

ABSTRACTS OF PAPERS

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ABSTRACTS

CONTROL OF MOLD CONTAMINATION OF STORED CORN BY PHYSICAL AND CHEMICAL MEANS. A. A. Al-Heeti, A. H. El-Behadli, and K. M. Al-Adil, Plant Protection Department, College of Agriculture, Baghdad, Iraq.

In this study some physical and chemical methods to control corn-deteriorating fungi in storage were evaluated. The results indicated that ventilation of stored corn was very effective in prevention of fungi growth as a result of lowering the moisture content of the grains. Further, it was found that ventilated corn contained very low amounts (if any) of aflatoxin and zearalenone compared to nonventilated stored corn. On the other hand, chemical treatments with Luprisol and Tecto were also found to be effective in controlling fungi and their mycotoxins.

INCIDENCE OF MYCOTOXIN IN STORED CORN IN IRAQ. A. A. Al-Heeti, A. H. El-Behadli, K. M. Al-Adil, Plant Protection Department, College of Agriculture, Baghdad, Iraq.

Different samples of corn grains were collected from various locations in Iraq. Each sample was subjected to different analyses including grains discoloration, identification of molds and detection of their mycotoxins by chemical, physical, and biological methods. The results revealed that discoloration was associated with mold contamination. Deteriorating fungi were *Aspergillus niger*, *A. flavus*, *A. fumigatus*, *A. terreus*, *Penicillium* spp., *Fusarium moniliforme*, *Mucor* sp., *Rhizopus* spp., *Phoma* sp., and *Alternaria* spp. Seventy-nine percent of *A. flavus* isolates were able to produce aflatoxin B₁. However, the naturally contaminated stores were 45% with amounts ranging between 107 and 700 ppb. On the other hand, 30% of *F. moniliforme* isolates were capable of producing zearalenone with a percentage of contamination reaching to about 27.2%. Biological test indicated that extracts of corn invaded with *A. flavus* and some other fungi exert toxic effects on chicken embryos. In contrast, zearalenone contaminated samples showed no effects on these embryos.

MYCOPLASMA-LIKE ORGANISMS PRESENT IN STRAWBERRY PLANTS EXHIBITING WITCHES' BROOM SYMPTOMS. M. C. Alosi and A. H. Gold, Department of Plant Pathology, University of California, Berkeley, CA. 94720.

Field-collected strawberry plants exhibiting typical witches' broom symptoms were maintained in root fog culture. Twenty-five ppm tetracycline added to the culture media caused some symptom regression as indicated by runner production. Plants in chambers without tetracycline did not produce runners. Electron microscopy of diseased tissue revealed mycoplasma-like organisms (MLO) in the phloem. MLO were most abundant in roots; success in finding MLO in aerial portions of diseased plants were limited to samples taken from green, crinkled "islands" in leaves. The MLO exhibited much variation in morphological form: spherical, polymorphic, elongate, and beaded forms were seen. Budding of small elementary particles from spherical forms was found to occur and a rare, encapsulated form of elementary particle was seen. A concurrent study of healthy strawberry maintained in fog culture revealed no MLO.

EFFECTS OF CYCLOATE AND BIALLATE ON INFECTION OF SUGARBEET SEEDLINGS. Jack Altman, Botany and Plant Pathology, Colorado State University, Ft. Collins, CO 80523.

Cycloate (S-ethyl N-ethylthiocyclohexane carbamate) resulted in a 60% inhibition of growth of sugarbeet seedling roots and hypocotyl tissue at 2.5 µg/g to 15 µg/g after 14 days. Infection of seedlings by *Rhizoctonia solani* in agar plates amended with cycloate was more rapid than in non-amended plates. Increasing

Cycloate levels increased disease. Photosynthesis rates in cotyledons were inhibited (5-fold) by 2.5 and 5 µg/g Cycloate. Ten micron thick sections of 2.5 and 5 µg/g Cycloate treated plants showed a higher level of starch and an increased number of large leucoplasts. Assimilates accumulated in thickened, Cycloate treated leaves and were not translocated. With Diallate (S-2,3 dichlorallyl diisopropylthio carbamate) photosynthesis did not seem to be inhibited and histological examination showed less starch and a lower level of reducing sugars compared to Cycloate treated cell tissue. CO₂ fixation increased and chlorophyll content increased 30%. In the sugar-beet Diallate system a more rapid recovery from stress, growth inhibition and photosynthesis reduction occurred and in the Diallate-Rhizoctonia media less hypocotyl invasion occurred compared to Cycloate treated plants. Since other researchers have reported a reduced disease level when a Diallate Fusarium pathogen system was compared with inoculated controls, a continued evaluation of Cycloate and Diallate is warranted to help explain why Cycloate results in increased disease and Diallate reduces disease in a host pathogen interaction.

EFFECTS OF HYPOBARIC STORAGE ON QUALITY AND DISEASE INCIDENCE OF PAPAYA FRUITS. A. M. Alvarez, Department of Plant Pathology, University of Hawaii, Honolulu, HI 96822/USA.

Exposure of papaya fruits to subatmospheric pressure (20 mm Hg) for 15-19 days during shipment inhibited ripening and disease development. Fruits ripened normally after removal from low pressure containers (LPC), but abnormal softening occurred in ca. 10% of fruits. In winter shipments 76% of unwaxed LP-shipped fruits and 63% of NAP-shipped fruits were marketable. In summer shipments 72% of LP-shipped fruits and 15% of NAP-shipped fruits of one packer were marketable; all fruits of a second packer were soft or diseased. Fruit weight loss was greater in LPC than under normal atmospheric pressure (NAP). Three days after removal from LPC, fruits had 63% less peduncle rot, 55% less stem-end rot, and 45% less anthracnose than those kept at NAP. Fungicides applied with diluted carnuba wax reduced disease incidence; peduncle infection was reduced 36% by benomyl-wax and 38% by thiabendazole (TBZ)-wax applications; stem-end rot was reduced by 37% and 40%, respectively; anthracnose was less than 5% for all fungicide-treated and control fruits.

BACTERIAL AGGLUTININS FROM BEAN TISSUES. Anne J. Anderson and Claudia Jasalavich, Department of Botany and Plant Pathology, Oregon State University, Corvallis, OR 97331.

Water extracts from bean leaves contain a macromolecular fraction that agglutinates *Pseudomonas putida* cells. Purification of the agglutinin involved precipitation first by 75% ethanol and then 75% ammonium sulfate followed by passage without adsorption through DEAE and CM Sephadex resins. The agglutinin in these purified extracts was excluded from Sepharose 6B. SDS electrophoresis of these preparations showed three major bands of protein which co-stained for carbohydrate. As galactose and arabinose were detected as the major neutral sugars in these preparations, the agglutinin's structure appears to be similar to the plant glycoprotein complexes that have 8-lectin activity. The bacterial agglutinin has been isolated from leaves, stems, and roots of three bean cultivars and from suspension-cultured Red Kidney bean cells. Each bean preparation caused agglutination of *P. putida* and *P. fluorescens* cells but not of cells of several pathogenic pseudomonads.

ENVIRONMENTAL LAW AS A COMPONENT OF THE PEST MANAGEMENT CURRICULUM. J. H. Andrews and T. J. Dawson, Dept. of Plant Pathology, Univ. of Wisconsin-Madison, Madison, WI 53706, and Dept. of Justice, State Capitol, Madison, WI 53702

A course in environmental law has been developed as part of

the graduate pest management program at the University of Wisconsin to familiarize students with legal affairs and environmental issues. This course is unique in that it has been developed jointly by a plant pathologist and a lawyer specifically for biologists and agriculturalists. The 2-credit course comprises 32 hours of instruction presented over a period of 16 weeks in a lecture-discussion format. It is taught without prerequisites and at night to encourage enrollment of interested person from the community. Topics in chronological order are: an introduction to the legal system and environmental law; federal and state regulations; public policy and legal implications of pest control; the environmental impact assessment process; and role of the expert witness. Case histories and legal protocol are emphasized. This course provides a good overview of environmental issues associated with agricultural pest control and we recommend that similar offerings be developed elsewhere.

CONTROL OF THE RENIFORM NEMATODE ON PINEAPPLE IN HAWAII WITH PHENAMIPHOS. Walter J. Apt, Dept. of Plant Pathology, University of Hawaii, Honolulu, Hawaii. 96822

Phenamiphos successfully controlled reniform nematode (*Rotylenchulus reniformis*) on pineapple by: 1) application of a granular formulation to soil, 2) a vegetative seed piece dip, 3) foliar sprays and 4) application through a drip irrigation system. Granular applications of 11.2 Kg/ha a.i. were marginal, however, 22.4 to 44.8 Kg/ha significantly increased plant growth and fruit yields in plant crop and ratoon crop. Seed pieces dipped in phenamiphos at 600 to 2400 ppm reduced infection 85 to 99% up to 120 days after planting. Dip treatment demonstrated absorption and downward translocation of the nematicide. Foliar sprays from 2 to 5 Kg/ha a.i. applied at 1 to 3 month intervals reduced reniform populations with subsequent plant response and increased fruit yields. Increases were significantly greater in the ratoon crop than in the plant crop. Application of phenamiphos through a biwall drip irrigation tube with emitters 30.5 cm apart give significant nematode control with resultant positive plant response.

PATHOGENS CAUSING ALTERNARIA BLACK SPOT DISEASE OF BRASSICA SEED CROPS IN WESTERN WASHINGTON. M. Babadoost and R. L. Gabrielson, Western Washington Research and Extension Center, Puyallup, WA 98371.

Alternaria spp. are believed to cause serious losses of seed yield and reduction of germination in cabbage and Brussels sprouts. Field surveys revealed that seed plants of Brussels sprouts were severely affected, cabbage and cauliflower plants were moderately affected, Chinese cabbage and mustard were slightly affected while kale, rutabaga and turnip were not affected. *Alternaria alternata* group, *A. brassicae*, *A. brassicicola*, *Stemphyllium vesicarium*, *S. globuliferum* and *Ulocladium* sp. were commonly isolated from dark lesions on seed plants. Only *A. brassicae* and *A. brassicicola* were pathogenic following inoculation. *A. brassicicola* was more virulent than *A. brassicae* on seed plants following inoculation. Of 85 fields surveyed *A. brassicicola* was found in 67 fields, and *A. brassicae* was found in 6 fields.

DISEASE LOSS RELATIONSHIPS IN SOYBEAN CULTIVARS. P.A. Backman and J.C. Williams, Depts. of Botany & Microbiology and Research Data Analysis, Auburn University, Auburn, AL 36830.

Tests were conducted on 4 cultivars of soybeans, each treated with one of several fungicides to achieve different severities of foliar pathogens. Each cultivar x pesticide was replicated 4 times at each of 2 locations, and was rated before harvest on a 1-5 log scale for severity of each disease present. Yields from each plot were related to disease severity using linear regression. Losses averaging 150 kg., 112 kg. and 52 kg. per unit of severity for anthracnose (*Colletotrichum dematium* f. *truncata*), brown spot (*Septoria glycines*), and frogeye leafspot (*Cercospora sojae*) respectively were determined based on an average projected yield of 2960 kg/ha. Pod and stem blight (*Diaporthe phaseolorum* var. *sojae*) did not respond to fungicides, apparently because infections occurred after pod fill. Multiple linear regressions revealed that anthracnose and brown spot were nearly equal in damage potential, while the effect of frogeye was even less than that predicted by single regression. Quadratic regressions more accurately represented the data than did the linear. These data also revealed that for frogeye and brown spot, there were major differences in tolerance of cultivars to similar levels of disease.

DEVELOPMENT OF *ARCEUTHOBIUM PUSILLUM* ON INOCULATED BLACK SPRUCE. Fred A. Baker, Jr., George Hudler, and D. W. French, Department of Plant Pathology, University of Minnesota, St.

Paul, Minnesota 55108. Present address of second author: Department of Plant Pathology, Cornell University, Ithaca, New York 14850.

The development of dwarf mistletoe plants was monitored on black spruce branches inoculated in 1971. Of the 1120 seeds placed on branches that remained alive, 73 are estimated to have germinated. As of 1978, 52 infections have developed, suggesting that 71% of seeds which germinated successfully colonized host tissue and initiated symptoms. The symptoms observed included bark discoloration, twig swelling, loss of apical dominance, and broom formation. Aerial shoots first appeared in 1975 on 13% of the infected branches. These shoots produced flowers (and fruits on female aerial shoots) in 1976. In 1977, 23% flowered, 25% in 1978, and 17% will flower in 1979. An additional 21% have symptoms, but have not produced shoots. These results indicate that *A. pusillum* requires a minimum of five years to complete its life cycle.

DETECTION OF OAT BLUE DWARF VIRUS IN PLANTS AND IN THE ASTER LEAFHOPPER USING ENZYME-LINKED IMMUNOSORBENT ASSAY. E. E. Banttari, Dept. of Plant Pathology, University of Minnesota, 304 Stakman Hall, St. Paul, MN 55108.

The oat blue dwarf virus (OBDV) was detected in sap extracts from symptomless or mildly to severely affected barley, flax and oat plants using enzyme-linked immunosorbent assay (EIA). Alkaline phosphatase enzyme was used with disodium p-nitrophenyl phosphate substrate. In comparing EIA with latex flocculation (LF) serological assays or with leafhopper transmission (LT) assays for detection of OBVD in plants, there was 96% agreement between EIA and LT and 91% agreement between EIA and LF. The virus was detected in individual aster leafhoppers using EIA. Leafhoppers that were caged continuously on OBVD infected oat plants, transferred individually to seedling oat plants for 1 week were then assayed by EIA. There was 92% agreement between those leafhoppers assayed positive for the virus using EIA and those plants that developed symptoms following one week of transmission access feeding.

AN OUTBREAK OF SOFT ROT IN COMMERCIAL TOMATO FRUIT CAUSED BY A COMPLEX OF PECTOLYTIC BACTERIA. Jerry A. Bartz, Dept. of Plant Pathology, Univ. of Florida, Gainesville, FL 32611.

Bacterial soft rot, the most important post-harvest disease of Florida-grown tomatoes, is usually caused by *Erwinia carotovora* var. *carotovora* (Ecc). The isolation of at least three different pectolytic bacteria from lesions in fruit rejected at the receiving point, however, leads to the conclusion that naturally occurring bacterial soft rot in tomatoes can involve a complex of bacteria. A box of fruit from that shipment was examined within 2 days of its rejection. Sixty percent of the fruit were diseased. The lesions were slightly sunken, water-soaked, and ranged from light to dark in color. Many lesions fluoresced in ultraviolet light. Pectolytic bacteria were isolated from 86% of 50 randomly sampled lesions. The isolates were identified as Ecc (66%), *Pseudomonas marginalis* (17%), and *Ps. aeruginosa* (17%). Pathogenicity of the bacterial isolates to green and red fruit was confirmed by Koch's postulates. This is the first report of fluorescent pseudomonas being involved with an outbreak of bacterial soft rot in commercial tomatoes.

ROOTLET MORTALITY: AN INITIAL INDICATION OF DECLINE IN URBAN SUGAR MAPLES. S. R. Bassett and J. E. Kuntz, Dept. of Plant Pathology, Univ. of Wisconsin-Madison, Madison, WI 53706

A decline disease incites dieback and eventual mortality of urban maple tree populations in southern and eastern Wisconsin. In three cities, 57% of 966 sugar maples surveyed in 1977 and 1978 showed varying degrees of decline. Other maple species also were affected, but to a lesser degree. Survey data were used to develop Maple Crown-Vigor Classes (I=apparently healthy to V=severe dieback). These classes, in turn, served as disease indexes to rate disease severity in individual trees. Crown vigor was inversely related to rootlet mortality in declining sugar maples. Rootlets sampled from five trees of each vigor class yielded average rootlet mortalities of: Class I, 21.7; II, 29.6; III, 49.7; IV, 67.3; and V, 79%. High rootlet mortalities in apparently healthy trees may constitute an initial indication of decline in the species. Large ranges of rootlet mortality within a given crown-vigor class and the overlap between crown-vigor classes help explain the variation in the rates and patterns of decline among different trees. Other initial disease indicators include a deficiency of mycorrhizae, an unusual internal wood discoloration, and loose bark of the root collar.

PURIFICATION AND SEROLOGY OF A MOROCCAN ISOLATE OF WATERMELON MOSAIC VIRUS (WMV). R. H. Baum, D. E. Purcifull and E. Hiebert

An antiserum was prepared to a Moroccan isolate (WMV-M) of WMV to test the serological relationship of this isolate to other WMV strains. WMV-M was purified by a procedure used for WMV-1 (D. E. Purcifull and E. Hiebert. *Phytopath.* 1979, 69:112-116), except that CsSO₄ was used for equilibrium density gradient centrifugation. In SDS double diffusion tests, the antiserum collected 10 to 45 days after injection reacted either with sap from WMV-M infected pumpkin or with purified WMV-M (50 µg/ml), but not with healthy pumpkin sap. In reciprocal tests no reactions were detected with a Florida isolate of WMV-1, a Florida isolate of WMV-2, or a Jordanian isolate of WMV. Papaya ringspot virus, which is serologically related to WMV-1, did not react with WMV-M antiserum. No reaction was detected in reciprocal tests with WMV-M versus blackeye cowpea mosaic, soybean mosaic, or bean common mosaic viruses, all of which are serologically related to WMV-2. The results indicate that WMV-1, WMV-2 and WMV-M are serologically distinct.

PROCHLORAZ - A NEW FOLIAR FUNGICIDE WITH POTENTIAL IN A WIDE RANGE OF CROPS. R. J. Birchmore, The Boots Co., Ltd. Nottingham, U.K. and J. C. Meneley, Boots Hercules Agrochemicals Co., Wilmington, DE 19899. Abstract - Prochloraz (1-(N-propyl-N-(2-(2,4,6-trichlorophenoxy)ethyl)carbamoyl)imidazole) is a new broad spectrum fungicide discovered by The Boots Company Ltd. showing potential against a wide range of crops. It is particularly active against pathogens from the Ascomycetes and Fungi Imperfecti families. In Western Europe, outstanding activity has been achieved against most foliar pathogens of small grains. In other parts of the world, particularly the USA, primary activity has been noted in the control of scab and mildew in pome fruits, prevention of fungal spoilage in stored fruit and vegetables, prevention and eradication of turf diseases, control of rice diseases and protection of soybeans from pod and stem blights. Field results around the world over the past two to three years have confirmed the high level of activity in this diverse range of crops. In all cases activity (both protectant and eradicator) has compared well or bettered that of the standard commercial chemicals.

INOCULUM DISPERSAL OF THE PINE PITCH CANKER FUNGUS, FUSARIUM MONILIFORME var. SUBGLUTINANS. G. M. Blakeslee, R. D. Dorset and S. W. Oak. School of Forest Resources and Conservation, University of Florida, Gainesville, FL 32611

Airborne dispersal of inoculum of *Fusarium moniliforme* var. *subglutinans* (FMS) was studied at weekly intervals during a 12 month period (June 77-June 78) in replicated plots located in two pitch canker-infected slash pine plantations (11- and 20-year-old), in a natural slash pine stand with low disease incidence, and in an area that was recently clearcut during salvage harvesting of a diseased 21-year-old plantation. Sheltered spore traps were located in the mid-crown position in the stands and at 1.5 m in the clearcut area. Qualitative (identity, pathogenicity) and quantitative determinations of airborne inoculum were made from colonies of FMS developing on a *Fusarium*-selective media used as the trapping surface during the 6 hr exposure period. Viable airborne inoculum of FMS was trapped during each sampling period in all seasons of the year. FMS was the principle *Fusarium* species encountered. Mean colony counts were highest (17.9 and 17.3) in the diseased plantations, intermediate (3.1) in the natural stand and lowest (2.0) in the clearcut area. Partitioning the data according to local weather conditions (precipitation with concurrent air turbulence (PT), precipitation only (P), air turbulence only (T), or no precipitation and no substantial air turbulence (N), indicated that maximum dispersal occurred during precipitation accompanied by turbulent air, e.g. 11-year plantation: PT = 90.6, P = 10.9, T = 2.5, N = 1.7; natural stand: PT = 19.6, P = 2.9, T = .43, N = .24. Diurnal patterns of dispersal were not evident during periodic 24-hour samplings. Of the 914 FMS isolates tested, 98.3% were pathogenic to slash pines.

LOCALIZED INFECTION OF SILIQUES AND SEED OF CABBAGE SEED PLANTS BY PHOMA LINGAM. J. M. Bonman and R. L. Gabrielson. Western Washington Research and Extension Center, Washington State University, Puyallup, WA 98371 USA

The cabbage blackleg pathogen, *Phoma lingam*, has been found in cabbage seed produced in western Washington and Oregon. Leaf spots have been seen on cabbage seed plants but infected siliques have not been observed previously. This work was undertaken to ascertain whether the absence of obvious silique infections is due to systemic activity of the fungus or to other causes. In July 1978 a cabbage seed field in Oregon was observed to have a high incidence of *P. lingam* infection on overwintered leaves and seed stalk bases, but not on siliques.

Seeds from individual siliques were analyzed for the presence of *P. lingam* and isolations were attempted from the stigmatic and pedicellar ends of siliques which harbored infected seed, from the pedicels of these fruits and from supporting branches. Most silique infections were at the stigmatic end and the fungus was rarely isolated basipetally. Infection of the seed therefore took place through localized infections. All siliques which produced infected seed had internal blackening of the locular walls. Only seven percent of siliques with infected seed showed obvious external tissue discoloration and pycnidia. The difficulty in observing *P. lingam* infection on siliques is due to the lack of obvious external symptoms and signs, the low level of silique infections and the masking of *P. lingam* signs by infections caused by *Alternaria* spp., *Mycosphaerella brassicicola* and *Peronospora parasitica*.

MULBERRY MOSAIC: A VIRUS DISEASE OF MORUS ALBA IN THAILAND. W. M. Brown, Jr., T. Sutabutra, and N. Thauetchai, Muller Berry Farm, Denair, CA 95316; and Plant Pathology Department, Kasetsart University, Bangkok, Thailand.

A new disease of mulberry was observed in 1968 in Northeastern Thailand by the senior author. Leaves affected with the disease show typical mosaic and are frequently distorted and cupped downwards. Other symptoms sometimes show as ringspots, yellow blotches vein banding, or a brilliant yellow mosaic. Severely infected plants are stunted and show depression of shoot growth and leaf size. Transmission was accomplished by both inarching and T-budding. Attempts to transmit the disease by mechanical means from mulberry to mulberry or to herbaceous hosts were unsuccessful. Leaf dip preparations from diseased mulberry leaves were examined under the electron microscope and elongated particles measuring 10 nm dia and 400-500 nm in length were observed. These particles are similar to those observed by Tsuchizaki et al. (*Ann. Phytopath. Soc. Japan* 37:266-271) from mulberry ringspot infected leaves but not elucidated. This is the first report of a virus or viruslike disease on mulberry in Thailand. It is probable that this mulberry disease is different from those mulberry virus diseases reported elsewhere. Although the fig mosaic virus is suspected to be the cause, more research is needed before the agent causing the disease can be characterized conclusively.

USE OF MAUGET INJECTION TECHNIQUE FOR FIELD CONTROL OF MULBERRY DWARF DISEASE WITH OXYTETRACYCLINE. W. M. Brown, Jr., Y. J. La, Y. T. Kim, and C. L. Lim, Muller Berry Farm, Denair, CA 95316; and Seoul National University and Sericulture Research Institute, O.R.D., Suwon, Korea.

Field trials at the Sericulture Research Institute in 1975 demonstrated that field control of mulberry dwarf disease with oxytetracycline hydrochloride is feasible. Oxytetracycline hydrochloride 2,000 ppm solutions were injected into dwarf-infected mulberry plants by use of Mauget injection units. Dosage of the antibiotic was varied at 0, 10, 20, and 30 cc per plant by varying the number of Mauget units applied per plant. Remission of dwarf symptoms occurred with the higher dosage of 30 cc per plant when applied July 18 after dwarf-infected plants were cut back to the main trunk and new growth allowed to occur after injection was observed. Remission was only temporary and traces of lateral bud proliferation were observed on October 10. This is the first report of field control of mulberry dwarf with oxytetracycline.

ASSESSMENT OF YIELD LOSS IN WHEAT CULTIVARS INFECTED BY SEPTORIA TRITICI IN CALIFORNIA. K. H. Brownell and D. G. Gilchrist, Department of Plant Pathology, University of California, Davis, CA 95616, USA.

The impact of *Septoria tritici* infection on various yield components of 10 bread wheat cultivars and 13 F₅ lines derived from crosses of resistant X susceptible cultivars was evaluated under field conditions at Davis, California. Epidemic disease level, achieved through periodic inoculation with *S. tritici* spores, as one treatment was evaluated against a fungicide (chlorothalonil) protected treatment and a third treatment which received only natural inoculum. Total yields (kg/ha) and yield components including seeds/spike, 1000 seed weight, and tillers/plant were measured in each of the three treatments arranged in a randomized split-plot design. *Septoria* infection levels were assessed separately on the flag leaf, top one-half, and bottom one-half of the plants for each plot. Visual ratings, expressed on a 0-9 scale (0-80% leaf area necrotic), were taken at two growth stages (flowering and maturity). Infection levels at plant maturity varied from zero in fungicide protected plots to a maximum of >80% of the leaf area covered by lesions with pycnidia in certain susceptible entries. Seven of the bread wheat

cultivars sustained significant yield losses ($P = .05$) with entries ranging from 19 to 33% less total yield than the fungicide protected treatment. The 1000 seed weight and seeds/spike were reduced significantly ($P = .05$) in six of seven susceptible bread wheats. Predictive value of specific types of disease ratings as a function of time and portion of the plant infected in relation to yield loss will be discussed.

EFFICACY OF CIBA-GEIGY EXPERIMENTAL SYSTEMIC FUNGICIDE (CGA-48988) IN CONTROL OF ST. AUGUSTINEGRASS DOWNY MILDEW CAUSED BY SCLEROPHTHORA MACROSPORA. B.D. Bruton and R.W. Toler, Texas A&M University, College Station, TX 77843.

CGA-48988 at 14.2, 28.4, 56.7, and 85.1 g ai/92.9m², and water control with surfactant were applied as foliar sprays to downy mildew diseased Scott 1081 St. Augustinegrass. Each application rate of CGA-48988 significantly reduced % diseased leaves 28 days after treatment. Significant increases in plant height and foliage weight were observed at each fungicide rate on diseased plants; however, no differences were obtained when the chemical was applied to healthy plants. CGA-48988 at each rate inhibited sporangia production by *S. macrospora*. When healthy plants were sprayed and subsequently inoculated with a zoospore suspension, protection from infection was provided by the fungicide for a minimum of 28 days.

SUSCEPTIBILITY OF THE APPLE CULTIVAR MUTSU TO PSEUDOMONAS SYRINGAE PV. PAPULANS. T. J. Burr and B. Hurwitz, Dept. Plant Pathology, N.Y. State Agric. Expt. Sta., Cornell University, Geneva, N.Y. 14456, USA.

Fruits of the apple cv. Mutsu (*Malus pumila* Miller) were most susceptible to *Pseudomonas syringae* pv. *papulans* (Rose, 1917) comb. nov. from ca. June 20 through July 31 in 1978. Inoculations were made weekly from bloom until September 7 by spraying individual limbs bearing 5 to 10 fruits, with a water suspension containing ca. 10⁶ colony-forming-units/ml of the pathogen. Typical blister spot lesions developed on fruits within 10 days after inoculation. The susceptibility of the fruits was evaluated by counting the number of lesions at harvest time. Fruits were rated using categories of 0, 1-50, 50-100, 100-300, or over 300 lesions per fruit. Natural infections occurred infrequently in 1978, possibly because of an unusually dry summer. Blister spot was verified only on the cv. Mutsu and in one Jonagold orchard. Other cultivars including McIntosh, Idared, Delicious, Golden Delicious, and Cortland also developed the disease when inoculated in the orchard.

DIFFERENTIAL PROPERTIES OF THREE SWEET POTATO VIRUS STRAINS. B. B. Cali and J. W. Moyer, Department of Plant Pathology, North Carolina State University, Raleigh 27650.

Virus isolations from roots and leaves of *Ipomoea batatas* 'Unit I Porto Rico' were made to *Ipomoea nil* or *I. setosa*. Dilution series and serial aphid and local lesion transfers were used to separate isolates. Three strains were obtained. Two strains were differentiated by lesion development in *Chenopodium amaranticolor* and the severity of russet crack (RC) lesions on 'Jersey' sweet potato roots. Neither strain reacted with Feathery Mottle Virus (FMV) antiserum in gel diffusion tests. The third strain was FMV based on host range and FMV antiserum reactions. Virions from all three strains observed in leaf dips and partially purified preparations were similar to FMV. The TIP (60-65°C) and DEP (10⁻³-10⁻⁴) were similar for all three strains; the severe RC strain was stable in *I. nil* sap at 4°C for 10-20 days compared to a few hours for the other strains.

IS BEAN ROOT-ROT A SIMPLE INTEREST DISEASE? C. Lee Campbell and S. P. Pennypacker, Department of Plant Pathology, University Park, PA 16802.

Twenty-two snapbean (*Phaseolus vulgaris* L.) fields were sampled to determine incidence and severity of root-rot induced by *Rhizoctonia solani* and *Fusarium solani* f. sp. *phaseoli*. From these evaluations 44 disease progress curves (DPC's) were developed (22 for severity and 22 for incidence). The Weibull distribution function shape (c) parameter was estimated for each DPC; if 'c' = 1.0, a "simple interest" (SI) progression is indicated, if 'c' = 3.6, a "compound interest" (CI) progression is indicated. The 'c' values for all severity DPC's and 21 incidence DPC's were significantly greater than 1.0. The 90% confidence interval of the 'c' parameter included 3.6 for 11 severity DPC's and 6 incidence DPC's. Disease severity and incidence values were transformed as $\ln 1/(1-y)$ or $\ln y/(1-y)$ and regressed against time to form SI and CI models, respectively. Residual plot inspection and magnitude of R-squared

value were used as criteria to evaluate the adequacy of the models. Five severity DPC's were fit by the SI model, 6 by the CI model, and 11 were not described by either model. For incidence DPC's, 11 were fit by the SI model, 7 by the CI model, 3 by either the SI or CI model, and 7 were not described by either model. Thus, bean root-rot may not be classified as a strictly simple interest disease.

A NEW MULTIPLE USE FUNGICIDE: α -BUTYL- α -PHENYL-1H-IMIDAZOLE-1-PROPANENITRILE. H. E. Carley, Rohm and Haas Company, Spring House, PA 19477 USA

SISTHANE® fungicide (α -butyl- α -phenyl-1H-imidazole-1-propanenitrile) is a new experimental fungicide being developed by the Rohm and Haas Company. The compound represents a new class of systemic fungicides possessing protective and curative activity against many phytopathogenic Ascomycetes, Fungi Imperfecti, and Basidiomycetes. SISTHANE® fungicide can be used as a seed treatment (0.3-1.2 g ai/kg) for the control of seed- and soil-borne diseases incited by species of *Fusarium*, *Helminthosporium*, *Septoria*, *Tilletia*, and *Ustilago*; as a foliar treatment (30-120 g ai/100 l) for the control of as-sorted powdery mildews and rusts, apple scab (*Venturia in-aequalis*), *Helminthosporium* spp. and *Septoria* spp., and as a postharvest treatment (30-120 g ai/100 l) for the control of *Penicillium* spp.

BACTERIAL MOSAIC, A DISEASE OF WHEAT INCITED BY A MEMBER OF THE GENUS CORYNEBACTERIUM. Randall R. Carlson and Anne K. Vidaver, Department of Plant Pathology, University of Nebraska Lincoln, Lincoln, NE 68583.

A specific bacterium was isolated in 1976, 1977, and 1978 from winter wheat showing a mosaic type symptom. The bacterium is a member of the genus *Corynebacterium* and is distinct from the previously described *Corynebacterium* wheat pathogens, *C. iranicum*, *C. rathayi*, and *C. tritici*. Inoculation by vacuum infiltration reproduced field symptoms in wheat and the pathogen was easily reisolated. The bacterium is orange pigmented, grows on a medium selective for coryneform bacteria, and does not infect corn. The data show differences between this bacterium and *C. michiganense*, *C. insidiosum*, *C. nebraskense*, and *C. sepedonicum*, although it is more closely related to these than other phytopathogenic corynebacteria. Further taxonomic studies of the genus *Corynebacterium* will show whether this bacterium is a new species or a pathovar of a described species.

