoms but all were marketable. All other treatments resulted in marketable carrots. In 1986, two susceptible cultivars (Chanton and Comet) were treated with a metalaxyl seed dressing (0.012 kg ai/ha) or with granular metalaxyl at 0.2, 0.5, 1.0, 2.0 or 4.0 kg ai/ha. A reduction in seedling emergence occurred at levels of 2.0 and 4.0 kg ai/ha of metalaxyl above. Disease control in relation to metalaxyl residues in carrots is discussed.

CHRYSANTHEMUM PHLOEM NECROSIS: I. ETIOLOGY AND ASSOCIATION OF PHENOLICS. R. J. McGovern and R. K. Horst. Department of Plant Pathology, Cornell University, Ithaca, NY 14853.

Increased leaf polyphenols (tannins) occur in a number of diseases induced by mycoplasma-like organisms. Because mycoplasmas have been implicated in chrysanthemum phloem necrosis (CPN), the effect of antibiotics on leaf polyphenol content was examined in *Chrysanthemum morifolium* 'Pink Marble' and 'Bonnie Jean' affected or unaffected by CPN, respectively. Leaf polyphenols were assayed by the nitroso reaction (Reeves, Stain Technol. 26:91-96). Polyphenol accumulation was significantly reduced by tetracyclines (TC) but not by penicillin in CPN-infected leaves of 'Pink Marble'. Treatment of 'Bonnie Jean' with TC did not result in a similar reduction. We conclude that the decrease in 'Pink Marble' polyphenols accompanying TC treatment resulted specifically from a reduction of the CPN disease and not from a generalized inhibition of chrysanthemum phenol metabolism.

CHRYSANTHEMUM PHLOEM NECROSIS: V. STOMATAL MORPHOLOGY AND PHYSIOLOGY. R. J. McGovern, R. K. Horst, T. Whitlow, and B. Hazen. Plant Pathology Dept., Cornell University, Ithaca, NY 14853.

The effects of chrysanthemum phloem necrosis (CPN), a mycoplasma-like disease, on stomata of *Chrysanthemum morifolium* 'Pink Marble' and 'Bonnie Jean', CPN-affected and unaffected, respectively, were examined. Morphological studies showed that guard cells of 'Pink Marble' but not 'Bonnie Jean' were often necrotic and distorted, and sometimes contained wall appositions rich in callose and polyphenols. Physiological studies showed that diffusive leaf resistance was higher and transpiration lower in upper leaves of 'Pink Marble' than 'Bonnie Jean' in plants grown hydroponically at 25 C. Moreover, mean stomatal aperture in both whole leaves and epidermal strips was significantly lower in 'Pink Marble' than 'Bonnie Jean'.

CHRYSANTHEMUM PHLOEM NECROSIS: VII. INCIDENCE IN GARDEN CHRYSANTHEMUMS. R. J. McGovern and R. K. Horst. Flower Time, Lindenhurst, NY 11757; and Department of Plant Pathology, Cornell University, Ithaca, NY 14853.

Observations of garden chrysanthemums in production revealed a cultivar-related range of susceptibility to chrysanthemum phloem necrosis (CPN). 'Lavender Pink' and 'Yellow Starlet' showed severe CPN symptoms, which included flecking, yellowing, and complete deterioration of lower leaves. Mild

symptoms of CPN, few flecks on lower leaves, were exhibited by 'Quaker White', 'Ivory', 'White Stardom', and 'Stargazer'. Intermediate CPN symptoms included pronounced flecking in lower leaves. Histological examination of symptomatic 'Lavender Pink' revealed necrosis, lignification, and phenolic accumulation in the phloem. Wall appositions containing callose were occasionally observed in affected mesophyll cells. These observations reveal a broader range of affected cultivars and suggests a possible reservoir source of the pathogen.

APPARENT PHOTOSYNTHESIS, TRANSPIRATION, AND STOMATAL RESISTANCE OF FLAG LEAVES INFECTED WITH WHEAT STEM RUST. M.T. McGrath and S.P. Pennypacker. Dept. of Plant Pathology, Pennsylvania State University, University Park, PA, 16802.

A portable photosynthesis monitoring system (LICOR LI-6050) was used on flag leaves of Tyler winter wheat (*Triticum aestivum*) in field studies to measure the effect of rust severity during grain fill on apparent photosynthetic rate (pr), transpiration rate (tr), and stomatal resistance (sr). Stem rust severity was assessed with a computer-controlled video image analysis system. Compared to leaves sprayed with Dithane M-45, leaves infected with *Puccinia graminis* f. sp. *tritici* usually exhibited greater sr, lower tr, lower pr, and lower chlorophyll content per unit leaf area. Although there was a significant difference between healthy and infected leaves for each of these variables, severity was a good predictor only of the last two variables. The lower pr of infected leaves could not be completely accounted for by the loss of healthy leaf area or by the reduction in chlorophyll content.

