ABSTRACTS OF PAPERS

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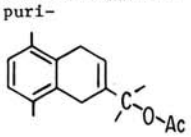
ABSTRACTS

ISOLATION, PURIFICATION, AND STRUCTURE ELUCIDATION OF A NEW RISHITINOL-RELATED POTATO STRESS METABOLITE. Leo M. Alves, Plant Morphogenesis Laboratory, Biology Dept., and Richard M. Kirchner, Denise T. Lodato, Patricia B. Nee, and Jean M. Zappia, Chemistry Dept., Manhattan College, Bronx, NY 10471; and James D. Stuart, Chemistry Dept., Univ. of Connecticut, Storrs, CT 06268; and Edwin B. Kalan and John C. Kissinger, ERRC, ARS, USDA, Philadelphia, PA 19118.

We have reported that a controlled atmosphere of ethylene in oxygen (E/O_2) elevates rishitin and phytuberin levels in hypersensitive potato tuber tissue compared to incubation in air. E/O_2 also elevates levels of unidentified sesquiterpenoid stress metabolites (SSMs). One such SSM was extracted from approximately 40 Kg of tuber tissue, isolated, and purified. Mass spectral, NMR, IR, and UV data lead us to propose the accompanying structure. This newly-identified SSM may be related to rishitinol by the latter's loss of water and esterification.



IMPLEMENTATION OF AN INTEGRATED PEST MANAGEMENT PILOT PROGRAM FOR ONIONS IN NEW YORK. J. T. Andaloro and J. W. Lorbeer, Dept. of Entomology, Cornell Univ., Geneva, NY 14456; Dept. of Plant Pathology, Cornell Univ., Ithaca, NY 14853.

An integrated pest management pilot program for commercially grown onions in New York was initiated in 1979 on 200 acres and was increased to 900 acres in 1981. The primary insects monitored were the onion maggot and onion thrips. The primary disease monitored was Botrytis leaf blight. With respect to leaf blight (caused by Botrytis squamosa), disease severity was assessed weekly by taking lesion counts on three intermediately aged leaves (avoiding youngest and senescing leaves) on each of five contiguous plants at seven to ten randomly selected sites across the selected sample area in a field. Although leaf blight initiation was near simultaneous in most of the fields sampled, the average incidence of lesions per leaf differed greatly between sampled fields as the growing season progressed. This occurred because of wide differences in fungicide selection, application timing, and application procedures by the cooperating growers.

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

Two sweet corn cultivars, Bonanza and Stylepak, were planted on 8 May, 5 June, 19 June and 3 July 1981 and inoculated at the 7-8 leaf stage with maize dwarf mosaic virus strain A (MDMV-A). Uninoculated plots of each cultivar were maintained at each planting date. There was a significant reduction in marketable ears harvested from inoculated plots of Bonanza from each planting except the first and an absence of marketable ears in inoculated plots of Stylepak at the later plantings. Disease incidence rose progressively on both cultivars as planting date was delayed. Also the effect of MDMV-A infection was greater in later plantings in that plants were more severely stunted. The growth rates of uninoculated plants were increased by delays in planting evidenced by an increase in plant height measured at anthesis. The data suggest yield losses due to MDMV-A are mediated by growth rate of the host and therefore, early planting may reduce losses.

STRAIN DIFFERENCES AND CONTROL OF DIPLODIA PINAE. P. R. Bachi and J. L. Peterson, Dept. Plant Pathology, Rutgers University/Cook College, New Brunswick, N.J. 08903.

Isolates of Diplodia pinae from Austrian and Scotch pine varied in growth and sporulation in laboratory culture. There were also spore germination and growth differences among isolates on benomyl-amended media. Benomyl, mancozeb, chlorothalonil, Zyban and certain fungicide combinations were applied to three different plantings of Austrian and Scotch pine. Treatments varied as to time and number of application. All fungicides except chlorothalonil gave consistently significant tip blight control. Benomyl-mancozeb combinations gave the best disease control although not statistically better than benomyl or Zyban. Different application times could not be correlated with differences in the amount of disease control, but trends were noted.

HISTOLOGICAL OBSERVATIONS OF BURSAPHELENCHUS XYLOPHILUS IN SYMPTOMATIC TISSUES OF LARIX LARICINA AND PINUS RESINOSA. D.R. Bergdahl and D.L.K. Smeltzer, Dept. of Forestry, Univ. of Vermont, Burlington, VT 05405.

Eastern larch (Larix laricina) and red pine (Pinus resinosa) were inoculated in the greenhouse with the pine wood nematode (Bursaphelenchus xylophilus). Symptomatic tissues were excised, fixed and stored in FAA before sectioning on a freezing microtome. Sections of wood were stained with safranin/cotton blue in glycerine/alcohol before examination for nematodes. Nematode populations were higher in tissues of red pine than in eastern larch. In red pine, nemas were abundant in longitudinal and radial resin canals of the xylem, but only occasionally observed in tissues of the bark. Nemas in eastern larch were not observed in the xylem tissues, but were found in the cambial region and in the phloem, cortex and resin canals of the bark.

POPULATIONS OF SELECTED FOREST SOIL ORGANISMS AFFECTED BY SOIL COMPACTION. D.L.K. Smeltzer, D.R. Bergdahl and J.R. Donnelly, Dept. of Forestry, Univ. of Vermont, Burlington, VT 05405.

During the 1980 growing season, soil samples were collected twice monthly from each of four soil compaction, mulch and litter removal treatments (2 replications, compacted up to 4 years) on a loamy sand supporting a mixed northern hardwood forest. Soil organism populations were measured using selective media and other isolation methods, and significant differences between treatments were detected. Numbers of total fungi, bacteria, nematodes, and soil arthropods were highest in non-compacted soil and the 2 mulch treatments were usually intermediate. The treatment causing greatest soil disturbance had the highest population of Fusarium spp., undisturbed soil lowest, and mulched soils intermediate. Bioassays with alfalfa seeds in soil from treated areas resulted in least survival from soils having highest populations of Fusarium spp. Isolations from some wilted alfalfa seedlings yielded Fusarium spp. Sampling in July 1981 revealed little change from the above results.

RESPONSE OF CELERY TO HEAVY METALS AND MELOIDOGYNE HAPLA IN SOILS NEAR A NICKEL REFINERY. S. Bisessar and R.J. Rinne, Phytotoxicology Section, Ontario Ministry of the Environment, Toronto and J.W. Potter, Agriculture Canada Research Station, Vineland Station, Ontario

This study was undertaken to determine the effects of heavy metals (HM) and root knot nematode in soils on the growth of celery. Seedlings, non-inoculated and inoculated with M. hapla larvae, were transplanted on HM contaminated and non-contaminated organic soils near a nickel refinery in Southern Ontario. Results showed that celery shoot weight was reduced

86% by HM and root-knot nematode in combination, with 75% attributed to HM and 11% to nematodes. HM concentrations in celery followed a root > leaf > stalk gradient. Leaf injuries and stunting of celery were attributed mainly to nickel toxicity. Roots of inoculated plants from HM soil (7500 ppm Ni) had significantly more galls than the roots of inoculated plants from non-contaminated soil (50 ppm Ni), indicating that HM, primarily nickel, predisposed celery to greater attack by the pathogen.

THE ETIOLOGY OF INTERNAL BROWNING--GRAYWALL OF TOMATO. J.S. Boyle, Department of Plant Pathology, The Pennsylvania State University, University Park, PA 16802.

The term "Internal Browning" (IB) has been used to identify a tobacco mosaic virus (TMV) incited disease of tomato in PA while in FL a disease with similar symptoms has been called "Graywall" (GW) and ascribed to bacterial infection. IB has been consistently reproduced with strains of TMV while the syndrome of GW has never been experimentally reproduced, although bacterial isolates have been used to incite a browning of tomato tissue when introduced through wounds. In 1968, 80 and 81, approximately 50 fruit which workers called GW were obtained in the Homestead and Naples areas. TMV was consistently isolated from these fruit. In a split plot, irrigated-nonirrigated field experiment in 1981, 4 FL TMV isolates incited high incidence of IB--GW in inoculated Rutgers and Floradade plants. Disease severity was less in Floradade and the non-irrigated plots. Non-inoculated plants were free of IB--GW. Preliminary information suggests bacteria may accentuate severity of symptoms and gain entrance through microscopic riffs in the cuticle over necrotic areas following the "shock" reaction of TMV infection.

CONTROL OF POWDERY MILDEW ON WHEAT AND ITS SUBSEQUENT EFFECT ON SEPTORIA SEVERITY AND YIELD. S. C. Broscious, J. A. Frank and H. Cole, Jr. Dept. of Plant Pathology and USDA-ARS, Center for Cereals Research, The Pennsylvania State University, University Park, PA 16802.

Field experiments were designed to study the effect of fall and fall & spring fungicide applications on severity of powdery mildew and Septoria leaf blotch. Six wheat cultivars were sprayed with 70 g/ha of triadimefon. Spray schedules included a single fall application and a fall & spring combination. Disease evaluations were made at growth stage 10.1 with yields and thousand kernel weights (TKW) calculated after harvest. All fungicide treatments resulted in significantly lower mildew severities than the controls with the combination fall & spring spray resulting in the lowest mildew severities with all cultivars. The severity of Septoria leaf blotch generally increased with all fungicide applications on all cultivars. However, all cultivars had significant yield increases and superior TKW in all fungicide treated plots when compared to controls.

Tenacity of Fungicide Deposits with Respect to Simulated Rainfall. E.J. Butterfield and R.J. Pocchiari. Boyce Thompson Institute for Plant Research, Tower Road, Cornell University, Ithaca, New York 14853.

Several formulations of thiabendazole and triphenyltin hydroxide as well as benomyl and captan were evaluated in laboratory tests for tenacity to rainfall. Controlled deposits of the fungicides were made on leaves of soybean and subjected to simulated rainfall. Fungicide residues were determined by a leaf-disc bioassay with Colletotrichum lagenarium. The locally systemic fungicides thiabendazole and benomyl were less tenacious than the protectant fungicides triphenyltin hydroxide and captan. Tenacity of thiabendazole and triphenyltin hydroxide was affected by both formulation and deposit size. Solubilized formulations of thiabendazole improve leaf penetration but significantly reduce tenacity. This effect is amplified with increased deposit size. In contrast, the tenacity of more tenacious formulations is enhanced by increased deposit.

NATURE AND EXTENT OF CULLAGE IN CONSUMER SAMPLES OF FRESH BLUEBERRIES. R. A. Cappellini, M. Ceponis and G. Koslow. USDA-New Jersey AES Postharvest Research Center, P.O. Box 231, New Brunswick, N.J. 08903

A study was conducted to determine the condition of fresh blueberries marketed in Greater New York during 1978-1980. Four to six pints were purchased once or twice weekly at each of 5 high volume supermarkets. Berries from North Carolina, New Jersey and Michigan were examined on the same day of purchase from May to September. Defective berries averaged 15.2%. Fungal decays, principally anthracnose, gray mold and alternaria rots, accounted for 2/3 of the culls. The remainder resulted from overripe and shrivelled fruits, and mecahnical injuries. An apparently new, fungal, blossom end-rot was found on berries from all three states. An unidentified acervular Coelomycete was associated with this rot.

AUTUMN ROOT STARCH CONTENT AND ITS RELATIONSHIP WITH THE SEVERITY OF DECLINE SYMPTOMS IN URBAN SUGAR MAPLES. J.E. Carroll and T.A. Tattar, University of Massachusetts, Amherst 01003 and P.M. Wargo, USDA Forest Service, Hamden CT 06514.