RED PINE STAND CHARACTERISTICS AND THEIR RELATIONSHIP TO METHODS OF EXPRESSING INTENSITY OF SCLERODERRIS CANKER INFECTION. R. P. Carvin and P. D. Manion (SUNY College of Environmental Science and Forestry, Syracuse, NY 13210)

Twelve permanent plots containing from 273 to 1444 trees, with heights of 3.66m-4.88m, were established in young red pine plantations throughout the range of *Scleroderris* canker in New York. Site index, stand density and individual tree characteristics (height, age and d.b.h.) were correlated with several methods of expressing disease intensity. Little variation was found in the average height of infection (range 0.5-0.9m). The average of the youngest infected whorl was negatively correlated with stand age ($R = -.85$, $P < .001$). A positive correlation existed between stand age and the percent of trees infected ($R = .66$, $P < .01$). Low correlations were found between the various measures of disease and site index, density and tree size. These data suggest that *Gremmeniella abietina* infections in these plantations have not progressed up the trees as would be expected from the European strain of the fungus.

POSTHARVEST DISEASE CONTROL OF STORED BLUEBERRIES BY PRECOOLING, FUNGICIDE, AND MODIFIED ATMOSPHERES. M. J. Ceponis and R. A. Cappellini. USDA and New Jersey AES Postharvest Pathology Research Center, New Brunswick, New Jersey 08903. U.S.A.

Field run Bluecrop blueberries dipped in 1000 ppm 2-amino-butane (2-AB), pre-cooled at 1.5°C and stored in modified atmospheres at 1.5°C for 4 days, developed less decay after 3 days at 21°C in air than berries receiving other experimental treatments. Blueberries were taken from the 2nd and 3rd pickings of the Bluecrop cultivar and the controls developed 20.9 and 36.0% decay, respectively. Decay was reduced 85% in pre-cooled, 2-AB-treated berries stored in modified atmospheres. The 2-AB treatment alone reduced decay an average of 64%. Decay reduction averaged more than 50% in pre-cooled berries under modified atmospheres. Atmospheres were modified in 4-mil polyethylene bags each containing 6 pints of blueberries and filled prior to storage with air, or 10, 15, 20,

or 25% CO₂ in air. During the cold storage period, little change was observed in CO₂ levels. The O₂ levels ranged from 8-14% at the end of the storage period.

A PPLO BROTH BASE-FREE MEDIUM FOR THE CULTIVATION OF SPYROPLASMA CITRI. C. J. Chang and T. A. Chen. Department of Plant Pathology, Rutgers University, New Brunswick, NJ 08903.

S. citri has been found to grow better in a medium (CC-31) in which PPLO Broth was replaced with inorganic salts (CaCl₂, KCl, KH₂PO₄, MgSO₄·7H₂O, NaCl, NaHCO₃, Na₂HPO₄, NaH₂PO₄·H₂O), glucose, 20 amino acids, vitamins (ascorbic acid, biotin, Ca pantothenate, choline chloride, folic acid, i-inositol, niacinamide, para-aminobenzoic acid, pyridoxal HCl, pyridoxine HCl, riboflavin, thiamine HCl), organic acids (α -ketoglutaric acid, fumaric acid, malic acid, succinic acid), yeastolate and other components (e.g., coenzyme A, deoxynucleotides, flavin adenine dinucleotide, etc.). Quantitative cell count shows that in 48 hrs the growth yield of S. citri in CC-31 medium is 2.3 times more than that in C-3G medium. We have also found that asparagine is able to replace yeastolate in CC-31 medium (CC-60 medium). The helicity, motility and size of S. citri growing in CC-60 medium remain the same as those growing in C-3G medium; the yield was less as compared to that in C-3G and CC-31 media.

RESPONSE OF FLORISTS' GERANIUM IN OUTPLANT SITES TO PRIOR INOCULATION WITH VESICULAR-ARBUSCULAR MYCORRHIZAL FUNGI. J. A. Chatfield, L. H. Rhodes, C. C. Powell, Jr., The Ohio State University, Columbus, Ohio 43210, U.S.A.

Spores of Glomus mosseae and G. etunicatus or a control suspension lacking mycorrhizal fungi were used to inoculate rooted cuttings of florists' geranium (Pelargonium hortorum cv. 'Sincerity'). A complete fertilizer (NPK) or fertilizer lacking phosphorus (NK) containing 38 ppm N was applied at every watering or biweekly. After 12 weeks growth in the greenhouse, geraniums were outplanted to 12 field sites. Soil samples were taken at each site and analyzed for pH, P, K, Ca, Mg, Zn, Cu, B, Mn, Fe, organic matter, and soluble salts. Blooms were counted and plants were rated for performance at two week intervals. Foliage was analyzed for concentrations of macro- and micronutrients on a monthly basis. At the end of the 14-week outplant period tops were removed, dried, and weighed and root systems were harvested and assessed for mycorrhizal infection. Inoculated plants that received NK fertilizer at every watering or biweekly, and those receiving NPK biweekly had greater dry weights, more blooms, and higher performance ratings than non-inoculated plants. There were no differences between mycorrhizal and non-mycorrhizal plants given NPK at every watering. Growth measurements and performance ratings were correlated with soil analysis data for development of a model to predict mycorrhizal response for outplanted geraniums.

TEMPORAL AND SPATIAL VARIATIONS IN THE ACCUMULATION IN TREMBLING ASPEN AND PAPER BIRCH OF CERTAIN ELEMENTS ORIGINATING FROM PARTICULATE POLLUTION. Boris I. Chevone, Frank B. Russo and Sagar V. Krupa. Department of Plant Pathology, University of Minnesota, St. Paul, MN 55108.

As part of a long term study to determine the foliar accumulation and effects on terrestrial vegetation, of particulate pollutants originating from mining, trembling aspen (Populus tremuloides) and paper birch (Betula papyrifera) were sampled four times during a growing season at 8 and 6 study plots, respectively, in the iron mining region of northeastern Minnesota. Foliage was analyzed for 13 elements (Al, B, Ca, Cu, Fe, K, Mg, Mn, Ni, Pb, Zn, P and S). The importance of sampling times and spatial variation in the distribution of sampling sites was determined relative to the variation in the concentrations of the individual accumulated elements in the foliage. Significant ($P = 0.05$) temporal and/or spatial variations occurred in the foliar concentrations of individual elements depending upon the element and the plant species in question. These results suggest that where long term studies and/or long term effects of plant-accumulated pollutants are being evaluated, the type and design of foliar sampling for the quantification of elemental concentrations are a critical factor in data acquisition and interpretation.

CITRUS BLIGHT CONTROL. J.F.L. Childs, 1206 Nottingham St., Orlando, Florida 32803.

Citrus blight, a dehydration, defoliation and dieback disease of bearing trees caused by blockage of the vessels by fibrous plugs has been known in Florida since 1874. To date, it has

not been transmitted, perpetuated or reconstituted; nor has a single instance of recovery been documented. Beginning in 1976, the author has identified citrus blight in specimens from 7 foreign countries and 2 other states. Only one cause, a nutritional deficiency seems to fit all the specifications. Experimental applications of 9 chemical elements, cobalt, chromium, nickel, palladium, selenium, silicon, titanium, tungsten, vanadium and of Chicago sludge (dried sewage) caused a temporary response only with the last item. Experimental plots comprised 132 treated trees and 132 checks, each replicated 6 times. However, a volcanic ash mineral applied at 2.0 Kg per tree induced recovery ranging from 7.5% to 45.1% in 24 months. This mineral is believed to supply one or more trace elements not previously recognized as essential for plant growth. Recognition of blight in other countries and states suggests that the nutritional deficiency is not confined to the notoriously poor soils of Florida.

GENE-FOR-GENE INTERACTION IN BEAN-BEAN RUST SYSTEM. B. J. Christ and J. V. Groth. Department of Plant Pathology, University of Minnesota, St. Paul, MN 55108.

The interaction of genes for resistance and genes for virulence was examined in beans (Phaseolus vulgaris) and bean rust (Uromyces phaseoli) var. typica, respectively. Two single-pustuled collections of bean rust gave different patterns of virulence on several bean cultivars. Collection S1-5 was avirulent on cultivar US 3 and virulent on Early Gallatin (EG), whereas collection P10-1 was virulent on US 3 and avirulent on EG. Upon selfing, S1-5 showed segregation for virulence only on US 3 and P10-1 showed segregation for virulence only on EG. When the two rust isolates were crossed, the F₁ progeny showed ratios of 1 virulent to 1 avirulent on both cultivars. The F₂ progeny indicated that virulence genes were neither allelic nor closely linked. Crossing of the two bean cultivars resulted in F₁ plants that were resistant to both rust isolates. F₂ progeny segregated in a close fit to a 9:3:3:1 ratio of doubly resistant to both isolates:P10-1 resistant:S1-5 resistant:doubly susceptible. The data support a classical gene-for-gene interaction in beans-bean rust, with two nonallelic, recessive virulence genes in the pathogen specifically recognizing nonallelic, independent and dominant genes for resistance in the host.

THE EFFECT OF CADMIUM ON FOLIAR INJURY OF WOODY AND HERBACEOUS PLANTS. Bruce Clarke, Ronald Harkov and Eileen Brennan. Department Plant Pathology, Cook College, P.O. Box 231 New Brunswick, New Jersey 08903. U.S.A.

The association of cadmium with human disorders has prompted recent studies on the entry of this metal into the food chain. The application of sewage sludge to agricultural and forest ecosystems may intensify the problem. A study was conducted utilizing tomatoes and an ozone-sensitive clone of quaking aspen to determine the effect of cadmium on plants exposed to ozone in a controlled and ambient environment. Plants were grown in sand culture and received nutrient solution amended with cadmium daily. Treatment levels ranged from 0 to 0.75 ug/ml Cd for tomatoes and 0 to 10 ug/ml Cd for trees. These plants were fumigated with 287-382 ug/m³ for 3 hrs. The addition of relatively small amounts of cadmium added to the sand substrate increased sensitivity of both species to ozone injury. If the ambient concentration of oxidant cannot be reduced, it may be especially important to decrease the quantity of cadmium entering the soil - plant environment.

STRIPED RUST ON WINTER WHEAT IN THE PACIFIC NORTHWEST: CLIMATIC CRITERIA FOR EPIDEMIC DEVELOPMENT. S. Melugin Coakley and R.F. Line. Dept. Biological Sciences, Univ. of Denver, Denver, CO 80208 and USDA Cereal Disease Research Lab., Washington State University, Pullman, WA 99164.

Since 1959, the frequent occurrences of stripe rust epidemics on winter wheat in the Pacific Northwest have coincided with the climatic variations which have characterized the 1961-1978 period. For example at Walla Walla, WA, since 1961, 15 out of 18 winters (Dec., Jan., Feb.) had temperatures above the 75-yr. mean (1901-1975) and 12 out of 18 springs (Mar., Apr., May) had temperatures below the 75-yr. mean. Both trends favored the development of stripe rust epidemics, particularly on varieties with temperature-sensitive adult-plant resistance. Quantitative data on disease severity collected at Pullman, WA for 1968-1977 were analyzed in conjunction with meteorological data for that location. Two-week running averages of maximum, minimum, and average temperatures, and total precipitation, and the sum of negative and positive degree days (using a 7°C base) were evaluated. Only temperature criteria could be used to characterize years when severe stripe rust epidemics occurred and only during these years were the three following criteria met: it took

an above average number of days from Jan. 1 (a) for the maximum temperature to reach 4.4°C, (b) for the maximum temperature to remain between 0°C and 4.4°C, and (c) for the maximum temperature to remain between 0°C and 22.2°C. In addition, these years were characterized by having fewer positive degree days between April 1 and July 1 than the years with less severe disease. The above normal occurrence of stripe rust in 1978 could have been correctly predicted from the above criteria.

SEPARATION OF PHENOL CELLS FROM WATERHYACINTHS AND THE EFFECT OF SOME PHENOLIC ACIDS ON THE GROWTH OF TWO POTENTIAL BIOCONTROL AGENTS. Yvonne S. Cody and R.D. Martyn. Dept. of Plant Sciences, Texas A&M University, College Station, TX 77843.

The waterhyacinth (*Eichhornia crassipes*) is known to have a high polyphenol content due to the presence of specialized phenol cells (phc). It is believed that these phc have a significant role in the disease resistance mechanism of this plant. Intact phc were separated from leaves and assayed for phenolic acids. Cell preparations were initially prepared by grinding fresh leaves in citrate buffer. The leaf slurry was then treated with 2% Macerace for 16 hr at 22 C and filtered through a 325 mesh sieve. The resulting phc suspension was sonicated and the phenols extracted, concentrated, and then characterized by two-dimensional paper chromatography. The two most prominent phenolic acids were chlorogenic and vanillic although others were identified. The growth of two potential biocontrol agents of waterhyacinth (*Cercospora rodmanii* and *Acronium zonatum*) was monitored on media containing standard preparations of each of the phenolic acids identified. Both fungi grew well on water agar supplemented with 10 and 100 ppm of each acid, but were inhibited at 1000 ppm.

AN EXO-POLY- α -GALACTURONOSIDASE FROM *ERWINIA CHRYSANTHEMI*: PURIFICATION, CHARACTERIZATION, AND ASPECTS OF REGULATION. A. Collmer and D. F. Bateman, Department of Plant Pathology, Cornell University, Ithaca, N.Y. 14853.

An exo-poly- α -galacturonosidase (PG) was purified from *Erwinia chrysanthemi* (strain 307) culture filtrates by ammonium sulfate fractionation, gel filtration through Sephadex G-50, preparative electrofocusing in granulated gel, and gel filtration through Ultrogel ACA 54. The purified PG was free of pectate lyase (PL) contamination, had a specific activity of 185 μ moles/min/mg protein, and constituted 11% of the original PG. The enzyme had a pI of 8.5, an apparent molecular weight of 43,000 daltons, and a pH optimum of 6.0. Paper chromatography and gel filtration of reaction mixtures through Biogel P-2 demonstrated that the PG released a single reaction product which was identified as digalacturonic acid. The use of polygalacturonic acid, chemically labeled by partial digestion with endo-PL, revealed that the substrate was attacked from the nonreducing end and that the PG was capable of releasing dimers from both saturated and unsaturated pectic polymers. PG appeared to be regulated coordinately with PL, which was inducible and subject to catabolite repression. The extracellular pectic enzyme complement of strain 307 thus consists of exo-PG and endo-PL (previously characterized). The evidence available indicates that induction of pectic enzyme synthesis in *E. chrysanthemi* is mediated by pectic enzyme reaction products. We postulate that induction in the presence of complex substrates, e. g., plant cell walls, may involve synergistic attack by constitutively synthesized endo-PL and exo-PG, the former generating free ends, and the latter efficiently releasing putative inducers.

REGULATION OF ENDOPECTATE LYASE SYNTHESIS IN *ERWINIA CHRYSANTHEMI*. A. Collmer and D. F. Bateman, Department of Plant Pathology, Cornell University, Ithaca, N. Y. 14853.

We investigated the regulation of extracellular endopectate lyase (PL) synthesis in *Erwinia chrysanthemi* (strain 307) cultures maintained in mineral media supplemented with defined carbon sources. During logarithmic growth on glycerol, polygalacturonic acid (PGA), xylose, galacturonic acid, glycerol plus PGA, and glucose plus PGA, the respective differential rates of PL synthesis, as reflected in PL activity in culture filtrates, were 0.00, 0.75, 0.00, 0.00, 0.76, and 0.02 μ moles/min/mg bacterial protein. No PL was detected in the sonicates of cultures growing on glycerol alone until the end of the logarithmic phase. These data indicate that PL synthesis is inducible and subject to catabolite repression. A factor in the medium of cultures growing on PGA, capable of diffusion through dialysis tubing, stimulated PL synthesis 2-fold in glycerol-sustained cultures simultaneously supplied with PGA. This suggested that induction of PL by PGA was mediated by a PL reaction product. This interpretation was confounded, however, by the observation that ethylenediamine tetraacetic acid (EDTA), which completely inhibits PL, had

little effect on PL induction when present in the culture medium. The possibility that induction was stimulated by oligouronide contaminants in the PGA was diminished by our failure to detect such contaminants by paper chromatographic and molecular weight distribution analyses. The above observations led to the discovery in culture filtrates of a low level of polygalacturonase (PG) activity (c. 5% of PL) detectable by a reducing group assay performed in the presence of EDTA. Preliminary data indicate that PL induction may be effected by reaction products of either PL or PG.

SPIROPLASMA GROWTH FACTORS FROM CHLOROFORM EXTRACTED HORSE SERUM. P. J. Cotty and T. A. Chen. Department of Plant Pathology, Cook College, Rutgers University, New Brunswick, NJ 08903.

A simple method for reducing possible toxic elements in spiroplasma media was developed. Horse serum was extracted with 2 volumes of chloroform. The aqueous phase was recovered and partially evaporated. Media made with this fraction promoted faster growth and slower degradation of spiroplasma; this is assumed to be due to the elimination of unfavorable growth factors. These media are "cleaner" than those made with whole serum and thus aid dark-field microscopy. This technique provides a method for the preparation of new isolation media. Prolonged exposure to chloroform does not diminish the serum's growth promoting ability. C-3G medium also retains its ability to support spiroplasma growth when extracted in this manner.

QUANTIFICATION OF VIRULENCE IN *STEMPHYLIUM BOTRYOSUM*, LEAF PATHOGEN OF ALFALFA. W. A. Cowling and D. G. Gilchrist, Department of Plant Pathology, University of California, Davis, CA 95616.

Disease severity in *Stemphylium* leafspot of alfalfa can be measured as percent leaf area necrotic (%LAN). Severity is dependent on environment, inoculum concentration, and virulence of the pathogen isolate. Virulence of *Stemphylium botryosum* in California varies greatly in the field, and within single-spore isolates transferred in culture. It is necessary to stabilize and quantify isolate virulence for disease loss studies. However, to compare isolates of high and low virulence some measure of their respective lesion areas is required. Leaves in positions 2, 3 and 4 below the first leaf to receive inoculum were the most uniform, and therefore used to evaluate lesion areas and %LAN. No significant difference in mean lesion area per leaf was detected between 11 isolates from throughout California (0.77 mm²); between seven "cultural variants" of a single-spore isolate differing greatly in virulence (0.82 mm²); or in one isolate over an 80-fold range of inoculum concentration (0.66 mm²). In five experiments over a 10-month period, mean lesion area per leaf ranged from 0.60 - 0.82 mm², whereas mean leaf area ranged from 4.82 - 7.53 cm². Lesion area is therefore a relatively stable feature of the disease. Virulence of different isolates can therefore be compared by converting lesion numbers per leaf to %LAN using a common value of %LAN per lesion. A "standard lesion" with stable mean and variance in area may be the basic unit of virulence in this pathogen, and the observed difference in virulence between isolates may reflect different efficiency of lesion production by conidia. Results indicate stabilization of virulence in one isolate after three single-spore transfers in culture.

EFFECT OF PHOSPHOROUS AND POTASSIUM FERTILIZATION ON GLUME BLOTCH OF WHEAT IN A MINIMUM TILLAGE SYSTEM. Barry M. Cunfer and J. T. Touchton, Department of Plant Pathology and Department of Agronomy, Georgia Station, Experiment, Ga., USA 30212.

Five rates of phosphorous (P) and potassium (K) in all combinations were applied with fall-planted Holley wheat. The P and K, from 0 to 6 times the recommended rate, were applied at rates sufficient for both wheat and soybeans. Soybeans were no-till planted following the wheat. Conditions were favorable for an epidemic of glume blotch. Evaluations were made for lodging, grain yield, 1000 kernel weight, head rating for glume blotch, and seed infection by *Septoria nodorum*. Seed infection was not related to any fertilization treatment or glume blotch severity but averaged 45-55% for most treatments. The lowest glume blotch head rating was 25%. Potassium did not affect glume blotch, lodging or yield components. Increasing P rates were correlated with increased lodging and glume blotch ratings on heads, lowered yield and 1000 kernel weight. The results to date indicate a need to practice caution when applying P for wheat in minimum tillage systems.

BOTRYTIS BLIGHT OF ROSES IN SULAIMANIYA, IRAQ. Ihsan Shafik Damirdagh, Dept. of Biology, College of Sciences, University of Sulaimaniya, Sulaimaniya, Iraq.

Roses (*Rosa* spp.) in Sulaimaniya were found infected by *Botrytis cinerea*. There is no previous report of this disease in Iraq. The infection starts from the outer petals, the bud fails to open, and the infection proceeds to the flower-bearing twig. Favorable weather for the disease prevails during late October, November, December, and April. White colored roses seemed more susceptible than red ones. Sclerotia are usually formed on the fallen petals. Media containing corn flour initiated sooner sclerotial formation, more sclerotia, and more sporulation than Potato Dextrose Agar. Temperature of 15 C was better for the fungal growth than 5 and 25 C. Sporogenous germination of new and old sclerotia occurred normally in culture. Effect of different media and different temperatures on the fungal growth is under study. The growth is measured by the number of spores formed and number and total weight of sclerotia formed.

ASPERGILLUS FLAVUS INVASION AND AFLATOXIN CONTAMINATION OF FRESH PISTACHIO NUTS. D. Danesh and H. Mojtabedi, Horticulture Institute, University of Isfahan, Isfahan, Iran; and M. M. Morris and L. F. Bjeldanes, Department of Nutritional Sciences, University of California, Berkeley 94720.

Earlier studies have shown that initial *A. flavus* infection and aflatoxin contamination of pistachio nuts occur in the field. The purpose of the present study was to investigate the mode of infection of the nuts by the fungus. Three batches of unsound hulled, sound hulled and dehulled fresh nuts were spray-inoculated in the laboratory with 35×10^6 spores/ml suspension of the fungus followed by incubation at 28 ± 3 C and $95 \pm 5\%$ relative humidity. Samples were collected at 12 to 24 hr intervals for aflatoxin analysis and were simultaneously prepared for observation with a scanning electron microscope. Limited fungus growth was observed on sound and dehulled nuts only after prolonged incubation. There were detectable amounts of aflatoxin after 96 and 120 hr respectively. However, on unsound hulled nuts spore germination occurred after 12 hr followed by germ tube penetration, mycelial vesiculation, strigata formation bearing immature conidia after 24, 48 and 72 hr, respectively, with detectable aflatoxin after 48 hr. It also seemed improbable that $10 \times 19 \mu\text{m}$ natural openings present on the hull would serve as the port of the fungus invasion into the nut. (Supported in part by a grant from Fulbright Program.)

SEROLOGICAL RELATIONSHIPS AND BACTERIOCIN SENSITIVITY AMONG ERWINIA CAROTOVORA SEROGROUPS. De Boer, S.H., A. Quail and C. Crowley, Agriculture Canada, Research Station, Vancouver, B.C. V6T 1X2.

Serological relationships among flagella in *Erwinia carotovora* serogroups I, III, V and XVIII, based on reaction in double diffusion, were evident in drop agglutination studies and confirmed by using fluorescent antibody staining procedures to visualize flagellar antigens. The serological relationship among cell wall antigens from strains in the same serogroups but not among strains in different serogroups could be demonstrated using passive hemagglutination inhibition tests with crude antigen extracts. Bacteriocin sensitivity of strains in specific serogroups was also investigated. Sensitivity was tested against six *E. carotovora* strains which produced bacteriocins morphologically similar to bacteriophage tails as shown by electron microscopy. All var. *atroseptica* strains (serogroup I and XVIII) and some var. *carotovora* strains (serogroup III) were sensitive to one of the bacteriocins. Serogroup I and III but not XVIII strains were also sensitive to a second bacteriocin. Serogroup V strains were sensitive to one bacteriocin different from those to which serogroup I, III, and XVIII strains were sensitive.

THE INFLUENCE OF EIGHT COMMON SPECIES OF BACTERIA ON BACTERIAL SOFT ROT OF TOMATO FRUIT. Isabel Abreu De Ceara, Instituto Superior de Agricultura, (I.S.A.) Apartado Postal 166, Santiago, Dominican Republic and Jerry A. Bartz, Dept. of Plant Pathology, University of Florida, Gainesville, FL 32611.

The development of bacterial soft rot in tomato fruit following wound-inoculation with *Erwinia carotovora* var. *carotovora* (Ecc) was affected by the presence of some bacterial species reported to occur in healthy tomato fruit. The percentage of inoculated wounds that became diseased was decreased significantly ($P=0.01$) by *E. herbicola*, *Klebsiella pneumoniae*, and *Pseudomonas aeruginosa*, but not by *Ps. fluorescens*, two isolates of *Bacillus* spp., *Escherichia coli* or *Ps. marginalis*. However, *Ps. marginalis* increased the rate of lesion expansion over that of Ecc alone,

whereas, *E. herbicola* decreased that rate. No disease developed when *E. herbicola* was mixed with Ecc at a 9:1 ratio just prior to inoculation. The development of lesions following wound-inoculation with *Ps. marginalis* was also inhibited by *E. herbicola*. *Erwinia herbicola* may have potential as a biological control agent for bacterial soft rot of tomato fruit.

RESISTANCE TO PLANT DISEASE CONTROL AGENTS - HOW TO COPE WITH IT. Charles J. Delp, E. I. du Pont de Nemours & Co., Wilmington, DE 19898, USA.

In the last 10 years an increasing number of resistance problems have been associated with the exclusive and intensive use of potent new disease control agents with specific sites of action. Resistance can be mitigated or prevented by the early use of spray programs designed to prevent the sole, long-term exposure of the pathogen to the disease control agent by applying in appropriate mixtures or rotating with at least one other control agent or limiting use to a portion of the season. Field monitoring of pathogen populations is an essential procedure for determining the extent and level of resistance. Reintroduction has been successful but requires an appropriate delay and strict observation of the preventive measures noted above. Resistance problems highlight the importance of having a variety of chemical tools for skillful use. The loss of fungicides and delays in the availability of new agents through government regulatory action complicate the necessary job of producing healthy crops.

EFFECT OF SEEDING DATES ON SEVERITY OF DAMPING-OFF AND ROOT ROT OF SUGAR BEET. M. M. Dewan, A. H. El-Beheadli, and S. A. Al-Hassan. First and third authors: Technical Agricultural Institute, Abu-Ghraib, Iraq; second author: Agriculture College, University of Baghdad, Baghdad, Iraq.

Six seeding dates with 15-day intervals, starting from mid-September to the end of November, were compared for pre- and post-emergence, damping-off, and root rot. The field was artificially infested with *Rhizoctonia solani*, *Pythium aphanidermatum*, *Phoma betae*, and a mixture of these fungi. Seed germination was very low during the first seeding date due to unfavorable temperature. *R. solani* was more infective than other fungi during the first three seeding dates but less infective during the end of November. Plots infested with *R. solani* and the mixture showed high incidence of head rot when seeded during mid-September and early October. Head rot caused by *P. aphanidermatum* was less significant in all seeding dates than that caused by other fungi. In the last four seeding dates many plants were killed by *Phoma betae* before reaching maturity. No further death was observed after March but most of the surviving plants were partially infected near the crown. Yield was affected by seeding dates in the presence of root-rotting fungi. Low crop yield was produced in the *R. solani* plots at the early three seeding dates, and in the *Phoma betae* plots at the later three dates.

TOXIGENICITY OF FUNGI ISOLATED FROM GRAIN SORGHUM. U. L. Diener, N. D. Davis, G. Morgan-Jones, and R. E. Wagener. Botany and Microbiology Dept., Auburn Univ. Agric. Exp. Sta., Auburn, Alabama 36830.

Nineteen species of fungi were isolated and identified from eight samples of freshly harvested grain sorghum and from a sample stored on-farm for 8 to 9 months in 1976. Species of *Aspergillus*, *Penicillium*, *Fusarium*, and *Curvularia* dominated the mycoflora. Extracts from cultures of eight species were bioassayed for toxicity to brine shrimp. *Epicoccum purpurascens* and *P. herquei* were highly toxic, while *C. clavata*, *C. lunata*, and *Mucor mucedo* showed low to moderate toxicity. Extracts from cultures of 14 species, grown on both shredded wheat and grain sorghum media, were bioassayed for toxicity to chick embryos. *Curvularia clavata*, *C. lunata*, and *M. mucedo* were highly toxic, while seven other species showed low to moderate toxicity. Extracts from *C. clavata*, *C. lunata*, *M. mucedo*, *F. moniliforme*, and *Alternaria tenuissima* showed varying degrees of toxicity to day-old cockerels.

DOUBLE-STRANDED RNA ASSOCIATED WITH HYPOVIRULENT STRAINS OF ENDOTHIA PARASITICA HAS AN UNUSUALLY HIGH MOLECULAR WEIGHT. J. A. Dodds, Department of Plant Pathology, The Connecticut Agricultural Experiment Station, P. O. Box 1106, New Haven, Connecticut 06504.

The double-stranded RNA (dsRNA), presumed to be of viral origin, from numerous hypovirulent strains of *Endothia parasitica* was analysed by polyacrylamide gel electrophoresis.

Several patterns of slowly migrating dsRNA components were detected in gels stained with ethidium bromide. Stained gels were soaked in RNase and either water or 0.3 M NaCl. The fluorescent bands disappeared in water but remained intact in salt, confirming that they were composed of dsRNA. Molecular weights were estimated by comparison with the mobility of dsRNAs from *Ø6* bacteriophage ($MW = 4.8, 2.9$ and 2.0×10^6 d) and *Helminthosporium maydis* Hm9 VLP ($MW = 6.3 \times 10^6$ d). The values obtained for the major dsRNA components of *E. parasitica* were between 5.0 and 7.0×10^6 d. Linear molecules with the expected lengths and width were observed when dsRNA from *E. parasitica* was prepared for electron microscopy by the Kleinschmidt technique. The values reported here correct earlier molecular weight estimates of 3.0 to 3.4×10^6 d (Phytopathology 67:1393-1396). Multicomponent dsRNA molecules of this large size have not been previously associated with a fungus.

IN VITRO TRANSLATION OF TWO POTYVIRUSES IN A RABBIT RETICULOCYTE SYSTEM. W. G. Dougherty and E. Hiebert. Dept. of Microbiology and Cell Science and Dept. of Plant Pathology, Univ. of Florida, Gainesville, FL 32611.

Pepper mottle virus (PeMV) and tobacco etch virus (TEV) RNAs (39 S component isolated from sucrose density gradients) stimulated [35 S] methionine incorporation into TCA precipitable products fifteen to eighteen times over endogenous levels in the rabbit reticulocyte lysate system. Optimal label incorporation occurred at a RNA concentration of $2 \mu\text{g}/30 \mu\text{l}$ reaction mixture, at a 0.8 - 1.0 mM magnesium level and at a 100 - 125 mM potassium level. Translation of each viral genome under identical *in vitro* conditions resulted in unique products when analyzed by gel electrophoresis. MW determinations utilizing SDS-polyacrylamide gel electrophoresis and serological studies indicate that cytoplasmic inclusions and capsid proteins are synthesized *in vitro* with PeMV RNA. TEV RNA stimulated the *in vitro* formation of nuclear inclusion and capsid proteins. This is direct evidence that the pinwheel and nuclear inclusions associated with potyviruses are products of the viral genome. Supported in part by NSF BMS 75-14014.

SURVIVAL OF VERTICILLIUM DAHLIAE IN MIDDLE REGION OF IRAQ ON COTTON. A. H. El-Behadli, S. H. Samir, J. I. Al-Marsomi, Plant Protection Department, College of Agriculture, University of Baghdad, Abu-Ghraib, Iraq.

In order to study the possibility of the disease establishment under the environmental condition of the middle region of Iraq, which is different from that in the northern region where the disease occurs, the fungus was introduced to a protected experimental field located in the College of Agriculture. This was done by incorporating 80 kg of diseased cotton plant pieces into the soil (500 m^2) four months before planting cotton cultivars Coker 100 wilt, Halab-1, Acala, and Delta pine. In the second year all the diseased plants were left in the soil and two cotton cultivars were grown, Coker 100 wilt and Halab-1. All the plants, including the infected ones, were removed (whole plant) at the end of the second year and the plot was densely seeded with Coker 100 wilt in the third year. Fungal sclerotia formed on the buried pieces of plants which became infected in the field. Symptoms of the disease on the different cultivars appeared as leaf burning, little mottled leaves, and vascular browning. Infection percentages of Delta pine, Acala, Coker 100 wilt, and Halab-1 in the 1st year were $36, 30, 19,$ and $16,$ respectively. In the second year it was 7.4 for Coker 100 wilt and 6.9 for Halab-1. Infection dropped to 1% at the end of the third year.

EVIDENCE FOR A ROLE OF HAMAMELITANNIN IN THE PATHOGENICITY OF ENDOTHIA PARASITICA. John Rush Elkins, Wesley Pate, and Skeeter Hicks, Professor of Chemistry and Students in Biology, Concord College, Athens, WV 24712.

High performance liquid chromatographic analyses of aqueous extracts from the bark of blight susceptible American and European chestnut trees have shown a peak with the same retention time as hamamelitannin, a diester of gallic acid and hamamelose (2-C-hydroxymethylribose). Aqueous extracts from the bark of blight resistant Chinese and Japanese chestnut trees did not show a chromatographic peak corresponding to hamamelitannin. *Endothia parasitica*, the chestnut blight fungus, utilized hamamelitannin from the total aqueous extracts from the bark of American chestnut and from a minimal medium amended with a purified tannin fraction as the only carbon source as evidenced by the disappearance of the hamamelitannin peak and build-up of a peak corresponding to gallic acid. *E. parasitica* was also

able to utilize methyl gallate from both a minimal medium containing no other carbon source and a minimal medium supplemented with glucose. The delayed utilization of methyl gallate in the presence of glucose would appear to indicate that the esterase produced by *E. parasitica* is either an induced enzyme or inhibited by glucose. Further evidence on the possible role of hamamelitannin in the pathogenicity of *E. parasitica* comes from the fact that a peak corresponding to it is found in the blight susceptible chinquapin, live oak, and post oak and absent from blight resistant oaks (scarlet, red, chestnut, black, white, pin) and beeches (American and European). Blight resistant witch-hazel does contain hamamelitannin, however.