PRODUCTION OF MONOCLONAL ANTIBODIES TO CLOSTEROVIRUS-LIKE PARTICLES ASSOCIATED WITH GRAPEVINE LEAF ROLL DISEASE. E. G. Madden, F. Zee and D. Gonsalves, Dept. of Plant Pathology, Cornell University, NYAES, Geneva, New York 14456

Closterovirus-like particles have been consistently associated with grapevines affected by grapevine leafroll (GLRV). Virus particles were isolated from leaves of leafroll-affected 'Pinot Noir' vines growing in the Finger Lakes region of New York (NY-1 isolate) and used as an antigen source for producing monoclonal antibodies (MAbs). Two MAb producing cell lines were obtained from the fusion of murine myeloma cells with spleen cells from an immunized mouse. Screening for specific antibodies was accomplished using a multilayered sandwich enzyme-linked immunosorbent assay (ELISA) in which ELISA plates were precoated with polyclonal antisera to NY-1 in order to trap virus particles. Cell cultures which showed positive reaction to crude leaf extracts of NY-1 infected vines and no reaction to healthy controls were cloned by limiting dilution. Clones were retested by ELISA, expanded and used for antibody production by mass culture and ascites fluid. Tests are underway to determine the optimum conditions for using NY-1 MAB in ELISA as well as the specificity of the MAbs to the different isolates of GLRV.

RESISTANCE OF DOUGLAS-FIR TO RHABDOCLINE NEEDLECAST AND COOLEY'S ADELGID. W. Merrill and N. G. Wenner. The Pennsylvania State University, University Park, PA 16802.

Rhabdocline needlecast and Cooley's adelgid are the major problems affecting production of Douglas-fir Christmas trees in the Northeast. In 1975 a plantation containing 107 seed sources of Douglas-fir was established in Centre County, Pa. A block of 4 trees of each source was replicated 4 times. By 1 May 1986 Rhabdocline needlecast had intensified so that many trees were losing more than 50% of the 2nd-yr needles; the trees also were heavily infested with *Adelges cooleyi*. Trees from 16 sources (8/43 from New Mexico, 3/33 from Arizona, 1/6 from Colorado, and 4/22 from various other sources) were uninfested even though their branches often were intertwined with those of infected trees. Trees from 3 of these 16 sources also were devoid of Cooley's adelgid (2 = New Mexico "Santa Fe," 1 = Arizona "Coronado"). These seed sources are potential germ plasm for developing superior Christmas trees by breeding or by vegetative reproduction.

EFFECT OF ANTIVIRAL CHEMICALS AND HEAT TREATMENT ON PRODUCTION OF VIRUS-FREE ASPARAGUS CLONES. M.S. Montasser, R.F. Davis and C. K. Chin*, Depts. of Plant Pathology and Horticulture and Forestry*, Cook College, New Jersey Agricultural Experiment Station, Rutgers University, New Brunswick, N.J., U.S.A. 08903.

Asparagus virus I (AV-I) is the most frequently occurring virus of asparagus in New Jersey. AV-I was eliminated from infected asparagus plants by aseptic culture of shoot tips using modified Murashige and Skoog's medium plus selected anti-viral chemicals. Enzyme-linked immunosorbent assay was used for virus detection with purified IgG as well as crude ascites. The most effective chemical for AV-I elimination was 6-methyl

purine at 0.1, 1 and 10 mg/l but it had a highly toxic effect on plant growth at 1 and 10 mg/l concentrations. Malachite green at 2 mg/l, but not at 1, 3 or 4 mg/l was also effective for AV-I eradication from infected plants. However, AV-I was not eliminated from any plants using 2-thiouracil at 40, 60, 80, or 100 mg/l. In addition, AV-I was eliminated from shoot tips after heat treatment at 37 C for 4 and 7 days but not after 20 hr or 2 days. N.J.A.E.S. No. K-11191-8-86.

DETECTION OF CONIDIA OF *SCLERODERRIS LAGERBERGII* GREMMEN BY INDIRECT IMMUNOFLOUORESCENCE. C.L. Nelson and J.D. Castello, SUNY College of Environmental Science and Forestry, Faculty of Environmental and Forest Biology, Syracuse, New York 13210.

Antiserum to conidia of *Scleroderris lagerbergii* Gremmen was produced in rabbits. It was used to develop an indirect immunofluorescence staining procedure with a commercially prepared protein A: FITC conjugate. The procedure enabled detection of *Scleroderris* conidia produced in culture, isolated from pycnidia, and collected in spore traps in the field. The assay distinguished the conidia of *S. lagerbergii* from five species of *Fusarium* and a *Sirococcus* sp. which are morphologically similar and commonly found together in spore traps. We are attempting to verify the reliability of the assay through culturing of *Scleroderris*-like spores collected in spore traps.

A PHYSIOLOGIC BASIS FOR ENHANCED PATHOGENICITY IN TURFGRASS TREATED WITH PLANT GROWTH RETARDANTS. A. Pennucci, Univ. Rhode Island, Kingston, RI 02881.