Autumn root starch content in 93 urban sugar maple trees was measured histochemically and its relationship with the severity of maple decline symptoms determined. The correlation coefficient (r) between 1979 root starch and 1980 crown condition was 0.34 and between 1980 root starch and 1981 crown condition was 0.59. A linear relationship was found between root starch content and crown condition such that as root starch content declines crown condition worsens. Linear trend analysis of twig increment for the years 1976 to 1980 and crown condition in 1980 and 1981 showed a significant relationship between poorer crown condition and reduced increment for the years 1977 through 1980. In a similar analysis lower root starch contents for 1979 and 1980 were significantly related to less twig increment for the years 1979 and 1980. Starch content was a more dynamic parameter and change presaged crown condition changes better than twig increment or previous crown condition.

BACTERIAL SEEDLING BLIGHT OF TOMATO. F.L. Caruso, M.G. Zuck, and A.E. Bessette, Department of Botany and Plant Pathology, University of Maine, Orono, ME 04469.

In February 1981, eighteen tomato cultivars were screened for seed-borne Alternaria solani and/or Corynebacterium michiganense. Seeds were germinated on 1% water agar, and at seven days numerous necrotic flecks were observed on the stem and cotyledons of the seedlings of sixteen cultivars. Although Alternaria was occasionally present, isolations from affected tissue consistently yielded a creamy-white, Gram-positive, rod-shaped bacterium that produced numerous subterminal spores. The organism was identified as Bacillus polymyxa on the basis of thirty biochemical tests. The bacterium was seed-borne and could be eliminated from the seed by hot water treatment at 90°C for 30 seconds. Six isolates of the organism caused identical symptoms in seedlings grown from certified disease-free seed. Although B. polymyxa has been reported to cause tomato fruit soft rot, this is the first report of the organism causing seedling blight in tomato.

INFLUENCE OF COOLING RATES AND CARBON DIOXIDE ATMOSPHERES ON STORAGE ROTS OF BLUEBERRIES. M.J. Ceponis and R.A. Cappellini, USDA-New Jersey AES Postharvest Research Center, P.O. Box 231, New Brunswick, NJ 08903.

Ten tests with New Jersey 'Bluecrop' blueberries were conducted in 1981 to evaluate the effects of cooling rates and carbon dioxide (CO_2) storage atmospheres on fruit decay. Berries initially at 22° and 30°C, were cooled to 2°C in either 2, 48 or 72 hours and then held at 2°C up to 14 days in 12-pint packages with and without CO_2 atmospheres. At the end of the 14-day cooling and storage period, the berries were held at 21°C for 3 additional days. Decay for berries cooled to 2°C in 2, 48, and 72 hours averaged, respectively, 0.8, 2.7, and 3.7% at the end of cold storage, 2.0, 6.9, and 10.8% after 1 day, 6.8, 14.1, and 20.6% after 2 days, and 15.4, 20.7, and 24.8% after 3 days at 21°C. The addition of 10-20% CO_2 atmospheres, maintained during cold storage, further reduced decay almost 50%.

STUDIES ON A NEW STRAIN OF CORN STUNT SPIROPLASMA. T. A. Chen and J. H. Tsai, Dept. of Plant Pathology, Rutgers University, New Brunswick, NJ 08903, and Agricultural Research Center, University of Florida, Fort Lauderdale, FL 33314.

A corn stunt disease was observed in Dade County, FL, in 1979. The infected plants exhibited symptoms of both corn stunt and bushy stunt diseases. A new strain of corn stunt spiroplasma was isolated from the diseased plants. The organism grew slower in vitro and produced less acid than the Rio Grande strain (I-747). Serologically it can be easily separated from I-747 and Spiroplasma citri but it is related to both. The spiroplasma was readily transmitted by Dalbulus maidis. The

minimum acquisition access period (AAP) was 3 hr. The average incubation was 18.5 days with a range of 8-24 days at 25 C. The average retention period was 25.7 days with a range of 2-55 days at 25 C. The incubation period in a corn plant ranged from 15 days at 30 C to 43 days at 15 C.

EFFECTS OF INJECTED ANTIVIRAL COMPOUNDS ON APPLE MOSAIC, SCAR SKIN AND DAPPLE APPLE DISEASES. Susan M. Cheplick and G. N. Agrios, Dept. of Plant Pathology, University of Massachusetts, Amherst, MA 01003.

Several synthetic compounds with known antiviral activity were applied by pressure injection into young apple trees or individual branches of older apple trees infected with apple mosaic, scar skin, or dapple apple. Apple mosaic-infected McIntosh apple trees growing in the orchard and treated with ribavirin in the spring showed no symptom suppression during that season but exhibited delayed appearance and development of mosaic symptoms during the following season; trees injected with ribavirin in the autumn showed few or no mosaic symptoms the following growth season. Ribavirin injected into apple mosaic-infected Golden Delicious trees growing in the greenhouse completely suppressed foliar symptoms. Chemicals other than ribavirin had little or no effect on the expression of mosaic symptoms in the orchard or the greenhouse. None of the compounds had much, if any, effect on the fruit symptoms of scar skin-or dapple apple-infected trees.

THE POTENTIAL FOR INDUCED RESISTANCE IN APPLE AGAINST INFECTION BY VENTURIA INAEQUALIS (CKE.) WINT. R.H. Cody and F.L. Caruso, Department of Botany and Plant Pathology, University of Maine, Orono, Maine 04469.

Inoculation of a single leaf of 6-8 week-old McIntosh apple seedlings with Venturia inaequalis, Erwinia amylovora, Sphaeropsis malorum or Pseudomonas fluorescens and root inoculations with Phytophthora cactorum failed to protect plants against subsequent whole plant challenge inoculations with V. inaequalis. Varying inducer and challenge inoculum concentrations were used over a range of challenge intervals. Single leaf inducer inoculations of V. inaequalis induced no significant protection against subsequent whole plant V. inaequalis challenge in seedlings of three crabapple species and in clonal "McIntosh" shoots. Half-leaf inoculations of a single susceptible McIntosh seedling leaf with V. inaequalis failed to protect the opposite half-leaf when subsequently challenged by V. inaequalis. These findings failed to substantiate the existence of an induced protection phenomenon against scab in apple.

CONTROL OF POWDERY MILDEW ON WHEAT AND ITS SUBSEQUENT EFFECT ON SEPTORIA SEVERITY AND YIELD. H. Cole, Jr. and J. A. Frank Dept. of Plant Pathology and USDA-ARS, Center for Cereals Research, The Pennsylvania State University, University Park, PA 16802.

Field experiments were designed to study the effect of fall and/or spring fungicide applications of triadimefon on powdery mildew and Septoria leaf blotch of wheat. Wheat plants of six cultivars were sprayed during fall tillering and/or at growth stage 5 (LARGE) in the spring with 70 g/ha of triadimefon. Disease evaluations were made at growth stage 10.1 and yields and thousand kernel weights (TKW) were calculated after harvest. All fungicide treatments resulted in significantly lower mildew severities than the controls with the combination of fall and spring sprays resulting in the lowest mildew severities with all cultivars. The severity of Septoria leaf blotch generally increased with all fungicide applications on all cultivars. However, all cultivars had significant yield increases and superior TKW in all fungicide treated plots when compared to controls.

BARK CRACKS ASSOCIATED WITH INJECTION WOUNDS IN ELMS. C.W. Murdoch, J.S. Coleman, and R.J. Campana. New England Plant, Soil, and Water Laboratory, USDA-ARS, and Department of Botany and Plant Pathology, University of Maine, Orono, ME 04469.

Exudation of sap from injection wounds in elm is common, but bark cracks from such wounds are unreported. Observations on cracks in 148 elms (Ulmus americana L.), 36-99 cm. dbh, were obtained over a two year period in Maine. Data were recorded on vertical extent of cracks from wounds, date of wound, depth and configuration of cracks. Cracks ranged to 15 meters above and 1.2 below wounds. They developed more frequently from trunk than from root wounds. They extended upward to existing wounds or branch stubs, were widest at midpoints and tapered upward. Cracks below wounds were less frequent or extensive. All cracks were limited to separation of phloem; no xylem cracks were seen. Exposed xylem was discolored on tangential and radial lines. Wounds from stem injection enhanced cracking of elm bark.

FUNGI ASSOCIATED WITH ROOTS OF YOUNG APPLE TREES WITH POOR GROWTH SYMPTOMS. Daniel R. Cooley, and William J. Manning, Dept. of Plant Pathology, University of Massachusetts, Amherst MA 01003.

Newly-planted apple trees (Malus domestica Borkh.) in Massachusetts may exhibit poor growth symptoms: reduced shoot growth, marginal leaf necrosis, reduced root growth, and reduced endomycorrhizal infections. Root isolations from collected trees yielded species of Fusarium, Cylindrocarpon, Rhizoctonia, Pythium, Trichoderma, and Pencillium. In the greenhouse, 1-year-old M7a apple rootstocks were planted in soil from a problem orchard. Soil treatments consisted of: none (NT), steaming (S), adding 50% peat to NT (P), using a steamed non-orchard soil mix (SM) and 10% NT added to SM. After 5 months, root and stem dry wts., but not tree hts., were reduced by NT, P, and NT + SM treatments, with the greatest reductions in P, followed by NT + SM and NT. Fusarium, Cylindrocarpon, Trichoderma and Pencillium spp. were isolated, with frequencies correlated with degree of root reduction.

SYSTEMIC ROOT-FLARE MICRO-INJECTION FERTILIZATION OF MATURE ROADSIDE MAPLES. Arthur C. Costonis, Systemics, Inc., 138 Mill Street, Westwood, MA 02090

Fifteen (15) mature sugar maples planted along a travelled roadway were selected for fertilization treatments by systemic root flare micro-injection. The treatments consisted of the Mauget product Stemix HI VOLUME (SHV), Stemix HI VOLUME with elevated phosphorous (SHVP) and a water check. Both the SHV and the SHV-P showed significant increased twig growth the year after treatment when compared to the water controls. The average twig growth for each treatment was: SHV-9.3 cm; SHV-P-4.7 cm; and water-control-1.5 cm. The SHV-P treatment resulted in a pronounced visual increase in leaf chlorophyll six (6) weeks after the initial treatment. The effect was not persistent over the three year observation period. The 1980 terminal growth of these trees was brittle with a weaker bud set than the SHV. Observation of the closures of the injection sites was made.

EFFECTS OF INSECT MANAGEMENT ON PLANT GROWTH AND FUSARIUM STEM AND CROWN ROT IN FIRST-YEAR ASPARAGUS. John P. Damicone, William J. Manning, Dept. of Plant Pathology, and David N. Ferro, Dept. of Entomology, University of Massachusetts, Amherst, MA 01003

Beginning in mid-July, six applications of diazinon 50 WP, at 1/2 lb A.I./acre, were made at weekly intervals to manage the stem miner fly (Ophiomia simplex) and the common asparagus beetle (Crioceris asparagi) on first-year asparagus (Asparagus officinalis) from transplanted seedlings. At the end of the growing season, treated and nontreated plants were evaluated for fresh weights, stem miner activity, beetle-caused defoliation, and stem and crown rot caused by Fusarium moniliforme and F. oxysporum. Diazinon-treated plants were significantly larger (236.8 g vs. 203.1 g), with a lower disease index rating (1.49 vs. 2.16) (0-5 scale), ($P = 0.01$). A linear relationship ($r = 0.70$) was found between the number of O. simplex mines/stem and stem rot severity. Insect management with diazinon resulted in larger plants with reduced stem and crown rot.

PATHOGENICITY OF FUSARIUM SPECIES FROM CROWNS OF FIRST-YEAR ASPARAGUS. John P. Damicone, and William J. Manning, Dept. of Plant Pathology, University of Massachusetts, Amherst, MA 01003.