INTEGRATED MANAGEMENT SYSTEM FOR COTTON PRODUCTION. Kamal M. El-Zik and V. T. Walhoo, University of California, USDA Cotton Research Station, 17053 Shafter Avenue, Shafter, CA 93263, U.S.A.

Modern cotton production requires an integration of many diverse yet interrelated scientific disciplines. Technologies to permit growing cotton in a shorter period of time hold the key to management and control of late season insect pests and disease problems especially pink bollworm, tobacco budworm, and boll diseases, e.g. aflatoxin. This can be achieved by growing cotton in rows narrower than the conventional 1 m row width as in the U.S.A. The more uniform distribution of plants in the narrow row planting arrangement minimizes the time required to achieve full canopy coverage, resulting in increased photosynthetic efficiency. Protection of cotton against diseases, especially Verticillium wilt and seedling diseases, as well as other pests including nematodes and insects, can be enhanced by integrating and fitting together cultural inputs. Management tools essential to any system include optimum irrigation scheduling and amounts, nitrogen rates, plant populations, cultivars, planting dates, and row widths. A computer cotton plant growth model has been developed and can be used to project the appearance and peak of the various fruiting parts of cotton. The model is based on degree-days accumulated from the planting date. Based on the stage of development and progress of the cotton crop, pest pressures and economic thresholds, the model can assist growers in making timely management decisions to protect their crop and achieve optimum and economical cotton production. Furthermore, efficient management will aid in the protection of the environment and preservation of our natural resources.

CONTROL OF FUSARIUM WILT OF CARNATION WITH AN INTEGRATED NITRATE-NITROGEN AND SYSTEMIC FUNGICIDE CONTROL PROGRAM. Arthur W. Engelhard, Agricultural Research and Education Center, 5007 60th Street East, Bradenton, FL 33508

Fusarium wilt, *Fusarium oxysporum* f. sp. *dianthi*, of carnation is a serious and destructive disease in several countries. Occurrence and severity of Fusarium wilt may be affected by nitrogen source and a systemic fungicide (benomyl) drenched on the soil. In two greenhouse pot experiments, using a sandy soil:peat mix (3:1) at an initial pH of 5.6 and 5.7 respectively, plants fertilized with a complete nutrient solution in which the nitrogen source was $\text{Ca}(\text{NO}_3)_2$ were less diseased than plants receiving nitrogen as NH_4NO_3 . Similarly plants growing at an initial pH of 7.7 and fertilized with $\text{Ca}(\text{NO}_3)_2$ had a lower level of wilt than plants fertilized with NH_4NO_3 . Plants growing in soil drenched two times with benomyl before the plants were inoculated had a lower level of disease, regardless of nitrogen source, than plants similarly drenched with water. The two factors, which individually reduced the wilt but did not control it were additive when combined.

ALLELOPATHIC POTENTIAL IN OAT (AVENA SPP) GERMLASM FOR BIOLOGICAL WEED CONTROL. P. K. Fay and W. B. Duke, Plant & Soil Sci. Dept., Mont. State Univ., Bozeman, MT 59717.

Three-thousand accessions from USDA World Collection of *Avena* sp. germplasm were screened for their ability to exude scopoletin (6-methoxy-7-hydroxycoumarin), a naturally occurring compound with root growth inhibiting properties. Twenty-five accessions exuded more blue-fluorescing materials than a standard oat cultivar (*Avena sativa* L. 'Garry'). Analysis of the exuded materials revealed that four accessions exuded up to three times as much scopoletin as 'Garry'. When PI 266281 was grown with wild mustard (*Brassica kaber*) for 16 days in sand culture, the growth of the wild mustard was significantly less than that obtained when the weed was grown with 'Garry'. Wild mustard plants grown in close association with PI 266281 exhibited severe chlorosis, stunting, and twisting which appeared indicative of allelopathic effects rather than simple competi-

tion. Analysis of the culture solution indicated that levels of scopoletin were too low to cause the observed effects. The toxic effects were possibly due to the exudation of scopoletin in concert with other allelopathic compounds.

EXPERIMENTS WITH A POST-EMERGENCE GRASSKILLER (NP55), RELATED TO ALLOXYDIM SODIUM, SELECTIVE ON BROADLEAVES CROPS. A. Formigoni, SIPCAM Research Center, V. le Gian Galeazzo 3, 20136 Milan (Italy), I. Iwataki, H. Ishihara, NIPPON SODA CO., New Ohtemachi Bldg., Tokyo 100 (Japan)

Several experiments with the new grasskiller NP55 (2-(N-ethoxybutyrimidoyl)-5-(2-ethylthiopropyl)-3-hydroxy-2-cyclohexen-1-one), discovered in the Laboratories of NIPPON SODA Co., are described. NP55 is a powerful grasskiller, effective in post-emergence treatments against mostly of annual grass weeds at the low rates of 0.2-0.4 kg/ha A.I. until early tillering stage, whereas against some perennial grasses are required higher dosages or split applications, in view to kill the rhizomes. The new grasskiller, with very low water solubility and formulated as E.C., is chemically related to Alloxym Sodium but is 3 to 5 times more effective. Their high selectivity allow to use the new grasskiller on several broadleaves crops and successful results are obtained in early post-emergence application on Alfalfa, Beans of different species, Cotton, Carrots, Lettuce, Onions, Peas, Rapeseed, Sugar Beets, Sunflower, Tomatoes, Melon and Water Melons. The new post-emergence grasskiller can be used either alone after a previous pre-plant or per-emergence herbicide, effective against broadleaves weeds, or it can be tank mixed with several post-emergence herbicides in view to complete the spectrum of weed control.

THE EFFECT OF CARBON:NITROGEN RATIOS ON SCLEROTIAL GERMINATION AND PATHOGENICITY OF *MACROPHOMINA PHASEOLINA*. S. Gangopadhyay and T. D. Wyllie. Dept. of Plant Pathology, 108 Waters Hall, University of Missouri-Columbia, Columbia, MO 65211.

The effect of nutrition on sclerotial germination and pathogenicity of *Macrophomina phaseolina* on soybean was determined. Sclerotia were produced at different C/N ratios in agar and their pathogenicity was determined on 12-day-old soybean seedlings, cv. Williams. Maximum pathogenicity was produced by sclerotia produced at C/N ratios of 80:3 and 30:80 although their rate of germination was significantly less than at other C/N ratios. Total sugar and protein was also less. Although damage is influenced by inoculum density, maximum damage always occurred at the C/N ratios of 80:3 or 30:80 as compared to damage from sclerotia produced at other C/N ratios. These data suggest an excessive nutrient pool i.e., high sugar and protein content results in rapid germination, abundant growth, saprophytism whereas, reduced nutrient pool results in slower germination, less growth, increased parasitism.

GENETIC TRANSFORMATION IN *PSEUDOMONAS PHASEOLICOLA*. B. V. Gantotti, S. S. Patil, and M. Mandel, Department of Plant Pathology and Department of Biochemistry & Biophysics, University of Hawaii, Honolulu, Hawaii 96822.

Genetic transformation in phytopathogenic pseudomonads has not yet been reported. As a first step towards the transfer of plasmids which are involved in toxigenicity, from toxigenic strains of *Pseudomonas phaseolicola* to non-toxicogenic strains, we attempted the transfer of two drug resistance factors by transformation. Here we report, for the first time, a successful transformation of the G50tox⁻ strain of *P. phaseolicola* with RSP1010 (str^r) and pBR322 (Tet^rCarb^r) plasmids. A modified procedure of Mandel and Higa (1970) was used to make cells competent for transformation. Calcium shocked cells of non-toxicogenic strain G50tox⁻ were exposed to plasmid DNA followed by a heat pulse. After a brief incubation period in a drug free medium the cells were challenged with the respective drugs to select the transformants. *P. phaseolicola* cells were successfully transformed by the plasmids RSP1010 and pBR322. Based on three independent determinations the frequency of transformation in the case of RSP1010 was 0.8×10^{-7} - 4.0×10^{-7} and in the case of pBR322, 4×10^{-9} .

CITRUS TRISTEZA VIRUS INDEXING BY LIGHT MICROSCOPIC OBSERVATION OF VIRAL INCLUSIONS. S. M. Garnsey, AR, SEA, USDA, Orlando, FL 32803, and R. G. Christie, Plant Virus Laboratory, IFAS, Univ. Florida, Gainesville 32611.

Characteristic inclusions were observed in young phloem tissues of citrus plants infected with citrus tristeza virus (CTV). Fresh sections 20-40-μ thick were cut freehand, or by cryostat; stained several minutes in 0.1% Azure A (in 2-methoxy ethanol); rinsed sequentially in ethanol and 2-methoxy ethyl acetate; and

mounted in Euparal. The CTV inclusions, which stained a magenta color, most commonly consisted of groups of needlelike paracrystals; however, banded and vesicular forms were also observed. They normally occurred within the phloem, but occasionally were seen in adjacent cortical tissue. Inclusions were found in feeder roots, stem bark, leaf midribs, fruit pedicel bark, and albedo. Masses of inclusions were often found near the abscission zone between petiole and leaf. They were more common in young tissue than in mature tissue. Inclusions were observed in all common CTV-susceptible citrus varieties and inclusion morphology was consistent for all isolates examined, which included mild and seedling yellows types. Similar inclusions were not observed in healthy citrus or citrus infected with psorosis, xylporosis, exocortis, tatter leaf, citrus variegation or citrus leaf rugose. This simple, rapid indexing procedure provides a direct measurement of CTV infection complementary to other indexing procedures.

IN VITRO PROTEIN SYNTHESIS DIRECTED BY TOBACCO RINGSPOT VIRUS RNA. R.C. Gergerich, J.H. Asher Jr., D.C. Ramsdell, Department of Botany & Plant Pathology, Michigan State University, East Lansing, MI 48824.

Tobacco ringspot virus (TRSV) was purified from infected cucumber seedlings and fractionated by 3 cycles of sucrose density gradients. RNA was isolated from purified virus by phenol extraction (Asher, in press), and was assessed for purity and molecular weight by electrophoresis on agarose-formaldehyde denaturing gels. The molecular weights appear to agree with published values. At least one of the RNAs appears to have a 3' poly (A) tract since it was bound by oligo (dT) cellulose. These TRSV-RNAs were jointly translated in a wheat embryo cell-free protein synthesis system in the presence of ³H-valine. The ³H-valine products were separated by SDS-polyacrylamide gel electrophoresis. With total TRSV-RNA as messenger, 7 major and at least 3 minor products were produced (molecular weights ranged from about 15,500 to 115,000 daltons). One of the major products had an estimated molecular weight similar to that of TRSV coat-protein.

CONTROL OF APPLE AND STONE FRUIT DISEASES WITH CGA 64251. J. D. Gilpatrick, N. Y. State Agric. Expt. Sta., Cornell Univ., Geneva, N.Y. 14456, USA.

A new fungicide CGA 64251 provided excellent control in the orchard of scab (*Venturia inaequalis*) and powdery mildew (*Podosphaera leucotricha*) of apple and brown rot (*Monilinia fructicola*) and leaf spot (*Coccomyces hiemalis*) of tart cherry. Nine sprays per season were applied on apple and 7 on cherry at 3.3 kl/ha, of a 25% WP formulation (GA-1-105) at 1.9 and 3.8 g AI/liter. Sprays of CGA 64251 - 10% WP at 0.25, 0.5, and 1.0 g AI/100 liters was also highly effective against blossom blight and fruit rot (*M. fructicola*). Tart cherry blossoms were protected from brown rot when inoculated in full bloom after a single spray of CGA 64251 at white or green bud. The 10% WP also reduced brown rot markedly when fruits of cherry and plum were dipped in 0.9 g AI/100 liters either 24 hr prior to or after inoculation. CGA 64251 is a highly effective broad-spectrum fungicide for fruit disease control and appears to have eradicant and local systemic properties.

ULTRASTRUCTURAL EVIDENCE FOR THE SIMILARITY OF VESSEL OCCLUSION CAUSED EITHER BY *ERWINIA AMYLOVORA* OR ITS CAPSULAR POLYSACCHARIDE. GOODMAN, R.N., J.A. WHITE, AND C.G. SUHAYDA

Transmission and scanning electron micrographs reveal analogous fibrillar-granular substances occluding xylem vessels inoculated with either virulent or avirulent *Erwinia amylovora* isolates or extracellular polysaccharides (EPS) from a virulent isolate of the pathogen. Ontogeny of the occluding substance appears to be due, at least in part, to host-cell release or synthesis. The vessel-plugging material is detectable in vessels inoculated with bacteria after 12-24 h, whereas occlusion occurs in apple shoots exposed to *E. amylovora* EPS within 4 h. A rationale for the induction of occluding substances by EPS, virulent EPS-bearing *E. amylovora*, and avirulent EPS-deficient *E. amylovora* and the role of occluding substances in causing the wilt symptom of the fireblight disease syndrome is to be discussed.

DEVELOPMENT OF A MORE EFFICIENT SEROLOGICAL TEST FOR DIFFERENTIATION OF STRAINS OF *GREMMENIELLA ABIETINA*. A.R. Gottlieb and A.L. Liese, University of Vermont, Botany Department, Burlington, VT 05405

Pathologically severe strains of *Gremmeniella abietina* infecting hard pines in Vermont and New York have been found serologically similar to European strains of the fungus. Plant quarantine needs have arisen which require fast diagnosis for the European strain. Current serological strain determination

requires antigen preparation by growth of pure cultures in liquid media, large batch homogenization, Kjeldahl nitrogen determination, antigen concentration adjustment, and reading gel double diffusion spur reaction relationships to known European and Lake States isolates. This paper reports the development of a technique which reduces average strain determination time by more than 8 weeks and increases accuracy by eliminating the necessity of spur development. Fungus test samples were produced by selecting 2 cm. diameter colonies grown on agar medium and homogenized with a Tekmar tissueizer. Antisera to European and Lake States isolates were produced and cross-absorbed with heterologous antigen until only precipitation lines to homologous antigen resulted in gel double diffusion tests. European strain diagnosis was accomplished by reading gel double diffusion tests which were composed of a single precipitation line for a positive test or no precipitation line for a negative test. Use of a solid media antigen source and cross-absorbed antiserum for serological strain determination has reduced the time and resources needed for strain determination. This technique could be used in field laboratories.

ASSOCIATION OF PPLO-TYPE PARTICLES WITH NONAGGRESSIVE AND WEAKLY TO MODERATELY VIRULENT ISOLATES OF CERATOCYSTIS ULMI.

P. Gowen and P. Manion, SUNY College of Environmental Science and Forestry, Syracuse, N.Y. 13210

Small PPLO-type particles were detected in cultures of *Ceratocystis ulmi* by phase contrast microscopy. These particles never were observed in three culturally aggressive isolates and two highly virulent isolates that produced 90 and 100% wilting of 10-year old *Ulmus americana*. However, particles were observed in two of three nonaggressive isolates, and in four weak to moderately virulent isolates that produced 0, 19, 48, and 75% wilting of *U. americana*, respectively.

MACHISMO, A NEW DISEASE OF BEANS IN COLOMBIA. G. A. Granada, ICA, Apartado Aereo 233, Palmira, Colombia.

Symptoms very similar to those previously described as "machismo" in soybeans, which is caused by a mycoplasma-like organism, have been observed on beans in the Cauca Valley, Colombia. Initial symptoms are observed at the time of flowering and pod formation. Infected plants produce wrinkled, distorted pods with no bean formation. When plants are infected at later stages of growth, satisfactory yields may be obtained. Plants may produce normal pods, but immature seed germination within the pod may occur. In advance stages of the disease, active proliferation of buds takes place and the plants take on a witches' broom appearance. The leafhopper *Scaphytopius fuliginosus* Osborn (Homoptera:Cicadellidae) is a vector of machismo. The agent was neither mechanically nor seed-transmitted, but was graft-transmitted; the average period of incubation until symptom expression was 37 days (range 31 to 43 days) which is similar to that reported for soybeans (39 days) under the same conditions.

SEASONAL AND DIURNAL VARIATION IN SENSITIVITY OF PINTO BEAN AND RADISH TO SHORT EXPOSURES OF HYDROGEN CHLORIDE GAS.

A. L. Granett and O. C. Taylor, Air Pollution Research Center, University of California, Riverside, CA 92521, USA.

Pinto bean and radish seedlings were exposed to HCl gas for 20 minutes. The exposures, averaging 12.6 or 27.4 mg HCl m⁻³, were begun each hour, from before sunrise to after sunset. Fumigations were repeated in August, November, December, February, April, and June. HCl, light intensity (LI), temperature, and relative humidity were measured once during each exposure. Visible leaf injury was recorded two days after fumigation. Percent leaf area injured correlated best (p < 0.001) with higher LI; injury increased as LI increased seasonally and daily. Greatest phytotoxic responses followed August exposures and least injury was seen in February. An average of 89% of the exposed leaves were injured on plants exposed between 8 AM and 3 PM whereas earlier or later exposures effected less injury. Results suggest that HCl-induced injury is mediated on seasonal and diurnal scales by environmental variables, the greatest of which is LI.

THE EFFECT OF RUST ON QUALITY AND YIELD OF SWEET CORN CULTIVARS. J. V. Groth, R. J. Zeyen, and D. W. Davis, Departments of Plant Pathology and Horticulture, University of Minnesota, St. Paul, MN 55108.

Thirty sweet corn (*Zea mays*) cultivars were evaluated for response to rust (*Puccinia sorghi*) infection in a replicated

split-plot field experiment at St. Paul, MN. Spreader rows of a highly susceptible cultivar were inoculated, and control plots were kept rust-free by weekly applications of dithane M-45. All cultivars became rusted, although to significantly (P = .05) different degrees. Rust reactions, and several measures of yield and quality were recorded. Overall yield reduction in rusted plots as measured in both total uncut and cut weight of corn was 18%. In rusted plots, visually determined ear quality was also reduced, which would result in total yield losses greater than 18% if commercially acceptable ear quality standards were used. Total cut weight losses of mature sweet corn, regardless of ear quality, varied from 0% for many resistant cultivars to 47% for one susceptible cultivar. Primary ear quality and yield were less affected by rust than were secondary ear quality and yield. Eight cultivars showed significant reduction in quality of primary ears but not in cut weight yield, two cultivars showed significant reduction in cut weight yield but not in primary ear quality, and one cultivar showed significant reduction in both primary ear cut weight yield and in quality.

SEED BORNE PATHOGENS CAN DEMONSTRATE SOME HOST-PATHOGEN RELATIONSHIPS IN A GENERAL PLANT PATHOLOGY COURSE. James W. Guthrie, Department of Plant and Soil Science, University of Idaho, Moscow, ID 83843.

Seed borne pathogens can be used in a general plant pathology course to illustrate some important host-pathogen relationships. Infested seed also conveniently maintains the pathogen from year to year. Demonstrations of the relationship between seed and seed-borne fungi, bacteria, and viruses can make the teaching program more meaningful and are simple to conduct. Several bacterial plant pathogens such as *Pseudomonas phaseolicola*, the incitant of halo blight of beans and *Xanthomonas campestris*, the cause of black leg of cucifers can be isolated and used for class work. Plants showing symptoms of seed-borne virus diseases such as bean common mosaic, barley stripe mosaic and pea seed-borne mosaic are easily obtained simply by rearing the infected seed. Although not all important pathogens are seed-borne, a large and varied selection are found in association with the seed.

SURFACE CONTACT AS A REQUIREMENT FOR INDUCING DISEASE RESISTANCE IN PEAS. Lee A. Hadwiger, Washington State University, Pullman, WA 99164

Macroconidia of both *Fusarium solani* f. sp. *pisi* (virulent) and *F. solani* f. sp. *phaseoli* (avirulent) induce pisatin synthesis in pea endocarp tissue. However, when a dialysis membrane or a millipore filter (0.45 μ pore size) is utilized as a barrier between host and parasite, pisatin induction is essentially prevented. When host resistance is pre-induced by the avirulent pathogen this resistance is not readily transferred through either barrier to the virulent pathogen applied to the opposite side. Filter barriers with 5 μ pores which eventually allow fungal-host contact do not interfere with normal host-parasite interactions. This suggests that resistance in the pea tissue develops as a result of, and subsequent to, contact between the germinating macroconidia and the pea cell. Highly purified cell walls of *F. solani* were visibly degraded within 24 hours following their application to endocarp tissue, suggesting that the contact of the fungus with the host tissue results in the generation of products which influence the relationship between host and parasite.

EFFECT OF HERBICIDES ON WISCONSIN BEAN ROOT ROT COMPLEX. D. J. Hagedorn, L. K. Binning, and R. E. Rand, Depts. of Plant Pathology and Horticulture, Univ. of Wisconsin-Madison, Madison, WI 53706.

Root rot of processing bean (*Phaseolus vulgaris* L.) in Wisconsin is caused by *Pythium* spp., *Fusarium solani* f. sp. *phaseoli*, and *Rhizoctonia solani*. It is the most important production problem in the prime growing area. In 1977 and 1978 we conducted studies to determine the effect of herbicides on the disease in plots located in a highly infested field. Five treatments, using the two herbicides Trifluralin and DNBP alone at two rates and in combination were compared with the untreated control. Four replications of plots, with four rows of beans planted lengthwise and 92 cm apart, were treated with Trifluralin at .6 and .8 kg active ingredient per hectare (ai/ha), DNBP at 6.7 and 10.1 kg ai/ha, and Trifluralin at .6 plus DNBP at 6.7 kg ai/ha. All treatments were preplant incorporated immediately after chemical application to a depth of 10 cm. Treatments were placed in the same location both years to determine additive effect. A disease index (D.I.) reflected disease severity; D.I. 0 = all plants (roots) healthy, 100 = all plants dead. In 1977, at harvest stage the untreated control had a D.I. of 49 and a yield in q/ha of 36.6. All three DNBP treatments suppressed disease severity signifi-

cantly, but yields were not increased. In 1978, the controls had a D.I. of 73 and yielded 9.8 q/ha; significant beneficial D.I. and yield results were obtained with DNB treatments. With DNB at 6.7 kg ai/ha, the D.I. was 48 and yield was 35.0 q/ha. These experiments indicate that certain herbicides may have a suppressive effect in Wisconsin's bean root rot disease complex.

DEVELOPMENT OF PROCESSING TYPE BEANS (*PHASEOLUS VULGARIS*) RESISTANT TO BACTERIAL BROWN SPOT (*PSEUDOMONAS SYRINGAE*).
D. J. Hagedorn and R. E. Rand, Dept. of Plant Pathology, University of Wisconsin-Madison, Madison, WI 53706.

Bacterial brown spot (*Pseudomonas syringae*) is one of the most important diseases of bean (*Phaseolus vulgaris*) in the Midwest. Our research efforts toward control have emphasized the development of disease resistance. Hybridizations were made between the highly resistant selection Wis. 133 and susceptible commercial cultivars Cascade, Slingreen and Tenderwhite. Backcrosses were to Slingreen. The F₂, F₃ and sometimes F₄ generations were studied for disease reaction in the greenhouse after artificial inoculation of young leaves with an air-gun at ca 10⁷ cells per ml. Advanced generations were tested in field plots where selection for good plant and pod characters could be made under heavy disease pressure. Excellent disease reaction data has been obtained in 1976, 1977 and 1978. In those seasons, respectively, the susceptible control developed 47,400, 56,800 and 48,750 lesions per 50 plants, while such readings for our best bean breeding lines were 50, 23 and 12. Wis. 133 showed no lesions per 50 plants in any of the trial years. The new beans have proper maturity, good bush habit and pods of good length and shape, although their color is not dark green. One of these beans has been released as elite germplasm to all bean breeders, the first processing type bacterial brown spot resistant bush bean.

DETERMINATION OF THE FEASIBILITY OF SELECTING GERANIUM CELLS FOR RESISTANCE TO A TOXIN PRODUCED BY *XANTHOMONAS PELARGONII*.
Freddie Hammerschlag, USDA, SEA, AR, Beltsville, Md. 20705

To determine whether a toxin produced in culture by *Xanthomonas pelargonii* can serve as a screening agent for selecting resistant geranium cells, it is necessary to establish whether the toxin acts at the cellular level and whether the toxin found in the culture filtrate is also found in diseased tissue. Dry weights of 1) untreated geranium callus, 2) callus treated for 3 hr with either a low molecular weight culture filtrate (LMF) from *X. pelargonii* or 3) nutrient broth, and all plated on tissue culture media for 3 wk were 42.5 mg, 2.1 mg, and 31.7 mg, respectively. Average disease ratings (0=healthy to 5=death) of geranium seedlings, 10 days after exposure to extracts from either healthy or diseased geraniums were 0.6 and 4.1, respectively. A cellulose thin-layer chromatography system using callus as the bioassay agent detected toxin activity in LMF from *X. pelargonii* and in extracts from diseased plants at the same R_f. These results indicate that a toxin present in LMF from *X. pelargonii* is active at the cellular level and may be present in diseased tissue.

NEW ORGANIC SEED FUNGICIDES TO CONTROL COVERED KERNEL SMUT (*SPHACELOTHECA SORGHII*) OF SORGHUM (*SORGHUM BICOLOR*). Earl D. Hansing, Department of Plant Pathology, Kansas State University, Manhattan, Kansas 66506, U.S.A.

'Pink Kafir' sorghum seed was infested at the rate of 5 ml teliospores/1000 ml seed. Then 500 ml seed lots were treated with standard and experimental organic fungicides. Treated seed, plus a nontreated control, were planted in a sandy loam soil on two different dates in each May 1975-1978. Treatment rows were 40 ft (12.2 m) spaced 2 ft (0.6 m) apart and replicated twice. Percentages of smutted panicles were determined each September. Mean smutted panicles in the control was 49% for the 4 years. Excellent control was obtained, with average smutted panicles of 1% or less, when seed was treated at 1.0 oz/bu (0.9 g/kg) with each of these fungicides: benodanil, captafol, captan (standard), carboxin, furanil, nuarimol, thiram (standard), triadimefon, triadimenol, and zinc omadine.

AN ECOPHYSIOLOGICAL ANALYSIS OF THE SUSCEPTIBILITY OF WOODY AND HERBACEOUS PLANTS TO OXIDANT DAMAGE. Ronald S. Harkov and Eileen Brennan. Department of Plant Pathology, P.O. Box 231, Cook College, New Brunswick, New Jersey 08903.

The existing literature pertaining to the relative susceptibility of herbaceous and woody vegetation to photochemical oxidant, reveals that herbaceous plants are more susceptible to oxidant damage than woody plants. Hybrid poplar (clone #388) has been reported to be very susceptible to ozone, yet in a three year study in New Jersey, using open-top chambers, ambient oxidant had little effect on the growth of these trees.

This information has forced us to explore the possible mechanisms that would lead to the greater susceptibility of herbaceous vegetation. Our analysis has led us to conclude that differential growth rates, growth strategies, successional standing and the ability to react to fluctuating environmental factors may be important in determining the relative susceptibility of various plant species. Slower growing vegetation, which often typifies late successional communities, are less susceptible to oxidant damage than fast growing species, which are often early successional species.

ERWINIA SPP. PATHOGENIC TO POTATOES DESCRIBED FROM BOLIVIA.
Monty Harrison, Colorado State University, Fort Collins, CO, 80523, Gaston Carvajal, Gerardo Caero, Tito Revollo and William Brown, MACA/IBTA, Cochabamba, Bolivia.

In March and April 1979 a survey was conducted in the principal potato growing areas of Bolivia to confirm reports of *Erwinia* species in *Solanum tuberosum* subsp. *andigena* in neighboring Peru (deLindo, L., P.R. French and A. Kelman. 1978. *Erwinia* spp. Pathogenic to Potatoes in Peru. Amer. Potato Jour. 55: 383). Both healthy appearing randomly collected potato stems and potato stems with blackleg symptoms were collected in fields at elevations of 2,000 meters and higher in the Departments of La Paz, Cochabamba, Sucre, Potosi and Santa Cruz. Of the 526 isolations performed, 169 yielded *Erwinia* species. A random sample of the *Erwinia* isolates from each area were subjected to the standard biochemical tests to determine which organisms were present. Both *Erwinia carotovora* var. *carotovora* and *Erwinia carotovora* var. *atroseptica* were recovered from all locations except the Department of Santa Cruz where only *E.c.* var. *carotovora* was identified. No isolates of *Erwinia chrysanthemi* were found. The *Erwinia* spp. have not been associated with potatoes in Bolivia prior to this report and an evaluation of their role in stand and production losses will now be necessary.

HISTOPATHOLOGICAL EVENTS DURING THE DEVELOPMENT OF CANKERS ON CHESTNUT SPECIES INCITED BY VIRULENT (V) AND HYPOVIRULENT (H) STRAINS OF *ENDOTHIA PARASITICA*. F.V. Hebard and G.J. Griffin, Dept of Plt Path & Physiol, VPI&SU, Blacksburg, VA 24061, and J.R. Elkins, Dept of Chem, Concord College, Athens, WV 24712.

The time-course of histopathological events following artificial inoculation with *E. parasitica* was studied in highly resistant (HR) *Castanea mollissima* 'Nanking', fully susceptible (FS), and a partially resistant (PR) *C. dentata*. In all three types, a necrotic region, ca. 0.5 cm larger than the inoculation wound formed when a V or H strain of *E. parasitica* was present. 10 d after inoculation, this lesion, or the wound of the uninoculated check, was surrounded by a lignified zone. In all spp. and treatments, wound periderm formation had commenced by 14 d at the non-necrotic border of the lignified zone. At 10 d, the necrotic regions of all host-parasite combinations were infiltrated with individual hyphae; mycelium build-up had commenced by 14 d in the necrotic region of the compatible combination (e.g. V & FS) but was delayed in incompatible combinations (e.g. H or V & HR). By 18 d, an advancing mycelial fan had penetrated the lignified zone and developing wound periderm in the compatible combination; this was delayed in less compatible combinations (e.g. H & FS and V or H & PR) and did not occur in incompatible combinations. These results suggest that the crucial component of a compatible reaction is the ability of *E. parasitica* to obtain nutrition from, and not be inhibited by, the contents of dying tissues of *Castanea* spp.

IMPLICATIONS OF CHESTNUT BLIGHT INCIDENCE IN RECENTLY CLEARCUT AND MATURE FORESTS TO BIOLOGICAL CONTROL OF BLIGHT WITH HYPOVIRULENT STRAINS OF *ENDOTHIA PARASITICA*. F.V. Hebard and G.J. Griffin, Dept of Plt Path & Physiol, VPI&SU, Blacksburg, VA 24061, and J.R. Elkins, Dept of Chem, Concord College, Athens, WV 24712.

In two sites clearcut ca. 15 yr previously, natural incidence of blight on American chestnut approached 100%, while it was much lower in sites where *Castanea dentata* was an understory tree. Resistance of *C. dentata* to colonization by *E. parasitica* in both types of sites was approximately equal. Inoculation success with *E. parasitica*, and sizes of initial lesions (43 d after inoculation) were lower and smaller, respectively, in understory trees. Stromatal density (sporulation) was markedly higher on clearcut-grown trees than on understory trees by 100 d after artificial inoculation. Low stromatal density was associated with the presence of rhytidome, which was rare at clearcut sites but common at understory sites. Some other potential factors contributing to the epiphytotics at clearcut sites were higher numbers and sizes of stump sprouts per sprout clump, and lack of protection from inoculum by a closed canopy. These findings may explain, in part, the persistence of chestnut stump sprouts in the eastern U.S.A. They also indicate

that mass inoculation of uninfected, clearcut-grown chestnuts with hypovirulent strains, having capabilities for sporulation, may be a good method for introducing hypovirulence into the American population of *E. parasitica*.

USE OF OPEN-TOP CHAMBERS TO ASSESS THE EFFECTS OF PHOTOCHEMICAL OXIDANTS ON YIELDS OF SWEET CORN IN MARYLAND. H. E. Heggstad, USDA-SEA-AR, Plant Physiology Institute, Beltsville, MD 20705

Open-top chambers (3 m dia. x 2.4 m high) were used to evaluate the effects of photochemical oxidants (primarily ozone) on the yield of sweet corn at Beltsville, MD. In 1977 the cultivars NK 199, Iobelle, Jubilee and Silver Queen were compared in chambers supplied with either charcoal-filtered or unfiltered air and in plots without chambers. In 1978, NK 199, Silver Queen, Iochief and Seneca Chief were compared. The 3 treatments were replicated 4 times in a randomized block design. The cultivars formed a 4 x 4 Latin square as a split plot in each treatment. Ozone concentrations were somewhat higher in 1977 than 1978 but were about normal for the Washington Metropolitan Area. The average yields in unfiltered air were lower than in filtered air; i.e. reduced 9.9% in 1977 and 8.5% in 1978. The higher yields in filtered air seemed related primarily to more complete filling of ear tips rather than to any increase in the diameter or length of ears. Silver Queen was the best yielding cultivar and it showed the least ozone injury to leaves.