Previous work at URI showed that the application of plant growth retardants (PGR) increased turf disease. The effect of PGR on nitrogen and soluble sugars in relation to leaf spot disease in Kentucky bluegrass was determined. Five PGR were applied to greenhouse and field grown Kentucky bluegrass. Soluble sugars were determined weekly for 12 weeks, total nitrogen was determined at 6 weeks. Soluble sugar and nitrogen levels declined rapidly the first week after treatment with mefluidide or amidochlor while leaf spot disease increased rapidly. Sugar levels increased with maleic hydrazide but remained unaffected by treatment with paclobutrazol or flurprimidol while nitrogen levels were unaffected by these treatments. In the latter cases, only slight increases in lesion numbers, caused by *Drechslera* sp., were detected.

OVERWINTERING AND SPREAD OF *OVULINIA AZALEA*. R. G. Perry, Dept. of Biological and Allied Health Sciences, Fairleigh Dickinson Univ., Madison, NJ 07940 and J. L. Peterson, Plant Pathology Dept., NJAES, Rutgers Univ., New Brunswick, NJ 08903.

In a 3-yr field experiment no apothecia were formed on overwintering sclerotia. To determine the overwintering and infection potential of mycelium or conidia, flower buds *in situ* were enclosed prior to and during bloom in polyethylene bags containing overwintered sclerotia, prior year's blighted flowers with sclerotia removed, current year's blighted flowers, or without anything. Flowers bagged with sclerotia alone or without anything were disease free. Unbagged adjacent flowers were diseased. Blight incidence in flowers bagged with overwintered or current year's diseased petals averaged 84%. To determine the distance conidia are disseminated, spore traps were installed during two flowering seasons at various intervals from the infection site. Conidia trapped within 3, 6, 50 and 100 ft averaged 77, 14, 9 and 0%, respectively. New Jersey Agricultural Experiment Station, Publication No. K-11410-1-86.

'SURE CROP', A NEW PEA (*PISUM SATIVUM* L.) CULTIVAR RESISTANT TO *FUSARIUM* ROOT ROT. Avery E. Rich, Dept. of Botany and Plant Pathology, University of New Hampshire, Durham, NH 03824.

Pea root rot, caused by *Fusarium solani* f. sp. *pisi*, is a serious disease of peas in the Northeast. Most cultivars are very susceptible to this disease, but 'New Era' is an exception. 'New Era' was crossed with 'Laxton's Progress'. The F₁, F₂, and F₃ generations were selfed and individual plant selections were made that possess resistance to root rot and desirable horticultural characteristics. One plant appeared to be especially promising. Seeds from the progeny of this plant were saved, increased, and field tested for several years for resistance to root rot. It outyielded 'New Era' by about 20% and all other cultivars by more than 100%. Only a trace of disease was evident while other cultivars except 'New Era' were nearly dead before the second picking.

UPRIGHT AND RUNNER DIEBACK IN CRANBERRY. K.A. Rosenberg and F.L. Caruso. Cranberry Experiment Station, University of Massachusetts, P.O. Box 569, East Wareham, MA 02538.

Dead uprights and runners are common in many Massachusetts cranberry bogs. Affected uprights/runners may be scattered throughout the bog, or occur in significant patches where entire plants are killed. There appears to be two phases of symptom expression; one occurring (mostly in newer bogs) from late May through July, the other occurring from late August through September. Death of the tissue starts at the tip and works downward. Isolations from diseased plant tissue have yielded high percentages of *Phomopsis*, *Pragmopycnis* (tentative identification), *Gloeosporium*, and an unidentified Deuteromycete. The results of artificial plant inoculations and observations on the disease and its probable pathogen(s) will be discussed.

LEAF IMMERSION TO INOCULATE SUNFLOWERS WITH DOWNY MILDEW (*PLASMODIUM HALSTEDII*). W.E. Sackston, Brigitte Vimard, and Rachele Arcelin. Macdonald College of McGill University, Ste. Anne de Bellevue, Quebec, Canada, H9X 1G0.

Sunflowers (*Helianthus Annuus*) susceptible to downy mildew (DM) were successfully inoculated by leaf immersion (LI) in a suspension of zoosporangia of *Plasmodium Halstedii* (PH) for 3 h at 15°C. Local lesions developed and PH sporulated, followed by systemic symptoms on leaves formed after inoculation. PH may sporulate sparsely on cotyledons of resistant sunflowers inoculated by whole seedling immersion (WSI), but not on the true leaves. Failure of PH to sporulate on leaves inoculated by LI in incompatible combinations indicates that resistance is physiological in addition to any barrier at the cotyledonary node. Sporulation of PH occurred on detached leaves and leaf disks inoculated by LI in preliminary experiments. It may be possible to use LI to determine if individual "escapes" in a population infected with DM by WSI are resistant. If leaf disk inoculations give consistent results, LI may be used to determine reaction of individual plants to several races of PH, and seed of those plants can be produced.