Isolations were made from internal crown tissues of 288 Mary Washington and 288 RMH 202 (Centennial) first-year asparagus

(Asparagus officinalis) plants grown from transplanted seedlings. One or more species of Fusarium were obtained from each crown of each cultivar. All were subcultured, identified, and evaluated for pathogenicity by inoculating aseptically-grown asparagus seedlings on Hoaglund's solution agar. F. moniliforme isolates (58%) had a mean pathogenicity rating of 2.9 (0-5 scale). F. oxysporum isolates (31%) had a mean rating of 1.5, while mixed colonies of F. moniliforme and F. oxysporum (10%) had a mean rating of 2.6. F. roseum and F. solani isolates (1%) were nonpathogenic. F. moniliforme was the most prevalent and pathogenic species isolated from crowns of first-year asparagus grown from transplated seedlings.

INFLUENCE OF ANTAGONISTIC BACTERIA ON SYNNEMATA OF CERATOCYSTIS ULMI. M.R. Dietz, V.J. Spadafora, and R.J. Campana. Dept. of Botany & Plant Pathology, University of Maine, Orono, ME 04469.

Antagonism of C. ulmi by microflora in vitro limits development of mycelia and synnemata. To evaluate the possibility of antagonism against pre-formed synnemata, additional studies were made. Suspensions of two species of bacteria antagonistic to C. ulmi were sprayed on heads of synnemata newly established on 60 discs of sterilized elm wood; 20 control discs with synnemata were left unexposed. Two rates (5,000 or 500,000/ml.) of bacterial suspensions were used. Discs were incubated on moist paper in plates at room temperature for four weeks. Data were obtained on frequency of synnemata/mm^2 before spraying with bacteria and during the following four weeks. Numbers of synnematal heads intact after four weeks were significantly greater (p=0.5) on unsprayed discs than on those sprayed. There were no differences in survival of synnemata between species of bacteria or rates of bacterial suspensions. The data suggest that antagonistic bacteria destroy synnematal heads of C. ulmi, and thus reduce populations of inocula.

EVALUATION OF SWEET CORN HYBRIDS FOR RESISTANCE TO HEAT SMUT. Edgington, L.V., G.C.A. Bruin and K.L. Benner, Department of Environmental Biology, University of Guelph, GUELPH, Ontario N1G 2W1.

Head smut, caused by the soil-borne fungus Sphacelotheca reiliana, has become a serious concern in Ontario. Hybrids of sweet corn were tested for resistance in a naturally infested field. The replicated trial was planted twice on different dates. The corn was rated when the ears matured. Smut incidence was compared using Tukey's Multiple Range Test. Hybrids were classed as Resistant: Green Giant-48, Tablevee, Seneca 258 and AX409; Intermediate: Gold Cup, Ontario Hybrid 796, Buttervee, White Lightning, Ontario Hybrid 794, Sweet Sue, Green Giant 7, Earlivee, Bi-Queen, Seneca Star, Stylepak, BVX 819, Flavoree, Silver Queen and Kandy Korn EH; and Susceptible: Ontario Hybrid 8011, Ontario Hybrid 797, Goldenvee, Burgundy Delight, Sun and Snow, VX719 and Platinum Lady. The ranking of resistant and susceptible hybrids was consistent in both plantings although the disease range was 0.5-28% and 4-70% in the early and late plantings respectively.

INFECTION AND COLONIZATION OF CHRYSANTHEMUM INOCULATED WITH FUSARIUM OXYSPORUM F. SP. CHRYSANTHEMI. N. L. Fisher and T. A. Toussoun, Fusarium Research Center, The Pennsylvania State University, University Park, PA 16802.

Colonization of chrysanthemum cultivars Yellow Delaware and Royal Trophy by Fusarium was investigated. Two week old plants were inoculated with a spore suspension of Fusarium, and plants were then sampled daily for 15 consecutive days. Thin sections at one-inch intervals of the stem throughout the height of the plant were indexed for Fusarium on agar. Colonization increased with time. Colonization was found to be discontinuous in 14% of plants sampled, perhaps due to conidia in vessels. Symptoms could first be observed 12 days post inoculation. Plants expressing symptoms were completely colonized by the fungus, but the fungus was also found in the vascular system of symptomless plants. Plant stub inoculations resulted in infection and colonization at the stub location, but there was no further colonization of stem tissues.

INTERACTIONS BETWEEN ROOT AND CROWN ROT ON BARLEY AND NET BLOTCH SEVERITY. J. A. Frank and H. Cole, Jr., Dept. of Plant Pathology and USDA-ARS, Center for Cereals Research, The Pennsylvania State University, University Park, PA 16802.

Field plots were established with varying levels of root and crown rot (Helminthosporium sativum) on winter barley. Half of these plots were sprayed with spore suspensions of H. teres, the causal agent of net blotch. At growth stage 9 (LARGE) plants were evaluated for net blotch and crown rot. Net blotch severities were higher in plots with root and crown rot levels greater than 5%. With increasing crown rot levels there was a significant increase in net blotch severity. With severe crown rot infections (greater than 20% severity) the spot blotch phase of H. sativum developed on the foliage. Therefore, with severe levels of crown rot the frequency of net blotch infection decreased due to the appearance of spot blotch.

THE INFLUENCE OF ROOT AND CROWN ROT ON THE WINTER SURVIVAL OF WHEAT AND BARLEY PLANTS. J. A. Frank and H. G. Marshall, Dept. of Plant Pathology and USDA-ARS, Center for Cereals Research, The Pennsylvania State University, University Park, PA 16802.

Winter survival of wheat and barley is altered by several soil-borne pathogens, particularly Helminthosporium sativum. Seed and soil-borne inoculum along with soil fumigation and seed treatments were used to vary levels of disease. Differences in winter survival due to H. sativum were measured as the differences in fall and spring stand counts, tillers per plant and grain yield. Disease was assessed as the proportion of diseased tissue on washed roots and crowns. Overall stand reductions, ranging from 7-29% in wheat and 10-61% in barley, were attributed to H. sativum and other pathogens. Although H. sativum reduces winter survival, H. sativum interacting with other soil-borne pathogens significantly reduces winter survival under natural inoculum conditions.

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A MODEL TO ESTIMATE MATURITY OF ASCOSPORES OF VENTURIA INAEQUALIS . D.M. Gadoury & W.E. MacHardy, Dept. of Botany & Plant Pathology, University of New Hampshire, Durham, 03824.

Effects of temperature on maturation of Venturia inaequalis ascospores were studied under laboratory and field conditions. The rate of maturation of ascospores was directly proportional to temperature from 6 to 20 C. A linear relationship between the probit of ascospore maturity and degree day accumulation (base = 0 C) from the first appearance of mature spores allowed the formulation of a simple linear statistical model of ascospore maturation ($(Y = 2.51 + 0.01 X) \pm 0.814$, $p = 0.10$, $R^2 = 0.93$). The model can be used to estimate the cumulative percentage of matured ascospores, given the degree day accumulation since the first appearance of mature spores. The model was verified by comparison to its component data sets and was validated with additional field and laboratory observations of ascospore maturity. Applications of the model in a disease management program are discussed.

PLASMIDS OF ERWINIA HERBICOLA INFLUENCE PIGMENTATION, THIAMINE PROTOTROPHY AND BACTERIOCIN PRODUCTION, B. V. Gantotti and S. V. Beer. Dept. of Plant Pathology, Cornell University, Ithaca, NY 14853.

Several strains of Erwinia herbicola antagonistic to E. amylovora in vitro and in planta were found to harbor five plasmids. Nonpigmented variants that required thiamine were obtained when three strains were grown in the presence of sodium dodecyl sulfate or at 38C. All of the variants tested had lost a large plasmid (ca. 350 megadalton) suggesting that

pigmentation and thiamine prototrophy are specified by genes carried by that plasmid. Bacteriocin production by E. herbicola was not affected by treatment with seven plasmid-curing agents. However, bacteriocin production could be eliminated by transposon mutagenesis with Tn5. DNA of the nonbacteriocinogenic variants was isolated, resolved by agarose gel electrophoresis, and treated with a radioactive Tn5-containing plasmid. Hybridization occurred with a 96 megadalton plasmid of E. herbicola indicating that Tn5 had disrupted genes on that plasmid which function in bacteriocin production.

EFFECT OF THE DEPTH OF SCLEROTIA OF SCLEROTINIA MINOR ON THE INCIDENCE OF LETTUCE DROP. L. E. Garrabrant and S. A. Johnston Cook College, Rutgers University, New Brunswick, NJ 08903

A difference in incidence of lettuce drop, caused by Sclerotinia minor, was observed in the greenhouse when sclerotia were placed at depths of 0, 8 or 16 cm in observation boxes. Six weeks after transplanting, there was 100% mortality where sclerotia were placed on the surface of a peat-vermiculite soilless mix; whereas, no mortality occurred when sclerotia were placed at depths of 8 or 16 cm. In a spring field experiment, in microplots containing organic, loam or sandy soil, lettuce drop was significantly higher when sclerotia were placed at depths of 0, 1 or 2 cm than at depths of 4, 8 or 16 cm. Soil type had a significant effect on lettuce drop incidence, especially when inoculum was placed at 4, 8 or 16 cm. Disease incidence was greatest in organic, intermediate in loam and least in sandy soil.

THE EFFECT OF SINGLE AND COMBINATION APPLICATIONS OF BENOMYL AND CHLOROTHALONIL ON THE LEVEL OF BENOMYL RESISTANCE IN A FUNGICIDE-MODIFIED POPULATION OF SCLEROTINIA HOMOEOCARPA. P. L. Sanders, E. P. Gilbride, and H. Cole, Jr., Dept. of Plant Pathology, The Pennsylvania State University, University Park, PA 16802.

Alternating or combination fungicide regimes have been suggested for managing the level of fungicide resistance in fungal populations. This approach was ineffective over two growing seasons in reducing the resistance level in a fungicide-modified population of Sclerotinia homoeocarpa. A creeping bentgrass golf course fairway with a high level of benomyl resistant components in the extant population of S. homoeocarpa was treated on a 2-week schedule with benomyl and chlorothalonil singly, in combination, and in alternation. The S. homoeocarpa population was sampled throughout June, July, and August, 1980 and 1981. All recovered isolates were tested in vitro for sensitivity to benomyl. Of the 5,484 recovered isolates of S. homoeocarpa, all but 40 (0.7%) were resistant to benomyl in vitro (ED_{50}>1 ug/ml PDA). This high level of benomyl resistant components was stable across all treatments at all sampling times, with no differences among treatments.

THE EFFECT OF FORMULATION AND SPRAY ADDITIVES ON CONTROL OF APPLE SCAB WITH BITERTANOL. J.D. Gilpatrick, Department of Plant Pathology, New York State Agricultural Experiment Station, Geneva, NY 14456.

Bitertanol (Baycor) was applied to potted vegetative Macoun apple trees in the greenhouse at about 48 hr after inoculation with conidia of *Venturia inaequalis*. This fungicide at rates of 0.07-0.28 g/l was 2-4 times more effective in reducing the numbers of scab lesions on leaves as a 300 g/l emulsifiable concentrate (EC) than as a 50% wettable powder (WP) or a 480 g/l flowable (FL). The addition of the spreader-sticker, AL-411-F, at the rate of 1.2 ml/l of spray suspension also led to about a fourfold reduction in scab lesion numbers with the WP and FL but did not affect control with the EC. A tank mix of Glyodin 30 L (1.2 ml/l) and Baycor 50WP gave less scab control than Baycor alone. All bitertanol treatments either alone or combined with AL-411-F provided nearly complete inhibition of conidial production on lesions.

ROLE OF THE PHYTOTOXIN, CORONATINE IN BACTERIAL BLIGHT OF SOYBEANS. S.S.Gnanamanickam, A.N.Starratt and E.W.B.Ward. Research Centre, Agriculture Canada, University Sub P.O, London, Ont., Canada N6A 5B7.