CONTROL OF SOILBORNE PLANT PATHOGENIC FUNGI IN CARNATION, STRAWBERRY AND TOMATO BY TRICHODERMA HARZIANUM. Y. Henis, Y. Elad, I. Chet, Y. Hadar and E. Hadar. Department of Plant Pathology and Microbiology, Hebrew University of Jerusalem, Faculty of Agriculture, Rehovot, 76100 Israel.

An isolate of *Trichoderma harzianum* Rifai, capable of parasitizing *Rhizoctonia solani* and *Sclerotium rolfsii* was isolated from naturally infested soil and grown on wheat bran. Methyl-bromide - fumigated soil was heavily infested with *Rhizoctonia solani* under field conditions, treated with a wheat bran preparation at a rate of 100 g/m² (dry weight) and planted with carnations. It was found that the *Trichoderma* preparation protected the carnations from *R. solani*, and increased plants stand and flowers yield. When added to methyl bromide - fumigated soil in strawberry nursery at a rate of 40 g/m² (dry weight), *Trichoderma* preparation protected the seedlings from reinfection with *R. solani* as compared with the untreated control. Tomato seedlings grown in peat speedlings were treated with *Trichoderma* preparation at a rate of 20:1 (v/v) and planted in commercial plots, naturally infested with *Sclerotium rolfsii*. Significant reduction in disease and increase in yield were observed following this treatment. It is concluded that *Trichoderma harzianum* preparation with wheat bran as a carrier is a long-term effective biocontrol agent in artificially and naturally infested soil, and can be used to protect fumigated soils from reinfection with pathogen

PROSPECTIVE CONTROL OF VENTURIA INAEQUALIS BY CHEMICALLY INDUCED POSTHARVEST DEFOLIATION TO ENHANCE APPLE LEAF DECOMPOSITION. C. C. Heye and J. H. Andrews, Dept. of Plant Pathology, Univ. of Wisconsin-Madison, Madison, WI 53706.

To induce early leaf fall, the growth regulator ethephon, urea, and Triton CS 7[®] were applied combined at 1,200 and 50,000 and 60 ppm a.i., respectively, to McIntosh trees after harvest. Dropping leaves were collected in nylon mesh bags and overwintered on the orchard floor until budbreak. Treated leaves that fell two months prior to natural leaf fall lost 99.7% of their dry weight during the winter. This was 61.9% more than that lost by naturally fallen leaves, and 39.3% more than the decrease in weight of naturally fallen leaves that had been treated on the orchard floor with 50,000 ppm urea alone. An ethephon rate of 3,000 ppm was required to attain >95% defoliation within 2 weeks; ethephone at this rate applied with urea and Triton CS 7 at 50,000 and 100 ppm, respectively, decreased primary inoculum by 98%, due to a combined effect on leaf decomposition and ascospore production. Possible adverse effects of early defoliation on apple trees are being examined by standard branch tests.

EFFECTS OF ENVIRONMENTAL FACTORS ON GROWTH OF CERATOCYSTIS WAGENERI THROUGH SOIL. B. R. Hicks, F. W. Cobb, Jr., Dept. of Plant Pathology, University of California, Berkeley, CA. 94720 and P. L. Gersper, Dept. of Soils and Plant Nutrition, University of California, Berkeley, CA. 94720.

Influence of temperature, moisture tension and size of inoculum block on rate of fungus growth through sterilized and non-sterilized soil was determined by inoculation of soil with *Ceratocystis wageneri*. Mycelial strands were observed under

15X magnification, and confirmation of growth was made by soil dilution isolation on a selective medium. Growth was substantially greater in sterile than in non-sterile soil, but growth response to treatments was similar in both. After 70 days, maximum growth in non-sterile soil was 5 cm. Growth occurred at temperatures of 3-24 C (15-21 C optimum), and at moisture tensions of 0 to 18 bars (1 bar optimum). Growth up to 1 cm occurred from spore inoculum and increased with increase in inoculum block size. Growth on PDA was substantially increased by addition of 1000 ppm Mn⁺⁺. The results, in conjunction with field observations, suggest that growth through soil may be important in the spread of the pathogen.

CHARACTERIZATION OF THE CAPSID PROTEIN OF TOBACCO ETCH VIRUS BEFORE AND AFTER IN SITU DEGRADATION. E. Hiebert, J. H. Tremaine and Bill Ronald. Univ. of Florida, Gainesville, FL 32611 and Agriculture Canada Research Station, Vancouver, B. C.

The amino acid composition, behavior in SDS-polyacrylamide gel electrophoresis, reaction with 2,4,6 - trinitrobenzenesulfonate (TNBS) and electrophoretic patterns of cyanogen bromide (CNBr) peptides of tobacco etch virus (TEV) capsid protein were compared before and after limited proteolysis by either storage at 4C or trypsin treatment. About 45% of the lysine residues were lost while only 20% of the capsid protein chain was cleaved during limited proteolysis. Reaction of TEV with the lysyl-specific reagent TNBS before and after limited proteolysis, suggested that at least 6 lysyl residues per protein subunit were lost during the degradation. The electrophoretic patterns of CNBr peptides revealed the loss of at least two protein fragments upon the limited proteolysis of the capsid protein. These results indicate that the condition of the capsid protein must be defined when the above properties are to be used in potyvirus characterization.

POWDERY MILDEW OF SUGARBEET: DISEASE APPRAISAL AND CROP LOSS. F. J. Hills, L. Chiarappa, L. D. Leach and C. Frate. Department of Agronomy and Range Science, University of California, Davis, CA 95616.

Disease appraisal is accomplished by examining a recently matured leaf on each of 25 plants as to the percentage of the leaf area covered by fungus mycelium on a disease intensity scale (D) of 0 to 5. D's are based on the angular transformation of percentages: angle = arc sine(%/100)^{1/2}. The points of the rating scale are in multiples of 18 degrees and correspond to estimates of 0, 10, 35, 65, 90, and 100% of the mature leaf area diseased (% MLAD). A disease rating for a plot or field location is the mean rating (R) of 25 leaves. To evaluate a treatment effect, R is averaged over all replicates (R) then back transformed to % MLAD = 100[sine (R 18°)]². Since R is an angular transformation of a percentage, variances within treatments are usually homogeneous and amenable to analysis of variance procedures. Such a "pre-transformed" scale also has the advantage of giving more realistic estimates of percent disease as the categories are visually more easily distinguishable than the usually used equally incremented scale. Disease evaluation by this procedure is reproduced well by different evaluators and small differences in disease control can be detected. An average of biweekly determinations of % MLAD, taken from the appearance of disease to mid fall and weighted by weeks to mid fall, correlates well with crop loss.

ALKALIZED WATER AGAR AS A SELECTIVE MEDIUM FOR ENUMERATING SOIL ACTINOMYCETES. W. C. Ho and W. H. Ko. Department of Plant Pathology, University of Hawaii, Beaumont Agricultural Research Center, Hilo, Hawaii 96720.

Most media developed for enumerating soil actinomycetes do not prevent the growth of bacteria. When the pH of water agar (a selective medium for actinomycetes) was adjusted to 10.5, more than 90% of bacterial colonies from natural soil were suppressed, whereas the number of actinomycete colonies remained constant. The same pH adjustment did not affect actinomycete numbers on chitin agar (another selective medium for actinomycetes), but only about 66% of bacterial colonies were suppressed. When a diluted suspension of soil artificially inoculated with identified bacteria was plated on regular water agar, it was impossible to detect actinomycete colonies due to the presence of numerous bacteria. However, when alkalized water agar was used, more than 99.9% of the bacterial colonies were suppressed and the number of actinomycetes colonies was easily determined. Similar results were obtained with glucose-amended soil.

SEAKEM AGAROSE AS A SOLIDIFYING AGENT FOR STUDYING CHEMICAL ACTIVITY. W. C. Ho and W. H. Ko. Department of Plant Pathology, University of Hawaii, Beaumont Agricultural Research Center, Hilo, Hawaii 96720.

Inhibition of microorganisms by various chemicals is re-

duced substantially by agar and nutrients in media. Seven of eight solidifying agents tested contained nutrients sufficient to support spore germination of nutritionally dependent fungi. These fungi failed to germinate on 0.6% Seakem agarose, although conidia of nutritionally independent fungi germinated completely on the same medium. The inhibitory effect of CuCl_2 , ZnCl_2 and AlCl_3 on spore germination in agarose medium was about the same as that in water. The inhibitory effect of streptomycin and neomycin on bacterial growth was also greatly enhanced when agarose was used to replace agar in nutrient medium. Results suggest that Seakem agarose is suitable for use as a solidifying agent in the bioassay of inhibitory substances.

A CONCEPTUAL MODEL OF NEMATODE VARIATION. John P. Hollis, Plant Pathology & Crop Physiology Dept., La. State Univ. Agric. Expt. Sta., Baton Rouge, LA 70803.

Numerous races separable by differential hosts have long been known among plant parasitic nematodes. Their abundant occurrence in the mitotic parthenogenetic root-knot nematodes is inconsistent with the known absence of mechanisms for genetic change in these species but is explicable in terms of mutagenic nematode theory (MNT) (Mutagenic Action of Nematodes on Plants, Phytopath. So. Div. Abstr. 1979, to be publ.). The following points are determined by MNT: (a) Mutagenic action of nematodes \rightarrow root chimeras \rightarrow chimeras races of nematodes, (b) A few biotypes (ecologically-relevant races) are drawn by selection pressure from a vast pool of chimeric races, (c) Biotypes are limited to climatic, crop and soil complexes (ecosystems) and are stable only as the ecosystem is stable, (d) Chimeric race 1 \rightarrow biotype 1 (stable race in a stable ecosystem). When the ecosystem changes with respect to climate, crop cultivar or soil condition, it becomes unstable, biotype 1 disappears and is replaced by biotype 2. Chimeric race 2 \rightarrow biotype 2. A sequence biotype 1 \rightarrow biotype 2 is inconsistent with MNT.

MUTAGENIC ACTION OF ROOT CHIMERAS ON NEMATODES. John P. Hollis, Plant Pathology & Crop Physiology Dept., La. State Univ. Agric. Expt. Sta., Baton Rouge, LA 70803.

Many plant parasitic nematodes, including several species of *Meloidogyne*, reproduce by mitotic parthenogenesis (MP) essentially a cloning process; hence occurrence of numerous artificial races in *Meloidogyne incognita* (Kofoid and White 1919) Chitwood 1949 (Plant Dis. Rep. Suppl. 227: 86-88, 1954) has been explained in terms of a mutagenic nematode-host relation (Mutagenic Action of Nematodes on Plants, Phytopath. So. Div. Abstr. 1979, to be publ.). Specifically, physiological root chimeras produced by nematode feeding activities exert selection pressure (SP) for new strains of nematodes. Forty years ago it was thought new strains of organisms arose from SP on spontaneous mutations (M); it is now evident that mechanisms involving selection pressure on M, SP/M, SP originate new strains. I advance the view that artificial races which arise abundantly in MP nematode species are produced by mechanisms in root chimeras parallel to those conferring resistance to drug action in other organisms and in tissue (Schimke, et al. Science 202: 1051-1055, 1978) and that they be called chimeric races.

OAK DECLINE AND MORTALITY: IDENTIFYING FORESTS SUSCEPTIBLE TO THE GYPSY MOTH INITIATING AGENT. David R. Houston and Harry T. Valentine. USDA Forest Service, 151 Sanford Street, Hamden, CT 06514.

Oak decline and mortality is a disease complex initiated by insect defoliation and culminated by lethal attacks of organisms of secondary action such as *Agrilus bilineatus* and *Armillaria mellea*. Predicting where the disease will occur entails identifying forests susceptible to the initiating agent. A discriminant function incorporating tree species and several features of tree structure used by gypsy moths (*Lymantria dispar*) as refuges accurately identified stands that were either known to be resistant or susceptible to *L. dispar* or that were classified as resistant or susceptible with the aid of principal components ordinations. Death of defoliated trees is more difficult to predict than susceptibility and depends not only on levels of defoliation stress, but also on prior tree condition, environmental factors, and probably levels or conditions of the mortality-causing secondary organisms.

THE ACETONE POWDER TECHNIQUE FOR PRESERVATION OF MDMV-A INFECTED PLANT TISSUE. A. Huebner and R.W. Toler, Texas A&M University, College Station, TX 77843.

Leaf tissue infected with maize dwarf mosaic virus strain A was

preserved by the acetone powder technique. This method quickly dehydrates the material and preserves the infectivity over an extended period of time. The leaf tissue is commiserated in 10 volumes of pre-cooled acetone for 3 min in the cold room. The suspension is then placed in a cold bath of dry ice and ethylene glycol for 10 min. The aqueous layer is decanted and the tissue placed on filter paper in a Buchner funnel and washed twice with 3 volumes of acetone. To help remove the acetone, air is blown over the tissue. The tissue is dried *in vacuo* in a bell jar over H_2SO_4 for 2-3 days and then stored over CaCl_2 at 0 C. To inoculate plants, the tissue is rehydrated 1:10 (w/v) in phosphate buffer. In comparative tests, leaf tissue that had been simply frozen lost all infectivity after 7 months storage, while that stored as acetone powder was still 35% infective after 18 months.

ETIOLOGY AND CONTROL OF SUMATRA DISEASE OF CLOVES. P. Hunt, C.P.A. Bennett, Ministry of Overseas Devt., London, England/L.P.T.I. Sub-Station, Solok, Sumatera Barat, Indonesia; and P. Jones, Rothamsted Experimental Station, Harpenden, England.

A die-back and wilt disease of cloves has destroyed 70% of 15,000 ha in West Sumatra since 1968 and is now affecting other areas of Indonesia. A bacterium with rickettsia-like ultrastructure (RLB) is consistently found in the vessels of roots, trunks, and branches of diseased trees. Root decay associated with *Phytophthora cinnamomi* may also occur. Attempts to transmit the disease experimentally and to culture the RLB have so far been unsuccessful. Responses to trunk-injected antibiotics further implicate RLB's as the probable cause of the disease: trees given prophylactic doses of tetracyclines and streptomycin have remained symptomless compared with untreated controls and some trees treated early in symptom development have shown remission; ridomil and aliette had little effect on symptom development. The extremely high value of the crop (a good average of US \$100 per tree per year) would permit the use of antibiotic or other expensive chemical control as a temporary solution until sources of natural resistance have been sought and developed.

A XANTHOMONAS SPECIES CAUSING LEAF NECROSIS OF VITIS VINIFERA L. CV. CABERNET SAUVIGNON. B. Hurwitz and T. J. Burr, Dept. Plant Pathology, N.Y. State Agric. Expt. Sta., Cornell Univ., Geneva, N.Y. 14456, USA.

A gram negative, nonfluorescent bacterium possessing a single polar flagellum was consistently isolated from angular, interveinal, necrotic lesions on leaves of *Vitis vinifera* cv. Cabernet Sauvignon. Lesions often coalesced to form large necrotic areas. Large masses of bacteria were observed with the light microscope to ooze from the water-soaked margin of dissected tissues. The bacterium produced small, cream-colored colonies on potato-dextrose agar, King's Medium B, and nutrient agar after incubation for 72 hr at 28 C. Isolates were oxidase negative and caused a hypersensitive response on tobacco. Fourteen other differential tests were conducted to compare this bacterium to *Xanthomonas ampelina*, a known grape pathogen. These tests, which distinguish *X. ampelina* from other Xanthomonads, included: NaCl tolerance; maximum temp for growth; production of yellow pigment; growth on nutrient agar and on yeast extract-galactose- CaCO_3 agar; acid production from glucose, xylose, sucrose, and galactose; hydrolysis of starch and aesculin; urease and catalase activity, and gel liquefaction. Results of the first seven tests listed above indicated differences exist between the two bacteria; identical reactions were obtained in other tests. Greenhouse inoculations were made on 9-mo-old grape seedlings by applying carborundum to the adaxial leaf surface before gently rubbing with a suspension of the bacterium containing ca. 10^9 colony-forming-units per ml. Within two weeks leaf spots developed from which the bacterium was reisolated, thus confirming pathogenicity.

THE ROLE OF INHIBITORY SUBSTANCES IN THE IMMUNITY OF LOBLOLLY PINE CALLUS TO *CRONARTIUM FUSIFORME*. W. R. Jacobi, and H. V. Amerson, Departments of Plant Pathology and Botany, respectively, North Carolina State University, Raleigh, N. C. 27650.

Loblolly pine, *Pinus taeda*, callus grown on Gresshoff and Doyl or Brown and Lawrence media was not infected when inoculated with *Cronartium fusiforme*. Freshly cast basidiospores germinated normally on the callus but neither hyphae nor germinating basidiospores were able to colonize callus. Buffer (.05 M phosphate pH7) washes of loblolly pine, slash pine, and tobacco callus inhibited the growth of axenic cultures obtained from both urediospores and basidiospores. Whereas buffer washes of peanut and soybean callus were not inhibitory. Additionally, the presence of loblolly pine callus on a medium compatible to both pine and fungus inhibited hyphal growth. However, loblolly seedlings on the same medium did not inhibit hyphal growth. Effects of the inhibitory substances extracted

from loblolly pine callus were tested on susceptible loblolly pine embryos inoculated with basidiospores and will be reported.

LABORATORY TRANSMISSION OF MAIZE CHLOROTIC MOTTLE VIRUS BY CORN ROOTWORMS. Stanley G. Jensen, AR, SEA, USDA, Dept. of Plant Pathology, U. of Nebraska-East Campus, Lincoln, NE 68583

About 16% of a mixed population of *Diabrotica virgifera* and *D. undecimpunctata* collected at random in a field of diseased corn transmitted maize chlorotic mottle virus (MCMV) to corn seedlings in the greenhouse. From 5 to 30% of field collected nonviruliferous beetles of *D. longicornis* and *D. virgifera* transmitted MCMV after a 2-day virus acquisition period. Neither the age nor the sex of *D. virgifera* beetles had any influence on the level of transmission. However, transmission was higher at 25C than at either 15 or 35C. No latent period was found but transmission did continue through 8 transfers over 2 days. The virus was detected in the gut but not the hemolymph of beetles. There was no correlation between the ability of a beetle to transmit the virus by feeding and the presence of the virus in/on the insect as detected by infectivity assay. Larvae of *D. undecimpunctata* could transmit the virus after feeding on fresh plant material but not by eating dried plant residue or following surface contamination.

EFFECT OF DARKNESS ON NECROSIS INDUCTION IN COTTON INOCULATED WITH HOMOLOGOUS AND HETEROLOGOUS BACTERIA. William M. Johnson and L.A. Brinkerhoff, Dept. of Plant Pathology, Oklahoma State University, Stillwater, OK 74074

Under high light levels and long days, immune and susceptible reactions to bacterial blight in cotton are clearly expressed. The pathogen, *Xanthomonas malvacearum*, produces cell necrosis and a hypersensitive reaction (HR) in immune lines. After inoculations at high inoculum levels, the HR occurred in immune lines within 24 hr, but did not occur in susceptible lines. Necrosis occurred in typical watersoaked susceptible-type lesions seven days after inoculation. When exposed to postinoculation periods of continuous darkness, the typically susceptible line produced the HR when inoculated with *X. malvacearum*. Necrotic cells occurred in susceptible lines 24 hr after inoculation (as in immune cotton); tissues did not watersoak. Development of *X. malvacearum* in immune and resistant cotton was not altered by this treatment. Heterologous xanthomonads initiated the HR in all lines under both conditions.

A PEST MANAGEMENT SYSTEM FOR THE CONTROL OF SOILBORNE PATHOGENS. John Paul Jones and A. J. Overman, Agricultural Research & Education Center, 5007 60th Street E., Bradenton, FL 33508

Carbofuran, a methyl bromide:chloropicrin fumigant and soil acidity were evaluated in the field for control of *Verticillium albo-atrum* and various genera of nematodes. Two tomato cultivars were used: Walter (resistant to Fusarium wilt, susceptible to *Verticillium* wilt) and Floradade (resistant to Fusarium and *Verticillium* wilt). One and three fumigant streams injected into a 76 cm wide raised bed increased fruit yields of Walter 71 and 113%, respectively, and Floradade yields 22 and 47%, respectively. Carbofuran increased yields 15%. An increase in soil pH from 5.0 to 7.0 increased yields 41%. A further increase to 7.5 did not further increase yields. *Verticillium* wilt of Walter at harvest was reduced from 94% to 74 and 47% by 1 and 3 fumigant streams, respectively. At harvest, 51% of the Floradade plants in nonfumigated soil were infected with *Verticillium* wilt, whereas only 25 and 13% of the plants in soil treated with 1 and 3 fumigant streams, respectively, were infected.

RACE DETERMINATION OF PHYTOPHTHORA PARASITICA NICOTIANAE IN TENNESSEE. P. R. Jones, P. P. Hunter, and J. W. Hilty. Department of Agricultural Biology, University of Tennessee, Knoxville, 37901.

The occurrence of races of *Phytophthora parasitica nicotianae* has been reported from areas in TN where burley, flue-cured, and Connecticut shade tobacco types are produced. Isolations of the fungus were made from black shank-infected plants from TN counties where dark fired and air-cured tobacco are grown. Eight isolates were selected and identified with the following tobacco cultivars: Madole, L8, DF-300, and A23. Seedlings were grown in greenhouses in artificial media in 12-unit aluminum pans, each supported by an aluminum cake pan. Seedlings were inoculated by adding blended mycelium to water in the cake pans. Seedlings were removed after 14 days and root systems indexed for black shank severity. Reactions of known races 0, 1 and 3 were similar to reactions reported previously. Five isolates were identified as race 0; one as race 1; and the determination of the remaining isolates was inconclusive.

THE EFFECT OF IRRIGATION, PLANTING DATE AND MOISTURE CONTENT AT HARVEST ON AFLATOXIN CONCENTRATION IN A SHORT SEASON AND A FULL SEASON CORN HYBRID. Roger K. Jones and H. E. Duncan, Dept. of Plant Pathology, N. C. State University, Raleigh 27650

Aflatoxin B₁ concentration was significantly greater in non-irrigated than irrigated field corn planted in 1978. Early planted (April 3) corn of either a short-season (Pioneer 3780) or a full-season (Pioneer 3147) hybrid contained less aflatoxin B₁ than late-planted (May 3) corn of the same cultivar. Aflatoxin B₁ levels in the late-planted, short-season hybrid did not differ significantly from aflatoxin B₁ levels in the late-planted full-season hybrid. Irrigated treatments always contained less aflatoxin B₁ than non-irrigated treatments. Moisture content at harvest (28%, 24%, or 18%) was not related to aflatoxin B₁ concentration. Higher concentration of aflatoxin B₁ was correlated with increased incidence of *Aspergillus flavus* ($r = .83^{**}$), the association of that infection with insect injury ($r = .91^{**}$), incidence of European corn borer damage ($r = .52^{**}$), incidence of corn earworm damage ($r = .43^*$) and decreased yield ($r = -.63^{**}$).

METABOLISM OF PHYTUBERIN BY WHITE POTATO TUBER SLICES. Edwin B. Kalan, Edward G. Heisler and James Siciliano. Eastern Regional Research Center, Agricultural Research, Science & Education Administration, USDA, 600 E. Mermaid Lane, Philadelphia, PA 19118

Potato slices convert the C-15 stress metabolite solavetivone (katahdinone) to isolubimin, lubimin and rishitin; a biosynthetic pathway from solavetivone to rishitin was proposed (Phytochem. 15:775(1976)). When phytuberin is incubated with potato slices at 20°C, 70-80% of the compound disappears after 72 hrs. TLC separation of extracts of slices so treated revealed two spots with R_f values 0.18 and 0.48. The component with R_f=0.48 was identified as phytuberol by comparison of TLC, GLC and mass spectrophotograph with authentic phytuberol. The component with R_f=0.18, isolated by column chromatography and preparative TLC, yielded a single GLC peak, but two spots when rechromatographed on TLC plates with MeOH:CHCl₃(1:19); identities of these components have not been established. Results suggest that tuber tissue metabolizes solavetivone and phytuberin by independent pathways and the 1st step in phytuberin metabolism may be hydrolysis of phytuberin to phytuberol.

EFFECT OF DROUGHT STRESS AND WOUNDING ON CYTOSPORA (VALSA) KUNZEI INFECTION. L. K. Kamiri and F. F. Laemmlen, Department of Botany and Plant Pathology, Michigan State University, East Lansing, Michigan 48824, USA.

Potted 5-year-old Colorado blue spruce (*Picea pungens* Engelm.) seedlings in the greenhouse received one liter of water once a week throughout the summer (drought-stressed trees). Non-drought-stressed trees received 350 ml of water/day. Trees in these two treatments were wound-inoculated with mycelial blocks from monoconidial cultures and single ascospore cultures of *Cytospora* (Valsa) *kunzei*. Controls received similar treatment but were inoculated with water agar blocks. The amount of disease was evaluated from resin production, needle drop, canker formation, and fruitification on infected branches. All drought-stressed branches (8/8) wound-inoculated with ascospore cultures showed needle drop, produced typical resinosis and cankers, and died. Five of eight (5/8) wound-inoculated branches on non-drought-stressed trees produced symptoms of infection. Controls were not infected. Trees inoculated with monoconidial cultures were not infected. All non-wounded inoculated branches remained healthy and appeared free of cankers.

RELEASE AND DISPERSAL OF CONIDIA AND ASCOSPORES OF CYTOSPORA (VALSA) KUNZEI. L. K. Kamiri and F. F. Laemmlen, Department of Botany and Plant Pathology, Michigan State University, East Lansing, Michigan 48824, USA.

Release and dispersal of conidia and ascospores of *Cytospora* (Valsa) *kunzei* were monitored from early spring until first snowfall. Both conidia and ascospores were water-borne (released during rain) and air-borne (released following periods of wetness). All spore release was initiated by the presence of moisture. Rain dispersal of spores commenced with the onset of rain. Conidia were discharged in greatest numbers during mid-April through mid-May. The numbers of conidia caught declined through the summer and were observable throughout the autumn. Ascospore catches ran from April through early July. The number of conidia caught exceeded ascospore catches for both water-borne and air-borne spores.

SOLAR HEATING OF THE SOIL AND OTHER ECONOMICAL ENVIRONMENTALLY SAFE METHODS OF CONTROLLING SOILBORNE PATHOGENS, WEEDS AND PESTS. Jaacov Katan, The Hebrew University of Jerusalem, Department of Plant Pathology and Microbiology, The Faculty of Agriculture, Rehovot, Israel.

Soil-borne pathogens cause heavy losses to crops and reduce lands for crop production. Pesticides are used frequently for controlling them, though are costly and toxic to nontarget organisms. Models describing their interaction with the environment and methods for minimizing their use and hazards are described. A new non-chemical method for controlling soil-borne pathogens and weeds by means of solar heating of the soil was developed. This is done by covering (mulching) moistened soil with transparent polyethylene sheets in the hot season, thereby leading to increase in soil temperatures. Laboratory and field experiments showed effective control of pathogens (e.g., *Verticillium*, *Fusarium*, *Pythium*, *Pratylenchus*, *Rhizoctonia*, etc.) and weeds, with crops such as cotton, potatoes, peanuts, tomatoes, etc. Consequently, yields were increased. This method involves both physical (thermal) and biological control and can be regarded as one of integrated control. It has advantages of being safe, cheap, simple, does not involve toxic materials and is suitable for both developed and developing countries. The implications, potential and prospects for the future are described.

THE EFFECT OF SEED DECAY ON POPULATIONS OF ASPERGILLUS IN SOIL. B. Kennedy and R. Denny. Department of Plant Pathology, University of Minnesota, St. Paul, MN 55108.

Monthly analyses from April to October were made over two seasons on seven soils near rail terminals where spillage of varied cereal grain, soybean, and flax seeds had occurred periodically for more than 50 years. Such soils were compared with two agricultural soils enriched with controlled amounts of corn, soybean, or wheat seed pieces for varied lengths of time up to six months. Species of *Aspergillus* were enumerated at 27 C and 35 C via a peptone-glucose medium supplemented with 10% NaCl, 2 µg/ml 2,6-dichloro-4 nitroaniline (Botran), and 50 µg/ml each of streptomycin and tetracycline. While repeated planting of soybean in field soil increased numbers of colony-forming units by at least twofold, adding 5% soybean seed pieces decreased them by about twofold. On the other hand, addition of wheat or corn seeds increased number of propagules of *Aspergillus* species 3-5 fold. Numbers of colonies that developed on assay plates were greater at 35 C than at 27 C. In all seedpiece-enriched soils near rail terminals, numbers of propagules tended to fluctuate widely during the growing season but were always much greater than in either of two agricultural soils. Conclusions are that storage mold inoculum may be increased near grain storage elevators due to spillage of seeds.

INTRODUCTION OF PLANT PATHOGENS VIA VEGETABLE TRANSPLANTS. S. H. Kim, BPI, PA Dept. of Agr., Harrisburg, PA 17120

Vegetable transplants produced out-of-state have been inspected at PA receiving stations since 1959. Each year, approximately 1% of the inspected tomato plants have been rejected due to root-knot nematode. Other rejections were tomato bacterial-canker, 1970; cabbage black-leg and tomato early-blight, 1974; tomato bacterial-speck, 1978; and tomato southern-blight, 1979. In shipments of field-grown transplants, *Rhizoctonia solani* AG-4 including four different anastomosis groups of binucleate types from tomato, cabbage, pepper and sweet potato; *Sclerotium* spp. from tomato, cabbage and onion; *Pythium* spp. including *P. myriotylum* from tomato, cabbage, pepper and onion; and *Phoma* spp., found to be avirulent to cabbage, from tomato, cabbage, pepper and onion, exhibited 16; 3; 17; and 12% occurrence-frequency, respectively. Pennsylvania fields, planted with tomato transplants contaminated with *Sclerotium rolfsii*, demonstrated a plant mortality-rate ranging from 30 to 50%.

NATURAL FIELD INFECTION OF CORN KERNELS BY *FUSARIUM MONILIFORME* AND *CEPHALOSPORIUM ACREMONIUM* IN MISSISSIPPI. S. B. King, USDA-SEA-AR, Department of Plant Pathology and Weed Science, Mississippi Agricultural and Forestry Experiment Station, Mississippi State, MS 39762.

Field studies on time of kernel infection by *Fusarium moniliforme* (FM) and *Cephalosporium acremonium* (CA), the two most frequently found fungi of corn seed grown in Mississippi, were conducted in 1977 and 1978. At weekly intervals, from one week before mid-silk (MS) to nine to ten weeks after MS, 60 kernels from each of 15 ears were plated on Czapek solution agar and the amount of internally-borne FM and CA was determined. FM and CA were first detected two weeks after MS. FM infection generally increased linearly until reaching a frequency of 35-65% at final sampling. CA infection remained very low ($\leq 2\%$) for four weeks after MS but then increased to a frequency of 30-45% at final sampling. FM kernel infection was more frequent in the tip half than the butt half of ears during the first eight weeks after MS, but eventually became ran-

domly distributed. In contrast, CA kernel infection was at first randomly distributed but became more frequent in the butt half of ears during the last two weeks of sampling.

BAYLETON 50WP AS A FOLIAGE FUNGICIDE FOR THE CONTROL OF POWDERY MILDEW OF WHEAT IN SOUTH CAROLINA. Graydon Kingsland, Department of Plant Pathology and Physiology, Clemson University, Clemson, SC 29631.

Powdery mildew (pm) of Coker 68-15 wheat was controlled by 1 or 2 foliar applications of Bayleton 50WP fungicide at 2 and 4 oz (a.i.) per acre. Disease incidence (on a 0 to 100 scale; 0 = no disease) on leaves 1, 2, and 3 averaged 6 for all sprayed plots when rated on April 27 on a whole-plot basis, compared with 55 for plants on the unsprayed plots. Disease severity ratings averaged 2 (0 to 10 scale; 0 = no disease) for the plants in the unsprayed plots and 10 on the controls. The incidence of pm on leaves 4 and 5 was 20 for the control plots on May 19; incidence on the sprayed plots was 0. The average incidence of pm on all rows of sprayed plots was 6; compared with an average rating of 30 for the border rows of adjacent plots. Sporulation (0 to 10 scale; 0 = no sporulation) averaged 1.1 on leaves from sprayed plots and 5.7 on leaves from controls. Bayleton 50WP controlled pm of wheat under severe disease pressure and suppressed lesion development and sporulation in this experiment.

PLANT GROWTH PROMOTING RHIZOBACTERIA: EVIDENCE THAT THE MODE OF ACTION INVOLVES ROOT MICROFLORA INTERACTIONS. J. W. Kloepper and M. N. Schroth, Department of Plant Pathology, University of California, Berkeley, CA. 94720.