FAILURE OF METALAXYL TO CONTROL *PYTHIUM* BLIGHT ON KENTUCKY GOLF COURSES. P. L. Sanders, The Pennsylvania State University University Park, PA 16802.

In July, 1986, turf samples were received from two Kentucky golf courses, where superintendents reported inability to control *Pythium* blight with metalaxyl. A fungus typical of *Pythium aphanidermatum* was isolated from all tillers cultured, and identification was confirmed based on oospore, sporangial, and antheridial morphology. Recovered isolates were able to grow on medium containing 100 ppm metalaxyl. Two representative isolates, plus a metalaxyl-sensitive isolate from Pennsylvania, were tested on pot-grown 'Pennncross' bentgrass for pathogenicity and fungicide sensitivity. All isolates were pathogenic, producing symptoms typical of *Pythium* blight. The Kentucky isolates were not controlled by metalaxyl, but were controlled by propamocarb and fosetyl aluminum. The Pennsylvania isolate was controlled by all three fungicides.

PLANT GROWTH-PROMOTING RHIZOBACTERIA (PGPR) ON CANOLA AND SOYBEAN IN CANADA. Scher, F. M., J.W. Kloepper, D. Hume, R. Lifshitz, C. Simonson, C. Singleton, L. Lee, B. Tipping, K. Frauley, T. Kutchaw, M. Laliberté and I. Zaleska. Allelix Inc., 6850 Goreway Drive, Mississauga, Ontario, Canada, L4V 1P1.

Bacterial strains isolated from root zones of plants in diverse Canadian habitats were shown to positively affect plant growth of canola and soybeans in greenhouse and field trials. Early growth enhancements were associated with improved emergence, root and leaf area and plant dry weight. Field trials were conducted at two locations in 1985 on two canola and two soybean cultivars. Field seed yield ranged up to 57% for canola and to 35% for soybean; average yield increases were from 10-23% for individual strains tested in 3 to 14 field trials. PGPR strains included *Pseudomonas fluorescens*, *P. putida*, *Serratia liquefaciens*, *Arthrobacter citreus*, *Bacillus megaterium*, *Enterobacter aerogenes* and *Flavobacterium* sp.

SURVEY OF NEW YORK WINTER WHEAT FOR FUNGAL FOLIAR AND SPIKE DISEASES IN 1986. A. M. C. Schilder and G. C. Bergstrom, Department of Plant Pathology, Cornell University, Ithaca, NY 14853.

A survey of soft white winter wheat cultivars Houser, Frankenmuth and Geneva for fungal foliar and spike diseases was conducted in central and western New York State. Disease incidence and severity were rated at three growth stages in 32 fields. Samples were collected for laboratory identification

of leaf spotting fungi. Powdery mildew was of minor importance, but leaf spots were prevalent and severe in most fields. *Stagonospora nodorum* was the predominant organism isolated from leaf spots, but *Septoria tritici* and *Drechslera tritici-repentis* were also prevalent in some fields. Several *Ascochyta* species were associated with leaf necrosis, but their pathogenicity has not been investigated. A moderate level of leaf rust (*Puccinia recondita*) occurred at the end of the season. Scab, caused by *Gibberella zeae*, occurred in epidemic proportions, whereas glume blotch, caused by *S. nodorum*, was severe in only a few fields.

Characterization of an extracellular protease from *Erwinia carotovora* subsp. *carotovora* strain EC14. F. D. Smith, P. M. Berman and M. S. Mount. Dept. of Plant Path., Univ. of Mass., Amherst, MA. 01003.

An extracellular protease was isolated from *Erwinia carotovora* subsp. *carotovora* strain EC14 and purified by ammonium sulfate fractionation, DEAE cellulose chromatography and isoelectric focusing. The isoelectric point of the enzyme was 4.95. Optimal activity of the protease was at pH 7.0 and no ion cofactors were required for activity. Molecular weight of the enzyme is approximately 50,000. The native enzyme was found to be identical to an extracellular protease isolated from an *E. coli* clone harboring a hybrid pBR329 plasmid containing EC14 genes. A non-proteolytic mutant of EC14 containing the transposon Tn5 is being used to determine the role of this enzyme in pathogenicity.

STATISTICAL INTERACTIONS BETWEEN SEPTORIA NODORUM LEAF BLOTCH AND LEAF RUST ON SOFT RED WINTER WHEAT. V. J. Spadafora, H. Cole, Jr., and J. A. Frank, The Pennsylvania State University, University Park, PA 16802.

Interactions between *Septoria nodorum* and *Puccinia recondita* were investigated under field conditions in Pennsylvania in 1985 and 1986. Gradients of leaf rust severity were established by altering the frequency and timing of triadimefon fungicide applications. Analyses of variance indicated significant effects of fungicide treatments on the severity of leaf rust, but no effects on the severity of *Septoria nodorum* leaf blotch in both years. Regression analyses on data from individual plots, however, indicated significant negative relationships between the severities of the two diseases. Control of leaf rust with specific fungicides may increase the potential for leaf blotch epidemics. Interactions between pathogens should be considered in the evaluation of narrow-spectrum fungicides.