Coronatine was detected in culture filtrates of 12 of 19 strains of Pseudomonas syringae pv.glycinea. Quantitation was achieved by reversed-phase HPLC. Generally, production of systemic symptoms in infected plants was correlated with the ability of strains of pv.glycinea to produce coronatine in culture. Application of 5 to 10 µg coronatine to primary leaves caused localized and systemic chlorosis and stunting, similar to symptoms in infected plants. Infected leaves were found to contain ca. 3.0 µg coronatine per g tissue(f.w).None was detected in comparable samples of healthy tissue. The results indicate that although coronatine is not essential for pathogenicity it plays a role in symptom development.

EFFECT OF HOST GENOTYPE ON ESTIMATING RELATIVE PARASITIC FITNESS OF PLANT PATHOGENIC FUNGI. L. V. Gregory, J. E. Ayers, and R. R. Nelson, Department of Plant Pathology, The Pennsylvania State University, University Park, PA 16802.

An apparent increase, in recent years, in the severity of corn leaf spot caused by Helminthosporium carbonum race 3 prompted a comparative study of potential changes in relative parasitic fitness of three Pennsylvania populations collected in 1970, 1974 and 1979. Lesion size induced by 10 isolates of each population was measured on 10 corn cultivars ranging from resistant to susceptible. The 1979 population was significantly more fit on two cultivars, less fit on one cultivar, and similar in fitness on other cultivars. The increase in fitness of the 1979 population may account for the increase in severity of corn leaf spot but this conclusion is tempered by host genotype. The result of monitoring pathogen populations for changes in relative parasitic fitness may be misleading if host genotypes influence the relative ranking of populations.

DOSAGE EFFECTS OF RESISTANCE GENES IN FIELD CORN (ZEA MAYS L.) TO HELMINTHOSPORIUM TURCICUM. L. V. Gregory, J. E. Ayers, and R. R. Nelson, Department of Plant Pathology, The Pennsylvania State University, University Park, PA 16802.

A diallel set of F_1 hybrids, constructed from four inbred lines, CI28A, CI42A and CI64, known to contain genes for resistance on 3, 5, and 6 chromosome arms, respectively, and R4 containing no known resistance genes, were evaluated by lesion size to a natural population of Helminthosporium turcicum race 2 in the field in 1981. There was no difference in lesion size among the three CI lines although each sustained significantly smaller lesions than R4. F_1 hybrids containing R4 as a parent had smaller lesions compared to R4 but larger lesions in contrast to the CI lines. F_1 hybrids involving only CI lines had smaller lesions than F_1 hybrids containing R4 but were not different from their parental CI lines. Differences among F_1 hybrids were interpreted as a dosage effect of resistance genes. If gene dosage is a general phenomenon, use of F_1 hybrids heterozygous for resistance genes may result in a lower level of resistance compared to F_1 hybrids with homozygous resistance genes.

USE OF VARIABLE CONCENTRATION SO_2 FUMIGATIONS FOR SELECTION OF BIOINDICATOR PLANTS. C. S. Greitner and J. A. Laurence, Boyce Thompson Institute, Tower Rd., Ithaca, NY 14853.

A computer-controlled system was used to cause SO_2 concentrations in chambers to rise linearly to a peak and then fall to 0 within 3 hr. Concentrations peaking at 0.5, 0.75, and 1 ppm were used, yielding total exposures of 0.75, 1.125, and 1.5 ppm x hr. respectively. Seven species were tested: Amaranthus retroflexus, Ambrosia artemisiifolia, Bromus tectorum, Centaurea cyanus, Phaseolus vulgaris, Rumex crispus, and Saponaria officinalis. Of these, A. artemisiifolia, B. tectorum, and C. cyanus, were injured after 4 or fewer exposures to peaks of 0.75 and 1 ppm. A. artemisiifolia responded to 1 exposure peaking at 0.75 ppm. This species expressed the highest % leaf area injured, B. tectorum had the next highest and C. cyanus the lowest. Variable concentration fumigations are more representative of field conditions than are constant concentration exposures and so are more valuable in selecting bioindicators.

THE RELATIVE SENSITIVITY OF FIFTY PLANT SPECIES TO CHRONIC DOSES OF HYDROGEN CHLORIDE. Douglas S. Harper and Randall D. Jones, Ontario Ministry of the Environment, 880 Bay Street, Suite 347, Toronto, Ontario Canada

The relative degrees of foliar sensitivity to hydrogen chloride were assessed on 50 plant species growing in the vicinity of an anhydrous aluminum chloride manufacturer. American elm, bur oak, eastern white pine, basswood, red ash and several bean species were observed to be most sensitive.

Foliar injury on sensitive species was usually associated with concentrations of chloride ion in whole leaves in excess of 0.2% of the dry weight. Hydrogen chloride tolerant species displayed no foliar toxicity in spite of the presence of foliar concentrations of chloride as high as 5%. Injury and foliar chloride concentrations declined with distance from the source with no effects observed beyond 300 meters.

MULTIPLE STEM CANKERS MIMIC DUTCH ELM DISEASE SYMPTOMS IN MAINE. J.G. Hoch, R.J. Campana, J.S. Coleman and C.W. Murdoch. Dept. of Botany & Plant Pathology, University of Maine, Orono, ME 04469.

Although typical of Dutch elm disease and other wilt fungi, multiple foliar symptoms are not common from canker fungi. More than 20 elms with wilting branch flags typical of Dutch elm disease, were sampled in vain to confirm the presence of Ceratocystis ulmi. Many cankers were found instead in 200 stems, ranging from 0.5-5.0 cm in diameter. Cankers ranged from 0.5-8.0 cm in width to 1.0-12.0 cm in length. Shape, pattern, and color of cankers varied, suggesting the possibility of more than one pathogen. From 200 samples of bark or wood several fungi and one bacterium were isolated, but only fungi were recovered in large numbers. The fungi appear to include known canker pathogens, such as species of Cytospora, Tuberculariа, Dothiorella and Botryodiplodia. This is believed to be the first report of massive infection by different canker fungi that mimic symptoms of Dutch elm disease.

INVESTIGATION OF THE CARBON METABOLISM OF THREE SPIROPLASMAS. H. H. Hou and T. A. Chen, Dept. of Plant Pathology, Cook College—Rutgers University, P. O. Box 231, New Brunswick, NJ 08903.

Enzymes in Embden-Meyerhof-Parnas (Aldolase and lactate dehydrogenase) and Krebs cycle (Malate dehydrogenase, aconitase and isocitrate dehydrogenase) were found in cell free extract of three spiroplasmas: corn stunt spiroplasma, honey-bee spiroplasma and flower spiroplasma. The specific activity of enzymes fluctuated during the growth of the spiroplasmas. Glucose-6-phosphate dehydrogenase and phosphogluconate dehydrogenase were not detected. Metabolic inhibitors such as sodium fluoride (10^{-2}M) inhibited the growth of tested spiroplasmas, but malonic acid (5×10^{-2}M) only showed slight growth inhibition. These results indicated that certain metabolic pathways of EMP and Krebs cycle are operative in the spiroplasmas.

SAPSTREAK DISEASE OF SUGAR MAPLE IN N.Y. SUGARBUSHES. D.R. Houston and B.S. Schneider, USDA/FS, Forest Insect and Disease Laboratory, Hamden, CT 06514 and N.Y. State Dept. of Environmental Conservation, Lowville, N.Y. 13367.

Sapstreak of sugar maple, incited by Ceratocystis coerulescens, has been reported killing forest trees in North Carolina, Michigan, and Wisconsin, and one sugarbush tree in Vt. From 1978 to 1981, C. coerulescens was isolated from a number of dying trees in two sugarbushes in northern N.Y. All affected trees were located adjacent to access roads, bore severe root or buttress wounds, and had been tapped--some not for several years. Death of affected trees has usually occurred within 2 to 3 years after first appearance of foliar symptoms. Very little sap flowed from four diseased trees tapped in 1981. C. coerulescens was isolated from drill shavings of these trees, but not from the sap. Electrical resistance of the characteristically stained xylem was markedly lower than that of clear healthy tissue.

CONTROL OF LETTUCE, ENDIVE AND ESCAROLE DAMPING-OFF CAUSED BY PYTHIUM ULTIMUM WITH FUNGICIDE DRENCHES APPLIED AFTER SEEDING. Stephen A. Johnston, Rutgers Research & Development Center, R.D. #5, Box 232, Bridgeton, N.J. 08302.

Lettuce (iceberg, bibb and leaf), endive and escarole were seeded into Pythium ultimum-infested growing media and drenched with one of the following fungicides: Banrot 40W (1 lb/2,000 sq ft), Truban 30W (1 lb/2,000 sq ft), Ridomil 2EC (0.25 pt/2,000 sq ft) and Ferbam 76W (1 lb/2,000 sq ft). Where night temperature was below 20°C for iceberg, bibb and leaf lettuce; Banrot, Truban and Ridomil provided significant control of damping-off. Considering all treatments, a greater percentage of emergence occurred for iceberg and bibb than for leaf lettuce. In a separate experiment where the night temperature did not fall below 20°C for iceberg, endive and escarole, all fungicides resulted in a significant increase in emergence compared to the control. Over the entire test, a greater percentage of emergence occurred for endive and escarole than for iceberg lettuce.

PLANT GROWTH REGULATING EFFECTS OF THE TRIAZOLE AND PYRIMIDINE-METHANOL FUNGICIDES ON POA PRATENSIS L. R. T. Kane and R. W. Smiley, Department of Plant Pathology, Cornell University, Ithaca, NY 14853.

The triazole derivative fungicides CGA 64251 and triadimefon when applied at recommended rates reduced shoot densities, root weights, and leaf extension rates of greenhouse-grown 'Merion' and 'Fylking' seedlings. However, both compounds significantly increased the total nonstructural carbohydrate content of foliage and increased the chlorophyll retention of excised leaves of treated seedlings. When the fungicides were applied to field grown sod, the responses were similar but less striking and somewhat inconsistent. The pyrimidinemethanol fungicides fenarimol and nuarimol had comparable effects on plants in the greenhouse and field. Although structurally unrelated, these triazole and pyrimidinemethanol fungicides have the same sterol inhibiting mode of action in fungi and higher plants. Their plant growth regulating activity may be an important factor in suppression of Fusarium blight of Kentucky bluegrass, which is a stress induced disease.

VARIATIONS IN GROWTH AND PATHOGENICITY OF FUNGI ASSOCIATED WITH RED THREAD DISEASE OF TURF GRASS. J.D. Kaplan and N. Jackson, Department of Plant Pathology and Entomology, University of Rhode Island, Kingston, R.I. 02881.

A recent survey revealed that several fungi may be associated with red thread disease (pink patch or Corticium disease) of turfgrasses. The fungi isolated from such diseased turf fell into two categories: those with pink mycelium bearing no clamp connections and those with pink, clamped mycelium. Isolates without clamp connections were all identified as Laetisaria fuciformis (McAlp) Burds. and this fungus appears to be the predominant incitant of typical red thread disease in Rhode Island and several other locations where the disease commonly occurs. Isolates with clamp connections comprised a heterogenous group of fungi, including Athelia fuciformis (Wakef.) Burds., as well as other basidiomycetes with pink mycelium. Physiological and pathological studies with fungi in the two categories showed consistent differences which may explain previous inconsistencies observed on the incidence of the disease and its control by cultural and chemical means.

RECOVERY OF *AGROBACTERIUM RADIOBACTER* PV. *TUMEFACIENS* (ART) FROM GRAPE SAP AND VINEYARD SOIL. B.H. Katz, and T.J. Burr, Dept. of Plant Pathology, New York State Agricultural Experiment Station, Cornell University, Geneva, NY 14456

Art was isolated from sap of grape vines in the field, and from vineyard rhizosphere and field soil. Sap was collected in the spring from galled and non-galled vines and plated on the selective media of Schroth, New and Kerr, and modified New and Kerr containing sucrose as the carbon source. Suspect colonies were inoculated to sunflower and grapevines. Art was recovered from sap of 7 of 24 galled vines and 1 of 17 non-galled vines collected from five *Vitis vinifera* varieties. Of 120 sap isolates tested, 90 were pathogenic on sunflower, 88 pathogenic on grape, 17 positive for 3-Ketolactose, and 2 inhibited by *A. radiobacter* pv. *radiobacter* (Isolate 84). Thirty root and soil samples were collected from four vineyards. Root washes and soil dilutions were plated on the selective media and 244 suspect isolates were inoculated to sunflower. Only 6 isolates (2.5%) were pathogenic on sunflower. These results indicate that Art survives in vineyard soil and may be spread systemically in apparently healthy nursery material.