Investigations were made to determine if plant growth promoting rhizobacteria (PGPR) induced plant growth increases by bacterial products or by interactions with root microflora. Several bacterial strains inoculated on surface-sterilized radish seeds growing in sterile cellophane packets induced hormonal-like increases in root branching or total root length. However, there was no correlation between results obtained in root packets and those obtained when plants were grown in the greenhouse and field. There was no difference in plant growth between PGPR-inoculated seed and water-inoculated seed when plants were grown under sterile conditions; however, the same PGPR increased radish weight up to 100% compared to controls in field tests. Culture filtrates of PGPR isolated from potato did not stimulate potato plant growth compared to controls when dilutions of 10, 1, 0.1, and 0.01% were applied to seed pieces planted in field soil. Potato roots from PGPR-treated plants in field soils had 59% fewer rhizoplane fungi than untreated control plants. These results suggest that the PGPR used in our study increased plant growth by altering the root microflora rather than by producing products which directly stimulate the plant.

SOUTHERN BEAN MOSAIC VIRUS IN MEXICAN BEAN BEETLE AND BEAN LEAF BEETLE REGURGITANTS. J. A. Kopek and H. A. Scott, University of Arkansas, Fayetteville, AR 72701.

Regurgitants of Mexican bean beetles, *Epilachna varivestis* Mulsant, and bean leaf beetles, *Ceratomyza trifurcata* Forster, that had fed on southern bean mosaic virus (SBMV)-infected Black Valentine bean, contained amounts of virus similar to equal volumes of crude sap from infected leaf tissue. Beetles fed on healthy Pinto bean leaves that had been dipped in a suspension containing 10 mg purified SBMV/ml of buffer transmitted virus more frequently than those that fed on leaves treated with 1 mg virus/ml. In addition, induced regurgitant from beetles fed on leaves dipped in 10 mg SBMV/ml contained more virus than regurgitant from beetles fed on tissue dipped in 1 mg/ml. The pattern of serial transmissions with each species of beetle that fed on virus-dipped leaves was the same as the patterns demonstrated by beetles fed on systemically infected bean tissue. A decrease of infectivity in regurgitant paralleled the decrease in transmissions. This was not due to inactivation of virus by regurgitant components, since comparable lesion counts on Pinto bean were obtained from regurgitant of viruliferous beetles and infectious crude sap after storage of both at room temperature for 7 days. Beetles did not develop resistance or inhibitory factors to virus in the regurgitant. When transmission had dropped to low levels after the initial acquisition feeding, beetles could be recharged with virus to the original levels in the regurgitant by feeding again on virus-infected leaves.

SEASONAL DEVELOPMENT OF SPOROCHIA OF THE PITCH CANKER FUNGUS, *FUSARIUM MONILIFORME* var. *SUBGLUTINANS*, ON DISEASED SLASH PINES IN FLORIDA. S. H. Kratka, G. M. Blakeslee, R. D. Dorset, and S. W. Oak. School of Forest Resources and Conservation, Univ. of Florida, Gainesville, FL 32611

Sporodochia of the pitch canker fungus, *Fusarium moniliforme* var. *subglutinans* (FMS), have been observed on symptomatic slash pines in northern and central Florida and in southern Georgia. Inoculum production of FMS was studied in central Florida on ca 350 diseased, 10-12-year-old slash pines, according to the season of initial symptom expression, and monthly on diseased branches in piled logging debris residual from harvesting of diseased trees. Each month during the 16 mo study period (May 77-August 78), sporodochia were observed and the viability and pathogenicity of their macroconidia were determined. Sporodochia were observed during all months of the year on diseased trees with the highest mean frequencies occurring on branches that became symptomatic during the fall and winter seasons (11.9 and 12.3 sporodochia/dm of symptomatic branch, respectively). The highest frequencies observed on spring and summer symptomatic branches were 6.8 and 8.0 sporodochia/dm, respectively. Fall and winter symptomatic branches supported sporodochia for the longest period of time (> 6 mo) in contrast to the shortest period (< 4 mo) which occurred on summer symptomatic branches. In logging debris the longevity of individual sporodochia was shortest (< 2.5 mo) during the summer months. Substantial proliferation of new sporodochia was not observed in the piled debris although some increases were noted. Spore viability was consistently good (mean 68%) and all isolates, tested with field produced inoculum, were pathogenic.

COULOMETRIC EVALUATION OF RAINFALL CHEMISTRY IN CENTRAL MINNESOTA RELATIVE TO PLANT PATHOGENIC AIR POLLUTANTS. Sagar V. Krupa, M. R. Coscio, Jr., David W. Gardner, and J. L. Bechtold*. Department of Plant Pathology, University of Minnesota, St. Paul, MN 55108 and *Northern States Power Company, Minneapolis, MN 55401.

Individual rainfalls were sampled in central Minnesota during the summer of 1977 and 1978 at 7 different locations in the vicinity of a sulfur dioxide point source. The pH of these samples varied from 4.23 to 5.76. Coulometric analyses showed the following ranges in the concentrations of different acid species: strong acids 0.31 to 5.19×10^{-3} M; weak acids 0.78 to 4.76×10^{-5} M and total acids 1.09 to 8.26×10^{-5} M. The rain samples were also analyzed for major anions and cations. Sulfate and nitrate concentrations were frequently in excess of quantities required to account for the strong acid concentrations. Statistical analyses showed that most of the sulfate and nitrate may be present as neutralized salts such as $(\text{NH}_4)_2\text{SO}_4$, NH_4HSO_4 and alkaline metallic salts. The range in the concentrations of weak acids was comparable to the strong acids suggesting that weak electrolytes such as the ammonium salts may serve as proton donors. Further, insoluble particulates in our samples frequently contained sulfur, thus serving as a trap or adduct for the anion.

DERIVATION OF STRAINS OF COWPEA CHLOROTIC MOTTLE VIRUS. C. W. Kuhn and S. D. Wyatt. Department of Plant Pathology and Plant Genetics, University of Georgia, Athens, GA 30602, USA.

Two new strains of cowpea chlorotic mottle virus were derived by passage of the type strain (T) through susceptible beans or resistant cowpeas. The strain obtained from beans, designated M, caused very mild symptoms on cowpeas rather than the bright chlorosis caused by strain T. Furthermore, M differed from T in its level of replication in resistant cowpeas, its ability to compete with T in cowpeas and beans, and in the nature of RNA-3. When resistant cowpeas were infected with strain T, an intermediate virus form (deficient in RNA-3) accumulated slowly in inoculated leaves but not in uninoculated ones. Systemic movement was induced by continuous removal of new plant growth for 3 to 4 wks or by a high initial inoculum (T) concentration. Virus in uninoculated leaves, designated R, differed from strain T in several ways: symptoms, coat protein, and ability to move and replicate in resistant cowpeas. Pseudorecombinant studies with the RNA's of strains T, M, and R determined some of the genomic properties of individual RNA's: RNA-1 controlled virus replication and systemic movement; RNA-3 controlled systemic symptoms, coat protein, and virus replication. RNA-3 appears to have two genes which are not genetically linked.

HIGH FREQUENCY COTRANSFORMATION OF *ESCHERICHIA COLI* WITH CRYPTIC *ERWINIA* PLASMIDS AND PLASMID pBR322. George H. Lacy and Robert B. Sparks, Jr., Department of Plant Pathology and Botany and Department of Genetics, The Connecticut Agricultural Experiment Station, P. O. Box 1106, New Haven, Connecticut 06504.

Covalently closed circular (CCC) deoxyribonucleic acid (DNA) was isolated from cell lysates of *Erwinia* species by ethidium bromide-caesium chloride equilibrium centrifugation. *Escherichia coli* plasmid pBR322 DNA was either added to purified

CCC DNA of *Erwinia* species or it was already present as an individual plasmid species in the CCC DNA purified from *Erwinia*/pBR322 transformants. Stock solutions of DNA (0.8 mg/ml) were made in 50 mM Tris, 5 mM EDTA and 50 mM NaCl, pH 8. Recipient *E. coli* C600nal cells from 30 ml mid-exponential growth phase transformation broth cultures were washed and stored at 4°C in 1.2 ml of 30 mM CaCl₂. The CaCl₂-treated cells were transformed by incubating 300 µl of them with 2 µl of DNA stock solution for 2 hr at 0°C. The cells were then held at 42°C for 1 min, diluted with 3 ml of Luria broth and incubated at 37°C for 4 hr. Clones transformed with pBR322 were selected by their resistance to ampicillin and tetracycline. Cryptic plasmids were detected in at least 20 percent of pBR322 transformants examined by electrophoresis. This method may be used to move cryptic plasmids from phytopathogenic bacteria into a known genetic background (*E. coli*) in order to study the function of these plasmids.

TOP COMPONENTS OF SOME TYMOVIRUSES DIFFER IN SURFACE CHARGE FROM BOTTOM COMPONENTS. Leslie C. Lane, Department of Plant Pathology, University of Nebraska, Lincoln, NE 68583 USA.

I have isolated two tymoviruses in Nebraska. One of these appears to be Physalis mosaic (PMV) and the other a previously undescribed virus which infects hollyhock (HMV). PMV is cationic at neutral pH, while HMV is anionic with roughly half the electrophoretic mobility of turnip yellow mosaic virus (TYMV). Like TYMV, both PMV and HMV differ distinctly in electrophoretic mobility from bottom components. In both cases, the top components behave as if they contain less negative charge than the bottom components. In both cases, top component is more thermolabile than bottom component. The reason why top and bottom component differ in electrophoretic mobility is obscure.

RIBONUCLEIC ACID FIXATION BY GLUTARALDEHYDE. IMPLICATIONS FOR THE INTERPRETATION OF ELECTRON MICROGRAPHS. Willem G. Langenberg, USDA/SEA, Agricultural Research, Department of Plant Pathology, University of Nebraska, Lincoln, NE 68583, USA.

Ribonucleic acids of barley stripe mosaic virus, bromo mosaic virus, tobacco mosaic virus, bakers yeast t-RNA and Torula-RNA were fixed with varying concentrations of glutaraldehyde in .1M potassium phosphate-citrate, or 0.1M cacodylate, pH 7. Viral ribonucleic acids were inactivated. In buffered solutions of 5-10% Torula-RNA and 2.5% glutaraldehyde, the pH dropped to 5.5, but not in solutions of lower concentrations of RNA. A heavy precipitate settled out which could not be dissolved in buffer. Torula-RNA did not precipitate when the pH was gradually lowered to 4.5 in the absence of glutaraldehyde. No pH drop occurred in glutaraldehyde fixations of buffered 20% t-RNA solutions. It is concluded that glutaraldehyde reacts with free bases of nucleic acids but does not fix or insolubilize nucleic acids in solutions buffered as above. Consequently, it is possible that nucleic acids translocate intra-cellularly during glutaraldehyde fixation of plant tissues and preparation for electron microscopy, unless trapped by surrounding fixed proteins.

DISSEMINATION OF *PSEUDOMONAS SYRINGAE* BY RAIN. V. E. Langhans, A. L. Scharen, G. De Smet, and D. C. Sands, Department of Plant Pathology, Montana State University, Bozeman, Montana 59717.

The leaf spot bacterium, *Pseudomonas syringae*, is found on numerous field crops in Montana. Selective medium assay failed to detect this pathogen in soil or on plant residues in the spring. Most cereal seed samples carried this bacterium; yet seed treatments, effective in the laboratory, did not prevent infection in the field. This indicated that the pathogen was being introduced into the field by means other than infested seed. Dissemination by rain may be a major mode of pathogen spread. June and July rain samples, taken during thunderstorms from an airplane at altitudes ranging from 500 feet (rain) to 5000 feet (snow), contained oxidase positive (*P. fluorescens*) and oxidase negative (*P. syringae*) fluorescent bacteria.

THE PLANT PROTECTION PROGRAM AT THE OHIO STATE UNIVERSITY. P. O. Larsen, Dept. of Plant Pathology, The Ohio State University, Columbus, Ohio 43210.

The Plant Protection Program at The Ohio State University is an interdepartmental program among the departments of agronomy, agricultural engineering, entomology, horticulture, plant pathology and the school of natural resources in the College of Agriculture and Home Economics. Students major in one of the above academic units and are further required to enroll in

courses in allied areas that enable the student to obtain a diverse background in plant pest management related topics. The program is administered through the College Office which is advised by a committee composed of faculty members from the participating departments and school. A seminar series on current topics in plant protection and an internship program have been initiated. An industry advisory committee composed of representatives from many facets of the plant protection industry has been formed and serves as a resource for advice on job placement, internships, curriculum and seminars. Students who have completed a bachelor of science degree in plant protection while majoring in one of the above mentioned academic areas are prepared for employment in private pesticide application firms, plant pest management consulting businesses, plant pest regulatory agencies at the state or federal level, as pest management specialists in crop production programs, as technical assistants in research programs, agricultural chemical sales, and many other areas related to plant protection.

PURIFICATION OF GARLIC MOSAIC VIRUS. R. Lastra, P. Ladera and E.A. Debrot. Laboratorio de Virus de Plantas, I.V.I.C., Apartado 1827, Caracas, Venezuela

Garlic *Allium sativum* L. was found heavily infected throughout Venezuela similar to garlic mosaic virus (GMV). GMV was purified from garlic infected plants. Plant sap was extracted in phosphate buffer containing 0.1% thioglycolic acid. After low speed centrifugation the plant sap was clarified with 10% chloroform and concentrated with 5% PEG 6000. The virus was further purified in a sucrose density gradient and separated from remaining host components by CsCl density gradient centrifugation. Electron microscopy examination of the cytoplasm of infected mesophyll cells revealed the presence of virus particles, pinwheels and laminar inclusions characteristic of the potyvirus group.

TIMING CAPTAFOL SPRAYS FOR CONTROL OF SOOTY BLOTCH AND FLY SPECK OF APPLES. A.J. Latham and M.H. Hollingsworth, Department of Botany and Microbiology, Auburn and N. Ala. Hort. Substa., Cullman, respectively, Auburn Univ., Auburn, Ala 36830.

Sooty blotch and fly speck, caused by *Gloeodes pomigena* (Schw.) Colby and *Zygophiala jamaicensis* Mason, respectively, continue to be a problem in apple orchards in Alabama even though a standard fungicide spray schedule has been followed. Applications of captafol were made during spring-time for control of sooty blotch and fly speck. Red Delicious apples were sprayed with captafol 4.7 liters/378.5 liters water plus 0.94 liters non-phytotoxic oil at delayed dormant, pre-pink, and petal fall then covered with plastic bags. At harvest, only trace amounts of the disease were found. Unsprayed apples, covered at the same time, developed twice as much sooty blotch and three times as much fly speck during 1975. During 1976, with applications of captafol at pre-pink and near full-bloom, sooty blotch and fly speck ratings were less than 2 (0=no disease; 5=solid coverage). The 1977 data were inconclusive. During 1978, with one application of captafol at green tip followed by metiram 0.91 kg/378.5 liters water applied in the cover sprays, sooty blotch and fly speck were 0.9 and 0.2, respectively. The captafol single application technique used for apple scab control has given promising results as a spring clean-up for these two diseases.

GEN. A COMPUTERIZED STATISTICAL PROCEDURE FOR CREATING LARGE DATA SETS FROM SMALL DATA SETS FOR "TRAINING" DISCRIMINANT FUNCTIONS. Larry D. Lathrop and S. P. Pennypacker, Department of Plant Pathology, The Pennsylvania State University, University Park, PA 16802 USA.

A common procedure in disease resistance breeding programs is the classification of a potentially resistant cultivar into a resistance class based upon high to low resistance "type-responses" of "standard" or established cultivars. A computer program written in FORTRAN IV has been developed which generates a large data set with statistics equal to those derived from standard disease resistance categories. This procedure efficiently uses statistics derived from standard categories. The generated data sets can be used to "train" discriminant functions by "distribution free" techniques which require large data sets. The resultant "trained" discriminant function(s) can then be used to classify the data set for a potentially resistant cultivar into an appropriate resistance category with this classification based upon statistics derived from the standard categories. This computerized procedure is also applicable to other areas of plant protection in which classification is based upon small data sets.

EFFECTS OF SULFUR DIOXIDE ON THREE PLANT-VIRUS COMBINATIONS. J. A. Laurence, L. H. Weinstein, A. L. Aluisio, and D. C. McCune. Boyce Thompson Institute at Cornell University, Ithaca, NY 14853

Three plant-virus combinations [*Phaseolus vulgaris* L. 'Pinto' - southern bean mosaic virus (SBMV), *Lycopersicon esculentum* Mill. 'Bonny Best' - tobacco mosaic virus (TMV), and *Zea mays* L. RX-94 (Asgrow Seed Co., Kalamazoo, MI) - maize dwarf mosaic virus (MDMV)] were exposed to relatively low concentrations (262 to 524 $\mu\text{g}/\text{m}^3$) of sulfur dioxide (SO_2) for five to eight days. Titers of SBMV and MDMV were greater than controls in plants exposed to SO_2 , particularly if exposure occurred after inoculation. The titer of TMV was not affected by SO_2 exposure. SBMV-infected bean plants accumulated more sulfur in unifoliate leaves than did healthy plants, but significant differences were not found in trifoliate leaves. In addition, the effects of pre- and post-inoculation exposure on sulfur uptake in infected bean plants were more than additive. Exposure of maize plants to SO_2 following inoculation with MDMV resulted in a higher percentage of infected plants, and more severe symptoms when compared to non-exposed controls. There were no significant effects on dry mass of maize plants, regardless of treatment.

SCLEROTIA FORMATION ON AND IN RICE BY *Rhizoctonia solani*. F. N. Lee, University of Arkansas Rice Branch Experiment Station, P. O. Box 351, Stuttgart, AR 72160, USA.

Rhizoctonia solani, casual agent of rice sheath blight, was observed forming sclerotia between the leaf sheath and culm and within the lumen of elongated culms. Sclerotia were also found within the larger cells of leaf sheath tissue. Sclerotia formation in this manner is inconsistent with that normally observed with sheath blight. Differences in sclerotial formation and mycelial production were found when internal sclerotia forming (ISF) isolates were compared with external sclerotia forming (ESF) isolates by inoculating sterilized rice culms and leaves with mycelia plugs. ESF-1, an abundant aerial mycelium producing isolate, formed internal sclerotia in only 2 of 28 culms in two experiments. An intermediate aerial mycelium producing isolate, ESF-2, formed sclerotia in 7 of 30 culms. The isolate producing the least amount of aerial mycelium, ISF-1, formed internal sclerotia in 20 of 30 culms. Internal sclerotia were also observed in the internode lumen of random greenhouse plants inoculated with the ISF isolates.

FROST DAMAGE TO POTATO REDUCED BY BACTERIA ANTAGONISTIC TO ICE NUCLEATION-ACTIVE BACTERIA. S. E. Lindow, Dept. of Plant Pathology, University of California, Berkeley, CA. 94720.

Eight oxidase-positive fluorescent *Pseudomonad* isolates, one *Erwinia herbicola* and one unidentified bacterial isolate were selected from potato leaf surfaces on the basis of their ability to produce compounds antagonistic to ice nucleation active strains of *Pseudomonas syringae* and *Erwinia herbicola* in vitro, and their ability to effectively colonize potato leaf surfaces. Bacterial isolates found most effective in reducing frost injury to greenhouse-grown potatoes challenge inoculated with *P. syringae* before freezing also were most highly antagonistic to *P. syringae* in vitro. Although reductions in frost injury in the presence of antagonists was correlated significantly with reductions in *P. syringae* populations on leaves, frost injury was more highly correlated with the concentration of ice nuclei on these leaves. Frost damage to field-grown plants, grown from seedpieces treated with the *E. herbicola* antagonist, following a June frost (min. air temp. -4.0C) shortly after emergence, was significantly lower (11% of leaves injured) than untreated control plants (43% of leaves injured). Rifampicin resistant mutants of all 10 antagonists, when applied as a foliar spray to young plants (8 cm height) or as a seedpiece treatment (*E. herbicola*), were detected on leaves of potato throughout the growing season in populations as high as 10^6 cells/g fresh weight. The numbers of bacterial ice nuclei present on leaves colonized by antagonists were significantly lower than on untreated controls. During a September frost (min. air temp. -5C) these treated plants sustained significantly less frost damage (24-39% injured leaves) than unsprayed control plants (54% injured leaves). These bacterial antagonists were as effective as bactericides or bacterial ice nucleation inhibitors in reducing frost injury to potato.

EFFICACY OF EXPERIMENTAL FUNGICIDE ON CONTROL OF FOLIAR DISEASES OF ARACHIS HYPOGAEA. R. H. Littrell and June B. Lindsey, University of Georgia, Coastal Plain Station, Tifton, GA 31794.

Replicated field plots at two locations in Georgia were used to compare effectiveness of CGA-64251, a broad spectrum systemic fungicide, with fungicides commonly used for control of *Cercospora arachidicola* and *Cercosporidium personatum*. CGA

was evaluated at 89, 118.6, and 148 g using 15.3 l/ha of spray on Florunner groundnuts. Applications were begun after light infection of *C. arachidicola* was observed and continued every two weeks thereafter until two weeks prior to harvest. The experimental compound at all dosages compared favorably with recommended fungicides and significantly reduced infection from 91% in non-treated controls to 51% in plants treated with the highest dosage. Yield of pods was also significantly increased from 3,052 kg/ha in non-treated plants to 5,365 kg/ha in plants treated with the highest dosage. There were no significant differences among dosages in percent infection or yield. Mean percent infection and yield of commonly used fungicides was 72 and 4,859 kg/ha, respectively.

CONTROL AND EPIDEMIOLOGY OF BIRCH RUST IN PENNSYLVANIA.

J. Longenecker, N. Hill and D. Bingaman, Pennsylvania Dept. of Agriculture, Harrisburg, PA 17120

Birch rust, *Melampsorium betulinum*, was first detected in PA in 1973 in a seedling nursery bed. In 1974 and 75 the disease was detected at 3 and 6 locations respectively, establishing the need for chemical controls. Dithane M-45 (Manganese ethylene bis dithiocarbamate plus zinc ion) and Bravo 6F (Tetrachloroisophthalonitrile) were tested on both seedling and 2 1/2" caliper *Betula pendula*. Periodicity of spore release was studied in relation to the environmental parameters rainfall, temperature and relative humidity, but no correlation was found. In 1977, at 41°00 lat., 78° 26' long., elevation 1400 ft., first pustules were detected on June 20, however using a rotorod spore sampler, spores were not trapped until July 4. Major spore release occurred from mid August to mid October. Sprays were applied at 14 days intervals from mid June through mid October. Both Dithane M-45 (1.7 and 3.4 g/l) and Bravo 6F (7ml/l gave control, however, chlorothalonil was phytotoxic at this rate. No lower rate was attempted.

YIELD LOSS IN CROPS: A THEORETICAL APPROACH. L. V. Madden, S. P. Pennypacker, C. E. Antle, and C. H. Kingsolver, Departments of Plant Pathology and Statistics, The Pennsylvania State University, University Park, PA 16802; and Plant Disease Research Laboratory, Frederick, MD 21701 USA.

Crop loss is a function of many stress factors; one such factor is plant disease. Contemporary models for describing and predicting yield losses caused by plant diseases are selected (usually with ordinary least squares regression) to best fit the data and not necessarily represent biological reality. These models also are developed for specific cases without inherent flexibility. A generalized non-linear model has been developed to characterize the relationship between crop loss and plant disease. In addition to providing loss predictions at various levels of disease, this model also incorporates: (i) a threshold disease level below which no loss occurs; (ii) a maximum level of loss which may occur prior to the maximum amount of disease; and (iii) a large family of shapes to depict disease-loss relationships. The model was fit to simulated and actual disease-loss data sets. Results indicated that the general model could be applied to many disease-host systems with simple alteration of parameters. The ability to use a single model has the advantage that losses caused by different diseases on different crops can be compared directly.

FACTORS AFFECTING THE SENSITIVITY OF 2,4-D ASSAYS OF CRUCIFER SEED FOR PHOMA LINGAM. J. D. Maguire, R. L. Gabrielson, M. W. Mulanax and T. S. Russell. Washington State University, Pullman and Puyallup, Washington 98371.

The recommended International Seed Testing Association procedure for determination of blackleg (*Phoma lingam*) in crucifer seed calls for examination of seed and blotters for typical pycnidia and conidial ooze after 10-11 days incubation at 18-20C on blotters wetted with an "0.2%, 2,4-Dichlorophenoxyacetate (2,4-D)" germination inhibitor solution. Seed health testing laboratories have used different conditions in performing this test. The effects of these different factors on the sensitivity of the assays were determined in laboratory trials. Solutions of 2,4-D derived from acid formulations were toxic to *P. lingam*, but commercial water-soluble salt formulations were not toxic at recommended rates. Optimum temperature ranged between 20 and 25C. Light stimulated sporulation of *P. lingam*. White light was as effective as near ultra violet. Excess moisture depressed *P. lingam*. Moisture stress had no effect. Pretreatment of seeds with .11 and .05% NaClO solutions slowed fungal development, but did not reduce final pathogen counts. Close spacing of seeds did not inhibit *P. lingam*, but did exaggerate pathogen counts by growth from infected to healthy seeds. Close spacing also increased contamination problems from other saprophytic fungi.

GRAPEVINES AS PERENNIAL BIOINDICATORS OF OXIDANT AIR POLLUTION. William J. Manning and Robert L. Gilbertson, Department

of Plant Pathology, University of Massachusetts, Amherst, MA 01003

Herbaceous annual plants can be used to biomonitor phytotoxic concentrations of ambient oxidants (O_x). They must be replanted every year and several require extensive care. Perennial bioindicator plants are needed for long-term monitoring of O_x . Foxglove (*Vitis labrusca* L.) cultivars Ives (very sensitive), Van Buren (slightly to moderately sensitive), and Delaware (resistant) were evaluated as perennial bioindicators of O_x for two growing seasons at Waltham, in suburban Boston, and at South Deerfield, in the Connecticut Valley. Ten vines of each were planted at each location. Ives consistently exhibited extensive moderate to severe dark pigmented stipple and blotch. Van Buren showed occasional slight injury and Delaware none. During both seasons, O_x injury on Ives occurred more frequently and more extensively at South Deerfield than at Waltham.

A BIO-ASSAY FOR ASSESSING THE EFFECT OF SULFUR DIOXIDE ON OAT SEEDLINGS. Vincent J. Marchesani and Ida A. Leone, Allied Chemical, 1348 Block Street, Baltimore, MD 21231, Plant Pathology Dept., Cook College--Rutgers University, P. O. Box 231, New Brunswick, NJ 08903.

A bio-assay technique was developed to evaluate sulfur dioxide effects on the growth rates of oat seedlings. The system measured small changes in shoot length of seedlings *in vivo* with a millimeter ruler. The data, subjected to appropriate statistical evaluation, led to the conclusion that oat seedlings experienced subtle injury in the form of growth retardation during exposure to SO_2 concentrations close to ambient levels. Recovery of the seedlings was relatively rapid and indirectly proportional to sulfur dioxide concentration. However, recovery generally did not reach the pre-fumigation growth rate, indicating possible permanent growth impairment. Knowledge of such subtle injury to vegetation could lead to *in vivo* systems for the direct evaluation of air pollution effects on vegetation, expand knowledge in the areas of economic loss, or aid in the selection of tolerant species as buffer zones in land use planning.

THE RELATIONSHIP OF DENSITY OF CHLAMYDOSPORES OF FUSARIUM OXYSPORUM TO INFECTION OF TOMATO IN FUMIGATED AND NONFUMIGATED SOILS. J. J. Marois and D. J. Mitchell. University of Florida Department of Plant Pathology, Gainesville, Fl. 32611.

The relationship of inoculum density (ID) of *F. oxysporum* f. sp. *lycopersici*, which causes Fusarium crown and root rot of tomato, to percentages of infection of tomato was determined in nonfumigated soil and soil fumigated with methyl bromide-chloropicrin. Chlamydospores were formed from macroconidia after 4 weeks at 28C in deionized, autoclaved water. Two germinated Bonnie Best seeds were placed in a 100ml polypropylene beaker which contained 60g of infested soil layered over 50g of autoclaved sand. After 14 days at 20C the seedlings were plated on a selective medium. The experiment was repeated three times with 48 plants at each inoculum level. The percentages of seedlings infected in the nonfumigated soil were 10, 29, 45, and 94 at ID of 100, 500, 1000, and 4000 chlamydospores per gram of soil (dry weight), respectively. The percentages of infected seedlings in the fumigated soil were 22, 24, 67, and 93 at ID of 50, 100, 500, and 1000 chlamydospores per gram of soil, respectively.

A NEW BUD RUST OF SPRUCE IN INTERIOR ALASKA. J. H. McBeath, Institute of Arctic Biology, University of Alaska, Fairbanks, Alaska 99701

A rust that attacks the current year's leaf (needle) bud was found in the Fairbanks vicinity in 1977. This disease was most prominent on young seedlings. It attacked the terminal buds primarily; but occasionally it also infected one or two lateral buds. Bud rust infection first became visible in late May when the buds started to unfold. The infested shoots were bright yellow and severely stunted. Small spermogonia were found exclusively at the tip region of the needles. Aecia primordia, seen as long yellow streaks beneath the four bands of stomata, gave the needle a distinctive yellow color. By early June, aeciosori emerged from the host tissue and covered the entire length of the stunted needle except the tip region where the spermogonia were located. Later, the white peridial wall cracked and released many bright yellow aeciospores. The aeciosori remained active until mid-July; then the infested needle became dehydrated. Frequently, one or two of the lateral buds produced shoots—some were healthy looking but more often they were small and twisted. Several of these abnormal shoots were often produced by one lateral bud which gave it small witches' broom appearance. Aecia could also appear on needles of these shoots where they had close contact with the infested bud. However, no spermogonia could be found on these needles.

SCANNING ELECTRON AND LIGHT MICROSCOPY OF SPRUCE BUD RUST IN INTERIOR ALASKA. J. H. McBeath, Institute of Arctic Biology, University of Alaska, Fairbanks, Alaska 99701

From early May through June, samples collected periodically from bud rust infested spruce trees were prepared for scanning electron and light microscope studies. Spermogonia of the bud rust, found only at the tip region of the infested needle, were intraepidermal. When the needle matured, a slit developed on the cuticle, stretching into a pore-like form over the orifice of the flask-shaped spermogonia. Small spermatia were produced at the tapered tips of the singly branched sporophore as buds. Their size ranged from 1.6 to 2.0 μ in width and 2.0 to 3.8 μ in length, and their shape varied from oval or ovate to ellipsoid. The released spermatia were embedded in a mucilage which was exuded through the orifice, forming a honeydew. Aeciosori covered with white peridial wall was formed by the joining of a single layer of pentagonal and hexagonal shaped peridia. The outer surfaces of peridia were covered with a very coarse network; cleavages seen at the inner surface were fairly fine. Aeciospores produced from the sori were bright yellow. They ranged from between 10.9 and 25.0 μ in width and 23.4 and 34.4 μ in length. Approximately 1.0- to 2.0- μ -long annulated appendages covered the surface of the aeciospores. The shape of these appendages was cylindrical. Occasionally, partially cleaved appendages were seen as small patches, but no band or smooth area was ever observed.

RELATIVE FITNESS OF BENOMYL RESISTANT AND SENSITIVE POPULATIONS OF *VENTURIA INEQUALIS*. D.C. McGee and M. Zuck, Departments of Botany and Plant Pathology, Iowa State University, Ames, IA 50011, and University of Maine, Orono, ME 04473.

Isolates of *Venturia inequalis* (Cke.) Wint. were obtained from an apple orchard in Maine, where benomyl had been used exclusively to control apple scab and in which benomyl resistance had developed in the third year of the spray program. Isolates were classed as being either resistant or sensitive to benomyl, based on germ tube development of conidia placed on potato-dextrose agar amended with 5 μ g/ml benomyl. Separate benomyl resistant and sensitive populations and a 1:1 mixture of these populations were synthesized by pooling equal numbers of conidia of 11 resistant and 11 sensitive isolates. A similar group of populations also were synthesized from another 16 resistant and 16 sensitive isolates. Each population was inoculated onto separate groups of apple seedlings through several disease cycles, using conidia harvested from sporulating scab lesions as inoculum. All inoculations were made at the concentration of 200,000 conidia/ml. The proportions of benomyl resistant and sensitive conidia present after each cycle were determined using benomyl amended agar as described above. No changes were detected in the constituency of any of the separate resistant and sensitive populations. However, the proportion of resistant conidia in the mixed population gradually declined over 8 cycles in the first group of populations, while it increased over 4 cycles in the second group. This suggested that the fitness of these populations was independent of the characteristic of Benlate resistance.