THE GENETIC CONTROL OF VIRULENCE IN PHYTOPHTHORA INFESTANS. J. A. Sweigard, L. J. Spielman, P. W. Tooley, R. C. Shattock, and W. E. Fry. Cornell University, Ithaca, NY 14853.

The genetic control of virulence in *Phytophthora infestans* has been studied in a cross between two isolates recently collected from the field in Mexico. The A1 parent was avirulent against potato cultivars with resistance genes R2 and R4, and the A2 parent was virulent toward both. Fifty-eight F1 progeny were analyzed, and they segregated for virulence/avirulence to both host genes. Chi-square probabilities for 1:1 ratios were 0.3 for R2 and 0.07 for R4, and the two virulence factors appeared to be linked. The 1:1 segregation for virulence to R2 is consistent with single-gene control with dominant avirulence if the avirulent parent was heterozygous, but it is also consistent with dominant virulence if the virulent parent was heterozygous. The genetic control of virulence toward R4 may be more complex.

PROCHLORAZ AND TRIADIMENOL SUPPRESS TAKE-ALL OF WINTER WHEAT IN ONTARIO. J.C. Sutton, T.D.W. James and R. Turek, Department of Environmental Biology, University of Guelph, Guelph, Ontario N1G 2W1, Canada.

Seeds of wheat cv. Augusta were treated with prochloraz 40 EC (0.05 g a.i./kg seed), triadimenol 7.5 L (0.3 g a.i./kg) or triadimenol 30 F (0.3 g a.i./kg), or were left untreated, and sown in plots on 20 September 1985. Crowns of wheat colonized by *Gaeumannomyces graminis* var. *tritici* were buried 5-8 cm deep at densities of 0, 10 or 100 crowns/m² plot. No take-all symptoms were observed in the absence of inoculum. Incidences of roots with take-all symptoms on 15 May 1986 were 14% (checks) and 1-3% (fungicide treatments) in plots with low inoculum, and 59% (checks) and 5-9% (fungicide treatments) in the high-inoculum plots. The respective values for 25 June 1986 were 60% and 10-20%, and 87% and 31-47%. Numbers of whiteheads/m² on 24 June 1986 were 21 (checks) and 3-8 (fungi-

cide treatments) in plots with low inoculum, and 80 (checks) and 18-32 (fungicide treatments) with high inoculum. The three fungicides were equally effective in suppressing take-all.

NEMATOCIDE ALTERNATIVES FOR CONNECTICUT CIGAR TOBACCO. G.S. Taylor, The CT Agr. Exp. Sta., P.O. Box 248, Windsor, CT 06095

Over concern for groundwater we sought several alternatives for control of the tobacco cyst nematode (TCN) *Globodera tabacum*. In Oct 1984, D-Mencs (vorlex) at 187 l/ha (standard) and chloropicrin at 93.5 l/ha were injected by fumigun, and methylbromide (MB) at 392 kg/ha was applied under plastic. In June 1985, fenamiphos (Nemacur) granular at 6.7 kg ai/ha was raked in 5 cm deep on Merrimac fine sandy loam in 3.4 m x 5 m plots in a shade tent. Shade tobacco was grown in 1985. Plants from MB plots had the least wilt and the greatest plant height, leaf weight and area, stem diameter and root vigor. Tobacco from the fenamiphos plots had the whitest roots and fewest visible cysts on lifted roots, but the soil had the greatest number of TCN larvae recovered by sugar flotation. Tobacco from untreated plots was least in all parameters except TCN larvae. Fenamiphos may stimulate hatching of cysts but discourage root invasion. Tobacco from chloropicrin and MB but not fenamiphos had drastically reduced market value as cigar wrapper when compared to standard D-Mencs.

FIELD SEROLOGICAL DETECTION OF CLOSTEROVIRUS-LIKE PARTICLES ASSOCIATED WITH GRAPEVINE LEAFROLL DISEASE. D. Teliz, E. Tanne, D. Gonsalves, and F. Zee. Dept. of Plant Pathology, Cornell University, New York State Agricultural Experiment Station, Geneva, NY. 14456

Closterovirus-like particles were purified from leafroll diseased grapevines and its polyclonal antiserum was used to determine the distribution of these particles in leafroll diseased vines and the best time and tissues for its field detection. Grapevine leafroll disease was detected by direct ELISA in 8 year old Pinot noir vines in a commercial vineyard during the 1986 growing cycle. Flowers in the stage between visible and separated flower clusters, were the tissues from which the particles were first detected 15 days after bud break. Basal leaves did not become reliable source for virus detection until 40 days after bud break. The virus was evenly distributed in the shoots arising at the basal, medium and apical portion of one year old canes. Besides flower clusters and leaves, the virus was detected in roots, fruits, fruit peduncles, tendrils and bark tissues. In fruits, the virus was detected in all stages, except at the shot berry stage. Virus detection was not always correlated with rolling and reddening of typically diseased leaves, since the virus was found in symptomless leaves before and after the first symptoms appeared.