SYMPTOM VARIATION AND INCIDENCE OF ELM LEAF SCORCH. Stanley J. Kostka and James L. Sherald. ESL, NCR, National Park Service, USDI, Washington, DC 20242.

Three symptom types have been observed in leaf scorch-affected American elms. Of 526 urban park elms surveyed, 192 (36%) exhibited leaf scorch symptoms. Type-1 symptoms (106 trees) were characterized by an undulating, marginal necrosis bordered by a chlorotic halo, adaxial leaf curl, and premature leaf abscission. Symptoms progressed from older to younger leaves. Type-2 symptoms (28 trees) were less severe; chlorotic zones were wider, necrotic tissue lighter in color, and leaves curled

abaxially. Type-3 symptoms (17 trees) included flower abortion and delayed leaf bud opening. Leaf wilt, extensive necrosis, and adaxial leaf curl occurred by midsummer. Branch dieback was extensive. Forty-one trees had symptoms too limited for classification. Bacteria were isolated from trees with each symptom type using vacuum extraction or cultivation on an artificial medium. All isolates were serologically related to the elm leaf scorch-associated bacterium and the Pierce's disease bacterium.

THE INTEGRATION OF PRIMARY INOCULUM AND FUNGICIDE RATE FOR MANAGEMENT OF APPLE POWDERY MILDEW. N. Lalancette, Jr. and K. D. Hickey, The Pennsylvania State University Fruit Research Lab, Biglerville, Pennsylvania 17307.

Epidemics caused by Podosphaera leucotricha on apple can be managed through reduction of initial inoculum and/or by lowering the rate of disease progress via application of fungicidal sprays. Rome Beauty apple trees having from 0 to 30 primary-infected terminals were sprayed to run-off with different concentrations of the fungicide bitertanol ranging from 0 to 150 mg a.i./liter. Five disease assessments for secondary mildew, observed as the percentage of infected leaves per vegetative terminal, were made throughout the growing season. A regression model incorporating fungicide concentration, amount of primary inoculum, and amount of secondary mildew over time was constructed, yielding an $R^2 = 88.5\%$. Additional treatments excluded from the model were not significantly different.

THE EFFECT OF HEAT AND MOISTURE ON SURVIVAL OF CYSTS OF THE GOLDEN NEMATODE, *GLOBODERA ROSTOCHIENSIS*, IN SOIL. J. A. LaMondia and B. B. Brodie, Department of Plant Pathology, Cornell University, Ithaca, NY 14853.

Encysted larvae of *G. rostochiensis* in water alone, in flooded sand or organic soil and in sand or organic soil at moisture levels of 0, 15, 25, and 35% were subjected for various time periods to temperatures of 40, 45, 50, and 55°C. Thermal death curves for encysted larvae were determined by visual observation of esophageal vacuolization and disruption and hatching of treated larvae. Encysted larvae in water alone did not survive 45°C-2 hr, 50°C-5 min, and 55°C-0 min. Survival time in soil was slightly increased, with a positive correlation between moisture and mortality. Encysted larvae at the zero moisture level were not affected at 55°C for 47 hr. Survival in sand or organic soil was not significantly different. Presoaking cysts decreased the time and temperature required for kill. All larvae in a cyst appear to be similarly affected, suggesting that the moisture level within the cyst may be an important factor influencing survival.

EFFECTS OF VARIABLE CONCENTRATION SO_2 EXPOSURES ON COMMON BLIGHT OF RED KIDNEY BEAN. J. A. Laurence and K. L. Reynolds, Boyce Thompson Institute, Ithaca, NY 14853.

Red kidney beans (Phaseolus vulgaris cv. 'California Lite Red Kidney' and 'Red Kloud') were inoculated with 10^9 CFU ml^{-1} and exposed on all possible combinations of 4 days to either 0.75 ppm·hr or 1.5 ppm·hr SO_2. Exposures lasted 3 hours, with the concentration of SO_2 increasing to either 0.5 or 1.0 ppm and then declining to 0 at the end of the exposure. Measurements of lesions were made daily and results were analyzed by analysis of variance, with partitioning of the treatment variance to allow examination of the effects of total dose as well as order within a given dose. Significant linear effects of total dose were found at both concentrations for decreased initial lesion size and increased latent period, but final lesion size was affected only at the higher dose. Generally, the cultivars responded similarly, except that the latent period of Xanthomonas phaseoli was affected by SO_2 in California Lite Red Kidney, but not in Red Kloud.

GENETICS OF SEX IN FUSARIUM LATERITIUM. Ellen B. Lawrence, Department of Plant Pathology, The Pennsylvania State University, University Park, PA 16802.

Isolates of Fusarium lateritium (Gibberella lat. ium) collected from different plants and locations around the world were crossed on a variety of media to produce the Gibberella stage. Though not all isolates proved fertile, those that crossed were heterothallic hermaphrodites which exhibited bipolar incompatibility. Data from back crosses indicates that the two compatibility groups are allelomorphs which are in no way linked to colony morphology. Isolates proved to be interfertile whether from the same location and host or from different locations and hosts. Perithecia formed most abundantly on carrot agar at 22°C under mixed cool white fluorescent and black lights on a 12-hr alternating light/dark schedule.

IN SITU DETERMINATION OF PHENOLOXIDASE ACTIVITY IN SOYBEAN HYPOCOTYLS AT SITES INOCULATED WITH PHYTOPHTHORA MEGASPERMA F. SP GLYCINEA. G. Lazarovits and E.W.B. Ward. Agriculture Canada, Research Centre, University Sub P.O., London, Ontario, N6A 5B7.

The phenoloxidase activity of six-day-old etiolated soybean hypocotyl tissue was determined at sites inoculated with drops of zoospore suspension of Phytophthora megasperma f. sp. glycinea. After varying incubation periods the inoculum drops were replaced with L-Dopa solution and the formation of dopaquinone was measured spectrophotometrically (λ485 nm). Phenoloxidase activity was detected within 2-3 hours after inoculation, but only at incompatibly reacting sites. However, phenoloxidase activity was obtained from compatibly reacting sites when they were reinoculated with an incompatible race. Injury caused by cutting or freezing also resulted in activity. Phenoloxidase activity appears to be a consequence of cell damage induced by an incompatible race.

UTILIZATION OF THE ELISA TECHNIQUE FOR THE DIAGNOSIS OF TWO FUNGAL DISEASES: SCLERODERRIS CANKER OF CONIFERS AND DOWNY MILDEW OF SUNFLOWER. A.L. Liese, A.R. Gotlieb, Botany Dept., Univ. of VT, Burlington, VT 05405, and W.E. Sakston, Dept. of Plant Science, Macdonald campus of McGill Univ., Ste. Anne de Bellevue, P.Q., H9X 1C0 Canada.

The ELISA technique has been used primarily for the detection of viral plant pathogens. It is a valuable tool because of its applicability to plant breeding, quarantines and any situation where rapid diagnosis is needed. ELISA was successful in the detection of Gremmeniella abietina antigen in pine twigs displaying Scleroderris canker symptoms. ELISA diagnostic efficiency was 85% as compared to 10% for traditional isolation. Downy mildew of sunflower is a major quarantine problem due to a latent period before symptoms develop. ELISA was successful in the detection of Plasmopara halstedii, an obligate parasite, in sunflower leaves displaying symptoms without sporulation. Early detection of this seed-borne disease could greatly benefit quarantine agencies.

QUALITY OF TOMATOES HARVESTED FROM PLANTS RECEIVING CHRONIC EXPOSURE TO SULFUR DIOXIDE. R. J. Lotstein, D. D. Davis and E. J. Pell, Department of Plant Pathology and Center for Air Environment Studies, The Pennsylvania State University, University Park, PA 16802.

Tomato plants (Lycopersicum esculentum, cv 'Merit') were grown from seed to maturity in controlled environment chambers. Plants were exposed to either charcoal filtered air or 290 μgm^{-3} SO_2 for 72 continuous hours per week during weeks 1-5, 6-10, or 1-10 beginning 2 weeks after emergence. Following the final exposure, 5 fruit were harvested from each plant as they reached the 'red ripe' stage; ascorbic acid, percent sucrose and total solids were determined for each fruit. Fruit and foliar samples also were analyzed for percent sulfur and total yield per plant was determined. Exposure to SO_2 resulted in a significant increase in foliar sulfur content and a significant decrease in fruit ascorbic acid, expressed on a dry weight basis. Foliar sulfur content was significantly inversely related to the fruit ascorbic acid on a fresh weight basis.

COMPARATIVE SAMPLING OF GREMMENIELLA ABIETINA CONIDIA. C. J. Luley and P. D. Manion, SUNY College of Environmental Science and Forestry, Syracuse, NY 13210

Two methods of sampling airborne conidia of G. abietina were compared in two Scleroderris canker infected Pinus resinosa stands and an adjacent hardwood stand. Vaseline coated slides (VS) and monofilament line (ML) spore traps were exposed at various heights up to 11 m in the canopies, collected weekly, and observed microscopically. The ML trap collected fog, rain and conidia on 8 m of 290 µm line strung over a 27 cm^2 area. Water samples were centrifuged to concentrate the spores for counting. Both types of traps demonstrated uniformly low conidia levels at all heights in the hardwood stand. Spore density in the P. resinosa stands did not vary significantly with height or between stands when monitored by the VS. However, significant differences in the spore density at various heights and between stands were detected using ML traps. The ML spore trap is a more effective means of sampling spores dispersed in rain or fog. Spore densities appear to be affected by air movement patterns associated with each stand.

AN APPROACH TO INTEGRATE CONTROL MEASURES FOR USE IN APPLE SCAB MANAGEMENT PROGRAMS. *W. E. MacHardy and M. J. Jeger. Dept. of Botany and Plant Pathology, Univ. New Hampshire, Durham, 03824, and Plant Pathology Dept., East Malling Research Station, East Malling, England ME19 6BJ.*

All recently-developed Apple Scab Management Programs are designed to increase the efficiency of fungicide applications. However, there is still an almost total reliance upon fungicides for disease control. Resistant cultivars and sanitary measures which reduce the severity of scab epidemics are usually ignored, mainly because their influence on lesions development has not been expressed in quantitative terms. A summary model has been developed that identifies the components contributing to scab development and relates them mathematically so that each component's contribution can be expressed quantitatively. The influence of each control measure on lesion density is then related to a quantitative reduction in the number of lesions expected from an infection period. The reduced lesion estimate can then be related to an economic threshold to adjust the rate and timing of fungicide applications.

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FOURTH INFECTION PERIOD IN NAEMACYCLUS NEEDLECAST OF SCOTS PINE W. Merrill, Penn State University, University Park, PA 16802

We earlier reported three infection periods in Naemacyclus minor needlecast of Scots pine. However, in 1979 and 1980, 15 to 35% of the total infection could not be attributed to these periods. Infection occurred from early Sept to early Oct, thus occurring between infection periods 1 (July to mid Aug) and 2 (Nov to early Dec). Field studies suggested that the inoculum originated from third year needles that did not develop symptoms the autumn of the second growing season, and bear fruit bodies then or in spring prior to the third growing season. Instead, the infected needles remained symptomless until early to mid summer of the third growing season, bore fruit bodies in late summer and early fall, and were cast in early to mid fall after the third growing season. This finding gives significance to our previous report of high levels of infection in second year needles at the onset of their third growing season.