VESICULAR-ARBUSCULAR MYCORRHIZAL UPTAKE OF CESIUM-134 IN TWO TROPICAL PASTURE GRASS SPECIES. A.-C. McGraw, J.F. Gamble, & N.C. Schenck, University of Florida, Gainesville, FL 32611

Ten mycorrhizal species from the genera *Glomus*, *Gigaspora*, *Acaulospora*, and *Sclerocystis* were independently inoculated on two grass species, *Pennisetum bahiagrass* (*Paspalum notatum*), and *Pangola digitgrass* (*Digitaria decumbens*), in miniature soil chambers and analyzed for mycorrhizal hyphal transport of cesium-134 (^{134}Cs) to the plants. Mycorrhizal or check plant roots were confined to soil in partitioned soil chambers (15 X 1.5 cm) and ^{134}Cs was injected 5 cm from roots in the vicinity of invading mycorrhizal hyphae. Digitgrass root growth in the injection area precluded any conclusions concerning this species. Infection of bahiagrass roots by two of the ten mycorrhizal species resulted in a two-fold increase of the radioactivity in leaf tissue 48 hours after injection, indicating that some mycorrhizal species enhance ion uptake. Limited hyphal growth or lack of mycorrhizal hyphal uptake of ^{134}Cs may account for the fact that the remaining species did not enhance uptake.

SEVERE STRAINS OF TOMATO MOSAIC VIRUS IN STAKED TOMATOES. J.M. McGuire, M.J. Goode and S.L. Wickizer, Department of Plant Pathology, University of Arkansas, Fayetteville, AR 72701.

Two severe symptom strains of tomato mosaic virus (ToMV) [tomato strains of tobacco mosaic virus (TMV)], occurred recently in staked tomatoes (*Lycopersicon esculentum* Mill.) in southeastern Arkansas. In 1976, severe leaf distortion and curling accompanied by purple coloring of leaves occurred in plants in a few fields and reduced yields. The incidence of this disease has increased. The virus was determined to be a form of TMV by differential host reactions, serological tests and observation of rod-shaped particles by electron microscopy. Symptoms were reproduced by mechanical inoculation of tomato in the greenhouse. An even more serious disease caused by ToMV first occurred in several fields of staked tomatoes of a hybrid variety, Pinkwrap, in May, 1978. The major symptoms were necrotic fruit blotches and streaks, and mosaic in leaves. Most fruits on affected plants were severely damaged and unmarketable. Fifteen virus isolates obtained from foliage and fruits reacted positively with TMV antiserum. Purified preparations contained

only rod-shaped particles. By mid-July the virus had spread throughout affected fields and symptoms were also evident in other tomato varieties. Foliar and fruit symptoms were reproduced in mechanically inoculated Traveler 76 tomatoes grown in field plots in late summer. Symptoms occurred in most plants inoculated at three different ages.

CONSUMER PREFERENCE TASTE TEST OF PEARS FROM TREES INFUSED WITH OXYTETRACYCLINE (OTC) TO REMIT PEAR DECLINE SYMPTOMS. John L. McIntyre, George H. Lacy, and Lester Hankin. Department of Plant Pathology and Department of Biochemistry, The Connecticut Agricultural Experiment Station, P. O. Box 1106, New Haven, CT 06504.

One year after pear trees with pear decline in two orchards were infused with OTC, fruit was randomly collected and pooled separately by treatment and by orchard for taste testing. The trees in orchard A had been infused with 0, 0.1 or 1.0 g OTC/tree (20 trees/treatment), and in orchard B with 0, 0.5, or 2.0 g OTC/tree (32 trees/treatment). Bioassay revealed no OTC-like activity in any of the pear samples. The samples from each pooled lot were prepared as uncooked sauce or fresh cubes, and tasted by a consumer taste panel using hedonic scale paired procedures. On each of 4 days, a minimum of 20 panelists tasted the same random pairs of samples (sauce or cubes from a single orchard). Chi-square analysis of paired similar samples showed reliability of the panel. Regardless of OTC rate or sample preparation, and on all 4 days, statistical analysis of paired dissimilar samples showed that the panel detected significant differences ($P < 0.01$) in the taste of fruit from treated trees as compared to fruit from untreated trees. On 3 days, fruit from treated trees was significantly preferred.

THE INFLUENCE OF PLANT SAP AND ANTIGEN BUFFER ADDITIVES ON THE ENZYME-IMMUNOASSAY OF TWO PLANT VIRUSES. M. R. McLaughlin and O. W. Barnett. Department of Plant Pathology & Physiology, Clemson University, Clemson, S. C. 29631.

Purified preparations of clover yellow vein virus (CYVV) and white clover mosaic virus (WCMV) were mixed with buffer and with homogenates of healthy red clover, *Trifolium pratense*, and white clover, *T. repens*, prepared with the same buffer. Leaf tissue was ground 1:4 (w:v) in phosphate-buffered saline (0.02M phosphate, pH 7.3, 0.15M NaCl, 0.003 M KCl) containing 0.05% Tween-20 (polyoxyethylene sorbitan monolaurate) with and without various combinations of 2.0% polyvinyl pyrrolidone (40,000 MW, PVP), 0.02 M sodium diethylthiocarbamic acid (NaDIECA), and 0.02 M 2-mercaptoethanol (2-ME). Alkaline phosphatase-labelled antibodies to CYVV and WCMV were used in the double antibody sandwich enzyme-linked immunosorbent assay (ELISA) of these virus preparations. Plant sap (red clover more so than white clover) decreased the sensitivity of the assay in both virus systems by increasing the level of non-specific background reactions and decreasing the level of specific reactions. The presence of NaDIECA and 2-ME helped decrease the level of these nonspecific background reactions and had no apparent effect or lessened the negative effect of plant sap on specific reactions in both virus systems. The presence of PVP also helped decrease the level of nonspecific background reactions in both virus systems. However, in the presence of PVP the level of specific reactions in the CYVV system decreased both with and without plant sap present. These findings indicate that the effect of buffer additives on various virus-host combinations should be examined carefully in order to optimize conditions for qualitative ELISA and may be critical to quantitative ELISA.

PATHOGEN AND SYMPTOM DEVELOPMENT OF SOYBEAN WITH ADULT PLANT RESISTANCE. Julia S. Mignucci and S. M. Lim, Department of Crop Protection, Mayaguez Campus, University of Puerto Rico, Mayaguez, Puerto Rico 00708, and Department of Plant Pathology, University of Illinois, Urbana, IL 61801, respectively.

Growth of *Microsphaera diffusa* Cke. & Pk. on individual leaves of soybean, *Glycine max* (L.) Merr. (cv. Clark, Cloud, Cutler, Hawkeye, Mukden, and Custer), at early seedling stage was followed by remission of fungal growth on later stages of plant development. Host reactions were variable (green and yellow 'islands', interveinal necrosis, necrotic specks, and crinkling of the leaf blade) and started appearing at time of remission of fungal growth. Mycelia and symptom development were affected by the cultivar, position and age of the leaf, and age of the plants at the time of inoculation. Designation of mature-plant-resistance response of *G. max* to *M. diffusa* requires several examinations of their interactions throughout the life span of the host.

AN ALFALFA SEEDLING ASSAY FOR DETECTION OF RESISTANCE TO PHYTOPHTHORA MEGASPERMA. S. A. Miller, J. A. G. Irwin and D. P. Maxwell, Dept. of Plant Pathology, Univ. of Wisconsin-Madison, Madison, WI 53706.

A rapid and efficient method for screening alfalfa seedlings for resistance to *Phytophthora megasperma* f. sp. *medicaginis* (Pmm) was developed. Forty alfalfa germplings were sown into water-tight cups containing a sand:vermiculite:perlite (1:2:1, v/v/v) mix infested with mycelium of Pmm. The moisture content was adjusted to 30% prior to sowing, then the cups were covered with plastic bags and placed in a growth room with a 14-hr photoperiod (11,070 lux) at 21 C in the light and 16 C in the dark. Three days after sowing, the bags were removed and 1 day later, the mix was saturated. For cultivars and breeding lines tested, the number of seedlings killed increased with the period of saturation and the inoculum concentration. At 7 days after saturation, the percentage of Vernal (susceptible) seedlings killed ranged from 0 to 100% at inoculum concentrations of 2.8×10^{-4} to 1.45×10^{-1} g dry weight of mycelium/kg dry weight of mix. The percentage of seedlings killed was always higher for Vernal than for Agate (moderately resistant). The seedling reactions of four alfalfa cultivars and 14 breeding lines were consistent with their reactions in mature plant tests. Thus, this seedling assay may be used in screening alfalfa for resistance to Pmm. This procedure was also useful in demonstrating the host specificity of *P. megasperma* isolates. Pmm (isolated from alfalfa) was pathogenic to alfalfa and not to red clover, whereas *P. megasperma* f. sp. *glycinea* (isolated from soybean) was not pathogenic to alfalfa.

EFFECTS OF ROW SPACINGS AND COTTON CULTIVARS ON DISEASES AND YIELD. E. B. MINTON, Plant Pathologist, USDA, AR, SEA in cooperation with the Texas Agric. Exp. Stn., Lubbock 79401.

Verticillium wilt susceptible 'Rilcot 90' and tolerant 'Paymaster 266' were grown with 1-, 2-, and 4-rows per 100 cm beds. The treatments were on the same plot for three years. The same seeding rate was used per meter of row for all row spacings, but stands were not related to seeding rates per ha. High stands were obtained with the close row spacings. Verticillium wilt was higher for Rilcot 90 than for Paymaster 266 and was reduced by close row spacings. Highest lint yields occurred with 2-rows per bed and the lowest were with 1. During the fourth year, seed of Verticillium wilt susceptible 'Lockett 4789A' and tolerant 'Paymaster 909' were planted in rows 100 cm apart. Seedling disease was higher and plant populations were lower following 2- and 4-rows than 1-row per bed, and were more intense after Rilcot 90 than after Paymaster 266. Verticillium wilt was lower following Paymaster 266 than following Rilcot 90.

VIRUSES INFECTING CUCURBITS IN NORTHERN IRAQ. Hassan Amin Mohammed and Ihsan Shafik Damirdagh, Dept. of Biology, College of Sciences, University of Sulaimaniya, Sulaimaniya, Iraq.

Identity and distribution of viruses infecting cucurbits were studied in a survey during 1977-1978 in the cucurbit-growing areas of Sulaimaniya and Al-Tamim governorates. The viruses were preliminarily identified by the use of the following plants: *Chenopodium amaranticolor*, *Citrullus vulgaris*, *Cucumis melo*, *Cucurbita pepo*, *Lavatera trimestris*, *Nicotiana glutinosa*, *Nicotiana tabacum*, and *Vigna sinensis*. The identity of the virus was established by studying the host range, physical properties, morphology in the electron microscope, and by serological tests. Three viruses were identified. These were watermelon mosaic virus - 2 (WMV-2), cucumber mosaic virus (CMV) and tobacco ringspot virus (TRSV). WMV-2 was more widespread than the others whereas TRSV was prevalent in the tobacco-growing areas included in this study. Thermal inactivation point of WMV-2 was 60 C; dilution endpoint was 1:1000, aging in vitro was 6-7 days. Thermal inactivation point of CMV was 60-65 C, dilution endpoint was 1:1000-1:10,000, aging in vitro was 2-3 days. Thermal inactivation of TRSV was 65 C, dilution endpoint was 1:1000-1:10,000, aging in vitro was 5-7 days.

SCREENING CABBAGE GERMLASM FOR RESISTANCE TO ALTERNARIA BRASSICICOLA. Arnold R. Moody and P. S. Benepal, Department of Life Sciences, Virginia State College, Petersburg, Virginia 23803.

Cabbage germplasm consisting of 572 Plant Introductions and commercial varieties was examined for resistance to *Alternaria* leaf spot under field conditions during 1976, 1977, and 1978. Single rows of 21 seedlings of each accession were planted in May and rated for resistance in August. The disease ratings were obtained by counting the number of lesions on the individual plants and estimating an average/plant/row. The rating

system used was: 1 = 0 lesions/plant, 2 = 1 to 10 lesions/plant, 3 = 11-25 lesions/plant, 4 = 26-50 lesions/plant, and 5 = 51-100 lesions/plant. Only the cultivar Storage Red was free of disease all three years while the cultivars Red Acre, Mammoth Red Rock, Keystone Hybrid 7234, and three red leafed Plant Introductions (244993, 246069, and 246109) were free from disease during two years.

BIOLOGICAL PROTECTION OF PLANTS AGAINST CROWN GALL. Larry W. Moore, Dept. of Botany and Plant Pathology, Oregon State Univ., Corvallis, OR 97331.

Biological control of crown gall with Kerr's *Agrobacterium radiobacter* strain 84 has been remarkably successful in numerous countries. To obtain control, roots, cuttings, seed, or graft unions are dipped or sprayed with an aqueous suspension of the antagonist at about 10^7 viable cells/ml. The antagonist produces a bacteriocin (agrocin 84) that apparently protects the tissues against agrocin-sensitive strains of *A. tumefaciens*. Pathogenic strains insensitive to agrocin 84 usually will infect plants, especially if the pathogen produces a bacteriocin against strain 84. Strain 84 is used as a preventative measure, because it will not prevent latent infections from developing. A number of rhizosphere fungi and bacteria including other strains of *A. radiobacter* will inhibit *A. tumefaciens* in vitro, but none have been as effective as strain 84 in controlling crown gall in the field.

A SOFT ROT OF EUPHORBIA TRIGONA CAUSED BY RHIZOPUS STOLONIFERA. E. N. Mulrean and A. H. McCain, Dept. of Plant Pathology, University of California, Berkeley, CA. 94720.

Euphorbia trigona is propagated commercially by rooting cuttings taken from the fleshy stem. A rapidly advancing soft rot of cuttings and mother plants was observed. *Rhizopus stolonifera* (RS) was consistently isolated from these tissues and pathogenicity was confirmed by inoculating healthy plants. To study the effects of temperature on disease development, freshly cut stems of *E. trigona*, growing at 16, 21, 27 and 32 C, were inoculated with sporangiospores from a 48 hr culture of the pathogen grown on PDA. Plants growing at 16, 21 and 27 C all showed typical symptoms of the rot within 48 hr. No differences were noted in the rate of symptom development or disease severity at these three temperatures. As a result of the more rapid callus formation, none of the plants growing at 32 C became infected. A host range study was conducted using six species of *Euphorbia* grown at 27 C. *E. trigona*, *E. lactea*, *E. mammillaris* and *E. leuconeura* were susceptible and *E. nivula* and *E. tirucalli* were resistant. All four of the susceptible species tended to be fleshy and remained moist for several hours following cutting, while the resistant species tended to be woody and the cut surface dried rapidly. The inability of RS to infect *E. trigona* at 32 C suggests that propagation at or above 32 C would be an effective control.

IN VITRO AND IN VIVO CHEMOTAXIS BY PSEUDOMONAS PHASEOLICOLA. E. N. Mulrean and M. N. Schroth, Dept. of Plant Pathology, University of California, Berkeley, CA. 94720.

Strongly chemotactic and non-motile isolates were selected from a Rifampicin® marked strain of *Pseudomonas phaseolicola*, were used to study the role of chemotaxis and motility in leaf invasion. A capillary assay indicated that chemotactic responses occurred at concentrations as low as 10^{-6} M for alanine, glycine, ornithine and serine. Seven-day-old primary leaves of *Phaseolus vulgaris* 'Red Kidney' were vacuum infiltrated with phosphate buffer or 1 mM serine in phosphate buffer. Plants were then immersed in a suspension of motile cells of *P. phaseolicola* (6×10^7 cfu/ml) for 1, 5, and 10 minutes. Leaves pre-treated with serine consistently showed a greater accumulation of the pathogen per cm² of leaf tissue. This response to serine was most pronounced in the first 60 sec (1.28×10^5 cfu/cm² leaf tissue for the serine treatment compared to 4.6×10^4 cfu/cm² for the buffer treatment). A similar experimental design was used to determine if chemotaxis facilitates location of wounds on the leaf surface. Leaves infiltrated with buffer and wounded with a thin glass rod were immersed in a cell suspension. After 10 min, 2.75×10^4 cfu/cm² were recovered from wounded areas and 1.3×10^3 cfu/cm² were recovered from unwounded areas of the same leaf. It was shown, using a non-motile, flagellated isolate that accumulation was not due to an increase in attachment sites caused by wounding, since the non-motile isolate showed no difference in accumulation between wounded and unwounded areas. These data indicate that *P. phaseolicola* is chemotactic and that directed motility is important in location of infection courts by the pathogen.

YIELD INCREASES IN RESISTANT AND SUSCEPTIBLE BARLEYS DUE TO FOLIAR FUNGICIDES. Roger R. Musick, Roy D. Wilcoxson, Dennis Warness, and Larry Smith, University of Minnesota, St. Paul, MN 55108.

In two natural epidemics of spot blotch, caused by *Helminthosporium sativum*, the average grain yield of Larker (susceptible) was 3014 kg/ha in plots sprayed with Dithane M-45 (2240 g/ha) at the boot stage of growth and 5 days later, and 2530 kg/ha in the unsprayed Larker plots. Average grain yields of Manker (resistant) were 2853 kg/ha in the sprayed plots and 2745 kg/ha in the unsprayed Manker plots. When Larker was sprayed 4-5 times it equalled yields from unsprayed Manker plots. In an artificial epidemic, the yield of Larker was 2153 kg/ha in plots sprayed with Dithane M-45 and 2422 kg/ha in plots sprayed with Rohm and Haas formulation 2161 (561 g/ha); the yield of the control plot was 1669 kg/ha in the Dithane M-45 test and 1400 kg/ha in the RH2161 test. The yields of Manker were 2691 kg/ha in the Dithane M-45 plots, 2853 kg/ha in the RH2161 plots, and 1830-2045 kg/ha in the unsprayed control plots. Kernel plumpness in Manker and Larker increased 15-20% and 30-40%, respectively, due to fungicides. Test weights were increased 116 g/liter for Larker and 40 g/liter for Manker by spraying.

EFFECT OF ORGANIC COMPONENT IN CONTAINER GROWING MEDIA ON SUPPRESSION OF RHIZOCTONIA DAMPING-OFF. E. B. Nelson and H. A. J. Hoitink, Department of Plant Pathology, Ohio Agricultural Research and Development Center, Wooster, OH 44691.

Celosia cv. 'Red Fox' was seeded in rows in flats (12.5 x 17 cm, two rows/flat) filled with container media consisting of various organic components, perlite and sand (5:3:2, v/v). Canadian peat (CP), composted hardwood bark (CHB), composted pine bark (CPB) and various ratios of peat and bark were the organic component. Available plant nutrients in all media were adjusted to similar levels (pH 6.4). Individual flats were placed in polyethylene bags and incubated at 27 C day (27 K. lux, 14 hr) and 21 C night temperatures. At emergence (3 days after seeding) inoculum of *Rhizoctonia solani* (10 mm disk from a 48 hr PDA culture) was placed 0.5 cm below the medium surface directly adjacent to the first seeding in each row. The length of seedling row damped-off after 8 days determined the relative suppressive effect of a container medium. Mean row lengths of damped-off seedlings in CHB, CPB and CP media were

0.0, 7.6 and 8.3 cm, respectively. Similar results were obtained with CHB and CPB from a variety of sources. Substitution of 0, 36, 50, 72, and 100% of the CHB in the organic component fraction with CP (v/v) resulted in mean damped-off row lengths of 0.0, 2.3, 5.1, 5.8 and 8.3 cm, respectively. It is concluded that composted hardwood bark suppressed *Rhizoctonia* damping-off while composted pine bark is as conducive as Canadian peat.

WINTER INJURY TO CHRISTMAS TREES. Thomas H. Nicholls. North Central Forest Experiment Station, USDA Forest Service, 1992 Foilwell Avenue, St. Paul, MN 55108.

The weather during the winter of 1977-78 caused severe winter injury to many Christmas tree species and varieties in the north central United States. To obtain information on susceptibility of various conifer species to winter injury, 2,000 trees of ten species were evaluated in Wisconsin and Minnesota (between 44° and 46° N latitude) in the spring of 1978. Long-needled varieties of *Pinus sylvestris* were much more resistant to winter injury than were short-needled varieties; the Spanish variety was the most susceptible. No winter injury was observed on *P. resinosa*, *Picea glauca*, or *P. pungens*. The following species were susceptible to winter injury, in order of increasing susceptibility: *Abies fraseri*, *A. balsamea*, *Pseudotsuga menziesii*, *Picea abies*, *Pinus strobus*, and *P. nigra*. As expected, winter injury was more severe in large, unprotected open fields. Severe winter injury occurs periodically and can increase the normal rotation length of susceptible trees by two or more years. It kills foliage and, in severe cases, buds and branches, reducing tree quality and salability. Winter injury stress may increase the susceptibility of trees to needlecast diseases. Winter-injury susceptibility should be considered when selecting species and varieties for Christmas tree planting.

ENZYMES FROM PEA TISSUE DEGRADE FUSARIUM SOLANI CELL WALLS; CHITOSAN FRAGMENTS BOTH INDUCE PISATIN AND INHIBIT FUNGAL GROWTH. Everett J. Nichols and Lee A. Hadwiger, Washington State University, Pullman, WA 99164

Highly purified cell walls of *F. solani* when applied to pea endocarp tissue are visibly degraded in 24 h. Acetone powders of pea tissue cleave β 1,4 linked N-acetylglucosamine residues

and de-acetylate N-acetylglucosamine. Since fungal cell walls contain chitin, preparations of chitin and its de-acetylated derivative chitosan were evaluated both as inducers of pisatin and as antifungal agents. Chitosan applied to pea endocarp tissue induced up to 500 μ g pisatin/g fr. wt. in 24 h compared with < 30 μ g induced by chitin or tri- and tetra-N-acetylglucosamine polymers. Pisatin inducers are also released when *F. solani* cell walls are digested with pea enzymes. Chitosan terminates the growth of *F. solani*. The pathogenic *f. sp. pisi* is completely arrested on endocarps when macrocoidia are administered with or subsequent to applications of chitosan. Polymers of amino sugars present in fungal walls both elicit host responses and directly suppress pathogenic fungi.

CONTROL OF POTATO EARLY BLIGHT WHEN FOLLOWING A POTATO LATE BLIGHT FORECASTING SPRAY SCHEDULE. F. W. Nutter, Jr. and W. E. MacHardy, Department of Plant Pathology, The Pennsylvania State University, University Park, PA 16802 and Department of Botany and Plant Pathology, University of New Hampshire, Durham 03824, USA.

Forecasting systems designed to control one specific pathogen cannot be relied upon to control other pathogens of the same crop every season. The traditional grower's spray program (10-12 sprays) normally controls *Alternaria solani* (early blight), as well as *Phytophthora infestans* (late blight). However, late blight forecasting systems time fungicide applications to coincide with periods favorable for infection and build-up by *P. infestans*, not *A. solani*. Hence, to be considered for adoption as part of a potato pest management program, three potato late blight forecasting systems were compared to a standard grower's late blight fungicide schedule for their ability to accurately time fungicide sprays to control potato early blight. No system controlled early blight efficiently as indicated by either an excess number of recommended sprays required to control both pathogens or higher percent defoliation and lower yield compared to the traditional fungicide program. Therefore, other methods were evaluated for their ability to accurately determine when additional fungicide applications are required to obtain adequate control of early blight when using a late blight forecasting system to time fungicide sprays. A tomato early blight forecasting model was evaluated for its accuracy in predicting the occurrence of early blight on potatoes and tomatoes in New Hampshire in 1977. Trapped *A. solani* spores or the initial observation of early blight lesions appeared to best indicate when fungicides should be applied to control early blight when following a potato late blight forecasting system in New Hampshire.

MATURE TISSUE RESISTANCE IN BEAN TO *PSEUDOMONAS PHASEOLICOLA*. T. Oguchi and S. S. Patil, Department of Plant Pathology, University of Hawaii, Honolulu, Hawaii 96822.

A time course study in which symptomatology, bacterial growth and phaseotoxin levels in primary leaves of susceptible Red Kidney beans of different ages inoculated with *P. phaseolicola* were compared. Leaves of 5 day old plants showed typical disease symptoms and maximum bacterial growth ($10^9/1.2\text{cm}^2$) and phaseotoxin level ($917\text{u}/1.2\text{cm}^2$) 5 days after inoculation. In tissues of 6, 7, and 8 day old plants the symptoms were a mixture of water soaking and silvering, bacterial growth about the same as in 5 day old plants, however, phaseotoxin levels were substantially reduced after the same time period after inoculation. In tissues of 11 and 14 day old plants there was no water soaking, only silvering, and bacterial growth was reduced slightly. However, in these tissues phaseotoxin levels were drastically reduced. These results indicate that a gradual expression of resistance occurs as Red Kidney tissues become mature and that presence of phaseotoxin in inoculated tissues is essential for the development of susceptibility.

INFECTION OF JUNIPERUS VIRGINIANA BY *KABATINA JUNIPERI*. Andrea Ostrofsky and Glenn W. Peterson, Dept. of Plant Pathology, Univ. of Nebraska, and Rocky Mtn. Forest and Rge. Exp. Stn., Forestry Sci. Lab., Univ. of Nebraska, Lincoln, NE 68583 U.S.A.

Kabatina juniperi is associated with branch tip dieback of *Juniperus virginiana* in eastern Nebraska. Infected branch tips become discolored in early spring when *J. virginiana* loses its winter coloration. Acervuli are present but not yet erumpent in February and early March. Erumpent acervuli are most numerous in April, but present in decreasing numbers through October. Isolates from various Nebraska locations exhibited variability in colony characteristics. The fungus grew in malt extract broth at 8, 12, 16, 20, 24, and 28 C, with maximum growth at 24 C. Spores germinated on water agar at 5, 8, 12, 16, 20, 24, 28, and 32 C; percent germination and germ tube lengths were optimum at 24 C. Spores incubated at 36 C did not germinate and were no longer viable. Wounding of healthy fol-

age prior to inoculation was necessary for infection at 16, 20, 24, and 28 C, 100 RH. Scanning electron micrographs reveal that the fungus entered the plant through wounds.

INFECTION OF POPULUS TREMULOIDES BY HYPOXYLON MAMMATUM AT OVIPOSITION SITES OF CICADAS (MAGICICADA SEPTENDECIM)(L.). Michael E. Ostry and Neil A. Anderson. North Central Forest Experiment Station, USDA Forest Service, 1992 Folwell Avenue, St. Paul, MN 55108, and Department of Plant Pathology, University of Minnesota, 304 Stakman Hall, St. Paul, MN 55108.

To study the infection process of *Hypoxyylon mammatum* a plantation of aspen (*Populus tremuloides*) was established from controlled crosses in 1971 on the Nicolet National Forest in Wisconsin. In the summer of 1976 an outbreak of the periodic cicada (*Magicicada septendecim*)(L.) resulted in extensive injury to one- and two-year-old branch wood by females during oviposition. Of 134 new branch cankers noted in August 1978, 118 originated at oviposition sites of the cicada, 10 at galls of *Saperda inornata*, and the origin of 6 could not be determined. Before 1978, 12 cankers had developed on plantation trees, 7 at cicada wounds, 4 at galls of *S. inornata*, and 1 origin could not be determined. In August 1978, a random sample of 365 2-year-old cicada wounds on aspen surrounding the plantation were examined; 47 of these wounds were infected by *H. mammatum*. One feature common to all but one infected cicada wound examined was failure of the wound to close tightly. High levels of *Hypoxyylon* infection have been observed in certain years. Occasional outbreaks of large numbers of cicada in an area and the subsequent injury to aspen branches could account for the periodic high infection levels of *Hypoxyylon*.

EFFECT OF THE HERBICIDE DACTHAL ON MYCORRHIZAL DEVELOPMENT OF PINUS RESINOSA AIT. IN NORTHERN WISCONSIN. J. G. Palmer, Jr., J. E. Kuntz, and J. G. Palmer, Sr., Dept. of Plant Pathology, Univ. of Wisconsin-Madison, Madison, WI 53706, and Center for Forest Mycology Research, USDA/FS, Forest Products Laboratory, Madison, WI 53705.

Dacthal W-75 (dimethyl tetrachloroterephthalate) is a selective pre-emergence herbicide widely used in tree nurseries for the control of many annual grasses and certain broadleaved weeds. Water suspensions of this formulation at rates of 10, 15, 20, 25, and 30 lb/A were sprayed overall, lightly raked, and overhead irrigated into light sandy soil of randomized treatment plots (each 1/280 A) in six complete blocks immediately following site preparation and transplanting with 3-l red pine (*P. resinosa*) seedlings lifted from nontreated nursery seedbeds. In late October, 10 trees from each plot were carefully dug, examined for mycorrhizal short roots, and measured for total shoot growth. Results showed that these mid-May soil treatments with Dacthal W-75 to newly planted transplant beds did not reduce either the total number or the percent of mycorrhizal short roots of pine seedlings when compared to short-root development on seedlings from nontreated beds. In fact, the greatest number of mycorrhizal short roots developed on trees in beds treated with 20 and 25 lb/A rates. Shoot dry weights of trees from treated plots did not differ significantly from shoot weights of nontreated trees.

RESISTANCE OF POPLARS TO SEPTORIA LEAF SPOT IN RELATION TO SEPTORIA CANKER RESISTANCE. Marguerita A. Palmer and Arthur L. Schipper, Jr. North Central Forest Experiment Station, USDA Forest Service, 1992 Folwell Avenue, St. Paul, MN 55108.

Septoria musiva Peck causes a serious leaf spot and canker of *Populus* spp. in the north central United States. To determine if a relation exists between leaf spot and canker susceptibility, 38 poplar clones planted at Ames, IA (2-year-old), and Rosemount, MN (3-year-old), were rated for *Septoria* leaf spot and canker severity in August of 1978. Leaf spot severity was rated on a scale of 0 (no leaf spot) to 9 (heavy leaf spot on most leaves) and canker severity on a scale of 0 (no cankers) to 9 (tree dead or dying from cankers). There was no linear relation between susceptibility to the two types of the disease. Clones with severe leaf spot and severe canker were found as well as clones with severe leaf spot but no canker. Clones with light to moderate leaf spot always had few or no cankers. The nature of susceptibility to *S. musiva* leaf spot and canker may be related to genetic background of the clone. Seven of nine clones highly susceptible to both leaf spot and canker had a *P. trichocarpa* parent. All *P. x euramericana* clones had low to moderate leaf spot and few cankers. Clones resistant to *Septoria* leaf spot cannot be identified by examining dormant poplars for *Septoria* canker, but clones resistant or moderately resistant to *Septoria* leaf spot tend to be resistant to canker. Therefore, selection of young trees resistant to *Septoria* leaf spot and canker should be based on leaf spot severity.

PLASMID RSF1010, A POTENTIAL CLONING VECTOR IN PSEUDOMONAS PHASEOLICOLA. N. J. Panopoulos, Department of Plant Pathology, University of California, Berkeley, CA. 94720.

RSF1010, a multicopy 5.5 Mdal non-conjugative plasmid conferring resistance to streptomycin and sulfonamides, has been used as a vector for cloning EcoRI-generated DNA fragments in *P. putida* and *P. aeruginosa*. Its ability to replicate and, therefore, its potential usefulness as a vector, in *P. phaseolicola* was investigated. A strain of *E. coli* C600 harboring RSF1010 and the conjugative plasmid RK2 (the latter conferring resistance to carbenicillin, neomycin/kanamycin and tetracycline, i.e., Cb^r, Am^r/Km^r, Tc^r) was mated with *P. phaseolicola*. Transconjugants selected for Sm^r were of two types: Sm^r, Su^r, Cb^r, Nm^r/Km^r, Tc^r (presumably RSF1010⁺, RK2⁺) or Sm^r, Su^r, Cb^s, Nm^s/Km^s, Tc (presumably RSF1010⁻). The latter did not transmit Sm^r to *E. coli* but became active donors of Sm^r and Su^r after acquisition of RK2 in a separate mating. The data indicate that RSF1010 can exist as an independent plasmid in *P. phaseolicola* and it is readily mobilized by P-group plasmids. These properties should permit the introduction and propagation of RSF1010-recombinant molecules in this organism from a transformable primary cloning host, such as *E. coli*, in which RSF1010 also replicates autonomously. A two-stage cloning scheme involving RSF1010 as a vector, *E. coli* as a primary host and *P. phaseolicola* avirulent mutants as secondary recipients, is being explored as a means for cloning and identifying specific segments of DNA from *P. phaseolicola* containing virulence genes.

THE EFFECT OF ORTHOPHOSPHATE ON THE INACTIVATION OF ORNITHINE CARBAMOYLTRANSFERASE BY PHASEOTOXIN. O. Kwok, S. S. Patil, and H. Ako, Department of Plant Pathology and Department of Agricultural Biochemistry, University of Hawaii, Honolulu, Hawaii 96822.