MANAGEMENT OF POWDERY MILDEW, SPHAEROTHECA HUMULI OF BLACK RASPBERRY ON A FIVE FOOT, DOUBLE WIRE TRELLISING SYSTEM. James W. Travis and Kenneth D. Hickey, The Pennsylvania State University, University Park, PA 16802.

Several fungicides were applied to a black raspberry planting to determine efficacy on powdery mildew caused by *Sphaerotheca humuli*. When infection was evaluated on new terminal growth 9 days after fungicide application, significant differences between the treatments were not observed. However, when leaf infection was evaluated, benomyl, Systhane, Rubigan and R015-1297 all resulted in significantly less leaf infection than the unsprayed control. None of the treatments reduced leaf infection below 22 percent. The data obtained showed that mildew incidence was significantly reduced 20 days after the application of benomyl, Systhane, Rubigan and R015-1297.

A MODEL FOR PREDICTING SPORULATION BY BOTRYTIS SQUAMOSA. P. C. Vincelli & J. W. Lorbeer. Department of Plant Pathology, Cornell University, Ithaca, NY 14853.

A model that provides daily forecasts of sporulation episodes by *Botrytis squamosa* was developed from 7 selected yr of data collected between 1969-81 with weather monitoring instruments and a first spore trap located in a commercial onion field. The model uses measurements of prior temperature and relative humidity to generate an environmental favorability index (EFI) for sporulation. The EFI is then modified by an algorithm that incorporates calendar date to generate a daily inoculum production index (IPI) ranging from 0 to 25. Significant sporulation can be expected within the next 24 hr when the IPI > 7. The model forecasted 81.3% of significant spore episodes (daily average > 1.0 spore/m³ air) from the 7 yr of data used to develop the model and 80.5% from an additional 3 yr of data.

SEQUENTIAL SAMPLING TO DETECT THE CRITICAL DISEASE LEVEL FOR INITIATING FUNGICIDAL CONTROL OF BOTRYTIS LEAF BLIGHT OF ONION. P. C. Vincelli and J. W. Lorbeer, Department of Plant Pathology, Cornell University, Ithaca, NY 14853.

A sequential sampling protocol (SSP) for Botrytis leaf blight of onion was developed. The SSP reduced sampling intensity from 50 plants/field to as few as 15 when disease levels were well above or well below the critical disease level (CDL) of one lesion/leaf (the action threshold for initiating a fungicide spray program). The SSP was tested by sampling from 15 to 50 computer-simulated lesion counts representing sequentially sampled plants until a decision was reached that the disease level was either below or above the CDL. Five hundred decisions were tested at each of nine mean disease levels (μ). For $\mu > 1.0$ and $\mu < 0.6$ lesions/leaf, use of the SSP led to the correct decision that the CDL had (100% accuracy) and had not (> 98% accuracy) been reached, respectively. For $\mu = 0.8$ lesions/leaf, use of the SSP often led to the decision that the CDL had been reached, indicating the conservative nature of the SSP. Similar results were obtained with field data.

STUDIES ON THE SELECTION OF TOMATO SPOTTED WILT VIRUS ISOLATES WHICH ARE MILD ON LETTUCE M. Wang and D. Gonsalves, Plant Pathology Department, Cornell Univ., NYSAES, Geneva, NY 14456

Tomato spotted wilt virus (TSWV) causes the most serious disease of lettuce in Hawaii. Cross protection is part of an integrated control approach. Various extraction buffers, pHs, incubation times and effect of centrifugation were tested in order to determine the optimal conditions for mutation experiments. *Gomphrena globosa* infected with a Hawaiian isolate was the virus source and *Nicotiana tabacum* served as single-lesion host. There was decreased virus infectivity in the supernatant after low speed centrifugation (1900g to 5900g/10min) with all buffers. The presence of a reducing agent such as Na_2SO_3 in buffered extracts was essential to maintain high infectivity. However, infectivity could not be maintained longer than 40 min at room temp. Virus infectivity was generally not affected at pHs 5.5 to 7.5; but it was dramatically decreased at pHs below 5.5. TSWV infectivity was abolished when the concentration of NaNO_2 in extraction buffer was higher than 0.4M. Incubation of leaf extracts in 0.125M NaAc, 0.01M Na_2SO_3 and 0.4M NaNO_2 at pH5.5 for 20 min at room temp was suitable for mutagenesis. Virus survival was reduced to about 5% as compared to controls without NaNO_2 . Several isolates with different degrees of mildness were selected.