CONTROL OF THE SHORT-NEEDLE DISEASE OF SCOTS PINE. W. Merrill, Penn State University, University Park, PA 16802

The short-needle disease of Scots pine is characterized by a stunting of one or both needles in some fascicles, whereas other needles on the same twig develop normally. The cause is unknown, but has been attributed by various workers to insects, mites, fly ash, and "acid rain". An experimental integrated fungicide-insecticide spray schedule in 1979 resulted in significant control ($P = 0.0001$). Trees receiving the first two of six sprays averaged 0.6% and unsprayed tree averaged 10.2% affected needles, respectively. In 1980 the same pesticides were applied individually to determine the effective compounds. Significant control ($P = 0.05$) was achieved with Diazinon AG500 at 1.25 ml fp/liter/acre applied at bud swell, and with Dylox 80SP at 1.5 g fp/liter/acre applied as needles emerged from the fascicle sheaths. Evidence suggests the short-needle syndrome is caused by insects probing into meristematic tissues at needle bases prior to or during needle elongation.

EFFECTS OF COMMERCIAL NURSERY PRACTICES ON ERICOID MYCORRHIZAE IN RHODODENDRON. Moore-Parkhurst, S.M. & L. Englander, Dept. of Plant Pathology-Entomology, Woodward Hall, University of Rhode Island, Kingston, RI 02881.

Surveys were made of Rhododendron spp. in commercial nurseries in Rhode Island for presence of ericoid mycorrhizae. The effect of disease suppression practices such as soil pasteurization and fungicide root drenches were assessed. Mycorrhizae were found in rhododendrons in all stages of commercial propagation. Steam pasteurization of the growth mix apparently inhibited mycorrhizal development. When all fungicide treatments were analyzed, only ethanzole-treated cuttings exhibited a level of mycorrhizae lower than the controls.

EVALUATION OF MICROFLORA POPULATIONS IN WETWOOD CAPILLARY LIQUID AND SOILS ADJACENT TO ELM STEMS. C.W. Murdoch and L.J. Potaro, N.E. Plant, Soil and Water Laboratory, USDA-ARS, Univ. of Maine, Orono, Maine 04469.

To further our understanding of the etiology of bacterial wetwood in elm, microflora populations were quantified from wetwood capillary liquid (WCL) extracted from 6 living American elm (Ulmus americana L.) trees (25-61cm dbh) and adjacent soils around stem bases. Samples were taken in June, July and September. Using the dilution plate method, populations of the following groups of microflora were determined by selective media: total fungi, bacteria, actinomycetes and gram negative bacteria; Bacillus spp.; Pseudomonas fluorescens; Trichoderma spp. and Enterobacteriaceae. Results were expressed as number of organisms/ml (WCL) or per gram dry weight soil. Population trends were highly variable among trees, and soil associated with them. In WCL, highest values were recorded for total bacteria (9.1×10^6/ml), gram negative bacteria (7.4×10^6/ml) and Bacillus spp. (1.7×10^6/ml). Results indicate a selective enrichment of certain bacterial groups within tree stems.

HOST PARTICIPATION IN TOXIN GENERATION IN VERTICILLIUM WILT OF TOMATO. Harry Mussell & Patricia Stilwell, Boyce Thompson Institute at Cornell, Ithaca, NY 14853.

Cell walls prepared from tomato (Lycopersicon esculentum 'Bonny Best'), eggplant (Solanum melongena var. esculentum '465 Classic') and cotton (Gossypium hirsutum 'M-8') contained enzymes capable of degrading the vegetative mycelium of Verticillium dahliae. These covalently bound mycelium degrading enzymes (MDE) could be solubilized from particulate wall fractions by digestion with purified Verticillium endoPG. The MDE exhibited a pH optimum of 6.5 and released carbohydrate but not protein from mycelium. Soluble breakdown products obtained by incubating mycelial powders of Verticillium with MDE were toxic to Bonny Best tomato cuttings, generating symptoms identical to those of Verticillium wilt of tomato. Toxicity of these preparations was greater if the tomato cuttings had been pretreated with endoPG. These results suggest that pathogenesis in Verticillium wilt of tomato results from a catenated sequence of events involving components from both host and pathogen.

PATHOGENICITY OF BURSAPHELENCHUS XYLOPHILUS (STEINER & BUHRER 1934) NICKLE. THE PINE WOOD NEMATODE. Ronald F. Myers, Plant Pathology Department, Rutgers University, AES, New Brunswick, New Jersey 08903.

Pine wood nematodes were inoculated into stems of 2-4-year old seedlings of Japanese red, Austrian, pitch, southwestern white, eastern white , Scots, and Japanese black pines; Colorado blue spruce; and Douglas fir. No symptoms developed in Douglas fir and pitch pine and nematodes could not be extracted from their stems. Nematodes could not be recovered from Colorado blue spruce although seedlings were killed when inoculated with 5,000 but not 500 nematodes. Nematodes increased in numbers and killed Southwestern white, Japanese red and black, Austrian, and Scotch pines. Eastern white pines were killed more rapidly than the other seedlings but appeared to be a poor host. After nematode inoculation, cortical tissues dehydrated and brown-necrotic areas developed. Necrotic tissue coalesced to girdle the stem.

A SEASONAL STUDY OF THE INFECTION OF FAGUS GRANDIFOLIA BY NECTRIA COCCINEA VAR. FAGINATA IN RELATION TO PERIDERM INJURY. **William D. Ostrofsky and Robert O. Blanchard, Dept. of Botany & Plant Pathology, University of New Hampshire, Durham, 03824.**

A study was conducted in which only the periderm of American beech (Fagus grandifolia) was removed prior to inoculation with Nectria coccinea var. faginata. Wounds were made by removing a 12 mm disc of periderm and inoculated with a 12 mm disc from a 3 week old agar culture of the pathogen. Trees

were inoculated in summer 1979, fall 1979, winter 1979-80, or spring 1980. The study was also designed to test the effect of various time intervals between wounding and inoculation (0, 2 days; 1, 2, and 4 weeks) on canker development. Observations were made in 1981, and characteristics of the necrophylactic periderm were noted. The fungus induced cankers when only the periderm was removed. Forty-four percent of the wounds inoculated in fall resulted in cankers, compared to 0, 2, and 8 percent of those inoculated in winter, spring, and summer, respectively. The longer the time interval between wounding and inoculation, the less cankering occurred.

THE EFFECT OF INTERMITTENT NITROGEN DIOXIDE EXPOSURES ON TOTAL GLYCOALKALOID CONTENT OF POTATO. J. A. Pawloski and E. J. Pell, Dept. Plant Pathology and Center for Air Environment Studies, The Pennsylvania State University, University Park, Pa. 16802.

Glycoalkaloids are basic, N-containing constituents of potato foliage and tubers which, at elevated levels, can be toxic to animals. An experiment was designed to test the hypothesis that potato plants exposed to nitrogen dioxide (NO_2) would contain higher quantities of total glycoalkaloids (tga) than would non-exposed plants. Cultivars 'Kennebec' and 'Atlantic' were grown in the greenhouse from April to August, 1981. Twice a week, 11 plants of each cv. were exposed to 0.20ppm NO_2 in a controlled-environment chamber. At harvest, tuber yield was determined and samples from each plant were lyophilized for tga and total N determinations. Foliage from individual plants was also harvested and oven-dried for similar analyses.

GUIDELINES FOR REDUCING INTERPLOT INTERFERENCE IN FIELD EXPERIMENTS WITH POLYCYCLIC DISEASES. R. E. Paysour and W. E. Fry, Department of Plant Pathology, Cornell University, Ithaca, NY 14853.

A previously described model of spore loss from small field plots is used to construct guidelines for diminishing the effects of interplot interference in epidemiological studies of polycyclic diseases. The model relies on a description of the primary disease gradient caused by the pathogen of interest and was quantified for Phytophthora infestans on potato. Model output includes relative numbers of spores transferred between experimental plots. This information is then used with estimates of maximum differences in disease severity between treatments to develop field designs that limit both negative and positive interplot interference to acceptable levels. These designs include optimal plot sizes and spacings. Field data are presented for additional verification of the model.

KABATINA JUNIPERI A CAUSAL AGENT OF JUNIPER TIP BLIGHT. R. G. PERRY and J. L. Peterson. Plant Pathology Department, Cook College, Rutgers University, New Brunswick, N.J. 08903.

Kabatina juniperi was confirmed, by wound inoculation of various juniper species and cultivars, under both greenhouse and field conditions, as an important tip blight incitant. The symptoms were similar to those reported for Phomopis juniperovora but developed under different environmental conditions, requiring low temperatures (16-21C) and relative humidities above 95%. Sunken ashen-gray cankers developed at the base of the blighted tip and rounded to ellopsoidal, erumpent, black acervuli measuring up to 1 mm in length usually developed in these areas. Hyaline conidiophores with pointed tips were packed together on a stromatic surface and hyaline, unicellular, ellipsoid conidia (2-3 x 4-8u) were produced. Twelve cultivars representing nine juniper species were artificially infected.

ISOZYME VARIATION: IDENTIFICATION OF GENOTYPIC CLASSES AND CONFIRMATION OF CROSSES BETWEEN LINES OF AGARICUS BRUNNESCENS. D. J. Royse and B. May. Department of Plant Pathology, The Pennsylvania State University, University Park, PA 16801 and Cornell Laboratory for Ecological and Evolutionary Genetics, Cornell University, Ithaca, NY 14853.

Thirty-four commercial and 162 research-maintained lines of Agaricus brunnescens deposited in The Pennsylvania State University Mushroom Culture Collection were examined electrophoretically for isozyme variation. Based on the variability at five structural gene loci (Gpt, Adh, Mpi, Pep-LLL-1, and Pep-LLL-2) they were partitioned into 28 genotypic classes. The allelic variability observed in mycelial extracts of these lines potentially allows the recognition of over 20,000 unique genotypic classes. The fact that only five genotypic classes were actually observed among commercial lines examined is evidence that the common mushroom is a near monoculture. Intraspecific crosses between putative homokaryotic lines of A. brunnescens were confirmed by the presence of heteromeric isozymes. Many of these newly developed lines fell into unique genotypic classes.

STABILITY OF BENOMYL SENSITIVE ISOLATES INTRODUCED INTO A BENOMYL RESISTANT POPULATION OF SCLEROTINIA HOMOEOCARPA. P. L. Sanders, E. P. Gilbride, and E. D. King, Dept. of Plant Pathology, The Pennsylvania State University, University Park 16802.

In fungicide-modified populations of fungal pathogens, high levels of resistant components have persisted for long periods in the absence of fungicide selection pressure. In spring 1981, four benomyl-sensitive isolates of S. homoeocarpa were inoculated individually across a creeping bentgrass fairway containing a persistent high level of benomyl resistant components in the S. homoeocarpa population. The population in these strips and in an uninoculated strip was sampled in June, July, and August, 1981. Recovered S. homoeocarpa isolates were tested in vitro for sensitivity to benomyl. The average proportion of sensitive isolates recovered from the inoculated strips were 30%, 84%, 87%, and 89%, and from the uninoculated strip, only 1%. These high proportions of sensitive components remained relatively stable over the three months of the study. Reintroduction of sensitive isolates may offer promise as a method for overcoming the stability of high resistance levels in fungicide-modified pathogen populations.

A CODIT VIEW OF DUTCH ELM DISEASE. Alex L. Shigo, USDA Forest Service, Northeastern Forest Experiment Station, Durham, NH 03824-0640.

CODIT, a model for Compartmentalization Of Decay In Trees, was used as the basis for studies on over 40 mature American elms infected with *Ceratocystis ulmi* in the vicinity of Durham, New Hampshire, over a 3-year-period. Emphasis was on barrier zones, energy reserves, and factors affecting cambial death. Freshly cut disks from felled trees and increment cores from standing trees, both healthy and infected, were saturated with I-KI. There was no starch in dying trees. Where there was no barrier zone, the ray cells nearest the cambium were killed, and separated from the cambium. Bark peeled easily from such areas in summer, while bark did not peel easily from healthy areas. There was no dark discoloration in the ray cells that were separated from the cambium. The observations suggest that elms die when the cambium is killed. The cambium is killed when no barrier zones form. No barrier zones form when energy reserves are depleted.