The exotoxin of *Pseudomonas phaseolicola*, phaseotoxin, inhibits bean ornithine carbamoyl transferase (OCT). The inactivation is an example of active-site-directed irreversible inhibition, since it is prevented by high concentrations of one of the substrates, carbamyl phosphate. Orthophosphate, which is a product of hydrolysis of carbamyl phosphate by OCT, also protects the enzyme from inactivation, and the protection is dose dependent. In the presence of orthophosphate the initial inactivation rate is decreased and the half time of inactivation is increased. However, the protection is limited by the fact that at higher concentrations, phosphate itself is inhibitory to OCT. At low concentrations (below 1mM) the protective effect is not permanent and the inactivation is ultimately complete at concentrations of phosphate tested (0.1 to 1mM). Nevertheless, the inactivation half time is greatly lengthened.

LIBERATION OF ASCOSPORES OF EUTYPA ARMENIACAЕ. R. C. Pearson, Dept. Plant Pathology, N.Y. State Agric. Expt. Sta., Cornell Univ., Geneva, N.Y. 14456, USA.

Liberation of ascospores of *Eutypa armeniacae* Hansf. & Carter, the cause of *Eutypa* dieback of grape (*Vitis* sp.), was studied under field conditions. Concord grape stumps containing the perithecial stage of *E. armeniacae* were placed around a Burkard volumetric spore trap which was located at a weather station at Geneva, N.Y. Ascospore release began 1 to 2 hr after initiation of rainfall, continued throughout the rainy period, and ceased after rainfall ended and stromata dried. Water from snowmelt also stimulated ascospore discharge. Ascospores were released during each period of rainfall throughout the year, but the months with highest counts were January, February, March and April. Ascospore discharge declined greatly in the summer months. Grape stumps containing *E. armeniacae* stromata were collected from a vineyard in early November, 1977, and stored in the laboratory under environmental conditions of 20 to 24 C and 40 to 50% relative humidity; at monthly intervals they were soaked in water for 1 hr and then placed in a spore discharge tower for another hour. Ascospore counts from these stumps stored in the laboratory showed similar seasonal periodicity during 1978-1979 as counts from spore trapping in the field. No explanation of this phenomenon is available at present. Maximum release of ascospores from this wound pathogen during winter and early spring is significant since this is the time of grape pruning in New York State.

ALTERED TUBER QUALITY OF POTATO PLANTS EXPOSED TO OZONE. Pell, E.J., W. C. Weissberger, J. Speroni, Department of Plant Pathology & Center for Air Environ. Studies, The Pennsylvania State University, University Park 16802.

Potato plants of 'Norland' and 'Kennebec' cultivars (cvs) were exposed to 0.20 ppm ozone for 3 hr once every 2 wk throughout their growth. At 120 and 140 days, tubers of Norland and Kennebec, respectively, were harvested from exposed and nonexposed plants. The experiment was conducted in 1977 and again in

1978. Ozone induced severe foliar injury to Norland and slight injury to leaves of Kennebec. Ozone reduced (i) tuber number 19% and 22% in Norland, and 40% and 32% in Kennebec, and (ii) tuber weight 30% and 28% in Norland, and 51% and 30% in Kennebec, in 1977 and 1978 respectively. Ozone induced elevated levels of fructose, and α - and β -glucose in tubers from both cvs while sucrose was unaffected. Increases in the reducing sugars may have resulted from decreases in starch levels. An 8-26% reduction in total solids of tubers harvested from ozonized plants supports this hypothesis.

DETECTION OF POTATO SPINDLE TUBER VIROID IN FIELD-GROWN POTATOES BY A MODIFIED POLYACRYLAMIDE GEL ELECTROPHORESIS PROCEDURE. M. A. Pfannenstiel, S. A. Slack, and L. C. Lane, Departments of Plant Pathology, University of Wisconsin-Madison, Madison, WI 53706, and University of Nebraska, Lincoln, NB 68503, U.S.A.

Potato spindle tuber viroid (PSTV)-infected tubers of 14 potato cultivars were field-planted and shoot apices indexed by polyacrylamide gel electrophoresis (PAGE) at monthly intervals. All PSTV assays were positive in June and July, but, in August, PSTV was not detected in two of 42 assays, and PSTV bands in gels were less distinct. Healthy controls indexed negative. In greenhouse tests to quantify PSTV, recovery ranged from 0.64-2.20 μ g PSTV/g tissue among these cultivars. Nucleic acid extraction and PAGE procedures were similar to those reported by Morris and Smith (Phytopathology 67:145) except that LiCl fractionation was included in the initial homogenization, dialysis was omitted, and gels were stained with ethidium bromide (Schumann *et al.*, Phytopathology 68:1256). The modifications enabled PSTV assays to be completed in one day.

IDENTIFICATION AND EVALUATION OF POTENTIALLY BENEFICIAL PESTICIDE INTERACTIONS IN SOYBEAN PRODUCTION. D. V. Phillips and J. W. Todd, University of Georgia, Georgia Experiment Station, Experiment, GA 30212 and Coastal Plain Experiment Station, Tifton, GA 31794.

During the past four years we have evaluated fungicides and insecticides for interactions which might be exploited to increase the efficiency of disease or insect control. The effects of various insecticides, fungicides, or combinations on diseases or insect populations have varied considerably with the soybean cultivar used. This may be due to genetic differences which influence resistance or tolerance to the pests involved. The fungicides triphenyltin hydroxide (TPTH) and pyrazophos have consistently reduced insect populations and/or reduced insect feeding or damage to the plant. One or both fungicides has shown activity against soybean looper, velvetbean caterpillar, corn earworm and stink bugs. In some cases they have also significantly reduced populations of beneficial insects and spiders. The combinations of TPTH with carbaryl, diflubenzuron, methomyl, or acephate resulted in significantly better insect control than either component used alone. At least one of these combinations increased the control of soybean looper, corn earworm, and velvetbean caterpillar. In some cases fungicides have reduced the numbers of insect larvae killed by the fungus *Nomuraea rileyi* but this apparently did not contribute to significantly higher insect populations. We have not observed improved disease control by the insecticides alone or in combinations with fungicides.

EVALUATION OF HOT-WATER INJURY TO PEACHES, Douglas J. Phillips, U.S. Department of Agriculture, 2021 S. Peach Ave., Fresno, California 93727.

Postharvest injury of fruit has been associated with (1) water loss during storage, (2) surface browning (sometimes called brown stain), and (3) dye absorption. Injury of heat-treated peaches was examined by utilizing peach cultivars with differing maturity dates and correlating treatments with the above factors. Samples from each cultivar were left untreated, or were treated with 45 or 50C water for 1.5, 2.5, or 5 minutes. Immediately after treatment some peaches were dipped in 0.5 g fast green FCF and 0.5 ml detergent (Multi-film X 77, Colloidal Products, Sausalito, Calif.). Other treated peaches were held 2 days at 2.5C, RH 95% followed by 4 days at 18C, RH 70%, after which they were evaluated for moisture loss and surface browning. There was an increase of fast green absorption, external browning, and weight loss as the time and temperature of the hot-water treatment increased. Cultivars maturing early in the summer lost more weight in storage than late-maturing cultivars.

SCLEROTINIA BLIGHT OF SOYBEAN IN VIRGINIA. P. M. Phipps and D. M. Porter. Tidewater Research and Continuing Education Center, Holland Station, Suffolk, Virginia 23437/USA.

In August 1978, Sclerotinia blight of soybean was found in several fields planted to Essex and York soybean in southeastern Virginia. Surveys of infected plants in each field yielded only a few dead plants with symptoms and signs of Sclerotinia blight. No significant suppression of crop yield and/or value was apparent. With one exception, the fungus associated with the disease in soybean was identical to descriptions and reference standard isolates of *Sclerotinia minor* from peanut. In one field, a large sclerotia-producing isolate was found associated with diseased soybean plants. This isolate has been tentatively identified as *Sclerotinia sclerotiorum*. Pathogenicity tests with 4-week-old peanut and soybean seedlings have demonstrated that both species of the fungus are virulent on both hosts. Although sclerotinia blight appeared to cause only minor damage to soybean, we believe that rotation of soybean and peanut crops has contributed to the increased severity of this highly destructive disease on peanut.

ROOT ROT OF CELERY SEEDLINGS CAUSED BY RHIZOCTONIA SOLANI. David J. Pieczarka, Agricultural Research and Education Center, Belle Glade, Florida 33430.

A common root rot of celery seedlings grown on organic soils of south Florida is characterized by vascular discoloration in the tap root resulting in foliage yellowing, stunting, and occasionally plant death. *Rhizoctonia solani* and *Fusarium* spp. frequently were isolated from the discolored tissue. In pathogenicity tests the root rot symptoms were reproduced with *R. solani* only. The internal root discoloration was associated with lesions on the root exterior or on the base of petioles. In greenhouse tests the celery varieties Florimart, Earlibelle, June-Belle, Florida 2-14, Florida 683 and lines 1624 and 2192 were equally susceptible to *R. solani*. In seedbeds, removal of plant material after topping and varying plant population densities from 215 to 1076 plants/m² had no apparent effect on root rot severity. Control was achieved with weekly seedbed drenches of either Dithane M-45 + Benlate 50W, Kocide 101, Bravo 6F, Difolatan 4F and Benlate + Difolatan at 6.8 + 2.2, 3.4 kg/ha, 2.3, 14.0 l/ha and 1.1 kg/ha + 14.0 l/ha, respectively.

CROWN ROT OF GLOXINIA INCITED BY PHYTOPHTHORA NICOTIANAE VAR. PARASITICA. R. C. Ploetz and Arthur W. Engelhard, University of Florida, Agricultural Research & Education Center, 5007 60th Street East, Bradenton FL 33508

A crown rot of Gloxinia (*Sinningia speciosa* Convariety Fyfyiana) in commercial greenhouses was incited by *Phytophthora nicotianae* var. *parasitica* Dastur. The pathogen infects the stems (crown), leaves, and corms of plants and is most severe during the warmer months of the year (March-November). Crown infection causes the plant to wilt. Necrotic tissue occurs as a soft, wet decay, develops in the crown, and subsequently extends to the leaf petioles and bases of the leaves in a radiating pattern. High inoculum levels resulted in rapid wilting (2-3 days after inoculation), whereas low inoculum levels resulted in slower disease development (wilt within 8 days). Both inoculum levels almost always led to mortality. Good disease control was provided by experimental CGA-48988 (Ciba-Geigy Corp. Greensboro, N.C.), and poor or no control by Truban, Banrot, and experimental Ortho 20615 (Chevron Chem. Co., Richmond, CA).

SUPPRESSION OF SCLEROTINIA BLIGHT OF PEANUTS WITH HERBICIDES. D. M. Porter and O. E. Rud. USDA, SEA, Tidewater Research Center, Suffolk, VA 23437.

Dinoseb and naptalam plus dinoseb (concn of 1 to 5 ug/ml) inhibited mycelial growth of *Sclerotinia minor* on amended potato-dextrose agar (PDA). Suppression of mycelial growth was more pronounced on PDA amended with dinoseb alone than on media containing naptalam plus dinoseb. Dinoseb completely inhibited mycelial growth at 80 ug/ml. Other herbicides including naptalam, vernolate, alachlor and 2,4-DB used at conc of 15 ug/ml were not effective in reducing mycelial growth. Pre-emergent applications of dinoseb or naptalam plus dinoseb applied at cracking of peanuts did not reduce the incidence of Sclerotinia blight. Post-emergent applications significantly reduced disease incidence. Dinoseb was more effective in reducing disease incidence than naptalam plus dinoseb. Pod yields averaged 1997, 2295 and 2470 kg/ha in nontreated, naptalam plus dinoseb and dinoseb treated plants, respectively. Values/ha were 17% and 28% greater in plots treated with naptalam plus dinoseb and dinoseb, respectively, than nontreated.

INTERACTIONS BETWEEN OZONE AND CERTAIN BIOPATHOGENS ON SOYBEAN CULTIVAR HODGSON. Gregory C. Pratt and Sagar Krupa. Department of Plant Pathology, University of Minnesota, St. Paul, MN 55108.

Inoculation of appropriate hosts with certain biopathogens prior to exposure to ozone can reduce injury due to the ozone.

When soybean cultivar Hodgson was inoculated with *Pseudomonas glycinea* under our experimental conditions, well developed bacterial lesions appeared 5 to 6 days after the inoculation. Exposure of plants to ozone one to three days after the inoculation resulted in a general reduction of injury from ozone. However, when ozonation occurred 6 days after the inoculation, development of ozone injury symptoms was inhibited only in the areas around the bacterial lesions. This "halo" effect could be well visualized only when the chlorophyll was removed. Similar localized resistance to ozone injury was also observed on leaves infected with powdery mildew (*Microsphaera diffusa*). Experiments are in progress to evaluate the response of leaves infected with *P. glycinea* race 5 (induces hypersensitive reaction in soybean var. Hodgson) and cowpea chlorotic mottle virus (induces local lesions in soybean).

ROLE OF WEED MANAGEMENT IN PIERCE'S DISEASE AND ALMOND LEAF SCORCH DISEASE. A.H. Purcell, Division of Entomology and Parasitology, University of California, Berkeley, CA 94720 USA.

The principal vectors of Pierce's disease (PD) bacterium in the Central Valley of California are the leafhoppers *Draeculacephala minerva* and *Carneccephala fulgida*. A variety of sites were selected from ground and aerial surveys for vineyards with a high incidence of PD and for habitats where these leafhoppers were abundant. The species composition, stand age, and state of growth of weed populations were correlated with high populations of either leafhopper. Neither leafhopper was prominent in vineyard weeds until after midsummer. Complete clean cultivation or other excellent weed control at least once annually dramatically decreased populations of either leafhopper. Dormant or early growing season cultivation and the resultant typical weed species composition of vineyard cover crops is proposed as an explanation of why lush summer growth of vineyard annual weeds does not promote the subsequent occurrence of PD. Aerial surveys were useful in depicting disease gradients within vineyards and in pinpointing vector source areas. Analysis of disease gradients suggested that prevailing winds may strongly influence disease spread. These disease patterns are additional evidence that most persistent infections of PD are established as primary spread by vectors originating outside vineyards. None of the almond orchards adjacent to vineyards with a high incidence of PD showed any sign of almond leaf scorch disease, which is caused by the same bacterium.

EPIDEMIOLOGY, HOST-PATHOGEN INTERACTIONS AND CONTROL OF POWDERY MILDEW ON ELATOR BEGONIAS. James A. Quinn, C. C. Powell, Jr., The Ohio State University, Columbus, Ohio 43210, U.S.A.

Control of powdery mildew, (*Oidium begonia*), on begonias, using host range, temperature, humidity, irrigation, light and fungicides was studied. The optimum temperature for growth and sporulation of the fungus was 18-21°C. A constant temperature of 28°C stopped new infections from occurring and caused established infections to become dormant, but did not inhibit germination of conidia and formation of appressoria. Mildew was more severe on plants watered less frequently. A host range study on many species of begonias was done that showed the presence of two morphologically identical races of the pathogen. Dinocap, benomyl, triforine, and triadimefon fungicides all had eradication ability. All but triforine were protectants. The fungus was noted in places on the plant that would not be subject to fungicidal contact.

PHYSICAL AND CHEMICAL PROPERTIES OF BLUEBERRY SHOESTRING VIRUS AND TRANSMISSION BY THE APHID MASONAPHIS PEPPERI MACGILLIVRAY. D.C. Ramsdell, Department of Botany and Plant Pathology, Michigan State University, East Lansing, MI 48824, U.S.A.

Blueberry shoestring virus (BBSV) is an isometric virus 27 nm in diameter. The sedimentation coefficient ($S_{20,w}$) is estimated as 120S. Buoyant density of virions in CsCl is 1.392 gm/cm³. Particles contain 20% RNA and 80% protein, based on phosphorus analysis, diphenylamine and ribonuclease tests. The single RNA component is single stranded, based on thermal denaturation studies. Molecular weights of the RNA and the protein coat subunit are 1.45 x 10⁶ and 30,000 daltons, respectively, as determined by polyacrylamide gel electrophoresis. Electrophoretic mobility of the virus at pH 5.0 in 0.02 M sodium phosphate-0.02 M Tris buffer is 0.42 x 10⁻⁵ cm²sec⁻¹volt⁻¹ and the isoelectric point is between pH 4.6 and 4.7. Reversible self-aggregation occurs at 20°C, but not at 4°C. *Masonaphis pepperi* MacGillivray transmitted BBSV from diseased blueberry to healthy rooted green cuttings of 'Jersey' blueberry after a 2 min acquisition access feeding and a 100 hr inoculation feeding in 2/5 test plants. Although apparently serologically un-

related to other described viruses, it fits with viruses in the southern bean mosaic grouping, based upon the above properties plus stabilization by divalent cations and formation of multiple bands in Cs₂SO₄ gradients. The cryptogram is R/1:1.45/20:S/S:S/Ap.

POTENTIAL YIELD REDUCTION OF MAIZE (ZEA MAYS) BY KABATIELLA ZEA. Francisco J.B. Reifschneider and Deane C. Arny, Department of Plant Pathology, University of Wisconsin, Madison, WI 53706.

The potential yield reduction of maize, when infected by *Kabatella zea*, the cause of eyespot of maize, was determined by artificially inoculating the susceptible inbred W64A weekly (W), biweekly (B), or monthly (M), and comparing with noninoculated (check). A randomized complete block design was used, and two trials were conducted: on a plowed field and on an adjacent field under minimum tillage, with debris on the surface. On the plowed area plant fresh weights (kg/ha) were 18,944 (check) 15,884 (M), 14,451 (B), and 12,238 (W); plant dry weights (kg/ha) 6,863 (check), 5,830 (M), 5,161 (B), and 4,363 (W); grain dry weights (kg/ha) 3,167 (check), 2,626 (M), 2,273 (B), and 1,785 (W); and 1,000-kernel weights 173 (check), 161 (M), 156 (B), and 148 (W). On the minimum-tilled area plant fresh weights (kg/ha) were 13,150 (check), 12,369 (M), 11,718 (B), and 10,806 (W); plant dry weights (kg/ha) 5,656 (check), 5,296 (M), 4,737 (B), and 4,211 (W); grain dry weights (kg/ha) 2,530 (check), 2,315 (M), 2,006 (B), and 1,689 (W); and 1,000-kernel weights were not affected significantly. Although yields of checks were considerably lower in the minimum-tilled area than in the plowed, because of compaction and other soil factors, yields were approximately the same under the most severe eyespot infection. Only light infection was noticed on noninoculated checks at silking (FAO stage 8). Potential yield reductions as grain dry weight, thus, were observed to be as high as 44% on plowed and 34% on minimum tilled land.

HERBICIDE EFFECTS ON CORYNEBACTERIUM NEBRASKENSE AND DISEASE SEVERITY OF GOSS'S BACTERIAL WILT AND BLIGHT OF CORN. J. Riesselman, A. K. Vidaver, University of Nebraska, Lincoln, Nebraska 68583, USA

The preemergence herbicides, alachlor, Atrazine, butylate and dicamba, commonly used in corn (*Zea mays*) production, were evaluated for their effects on *Corynebacterium nebraskense* and disease severity of Goss's bacterial wilt. A recommended rate and a threefold higher rate were applied to 4mx 8m plots. A susceptible variety (A619x632) was inoculated with 4 x 10⁷ cells/ml of *C. nebraskense* 298. Herbicide treatment did not show significant differences from the control in disease severity. However, average disease incidence was reduced in the alachlor treated plots. Corn plants then were inoculated with different concentrations of bacteria in an *in vitro* herbicide assay system amended with 10ug/ml herbicide. Selective recovery of bacteria showed that alachlor reduced colony counts up to 97% at an inoculum of 10² cells/plant; other herbicides had no effect. At 10³ cells/plant no reduction occurred. The reduction appeared to be bacteriostatic.

THE TERMINOLOGY OF PLANT-PEST CONTROL. D. A. Roberts, Department of Plant Pathology, University of Florida, Gainesville, Florida, 32611, U.S.A.

Every plant-pest-control practice, whether chemical, cultural, or biological, exemplifies a principle, which principle is the scientific basis for the success of the practice. First principles, to which most would agree, are: (i) reduce the initial population of noxious organisms, and (ii) slow their rates of increase. I continue to recommend seven, perhaps somewhat controversial subsidiary principles: (1) exclusion, (2) eradication, (3) cure (therapy), and (4) specific (vertical) resistance to decrease the numbers of plant pests; and (5) general (horizontal) resistance, (6) prophylaxis (protection), and (7) evasion (avoidance) to slow the rates of increase in populations of plant pests. Such terminology, it seems, encompasses all practices of plant-pest control, defines the basic laws of crop protection, and unites all systems of plant-pest control in terms of their sole function of keeping plant-pest populations in check at or below their economic thresholds.

PLANTING TIME AND POSTEMERGENCE USE OF ETHYLENE DIBROMIDE (EDB) AND AN EDB-CHLOROPICRIN MIXTURE FOR CONTROL OF ROOT KNOT NEMATODES ON PEANUTS. R. Rodriguez-Kabana, P. S. King, H. W. Penick, and H. Ivey, Dept. Botany and Microbiol., Agric. Expt. Sta., Auburn Univ., Auburn, Ala. 36830, U.S.A.

Field studies were conducted during 1977 and 1978 to determine the feasibility of using EDB (Soilbrom 90 EC) or an EDB-chloro-

picrin mixture (Terr-0-Cide 72-27) as substitutes for DBCP for control of *Meloidogyne arenaria* and *M. hapla* on Flurunner peanuts. Planting time applications of EDB at 9.35 L/ha in a field heavily infested with *M. arenaria* were as effective as those of DBCP at the same rate but higher rates of EDB-chloropicrin were needed to obtain equal control. Maximal yield responses and best control of *Meloidogyne* spp were obtained with rates of 18.7 L/ha of either of the two EDB formulations. EDB applied post-emergence at midbloom at rates of 9.35-37.40 L/ha did not result in phytotoxicity. Planting time applications of the two EDB formulations resulted in higher yields and better control of *Meloidogyne* spp than equivalent postemergence applications.

CELLULAR EFFECTS OF ANHYDROUS AMMONIA ON PHYMATOTRICHUM OMNIVORUM SCLEROTIA. C.M. Rush, C.M. McClung and S.D. Lyda Department of Plant Sciences, Texas A&M University, College Station, Texas 77843.

Sclerotia were exposed to concentrations of ammonia (12 to 244 ppm) for 24 hours. With ammonia concentrations above 45 ppm the sclerotia became soft, and a brown liquid was exuded. Light microscopy indicated no gross changes in cell wall morphology. Intracellular organization showed varying degrees of disruption. The most obvious differences between treated and non-treated sclerotia were areas of stain accumulation in the treated cells. Electron microscopy showed aggregations of disrupted organelles and myelin-like figures. Ammonia concentrations as low as 33 ppm caused vacuolar and mitochondrial membranes to become irregular in shape. Breaks in the plasma-membrane, aggregation of the vacuolar contents, and complete distortion of all organelles occurred at 90 ppm. The inner membranes of mitochondria seemed especially sensitive. Cells treated with 135 ppm ammonia resulted in total disintegration of much of the intracellular organization.

A PLATE ASSAY FOR PLASMID CURING AGENTS. Sands, David C., Scharen, A.L., Dept. of Plant Pathology, Montana State University, Bozeman, MT, Warren, Guylyn, Dept. of Chemistry, Montana State University, Bozeman, MT, and Matern, Ulrich, Institute fuer Biologie, Freiburg W. Germany.

A simple and direct petri dish assay was developed for detection of plasmid curing agents. *Arthrobacter crystallopoietes*, when spread onto 2-hydroxypyridine agar at ca 300 colony forming units per dish, forms distinct green colonies, shown by Kollenbrander to be plasmid-mediated pigment production. White colonies in a zone of diffusion from a filter paper disc soaked with ethidium bromide 1000 µg/ml or acridine orange, denoted plasmid curing. Evidence for curing was non-reversion when the bacteria were restreaked on 2 HP medium, and by absence of plasmids detectible by agarose gel electrophoresis. This assay may be useful in screening natural products for plasmid curing activity to be used in chemotherapy, or to provide evidence of plasmid curing as a disease resistance mechanism used by plants or animals.

MONTHLY SPORE INCIDENCE OF VESICULAR-ARBUSCULAR MYCORRHIZAL FUNGI IN CORN RHIZOSPHERE SOIL AT FOUR DEPTHS. N. C. Schenck and J. R. Rich. University of Florida, Gainesville, 32611 and Agriculture Research Center, Live Oak, Fl. 32060.

Monthly samples of soil were collected at 4 depths from 5 sites in a field of *Zea mays*. Sampling began in December 1977 before planting and continued through November of 1978. Samples were wet sieved to extract spores of mycorrhizal fungi. Spores of *Gigaspora margarita*, *G. heterogama*, *G. gregaria*, *G. pellucida*, *G. rosea*, *G. nigra*, *Glomus macrocarpus*, *G. clarus*, *G. etunicatus*, *G. mosseae*, *G. microcarpus*, *G. fasciculatus*, *Sclerocystis sinuosa* and *Acaulospora gerdemanni* were recovered. Spores of *G. margarita* were most abundant, predominating at the 0-15cm depth, while *Glomus* species occurred most at the 31-45cm depth. Spores averaged 1200/liter of soil, consisting of 75% *Gigaspora* spp., 18% *Glomus* spp., and 7% other species. About 61% of the spores occurred at 0-15cm, 19% at 16-30cm, 12% at 31-45 cm and 8% at 46-60cm depth. Monthly spore numbers fluctuated most at 0-15cm with spore numbers being greatest in August for *Gigaspora* spp. and in December for *Glomus* spp.

SOYBEAN SEED LOTS CONTAMINATED BY MELANOPSICHIMUM PENNSYLVANICUM SMUT GALLS. C. T. Schiller and J. B. Sinclair, Dept. of Plant Pathology, Univ. of Illinois, Urbana, IL 61801.

Smut galls were found associated with Williams soybean seeds harvested from a field near Jerseyville, IL in 1977. The galls were caused by the smut fungus *Melanopsichium pennsylvanicum* infecting inflorescences of smartweed (*Polygonum pennsylvanicum*). We correct the misinterpretation of it being a smut of soybean, *M. missouriense*. The Jerseyville specimen was compared to herbarium specimens of *M. pennsylvanicum* on *P. penn-*

sylvanicum from the Ill. State Natural History Survey (ILLS), Urbana and the type specimen of *M. missouriense* obtained from the National Fungus Collections, Beltsville, MD (BPI). It was compared to fresh material from smartweed plants wound-inoculated with *M. pennsylvanicum* chlamydospores from the Jerseyville specimen. Scanning electron micrographs of chlamydospores showed variation in the wall ornamentation of some chlamydospores in the ILLS specimen. Based on the above comparisons, we consider that *M. pennsylvanicum* and *M. missouriense* to be synonymous.

DISTRIBUTION OF SEPTOTINA LEAF SPOT OF POPLARS IN THE NORTH CENTRAL UNITED STATES. Arthur L. Schipper, Jr., and Marguerita A. Palmer. North Central Forest Experiment Station, USDA Forest Service, 1992 Folwell Avenue, St. Paul, MN 55108.

The fungus *Septotina podophyllina* Whetzel causes a large zonate leaf spot on poplar leaves that can be readily identified by the presence of white sporodochia on the leaf surface within the spots, and by the distinct conidia. The disease has been reported previously on poplars in the New England States, Europe, and Japan. In 1975 and 1976, 13 small hybrid poplar plantations were established throughout the north central United States to determine the distribution of poplar diseases in the region. In 1977, *S. podophyllina* was found in the four northernmost plantations, located near Dukes in the Upper Peninsula of Michigan, Cass Lake and Cloquet in Minnesota, and Rhinelander in Wisconsin, but not in any of the plantations farther south in Minnesota, Michigan, or Wisconsin, or in those located in Iowa, Illinois, and Missouri. Heaviest *Septotina* infection was at Rhinelander in north central Wisconsin, where 22 of 38 poplar clones examined were infected. No consistent relation existed between clonal parentage and disease susceptibility. Apparently a wide range of poplar species and hybrids will serve as hosts for the disease. Although this disease has not caused significant damage to poplars in the north central United States yet, it does produce extensive leaf necrosis and premature defoliation, and may become a problem for northern poplar plantations grown under intensive culture for maximum biomass production.

EFFECTS OF A MYCOPHAGOUS APHELENCHOIDES SP. ON AN ERICOID MYCORRHIZAL FUNGUS. S. R. Shafer, L. H. Rhodes, and R. M. Riedel, Dept. of Plant Pathology, The Ohio State University, Columbus, Ohio, 43210, U.S.A.

A dark, slow-growing, sterile fungus was isolated from surface-sterilized, fragmented *Rhododendron* roots. On PDA, young mycelium was dense and cream-colored, but darkened to gray with age. Hyphae in the centers of week-old cultures formed aerial strands that were tufted at the tips, and the colony margin was white to light gray. On water agar, hyphae were sparse, dark, and resembled *Rhizoctonia*. The isolate was shown to be mycorrhizal through reinoculation of *Rhododendron carolinianum* seedlings maintained axenically on water agar. Microscopic inspection of KOH-cleared seedling roots stained with cotton blue showed characteristic hyphal penetration of cortical cells. A fungal-feeding species of *Aphelenchoides* was isolated from a central Ohio soil sample. Nematodes introduced into acid-PDA cultures of the endophyte fed on hyphae of various ages, including aerial strands, and reproduced freely in culture. Changes in fungal cultural characteristics were evident within one week. Growth was restricted in cultures inoculated with nematodes, and these cultures became black, depressed, and covered with slime. Bacteria or other contaminants were not detected in any nematode-parasitized fungal cultures. Results suggest a possible role of mycophagous nematodes in limiting the development and function of ericoid mycorrhizae. Because the endophyte can be cultured axenically, the ericoid mycorrhizal system provides an advantageous model for study of mycophagous nematode-mycorrhizal interactions.

BREEDING FOR STABLE RESISTANCE; A REALISTIC ALTERNATIVE? E. L. Sharp, Department of Plant Pathology, Montana State University, Bozeman, Montana 59717, USA

Resistance genes have been recognized for many years as those having major effects and as those with minor effects. In some cases, the major effect genes were associated with minor components which were lost during transfer into usable backgrounds. The durability of resistance genes utilized singly has often been disappointing and thus various methods have been devised to more effectively utilize combinations of major effect genes. More recently, attention has also been focused on the so-called minor effect genes as offering a potential for long lasting if not a general type of resistance. Methods have been developed for pyramiding these genes into host cultivars and data indicate that such genes occur for many host-pathogen combinations. The fact that they often occur in commercial cultivars which

appear susceptible under normal conditions can be effectively utilized for more rapid and successful development of resistant varieties.

MALE STERILE FACILITATED RECURRENT SELECTION POPULATIONS FOR DEVELOPING BROAD-BASED RESISTANCE BY MAJOR AND MINOR EFFECT GENES. E. L. Sharp, Department of Plant Pathology, Montana State University, Bozeman, Montana 59717, USA.

Plant pathogen populations are usually very diverse. To combat this situation, it is desirable to develop corresponding diversity in the host. Wherever feasible, genetic male sterility offers an excellent opportunity to easily produce a number of recombinations containing different genes for resistance. Barley is well designed for such an under-taking due to a wealth of known genetic male sterility genes. A base recurrent selection population (RSP) containing widely diverse but adaptable cultivars including male sterility is first selected and then desirable resistance genes are incorporated into the population and pyramided by recycling. Major genes for resistance are selected on the basis of using an array of appropriate virulence types for specific disease organisms. Special procedures such as extreme infection environments may be used for detecting cultivars for use in the base RSP for minor gene accumulation.

A QUANTITATIVE SOIL ASSAY FOR PHYTOPHTHORA CINNAMOMI. H. D. Shew, D. M. Benson, and L. F. Grand. Department of Plant Pathology, N. C. State University, Raleigh 27650.

A selective medium was developed for assaying *Phytophthora cinnamomi* from soil. The medium, PCH, contains per liter of distilled H₂O: KH₂PO₄ 1 g; MgSO₄ · 7H₂O, .5 g; KCl, .5 g; CaCl₂ · 2H₂O, .01 g; FeSO₄ · 7H₂O, .02 g, thiamine HCl, 1 mg; yeast extract, .3 g; NaNO₃, 1 g; dextrose, 15 g; agar, 20 g; pimaricin, 5 mg; PCNB, 35 mg; chloramphenicol, 10 mg; and hymexazol, 50 mg. Soil samples (5-100 g) are blended in 200 ml of H₂O until soil aggregates are destroyed, and then washed through nested 125 µm and 38 µm sieves. The residue on the 38 µm sieve is distributed in distilled H₂O onto 5-15 (depending on amount of residue) freshly poured plates of PCH. Plates are incubated at 20 C in the dark for 72 hr. Soil is then washed from the plates with running tap water. Colonies of *P. cinnamomi* can be counted macroscopically on PCH. The PCH-wet sieving technique is effective for *P. cinnamomi* isolates from azalea and Fraser fir soils with inoculum densities of .01 to >100 p/g.

FACTORS AFFECTING CHLORIDE UPTAKE IN PLANTS EXPOSED TO SALT SPRAY. Michael Simini and Ida A. Leone, Dept. of Plant Pathology, Rutgers University--Cook College, P. O. Box 231, New Brunswick, NJ 08903.