ARMILLARIA ROOT DISEASE IN A CHRISTMAS TREE PLANTATION ESTABLISHED ON A FORMER FORESTED SITE. Philip M. Wargo and David R. Houston, USDA Forest Service, 51 Mill Pond Rd. Hamden, CT 06514

Mortality of balsam fir, *Abies balsamea* (L.) Mill. in a Christmas tree plantation that had been planted on former forest land was attributed to *Armillaria* root disease. The forest, mixed deciduous and pine, was cut in winter 1978. Stumps were chipped to below ground level and fir seedlings were planted in autumn 1978. Mortality appeared first in 1982 and by 1985 clusters of dead and chlorotic trees were apparent. In 1985 we evaluated the role of *Armillaria* and made management suggestions. Examination of many trees showed that *Armillaria* had colonized nearly all dead trees, most chlorotic trees, and many "healthy" green trees. In one 0.75 acre block 806 trees were examined for *Armillaria* at the root collar (RC). Twenty seven of 39 dead trees, 11 of 24 chlorotic trees, and 61 of 743 green trees were colonized at the RC. We recommended cutting all green trees in 1985 (two years before optimum commercial "maturity") and removing stumps before replanting.

EFFECTS OF LEAD AND TRACE METALS ON GROWTH OF THREE ROOT PATHOGENS OF SPRUCE AND FIR. P.M. Wargo¹, A.C. Carey², G.T. Geballe², W.H. Smith². ¹USDA Forest Service, Hamden, CT 06514. ²School of Forestry, Yale University, New Haven, CT 06511.

Armillaria (Biol Spp 1) (AM), *Scytinostroma galactinum* (SG) and *Perenniporia subacida* (PS) were grown at pH 4.5 and 3.5 on malt agar containing the metals. Growth of the three fungi was inhibited by soluble ($\text{Pb}(\text{C}_2\text{H}_3\text{O}_2)_2$) lead (Pb) at concentrations above 10 ppm. Inhibition was greater at pH 3.5. Rhizomorph growth by AM was also inhibited by insoluble (PbSO_4) Pb at concentrations above 10 ppm especially at pH 3.5. PS and SG were inhibited at 1000 ppm insoluble Pb. Addition of trace metals (Cd, Cu, Ni, and Zn) to the Pb amended medium at minimum (MIN) and maximum (MAX) concentrations (with respect to their levels found in forest soils) inhibited all 3 fungi depending on pH and trace metal concentrations. There was no interactive effect of trace metals and Pb on growth of PS and SG but for AM at pH 4.5 there was an additional progressive decrease in rhizomorph growth with increasing concentrations of Pb up to 300 ppm in both MIN and MAX.

CHRYSANTHEMUM PHLOEM NECROSIS: VI. CHEMOTHERAPY WITH SILVER. K. F. Weaber and R. K. Horst. Dept. of Plant Pathology, Cornell University, Ithaca, NY 14853.

The effect of foliar applications of dilute Ag^+ solutions on foliar chlorosis and necrosis, dominant symptoms of the chrysanthemum phloem necrosis (CPN) disease infecting *Chrysanthemum morifolium* 'Pink Marble', was studied in greenhouse and controlled environment conditions. Cuttings were rooted under mist 21 days in vermiculite, potted in Peat Lite, and grown at temperatures of 16, 21, 27 and 32C with a 16 hour photoperiod at 70 klux. Plants were treated weekly with foliar sprays of dilute silver thiosulfate, silver nitrate, or left untreated. Plant height and weight, and percentage of leaves showing chlorosis or necrosis were observed and evaluated for 4 to 12 weeks. Plant height and weight were unaffected by Ag^+ . Foliar spraying of Ag^+ , however, consistently reduced the percentage of leaves expressing chlorosis and necrosis.

INFLUENCE OF MYCORRHIZAE ON GROWTH AND SURVIVAL OF SCOTCH PINE SEEDLINGS EXPOSED TO LANDFILL GAS. Richard B. Weidman and Ida A. Leone. Plant Pathology Department, Cook College, New Jersey Agricultural Exp. Station, Rutgers University, New Brunswick, NJ 08903.

Pisolithus tinctorius, a symbiotic fungus, was used to inoculate two-year-old Scotch pine seedlings in the greenhouse and in the field at Edgeboro landfill in East Brunswick, New Jersey. Inoculated seedlings in the combustible gas plot at Edgeboro showed an increased tolerance to landfill gas despite carbon dioxide levels ranging from 2-30 percent. The control plot containing low levels of combustible gas showed only slight variation between inoculated and uninoculated seedlings. Greenhouse studies also reveal increased growth and lower shi-gometer readings of inoculated seedlings indicating improved health and vigor. Others have reported the tolerance of seedlings inoculated with *Pisolithus tinctorius* to adverse growing conditions.

BUDBREAK OF DOUGLAS-FIR IN RELATION TO THE CONTROL OF RHABDOCLINE NEEDLECAST. N. G. Wenner and W. Merrill, The Pennsylvania State University, University Park, PA 16802.