A CODIT VIEW OF TREE CANKERS. Alex L. Shigo, USDA Forest Service, Northeastern Forest Experiment Station, Durham, NH 03824-0640.

A CODIT view of cankers and other stem and root diseases, is that a tree survives after injury and infection as long as it has the time, energy, and genetic capacity to recognize and compartmentalize rapidly and effectively, injured and infected tissue, and to generate enough new tissues to maintain the tree. CODIT, a model for Compartmentalization Of Decay In Trees, was used as the basis of studies on several tree cankers: *Hypoxylon mammatum* on *Populus tremuloides*, *Strumella coryneoidea* on *Quercus alba* and *Q. rubra*, and *Endothia parasitica* on *Castanea dentata*. The fungi infected bark first and then wood. The trees had three major lines of defense; bark periderms, xylem extensions into the bark, and compartmentalization in the wood. Xylem rays extended into the bark and formed wood barriers in front of the infected bark. Some *C. dentata* trees produced strong wood barriers in the bark and they lived for several years after the infection.

CUMULATIVE EFFECTS OF WOUNDING ON THE COMPARTMENTALIZATION RESPONSE OF MAPLE. Walter C. Shortle and Alex L. Shigo, USDA Forest Service, N.E. For. Expt. Stn., Durham, NH 03824-0640.

The compartmentalization response occurring in boundary tissue separating decaying, infected wood from sound sapwood in red maple (*Acer rubrum* L.) varied with proximity to older columns of discolored and decayed wood, and with loss of phloem. Trees were wounded by drilling into the stem at an angle so that ray tissues along the outer margin of columns initiated by the angled wound were connected to living phloem. Tissue samples taken for chemical analysis and for isolations along the inner and outer margins were of equal age. Maximum color intensity

and phenol content and lowest relative occurrence of decay fungi and their "pioneers" occurred at the outer bounds. Removal or death of phloem caused a loss or reduction in the response. Color intensity and phenol content at the inner bounds decreased with mean distance from the central decay column. Relative occurrence of all fungi was higher at inner bounds than outer and that of decay fungi increased with decreasing phenol content.

THE USE OF EASILY MONITORED WEATHER VARIABLES TO ESTIMATE RESIDUE LEVELS OF CAPTAN ON APPLE FOLIAGE. *F. D. Smith & W. E. MacHardy, Dept. Botany & Plant Pathology, Univ. New Hampshire, Durham, 03824.*

Captan residue levels were monitored on apple foliage in a research orchard throughout the 1980 and 1981 growing seasons. Spectrophotometric analysis was used to analyze extracts taken (i) immediately before fungicide application, (ii) immediately after application, (iii) prior to rainfall, and (iv) following rainfall. Captan residues were also assessed on apple seedlings which had been precision-sprayed in the laboratory and then subjected to measured amounts of simulated rain. Captan retention was negatively correlated with time after spraying, amount of rain, duration of leaf wetness, and duration of rain. Protectant fungicides are normally applied in apple orchards at prescribed intervals, with little regard for weather conditions which prevail between applications. Findings indicate that guidelines for scheduling and selecting the rate of captan application utilizing the monitored weather variables could be established for use in apple disease management programs.

CADMIUM SENSITIVITY RELATED TO ABILITY OF SOYBEAN PLANT TO UTILIZE IRON EFFICIENTLY. Gretchen Smith and Eileen Brennan. Department Plant Pathology, Cook College, PO Box 231 New Brunswick, N.J. 08903.

The comparative response of 'Hawkeye' (HA) and PI-56419-5-1 (PI) soybean (Glycine max (L.) Merr.) genotypes to cadmium treatment was examined. HA (iron -efficient) and PI (iron-inefficient) seedlings were grown for three weeks in sand culture amended with 0, 0.05 or 0.30 ppm Cd as $CdCl_2$ in the nutrient solution. Symptoms of cadmium toxicity resembling iron chlorosis appeared first and were more severe on the iron inefficient (PI) than on the efficient (HA) plants. Foliar concentrations of cadmium were similar in both genotypes. However, cadium effectively reduced the iron content of PI shoots and caused a significant increase in the iron concentration of the HA leaf tissue. These results support the hypothesis that the response of HA and PI soybeans to cadmium is dependent, directly or indirectly, on their relative ability to utilize iron efficiently.

INFLUENCE OF POTATO CANOPY STRUCTURE ON DEVELOPMENT OF LATE BLIGHT. V. J. Spadafora and W. E. Fry, Dept. Plant Pathology, 334 Plant Science Bldg., Cornell Univ., Ithaca, NY 14853-0331.

Because the effects of potato canopy structure on potato late blight development are not precisely known, we quantified these influences in field experiments. Two disease susceptible cultivars, Hudson (tall plants) and Monona (short plants), were planted at two in-row spacings (15 and 30 cm), to produce canopies of different structure and density. Close spacing relative to wide spacing enhanced disease severity slightly. These differences were equivalent to weekly applications of about .17-.25 kg chlorothalonil/ha--about one-fourth the recommended dosage. We conclude that fungicide efficiency can be increased by adjusting application rates and/or schedules to compensate for the influence of diverse canopies.

SENSITIVITY OF PHYTOPHTHORA MEGASPERMA AND OTHER PHYTOPHTHORA SPECIES TO METALAXYL. J. P. Stack and R. L. Millar, Dept. Plant Pathology, Cornell Univ., Ithaca, NY 14853-0331.

A study of survival of P. megasperma f. sp. medicaginis was hampered by lack of a marker by which to distinguish propagules added to soil from propagules of this pathogen and of other Phytophthora spp. naturally present in soil. Therefore an alfalfa isolate (Pm20) was selected for insensitivity to metalaxyl and then compared with 26 isolates of P. megasperma (from CA, MN, NY, WI) and single isolates of P. cryptogea, P. drechsleri, P. cactorum, and P. cinnamomi which had no prior exposure to this compound. Radial growth of Pm20 on cornmeal agar containing up to 100 ppm metalaxyl was unaffected during 7 days. The other isolates fell into two groups based on their relative sensitivity to 20 ppm metalaxyl; P. megasperma pathogenic to alfalfa (11 isolates) and the four other Phytophthora spp. were inhibited 98% (range: 90-100) whereas P. megasperma from apple or cherry (15 isolates) was inhibited only 55% (range: 35-70).

DIFFERENTIAL EFFECTS OF SEVERAL FUNGICIDES ON FRUIT ROTTING FUNGI OF CRANBERRY. A. W. Stretch, USDA, ARS, Blueberry and Cranberry Research Center, JNAES, Rutgers University, Chatsworth, New Jersey 08019.

Captafol, ferbam, mancozeb, chlorothalonil and certain tank-mix combinations of these fungicides were evaluated for their effect on specific cranberry (Vaccinium macrocarpon) fruit rotting fungi under field conditions. The fungicides were applied during bloom and post-bloom at maximum recommended rates for a total of 3 applications at 2805 L/ha per application. Decayed fruit were plated on PDA or V-8 agar to isolate and identify causal fungi. Mancozeb and chlorothalonil were more effective against Physalospora vaccinii than captafol. Captafol was more effective against Sporonema oxycocci than the other fungicides tested. A tank-mix of captafol/mancozeb at 1/2 maximum approved rate for each was equal in fruit rot control to mancozeb alone at full rate, and significantly better than captafol alone. This combination takes advantage of the two most effective fungicides on two important rot causing fungi and, in addition, reduces fungicide cost.

TOBACCO MOSAIC VIRUS IS CONFINED TO THOSE FEW INITIALLY INFECTED CELLS RESULTING FROM MECHANICAL INOCULATION OF COWPEA LEAVES. Michael A. Sulzinski and Milton Zaitlin, Department of Plant Pathology, Cornell University, Ithaca, NY 14853.

Only small amounts of tobacco mosaic virus (TMV) are produced in some mechanically inoculated plant species, a phenomenon studied by Cheo (*Phytopathology 60*:41-46), termed subliminal infection. To interpret this phenomenon in cowpea, *Vigna sinensis* cv. Black, primary leaves were inoculated with TMV (common strain), and at various times post-inoculation (p.i.) mesophyll protoplasts were isolated, incubated for 36 hr, and stained with a TMV-specific fluorescent labelled antibody. Only $\sim$ 1 in 50,000 protoplasts contained TMV antigen; this ratio was unchanged in protoplasts isolated immediately p.i. and in those prepared 24 hr p.i. This result suggests that cowpea leaves support TMV replication in cells which receive virus during mechanical inoculation but that TMV is unable to move from those original centers in this host. This work was supported in part by grants PCM 78-03255 (NSF) and 7800119 (USDA, Competitive Grants Office).

APPLIED USAGE OF VANGARD VAPOR IN THE CONTROL OF POWDERY MILDEW OF MANY HOSTS. Michael Szkolnik, Department of Plant Pathology, New York State Agricultural Experiment Station, Geneva, NY 14456

Highly unusual and effective control of powdery mildew of apple (*Podosphaera leucotricha*) and cucurbits (*Sphaerotheca fuliginea*) was obtained for over 3 months in a greenhouse at temperatures of 21 to 28°C by vapors from a cheesecloth curtain impregnated once with Vangard (etaconazole, Ciba-Geigy CGA 64251). Initially, the 6 M^2 cheesecloth in a 112 M^3 room was treated with 385 mg/M^3. In subsequent trials in greenhouse rooms of the same size, the 3.43 mg (a.i.) Vangard impregnated into cheesecloth of 3, 1.5, and 0.75 M^2 resulted in full protection against powdery mildew for 3 months and longer. Equal success with vapor action was obtained with Vangard at room rates noted above impregnated into braided cotton rope or with the fungicide sprayed onto polypropylene shading screen in the greenhouse in a series of 10 cm bands 2 M apart. Vapor from equivalent rates of Vangard also controlled powdery mildew on bean and peas (*Erysiphe polygoni*), grape (*Uncinula necator*), rose (*Sphaerotheca pannosa*), broad leaf plantain (*E. cichoracearum*) and papaya (*Oidium caricae*).

NATURE AND EXTENT OF LOSSES IN FRESH REPACKED TOMATOES. W.H. Tietjen and M.J. Ceponis, USDA-New Jersey AES Research Center, P.O. Box 231, New Brunswick, NJ 08903.

Terminal packinghouse losses in fresh tomatoes were studied in New York and Philadelphia metropolitan areas from February 1980 to June 1981. Periodic visits were made to cooperating packinghouses which collectively ripen and repack ca. 15,000 MT of tomatoes yearly. Cull samples from known volumes of tomatoes were collected to identify the nature of loss. Total loss at the terminal packinghouses was 10.1%. Parasitic diseases accounted for 90% of the culls and physical injuries and non-parasitic disorders caused the remainder. Florida fruit had a 7.6% loss due to parasitic disease, mainly from bacterial soft

rot, sour rot (Geotrichum candidum), and alternaria rot. California tomatoes had a 13.7% parasitic disease loss with gray mold rot the leading cause of loss (8.5%). Tomatoes from eastern states had the highest parasitic disease loss (16.5%). Sour rot, bacterial soft rot, and alternaria rot were the leading causes of loss in these fruits.

HISTOLOGICAL STUDY OF GRAFT UNION NECROSIS IN APPLE ASSOCIATED WITH TMRSV INFECTION. M. A. Tuttle and A. R. Gotlieb, Dept. of Botany, University of Vermont, Burlington, VT.

When 'Delicious' scions are grafted on MM106 rootstocks infected with tomato ringspot virus (TmRSV) a necrosis develops at the graft union after several years of compatible growth. Pegs of darkly-colored tissue develop as masses of undifferentiated, rapidly dividing cells which replace the cambium. A generating layer of cells extends around the periphery of this mass in the phloem and seems to be connected to the cambium on either side of the peg. An abrupt sharp increase in number of ray and axial parenchyma cells and a consequent reduction in number of vessels and fibers at the union and extending 2 to 4 millimeters into the scion is the first pathological response observed. The normal proportion of cell types is never re-established. Our research demonstrates that the virus-plant interaction is not one of hypersensitivity, but rather begins after the plant has switched from vegetative to reproductive phase with a loss in ability of cambium to differentiate normally.

EFFECTS OF SEED TREATMENTS ON GERMINATION, FUSARIUM COLONIZATION, AND DISEASE INCIDENCE IN FUSARIUM-TOLERANT AND SUSCEPTIBLE ASPARAGUS SEEDLINGS. Paul D. Vineis, and William J. Manning, Dept. of Plant Pathology, University of Massachusetts, Amherst, MA 01003.

Seed of asparagus (Asparagus officinalis L.) cultivars Mary Washington (MW) (Fusarium-susceptible) and UC 157 (UC) (tolerant) were treated as follows: no treatment (NT), 10% Clorox (CL) (10 min), CL, then thiram dust (CL + T), 24-hr. benomyl in acetone (BA) soak, and BA followed by CL. Some seed were immediately plated on selective media. The rest were planted in soil naturally-infested with fusaria. Seed treatments did not affect germination rates, but UC seed germinated sooner and seedlings grew faster. All treatments reduced fungi on seeds, but only CL + T reduced fungi on seedlings in soil. Fusarium moniliforme and F. oxysporum predominated on seedling roots. All treatments reduced fresh wts. for 10-week-old seedlings. CL + T alone reduced stem rot in UC, caused by F. moniliforme.

EFFECT OF A SINGLE APPLICATION OF TRIADIMEFON ON THE INCREASE OF ERYSIPHE GRAMINIS F. SP. TRITICI AND RESULTING YIELD OF WHEAT. G. R. Watson, J. A. Frank, M. A. Risius, Dept. of Plant Pathology and Agronomy, Center for Cereals Research, the Pennsylvania State University, University Park, PA 16802.

The effect of triadimefon (Bayleton 50WP, 70 g/ha) applied at growth stage 9 (LARGE) over five cultivars of wheat was evaluated for control of Erysiphe graminis f. sp. tritici (powdery mildew) and subsequent yield. Triadimefon decreased the apparent infection rate (r) of E. graminis over four of the five cultivars with the largest decrease occurring on the cultivar Hart (r = .062 nonspray, r = .000 spray). Thousand kernel weights (TKW) for the sprayed and nonsprayed treatments reflected this decrease in r value. Two cultivars had significantly higher TKW for the sprayed treatment compared with the nonsprayed treatment. For four of the five cultivars, mildew severity and r were decreased with a triadimefon application at growth stage 9 with the magnitude of decrease dependent on the resistance of the respective cultivars.

RESPONSE OF WINTER BARLEY CULTIVARS TO SEED TREATMENT-FOLIAR SPRAY COMBINATIONS. G. R. Watson, H. Cole, Jr., and J.A. Frank, Dept. of Plant Pathology and USDA-ARS, Center for Cereals Research, The Pennsylvania State University, University Park, PA 16802.

Seed treatments were tested in conjunction with a fall and/or spring foliar application(s) of triadimefon on winter barley cultivars. The seed treatments included a combination of three fungicides (triadimenol, iprodione, and metalaxyl), a mercury treatment (Ceresan M), and an untreated check. Disease and yield assessment showed that the combination seed treatment with a fall spray or fall and spring sprays were equal to or better than the same spray schedule combined with the mercury seed treatment. For the cultivar Maury, the thousand kernel weights of the combination and mercury treatments with the addition of the fall spray were significantly different (34.25 and 32.75, respectively). The field weights across all tested cultivars were significantly different for all spray combinations. The fall triadimefon application had more influence on yield and final disease severity than the seed treatments.

CELLULAR FATTY ACID COMPOSITION OF FIVE PLANT RICKETTSIA-LIKE BACTERIA. J.M. Wells, B.C. Raju, and S. Kostka, USDA-New Jersey AES Postharvest Research Center, P.O. Box 231, New Brunswick, NJ 08903; Dept. of Plant Pathology, Univ. of California, Davis, CA 95616; and National Park Service, Washington, DC 20242

The cellular fatty acid composition of 5 rickettsia-like bacteria isolated from plants and grown on BCYE agar were determined as part of a chemotaxonomic study. The bacteria, morphologically alike and serologically related, included the causal organism of plum leaf scorch, the bacterium associated with phony peach disease, with Pierce's disease of grape, with elm leaf scorch, and a bacterium isolated from ragweed. The most abundant acids in all bacteria were the saturated 16 and 17 carbon chains and an unsaturated 16 carbon (16:1). An unknown acid (equivalent chain length = 18.45) was present and abundant only in the phony peach bacterium and its one distinct strain. The proportion of hydroxy-substituted acids in all bacteria ranged from 1 to 4% of total acids. Iso and anteiso branched saturated chains composed 7 to 16% of total acids.

EFFECT OF INJECTION SITE ON INJURY SUSTAINED FROM CHEMICAL INJECTIONS IN OAK AND MAPLE. Susan G. Wisniewski and Robert O. Blanchard, Dept. of Botany & Plant Pathology, University of New Hampshire, Durham, NH 03824.

Chemical injections into urban trees has been increasing over the years as has the need for improved injection methods. This study was undertaken to determine which of four injection sites sustained the least amount of injury after chemical injection. Forty-eight trees each of red oak and sugar maple, from 20-26cm DBH, were injected with the systemic chemical, Arbotect 20-S. Injection sites were located on either the trunk, roots, or valleys or hills of root flares. Half of the trees received a second injection 12 months after the first injection. Trees were harvested 7 days, 4, 12, and 15 months after injection. The areas of discoloration and decay, isolated fungi, and anatomical changes at each injection site were compared. Chemical injections in the trunk and in hills of large root flares caused the least amount of damage to the tree. This is perhaps fortunate since these sites are the most accessible to the Arborist and offer a larger area for repeated injections.

INCREASE IN FREQUENCY OF THE AGGRESSIVE STRAIN OF CERATOCYSTIS ULMI IN NEW ENGLAND. K.R. Young and D.R. Houston, USDA/FS Northeastern For. Exp. Sta., Hamden, CT 06514

In a previous study (1977) fresh isolates of Ceratocystis ulmi (Buis) Moreau were grown on 2% Oxoid malt extract agar and typed as either aggressive (AG) or nonaggressive (NAG) strains. Comparisons with isolates collected 10 yrs. before indicated a shift in strain population toward AG--with this strain now dominant except in central Vt. and Me. In 1980, a systematic sample of diseased trees in Vt. (160) and Millinocket, Me. (25) revealed that AG continued to increase in relative frequency in areas dominated previously by NAG. Thus, from 1977 to 1980, relative frequencies of AG changed in Vt. from 51 to 77% overall, and from 28 to 56% in the mid-state region; and in Millinocket, Me., from 15 to 25%. A new area in northcentral Vt. was found to contain a high NAG population (89%). In Ct., 5 samples verified the continued dominance there of the aggressive strain.

OBSERVATIONS ON A MICROCONIDIOSPORE STAGE ASSOCIATED WITH GREMMENIELLA ABIETINA. S.J. Zajchowski and D.R. Bergdahl, Dept. of Forestry, Univ. of Vermont, Burlington, Vt 05405.

Microconidiospores were produced in 54 of 55 cultures producing pycnidia, representing North American, European, and intermediate serotypes of Gremmeniella abietina. All cultures were stored in the dark at about 3°C on 1.5% malt agar for up to 3 years. SEM revealed that microconidia were formed on simple or branched conidiophores as were macroconidia. Both micro and macroconidia were produced in pycnidia and occasionally observed on conidiophores originating directly from vegetative

mycelium. Microconidia were also formed on conidiophores originating directly from germinating macrospores. The microconidiospore stage rarely germinates and its biological function remains unknown. The microconidiospore stage appears to be an imperfect spore stage of G. abietina.

DETECTION OF DOUBLE-STRANDED RIBONUCLEIC ACID (dsRNA) BY THE ENZYME-LINKED IMMUNOSORBENT ASSAY (ELISA). D.H. Zanzinger, S.M. Tavantzis, Department of Botany and Plant Pathology, University of Maine, Orono, ME 04469.

The ELISA procedure has been successfully employed for the detection of synthetic double-stranded polyribonucleotides such as polyinosinic:polycytidylic [p(I:C)] or polyadenylic:polyuridylic [p(A:U)] acid. The test involves use of γ-globulins (1-5 μg/ml) from anti-p(I:C), suspension of dsRNA in 1xSSC buffer (0.15 M NaCl, 0.015 M Na citrate, pH 7.2), and incubation of the enzyme labeled anti-p(I:C) globulin solution at 20°C for 4-5 hours. This system is characterized by specificity for dsRNA and absence of non-specific reactions; p(I:C) is detectable at concentrations as low as 1-10 ng/ml. Absorbance values obtained with p(A:U) are lower than those obtained with corresponding concentrations of p(I:C) when substrate incubation periods are of the same length. Preliminary results show that this ELISA system can be used for the detection of potato spindle tuber viroid, the replicative form(s) of tobacco mosaic virus, and fungal virus nucleic acid in dsRNA-enriched fractions.

OCCURRENCE AND VARIETAL SUSCEPTIBILITY TO MAIZE WHITE LINE MOSAIC VIRUS IN NEW YORK. T.A. Zitter, C.W. Boothroyd, and M.E. Lyons. Department of Plant Pathology, Cornell University, Ithaca, NY 14853

Infection of sweet and dent corn hybrids with maize white line mosaic virus (MWLMV) was followed in plots located at Ithaca and 8 hybrid evaluation sites around NY State. MWLMV-infected plants were found in Ithaca on June 25, one month after seeding. Within field movement of the disease appeared to be minimal over the 3 yr period of observation. Among 10 sweet corn varieties tested in replicated trials, Silver Queen was the most susceptible (17%). MWLM was also found at 4 of 8 sites where early maturity dent corn hybrids were evaluated. As many as 4 reps in two of the counties had MWLM and in one (Cattaraugus Co.) infection reached 37%. In a total of 12 reps in the four counties with MWLM, 15 commercial hybrids had no infection, indicating that sources of resistance are likely available. Lack of MWLM in half of the sites suggests that the virus was not seedborne in the 1981 seed lots. The high incidence of MWLM in Cattaraugus and Ithaca plots planted to corn for 3 yr suggests the need for rotation because of the soil-borne nature of MWLMV.

POSSIBLE HYPERPARASITISM OF VENTURIA INAEQUALIS PERITHECIA BY CLADOSPORIUM SPP. AND HYALODENDRON SPP. M.G. Zuck, F. Hyland, and F.L. Caruso. Dept. of Botany & Plant Pathology, Univ. of Maine, Orono, ME 04469.

Cladosporium spp. and Hyalodendron spp. were observed sporulating directly on V. inaequalis perithecia, suggesting a hyperparasitic relationship. In a survey of apple leaf litter collected in Maine, New Hampshire, and Vermont both Cladosporium and Hyalodendron were seen sporulating as above in all samples. Sections of leaf litter were examined histologically after embedding in 2% agar or 5% gelatin, fixing in Craf III, dehydration in TBA, and final embedding in paraffin. An apparent lack of normal contents was observed in those perithecia with clear signs of colonization by Cladosporium or Hyalodendron. Preliminary observations suggest that V. inaequalis may be limited to some extent in nature by Cladosporium or Hyalodendron, which may act as hyperparasites during the overwintering phase of the pathogen's life cycle.