Rhabdocline spp. infect only current-year Douglas-fir needles from bud break through shoot elongation. The fungi release ascospores prior to bud break and through shoot elongation. Variation in bud break and rapid shoot elongation make chemical control difficult. Current controls are inadequate because the first fungicide spray is recommended when the majority of the new shoots are 1.2-5.0 cm long, leaving early-breaking trees unprotected. In spring 1986, four buds, one in each cardinal direction, were selected and tagged at 0.5m from the ground on each of 50, 1.5-2m "Lincoln" Douglas-fir Christmas trees. The 50 trees broke bud (at least one of the 4 selected buds opened) over a 22-day period; 197 of the 200 buds broke over a 27-day period. On May 5, when nearly 50% of the trees had broken bud, 12% had shoots averaging 3.1 cm long. Better chemical control may result if the first spray is applied when buds break on 10% of the trees, with a second spray 1 week later, and a third spray two weeks after the second.

Mung bean sprout disease caused by *Enterobacter cloacae*. R. L. Wick, K. K. Rane and D. K. Sutton. University of Massachusetts, Suburban Experiment Station, 240 Beaver St., Waltham, MA 02254.

Mung bean (*Phaseolus aureus* Roxb.) sprouts are increasingly becoming a popular vegetable. In Massachusetts, it is estimated that more than 3,000 tons are produced annually. Despite their current popularity, very little information is available on their diseases. *Enterobacter cloacae* (Jordan) Hormaeche & Edwards is reported here as a cause of inhibition of growth, root necrosis and death of mung bean sprouts. The pathogen has been cultured from diseased sprouts from several sources and Koch's postulates have been completed. The mung bean strains differ from most clinical strains of *E. cloacae* in their inability to produce acid from myo-inositol, lactose and rhamnose and the inability to utilize malonate as a sole carbon source.

Pythium soft rot of alfalfa sprouts. R. L. Wick, D. K. Sutton and K. K. Rane. University of Massachusetts, Suburban Experiment Station, 240 Beaver St., Waltham, MA 02254.

Alfalfa (Medicago sativa L.) sprouts are a popular salad and sandwich food. In Massachusetts alone, it is estimated that 600 tons are produced annually. A yellow soft rot, evident during harvesting of sprouts has been a problem for a number of Massachusetts sprout producers. Affected areas are found to occur randomly in circular patches and are 1 to 15 cm in diameter. Pythium ultimum var. sporangiiferum Dreschsler and Pythium aphanidermatum (Edson) Fitzp. were consistently associated with the rot and Koch's postulates were completed. Diseased sprouts were heavily colonized by bacteria but none of the strains isolated caused disease upon reinoculation.

VENTURIA INAEQUALIS ON APPLE CULTIVARS GROWN IN VITRO.

L. M. Yepes and H. S. Aldwinckle, Plant Pathology Department, NYSAES, Cornell University, Geneva, NY 14456.

A method is being developed to screen apple (Malus pumila) cultivars for resistance to V. inaequalis using in vitro propagated shoots. Comparative electron microscopic studies of the pathogenesis of V. inaequalis on susceptible and resistant apple cultivars grown in vitro or in the greenhouse were conducted. Conidial germination, appressorium formation and penetration of the cuticle were similar for all cultivars under both growing conditions. In resistant cultivars, a hypersensitive response and limited stromatic fungal growth without

sporulation were observed in vitro and in the greenhouse. In susceptible cultivars, formation of subcuticular stroma proceeded atypically in vitro. Although primary hyphae formed below the appressoria, ramification of secondary hyphae under the cuticle was more restricted than in plants grown in the greenhouse. Nevertheless, susceptible cultivars were distinguishable from resistant cultivars in vitro.

ISOZYME ANALYSIS OF THREE VARIANTS OF THE CONIFER ROOT PATHOGEN VERTICICLADIELLA WAGENERI. P. Zambino, T. C. Harrington, and D. O'Malley. Dept. of Botany and Plant Pathology, and Dept. of Forestry, Univ. of New Hampshire, Durham, NH 03824.

Starch gel electrophoresis of 47 strains of Verticicladiella wagneri was used to study genetic relationships among three morphological variants pathogenic to hard pines (HP), pinyons (PY) and Douglas-fir (DF). Of 17 loci coding for 14 enzymes, 9 were monomorphic, 7 had 2 alleles, and one had 6 alleles. Most of the limited gene diversity in this species (0.211 by Nei's method, PNAS 70:3321-3323) occurred between variants (0.165), with low diversity within variants (0.045). Greater diversity was found within the DF than within the PY or HP variants (0.080, 0.021, and 0.035, respectively). Genetic distances (Nei's D) between variants were 0.439 (PY and HP), 0.250 (PY and DF), and 0.222 (HP and DF). Therefore, of the three variants, the DF variant may most closely resemble the ancestral V. wagneri and perhaps should be designated as a new variety, as was recently done for the HP variant, V. wagneri var. ponderosa.

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