Various plant species were exposed to salt spray in chambers designed to simulate deposition rates occurring within 600 meters of the seacoast and in the vicinity of operating evaporational salt water cooling towers. Herbaceous plants absorbed more chloride than did woody species, and conifers more than woody deciduous species. After salting, plants were exposed to various levels of light, temperature, and relative humidity. Leaves from these plants were analyzed for chloride. Chloride uptake was favored by high humidity (>75%) and by temperature and light conditions optimal for plant growth. High relative humidity is believed to alter the physical properties of both the salt particles and the leaf tissues. Optimum light and temperature levels may be the most conducive to active transport of chloride into leaves. Information on environmental variables affecting chloride uptake in plants may help in reducing potential hazards to vegetation from salt spray.

THE IDENTIFICATION OF STRAINS OF GREMMIENIELLA ABIETINA BY FIELD AND LABORATORY METHODS. Darroll D. Skilling and Michael E. Ostry, North Central Forest Experiment Station, USDA Forest Service, 1992 Folwell Avenue, St. Paul, MN 55108.

The European strain of Scleroderris canker, caused by *Gremmeniella abietina* [Lagerb.] Morelet, causes dieback on most hard pines and kills large trees. Originally identified in New York State in 1977, the European strain of this organism now is also present in Vermont and Quebec, Canada. This is a significant extension of the range of the European strain. The major infection center still is in New York State, but new infection centers are being found to the north and east. Although Scleroderris canker has recently been found in Maine, as yet only the North American strain of *G. abietina* is present in this State. Preliminary identification of *G. abietina* strains can frequently be made in the field based on infection height in host trees and presence or absence of the apothecial stage. The European strain is found in trees of all sizes and may infect branches at any height. The North American strain

only infects lower branches and is not found above 2 m. The apothecial stage is common with the North American strain, but has not been found with the European strain. Although some isolates can be identified in the laboratory by mycelial characteristics, final determination of strains still requires the use of immunogenic techniques.

DEVELOPMENT OF THEMATIC MAPS FROM FALSE COLOR IR PHOTOGRAPHY OF PHYMATOTRICHUM ROOT ROT INCIDENCE FOR USER APPLICATIONS. B.D. Smith, R.W. Toler and H.T. Eaton, Jr. Texas A&M University, Remote Sensing Center, College Station, TX 77843.

Thematic maps of disease incidence for *Phymatotrichum* root rot of cotton caused by *Phymatotrichum omnivorum* may be used to study epidemiology of the disease. Cotton fields were identified from 1:20,000 scale photography covering all of Falls County, Texas. The boundaries of the fields were transferred from photography to acetate overlays on 1:24,000 scale USGS 7.5 min quadrangle maps, using a Bausch and Lomb Transfer Scope (ZTS). Coded Zip-a-tone was cut to fit boundaries and pressed to acetate overlays. Designations were based on percentage of field area displaying root rot signature on photography. Vacuum frame contact print process internegatives were made to reproduce overlays photographically. The reproduced overlays may be registered directly to the standard 7.5 min quadrangle. This process will facilitate use of remotely sensed disease incidence data by producers, researchers, extension plant pathologists and other agricultural agencies.

WEED CONTROL PRACTICES IN RICE. R. J. Smith, Jr., USDA-SEA-AR, P. O. Box 287, Stuttgart, Arkansas 72160, USA; and K. Moody, Int. Rice Res. Institute, P. O. Box 933, Manila, Philippines.

Effective weed control systems of rice combine preventive, cultural, mechanical, chemical and biological practices. Non-chemical methods are: planting weed-free seed, crop rotation, leveling land, seedbed preparation, selecting the proper seeding methods, managing water and fertilizer properly and hand-weeding. Chemical methods involve the use of herbicide treatments that selectively control weeds when applied correctly. The system that omits any one of these components is often inadequate. Herbicide usage in rice has steadily increased as effective herbicides have been developed. They are required to control weeds in rice when preventive, cultural and mechanical methods fail. Combinations of herbicides, in mixtures or in sequential applications, are often more effective than a single treatment of only one herbicide. The principal herbicides in use are propanil, molinate, 2,4-D, 2,4,5-T, MCPA, silvex, bifentox, bentazon, oxadiazon, butachlor and thibencarb. Research continues to find new herbicides. A newly discovered endemic fungus disease kills northern jointvetch in ricefields. The development of efficient and economical herbicides and combination methods for full-season control of weeds in rice has had a significant impact on rice production. Herbicides have improved yields and quality of rice, changed seeding methods and water management, permitted development of improved varieties that are more productive but less competitive with weeds, permitted timely management of high rates of fertilizer and reduced problems of certain insects.

IRRADIATED SLUDGE: EFFECTS ON BENEFICIAL ROOT INFECTIONS IN BEAN AND ONION. Roberta A. Spitko and William J. Manning, Department of Plant Pathology, University of Massachusetts, Amherst, MA 01003

During the last two years, we investigated the effects of land application of liquid irradiated, digested sludge, from the metropolitan Boston sewage treatment plant on beneficial endomycorrhizal infections (*Glomus* spp.), in bean (*Phaseolus vulgaris* L. 'Contender') and onion (*Allium cepa* L. 'Early Yellow Globe') and nodulation in bean by *Rhizobium phaseoli*. Sludge was applied to field plots at 38 and 72 metric tonnes/hectare at the beginning of each growing season. Results were compared to those from plots treated with commercial chemical fertilizer. The higher sludge rate inhibited mycorrhizal infections in bean and onion for the first 4 to 6 weeks. Both sludge rates consistently inhibited nodulation of bean, even when seeds were planted 3 months after sludge application.

LOPHODERMELLA CERINA, A PATHOGEN OF PINE FOLIAGE. John M. Staley, Rocky Mountain Forest & Range Expt. Sta., 240 W. Prospect St., Ft. Collins, CO 80526.

Lophodermella cerina is a pine needle pathogen infrequently represented in herbarium collections. Its original description is based on only three specimens: the type (on *Pinus contorta*) and two *P. ponderosa* specimens, all from California. The geographical and host ranges of *L. cerina* are wider than this. *L. cerina* is found from Georgia and Florida to Louisi-

ana, and in Colorado, New Mexico, and Arizona, as well as in California. Additional hosts include *P. elliottii*, *P. taeda*, and *P. sylvestris*. Inoculations to *P. ponderosa* (using naturally produced inoculum under field conditions) resulted in significant disease development as compared to controls. Spore germination in nature is by appressorial formation and penetration appears to be directly through the cuticle. The normal disease cycle is one year, however artificial inoculations at a low density of ascospore deposition resulted in a two year cycle.

PREVENTION OF PHASEOLOTOXIN-INDUCED CHLOROSIS BY TRIPEPTIDES. B. J. Staskawicz and N. J. Panopoulos, Department of Plant Pathology, University of California, Berkeley, CA. 94720.

Phaseolotoxin [(N⁶-phosphosulfonyl)ornithylalanylhomocysteine], a tripeptide toxin produced by *Pseudomonas phaseolicola*, causes chlorosis, inhibition of ornithine carbamoyl transferase, accumulation of ornithine in bean leaves, and inhibits the growth of *Escherichia coli* and *Salmonella typhimurium* in arginine deficient medium. Phaseolotoxin enters bacterial cells via an oligopeptide permease and its antibacterial effects can be prevented in the presence of tripeptides. To determine whether phaseolotoxin enters plant cells via a peptide permease we performed competition experiments with various peptides administered to bean leaves along with phaseolotoxin. Among the peptides tested triglycine at concentrations 500-fold greater than phaseolotoxin completely prevented chlorosis. Further evidence to support the hypothesis that a peptide permease mediates phaseolotoxin transport in planta will be discussed.

CGA-64251, A NEW BROAD-SPECTRUM FUNGICIDE. T. Staub, F. Schwinn and P. Urech, CIBA-GEIGY Ltd., Agrochemicals Division, CH-4002 Basle, Switzerland.

CGA-64251 is the code number of a new systemic fungicide with both protective and curative properties. Chemically, it is 1-(2-(2,4-dichlorophenyl)-4-ethyl-1,3-dioxolan-2-yl-methyl)-1H-1,2,4-triazole. It has a low mammalian toxicity (acute oral LD50 rat - 1343 mg/kg; acute dermal LD50 rat above 3100 mg/kg). CGA-64251 is active at low rates against members of the Ascomycetes, the Basidiomycetes and the Fungi Imperfecti. Activity is expressed both *in vitro* and *in vivo*. *In vitro* mycelial growth is more sensitive to CGA-64251 than spore germination with ED50 values around 0.1 ppm on agar for many fungi. In greenhouse tests, CGA-64251 proved extremely active against powdery mildews, rusts, leaf spot diseases and apple scab. In field tests, 2.5 - 10 g ai/100 L gave excellent control of the above diseases on apple, pecan, grapes and certain vegetables. CGA-64250 is the code number of another analogue of the same chemical class with a better performance against ear and foliar diseases of cereals and peanuts.

MODIFICATION OF THE WITHIN CANOPY MICROCLIMATE OF DRY EDIBLE BEANS AND POTENTIAL FOR WHITE MOLD DISEASE. J.R. Steadman, A. Weiss, B.L. Blad, Assoc. Prof. of Plant Path., Assist. Prof. of Ag. Meteorology, Assoc. Prof. of Ag. Meteorology, Univ. of Nebraska, Lincoln, NE 68583, respectively.

The relationship of bean canopy microclimate to white mold disease (*Sclerotinia sclerotiorum*) was studied over 3 years. Furrow or overhead irrigation was a necessary component of crop production each year. Crop architecture and irrigation frequency, amount, and application during night or day were variables. Measurements of air, wet-bulb, leaf, and soil moisture were made using the cultivar 'Aurora' and cultivars of Great Northern dry edible beans. Soil moisture and temperature interact to regulate germination of sclerotia of *S. sclerotiorum* and subsequent production of the initial inoculum, ascospores. Ascospore infection by *S. sclerotiorum* was influenced primarily by duration of leaf wetness and secondarily by leaf temperature. Canopy architectures and irrigation regimes which decrease duration of leaf wetness also decrease white mold disease potential.

THE EFFICACY OF "ARBOTECT" 20-S IN PREVENTING DUTCH ELM DISEASE IN AMERICAN ELMS. Mark A. Stennes and D. W. French, University of Minnesota, Department of Plant Pathology, St. Paul, MN 55108.

Nine mature American elms (*Ulmus americana*) with a mean diameter of 53.9 cm treated in 1977 with "Arbotect" 20-S (2-[4-thiazolyl] benzimidazole hypophosphite) were each artificially inoculated up to 40 times during the 1978 growing season with an aggressive strain of *Ceratocystis ulmi*. Four trees were treated with a dose equal to 3 times the maximum therapy label rate (3000 PPM - 2.08 liters/cm diameter), 3

were treated with a dose equal to 2 times the maximum therapy label rate (2000 PPM - 2.08 l/cm), and 2 were treated with a dose equal to the maximum therapy label rate (1000 PPM - 2.08 l/cm). All trees were injected through well exposed root flares. On the trees treated with the triple therapy rate, 1 of 100 branches inoculated before July 20, 1978, developed initial symptoms of Dutch elm disease in 1978, while symptoms developed in all of 44 untreated elms. Efforts to isolate the pathogen from 2 randomly chosen inoculation points on one of these trees were unsuccessful. Two of 10 inoculated branches on each of the 3 trees treated at the double therapy rate developed symptoms in 1978. One of the 2 trees treated with the maximum therapy label rate developed symptoms in 6 of 10 inoculated branches and the tree was systemically infected by the end of the season. The second tree developed symptoms in none of the 10 inoculated branches. We conclude that the triple therapy dose of "Arbotect" 20-S, when properly administered, can protect an elm from infection by *C. ulmi* for 2 growing seasons.

INDUCTION OF PRUNUS STEM PITTING IN PEACH WITH UNION NECROSIS-AFFECTED APPLE ROOTSTOCK BUDS. R. F. Stouffer and C. A. Powell. Pa. State Univ. - Fruit Research Lab, Biglerville, PA 17307 and Pa. Dept. of Agriculture, Harrisburg, PA 17120, respectively.

Two years following inoculation with buds from unidentified rootstock sprouts from 2 Starkrimson Delicious apple trees with union necrosis and decline (UN/D) symptoms, 100% of 6 "Boone County", 12 "Ferris strain" and 19 Halford peach seedlings showed typical symptoms of Prunus stem pitting (PSP). Enzyme-linked immunosorbent assay (ELISA) detected tomato ringspot virus (TmRSV) in the roots of all seedlings exhibiting PSP symptoms. None of the 85 control seedlings exhibited PSP symptoms and TmRSV was not detected in the roots of any of these trees. These results provide additional evidence supporting the common etiology of PSP and apple UN/D.

ULTRASTRUCTURAL CHANGES IN 'JONATHAN' APPLE VARIETY RESULTING FROM INFECTION BY ERWINIA AMYLOVORA. Charles G. Suhayda and R. N. Goodman. Dept. of Plant Pathology, 108 Waters Hall, University of Missouri-Columbia, Columbia, MO 65211.

Virulent *E. amylovora* cells inoculated into young stem tissue proliferated in mature vessel elements beyond the observed 8 mm from the inoculation point in 24 h. Bacteria were found only in vascular tissue and were undetected in intercellular spaces except directly in the wound area caused by the needle puncture. A loose, web-like, fibrillar material enveloping the bacteria partially occluded the xylem vessels in 24 h. Extremely dense, fibrous material completely embedding bacterial cells and totally occluding mature vessels was noted in 48 h. The occluding material apparently plays a role in the wilt symptom of the fireblight syndrome. Avirulent *E. amylovora* appeared restricted to xylem vessels 2 mm from the inoculation point. However, loose fibrillar material also was found to occlude the vessels in this area. Vessels beyond this point appeared to be unaffected.

ROOT DISEASES OF SOUTHERN PEA (VIGNA UNGUICULATA) IN AN INTEGRATED PEST MANAGEMENT SYSTEM. Sumner, Donald R., A. W. Johnson, N. C. Glaze, R. B. Chalfant, and C. C. Dowler. University of Georgia and U. S. Department of Agriculture, Coastal Plain Experiment Station, Tifton, Georgia 31794 USA.

A multiple-cropping sequence of turnip-corn-southern pea was grown in field plots each year for four successive years. Soil pesticide treatments were: (1) soil fumigation each fall with methyl bromide, and insecticides and fungicides for control of insects and foliage diseases; (2) soil fumigation with DD-MENCs each fall, and ethoprop, insecticides, fungicides, and herbicides used for maximum control of nematodes, insects and weeds in each crop; (3) ethoprop, insecticides, fungicides and herbicides used as needed on each crop; and (4) insecticides and one herbicide used on each crop. Soil fumigation significantly (P=.05) reduced root disease severity in southern pea in two of four years, and increased yields of shelled peas an average of 49% (1500 vs 1006 kg/ha in nonfumigated treatments). Each year 62 to 83% of the variation in yield was related to populations of nematodes and soil-borne fungi, and the frequency of isolations of fungi from roots of seedlings. Soil insect injury was negligible and did not affect yields or root disease severity. The factors contributing most to yield reductions were the frequency of isolation of *Rhizoctonia solani*, *Pythium* spp., and *Fusarium* spp. from roots; and populations of *Meloidogyne incognita*, *Pratylenchus* spp., *Criconeoides ornatus*, and *Trichodorus christiei* in soil. In greenhouse tests, the most virulent pathogens on southern pea, in order, were *R. solani*, *Pythium* spp., and *F. oxysporum*.

BROAD-SPECTRUM AFTER-INFECTION ACTIVITY BY CGA 64251 AGAINST TREE FRUIT DISEASES. Michael Szkolnik, N.Y. State Agricultural Experiment Station, Geneva, N.Y. 14456, USA.

Severe greenhouse evaluative spray tests were made on vigorous apple, cherry, and peach trees grown in clay pots for the control of apple scab (*Venturia inaequalis*), cedar-apple rust (*Gymnosporangium juniperi-virginianae*), cherry leaf spot (*Coccomyces hiemalis*), and brown rot blossom blight of peach (*Monilinia fructicola*). In after-infection tests the trees were inoculated with about 70,000 spores/ml of the respective fungi, placed in a moist chamber at 20 C (23 C for blossom blight) to induce infection, and finally treated with a dilute fungicide spray at 24 hr after inoculation. Ciba-Geigy CGA 64251 LOWP at active rates of 26 and 19 µg/ml gave at least 98 and 89% control, respectively, of apple scab, and at both rates 98 to 100% control of the other three diseases. Comparisons were made with the following fungicides at indicated active rates (µg/ml): dodine (293; 195 on cherry), captan (1200), benomyl (225), and mancozeb (1440). Apple scab control with dodine, captan, benomyl, and mancozeb was 83, 59, 59, and 47%, respectively. Control of cedar-apple rust with dodine and mancozeb was 47 and 29%, respectively. Cherry leaf spot control with benomyl, dodine, and mancozeb was 59, 47, and 29%, respectively. Control of blossom blight on peach with benomyl and captan was 84 and 14%, respectively. It was shown that the after-infection control of apple scab with CGA 64251 is about the same at equivalent active rates as that of the organic mercury fungicides. Before regulatory withdrawal mercurials were used commercially for after-infection control. There is a great need for safer fungicides of high after-infection potency against scab and other fruit diseases.

BIOLOGICAL CONTROL OF POWDERY MILDEWS BY AMPELOMYCES QUISQUALIS. Abraham Szejnberg, The Hebrew University of Jerusalem, Department of Plant Pathology and Microbiology, The Faculty of Agriculture, Rehovot, Israel.

Ampeomyces quisqualis was isolated from parasitized mildew on *Catha edulis*. Different media and conditions for growth were tested. Substantial growth and sporulation of *A. quisqualis* was achieved on 4% malt extract agar with 0.2% DL-asparagine, pH-6.5, at 22 C±2. The culture plates were flooded with sterile water and the conidial suspension was used for inoculation trials. After inoculation, the host plant species, all of which had powdery mildew, were first held for 24-36 hours in moist-chambers, and then maintained in the greenhouse. Seven to 8 days after inoculation there was a substantial reduction in sporulation, and degeneration of the mildew, due to pycnidial development of the hyperparasite on the mildew. Successful biocontrol was obtained by repeated inoculations every 10 days in the greenhouse on the following mildews: Sphaerotheca fuliginea on cucumber and watermelon, Erysiphe betae on sugar beet, E. umbelliferarum on carrot, Podosphaera leucotricha on apple, Phyllactinia suffulta on mulberry, Leveillula taurica on pepper, Oidium sp. on zinnia and sowthistle.

GENETIC ANALYSIS OF SEXUALITY, PHYTOALEXIN SENSITIVITY AND VIRULENCE OF NECTRIA HAEMATOCOCCA MP VI (FUSARIUM SOLANI). K. J. Tegtmeier and H. D. VanEtten, Department of Plant Pathology, Cornell University, Ithaca, NY 14853.

Genetic analysis of *N. haematococca* mating population VI provided information on the control of sexuality, phytoalexin sensitivity and virulence of the pathogen to pea (*Pisum sativum*). Opposite compatibility types are necessary to produce a fertile cross and are under control of a single allelic pair. In crosses, strains that are morphologically identical may act either as hermaphrodites or as males and results from crosses between them indicate control at one locus. Isolates derived from mycelial sectors in hermaphroditic, conidial cultures act only as males in crosses. Linkage between the mycelial and male characteristics is maintained through crosses and both characteristics appear to be controlled by the same gene. Progeny (51) from a cross between an isolate sensitive to the phytoalexin pisatin (48% inhibition in a radial growth bioassay using 161 µg pisatin/ml medium) and a pisatin tolerant isolate (17% inhibition) segregated for both sensitivity to pisatin and virulence on pea. Based on sensitivity the progeny could be grouped into two classes: those inhibited less than 20% and those inhibited between 40% and 49%. The latter were weakly virulent (lesions 1.6-3.2 mm) whereas the former were weakly to moderately virulent (lesions 2.1-6.6 mm). Tolerance to pisatin may be one factor necessary for high virulence on pea.

DYNAMICS OF CURLY TOP VIRUS TRANSMISSION TO A NONHOST OF THE VECTOR. P. E. Thomas, USDA-SEA, IAREC, P.O. Box 30, Prosser, Washington 99350.

The rate of CTV infection of sugarbeet and tomato seedlings was determined during intervals after release of viruliferous beet leafhoppers on pure cultures and on 50-50 mixed cultures of the two species. During the first hr, rate of infection in one species was not affected by the presence of the other species, but later the pattern of infection incidence vs. time in each species was markedly influenced by presence of the other species. In the 1- to 4-hr interval, infection rate in sugarbeets was much higher than in tomatoes in mixed cultures, and infection of tomatoes was much higher than sugarbeets in monocultures. Whereas infection in tomatoes declined and nearly ceased after 12 hrs in monocultures, infection in mixed cultures continued at a steady rate throughout the 16-hr test period. The pattern of infection was approximately the same in monocultures of the two species as it was when leafhoppers were held by leaf cages on individual plants of the two species.

EPIDEMIOLOGY AND CONTROL OF GREASY SPOT ON GRAPEFRUIT IN TEXAS. L. W. Timmer and R. J. Reeve. Texas A & I University Citrus Center, Weslaco, TX 78596.

In a 4-year study to determine the effect of *M. citri* on red grapefruit in the semi-arid Texas citrus area, the following spray programs were compared: 1) maximum: cupric hydroxide - spring, benomyl + oil - summer; 2) minimum: oil - summer; 3) control: no fungicide. The maximum program sharply reduced foliar greasy spot and somewhat reduced greasy spot ring bluish. The minimum program was less effective, but significantly reduced disease incidence compared to the control. Neither program increased yield, fruit size, or reduced defoliation compared to the control. Applications of the acaricides, chlorobenzilate and dicofol, to control citrus rust mite, Phyllocoptura oleivora, significantly reduced foliar greasy spot in some years. In 1978, production of ascospores of *M. citri* was low during spring, but sharp peaks occurred following light rains and flood irrigations in late June and in late July. Most of the ascospores were trapped during abundant rainfall in late August and early September. Under Texas conditions, infection apparently occurs primarily in late summer, symptoms do not appear until early spring, greasy spot does not cause excessive premature defoliation, and the benefits from fungicidal control of the disease are few.

THE ASSOCIATION OF PHYTOPHTHORA MEGASPERMA VAR. SOJAE RACES WITH SOYBEAN CULTIVARS IN WISCONSIN. P. W. Tooley, M. C. Stough, and C. R. Grau, Dept. of Plant Pathology, Univ. of Wisconsin-Madison, Madison, WI 53706

A number of soybean cultivars were grown in a field plot in Southeastern Wisconsin naturally infested with *Phytophthora megasperma* var. *sojae* (Pms) in which race 1 resistant cultivars had recently failed. Race identity of 87 isolates from the cultivars in this plot was determined by the method of Laviolette and Athow (Phytopathology 67:267-268) with P.I. 86972-1 substituted for P.I. 171.442. Races 3, 7, 8 and 9 comprised 78%, 3%, 1%, and 17%, respectively, of the total isolates. Race 1 was not isolated from this plot. No distinct correlation was noted between the frequency of races isolated and the presence or absence of resistance to races 1 and 2 in the cultivars from which isolations were made. Races 3, 7, 8 and 9 comprised 75%, 3%, 0% and 22%, respectively, of the isolates from seven cultivars containing no race-specific resistance to Pms. The same races respectively comprised 79%, 4%, 2% and 15% of the isolates from 14 cultivars resistant to races 1 and 2. From six additional fields in which cultivars containing no race-specific Pms resistance were grown in 1978, 75% of the total isolates were race 1. The results suggest that selection pressure exerted by cultivars containing race-specific resistance results in the development of more complex races.

BIOLOGICAL CONTROL OF ONION WHITE ROT. R.S. Utkhede and J.E. Rahe, Department of Biological Sciences, Simon Fraser University, Burnaby, B.C. V5A 1S6

Six bacteria and one fungus isolated from sclerotia of *Sclerotium cepivorum*, the causal agent of white rot of onions, produced diffusible antibiotics antagonistic to growth of *S. cepivorum* on potato dextrose agar. Three of the bacterial isolates applied as seed treatments reduced percent infection by *S. cepivorum* on onions, cv. Autumn Spice, grown in non-sterile muck soil for 10 weeks in a controlled environment chamber. Four of the bacterial isolates provided significant season-long protection in the field on the partially resistant cv. Festival, and the best of these also provided significant protection on the susceptible cv. Autumn Spice. The fungal antagonist has been identified as *Penicillium nigricans*, and all bacterial isolates have been tentatively identified as *Bacillus subtilis*. The levels of protection provided by some

of these latter isolates were comparable to those provided by chemical treatments and represent practical potential for field control of white rot.

PROTECTIVE LAYER FORMATION IN ROOTS OF RESISTANT AND SUSCEPTIBLE BANANA AFTER INOCULATION WITH *FUSARIUM OXYSPORUM CUBENSE*.
G. E. VanderMolen, Department of Plant Pathology-Entomology, University of Rhode Island, Kingston, RI 02881.

An electron-dense deposit, the protective layer, was observed in paravascular parenchyma cell 2 days after inoculation of resistant and susceptible roots with *Fusarium oxysporum cubense*. An increase in the number of Golgi is apparent in the parenchyma cells that deposit the protective layer. Golgi vesicles that contain electron-dense material appear to migrate to and fuse with the plasmalemma, thereby releasing the vesicle contents to the cell exterior. This material accumulates between the pit membrane and the plasmalemma and forms a continuous layer along the wall that borders the vessel. Fungal hyphae present in the vessel lumen penetrated 45% of those parenchyma cells that lacked a protective layer, but no fungal penetration of paravascular parenchyma cells was observed in cells that formed a protective layer.

GENOME-LINKED PROTEINASE K-SENSITIVE FACTOR ESSENTIAL FOR THE INFECTIVITY OF SOUTHERN BEAN MOSAIC VIRUS. V. Veerisetty and O. P. Sehgal. Dept. of Plant Pathology, University of Missouri, Columbia, MO 65211.

Treatment (25 C, 1 hr) with Proteinase K (0.1 µg/ml) abolished the infectivity of southern bean mosaic virus ribonucleic acid (SBMV-RNA) without affecting its structural integrity. A fifty fold greater concentration of the enzyme, however, caused no decline in the infectivity of tobacco mosaic virus RNA. SBMV-RNA heated at 60 C for 10 min in 1% SDS or 8 M urea or 0.5 M urea + 1% SDS + 1% β-mercaptoethanol possessed the same specific infectivity as the untreated RNA. Also, incubation (25 C, 1 hr) of SBMV-RNA in 50% formamide + 25% dimethyl sulfoxide did not alter its specific infectivity. These results demonstrate that a covalently-linked protease-sensitive moiety is needed for the infectivity of SBMV-RNA. (Supported by Research Grant No. PCM 76-22730 by the National Science Foundation).

REACTIVATION OF THE *IN SITU* HEAT-INACTIVATED GENOME OF SOUTHERN BEAN MOSAIC VIRUS. V. Veerisetty and O. P. Sehgal, Dept. of Plant Pathology, Univ. of Missouri, Columbia, MO 65211.

Southern bean mosaic virus ribonucleic acid (SBMV-RNA) isolated from the heat-inactivated (65 C, 10 min; infectivity 1-3%) virus sedimented slightly faster than the control RNA (isolated from the non-heated virus) and was poorly infectious. However, the infectivity of such RNA was markedly enhanced if treated (25 C, 1 hr) with 8 M urea or 50% formamide plus 25% dimethyl sulfoxide. These treatments also resulted in the identical sedimentation of RNAs obtained from the heated or nonheated SBMV. The sedimentation behavior of the RNA isolated from the heat inactivated SBMV was not altered if treated with Proteinase K indicating that increased sedimentation was not due to coat protein binding. These results signify that (i) heat-inactivation of SBMV virions is due to an increased strengthening of the RNA secondary structure and (b) destabilization of this structure is necessary for restoring the genomic infectivity.

CULTURAL SYSTEMS FOR PEST MANAGEMENT IN COTTON. V. T. Walhood and K. M. El-Zik, USDA Cotton Research Station, Shafter, CA 93263 and T. J. Henneberry, USDA Western Cotton Research Laboratory, Phoenix, AZ 85040.

Initial problems and manipulations for growing cotton in narrow rows have been solved. Techniques for growing a crop that capitalizes on up to 100% increase in photosynthetic efficiency indicate higher lint yields and a crop that can be harvested 15 to 60 days earlier. Studies were made in 1978 to observe the response of cotton to narrow row cultural techniques with reference to insect pest management. The objective was to effect a maximum yield response with crop termination before September 1. Cotton was planted in conventional 100 cm rows and in 2 rows 35 cm apart on 100 cm beds. The population was 100,000/ha. N was applied in the amounts of 168 and 280 kg/ha. First irrigations were applied at the times of first square, May 8, or first flower, May 25, and last irrigations on July 10 or September 24. Total post-plant water applied ranged from 41 to 137 cm. No insecticides or seven applications of insecticides were applied mid-to-late season. Final irrigation applications in early July effectively terminated seed cotton production by August 24 at which time conventional rows produced 3357 kg seed cotton/ha and narrow rows 4011 kg, or

19.4% more; yields were decreased when irrigations continued to September and no insecticide applications were made. When irrigations continued to September and timely insecticide applications were made seed cotton yields of 5325 and 6368 kg/ha were harvested by November 15 from the 100 cm and narrow rows, respectively. First irrigations at first square delayed the rate of early boll opening and did not differ in total yields from first irrigation at first flower. N levels did not influence yields from 100 cm rows; 280 kg/ha delayed boll opening and reduced yields from narrow rows.

ANNOSUM ROOT ROT ON HIGH AND LOW HAZARD SITES IN UNTHINNED LOBLOLLY PINE PLANTATIONS. R. S. Webb and S. A. Alexander, Dept. of Plant Pathology and Physiology, VPI & SU, Blacksburg, VA 24061, USA.

Incidence and severity of root rot caused by *Heterobasidion annosum* were determined for 11 unthinned loblolly pine plantations in Virginia and Texas. Two circular 0.02 ha plots positioned at least two chains apart were located in each plantation except for one stand which received four plots. All plots were located in old-field plantations. Fourteen high hazard and 10 low hazard plots were bulldozed to expose entire root systems which were inspected for the presence of resin soaking and/or stringy decay symptoms. Root colonization was subsequently determined by isolation of the conidial stage on selective media (ortho-phenyl phenol and Hendrix-Kuhlman). Forty-four of the 399 root systems (11%) on high hazard sites were colonized by *H. annosum* with 2% of these exhibiting symptoms on greater than 1% of the total root system length. Those trees colonized greater than 1% exhibited 24% average decay by length. On low hazard sites, 10 of 300 root systems (3%) were colonized with 2 (0.6%) colonized greater than 1% (71% decay by length). These results suggest that important levels of *H. annosum* colonization occur in unthinned loblolly pine stands, particularly on high hazard sites, and that certain individual stands may exhibit extensive colonization.

VARIATION IN STRAINS OF GUIGNARDIA INFECTING CRANBERRY. G. J. Weidemann and D. M. Boone, Dept. of Plant Pathology, Univ. of Wisconsin-Madison, Madison, WI 53706

A comparative study of *Guignardia* isolates infecting cranberry has revealed the presence of two distinct strains of *Guignardia vaccinii*. Research was conducted to differentiate these strains on the basis of morphology, distribution, pathogenicity, and response to environmental factors. Comparative pathogenicity of both strains was determined in growth chamber studies under a range of environmental conditions. Temperature optima were determined for growth and spore germination both in culture and on host surfaces. One isolate type was characterized by rapid mycelial growth in culture, presence in all commercial cranberry areas surveyed, and an association with latent infections of cranberry leaves and fruit. The other strain possessed a slower mycelial growth and more compact colony morphology, was isolated only in those areas where early rot was a problem, and developed characteristic lesions on leaves and fruit in growth chamber studies.

EFFECTS OF O₃ AND SO₂ ON BUD FORMATION AND DEVELOPMENT AND NEEDLE INJURY ON 15 SCOTCH PINE PROVENANCES. T. Craig Weidensaul, Laboratory for Environmental Studies, Ohio Agricultural Research and Development Center, Wooster, OH 44691.

Scotch pine seedlings (grown 4 mos.) from 15 seed sources were produced in the greenhouse. They were exposed to O₃ at 0 or 200 µg/m³ alone or in combination with 0, 133, 400, 666, 933, or 1332 µg/m³ SO₂ for 6 hr. Provenances were rated for number of terminal buds present before exposure, buds developing 42 days after exposure, buds present and developing 2 mo. after exposure, and extent of mottling and necrosis of mature, hardened-off, secondary needles. Ozone was most associated with mottling and SO₂ with necrosis. Only slight necrosis occurred on trees receiving less than 1332 µg/m³ SO₂. The severity of SO₂-induced necrosis was potentiated at SO₂ levels as low as 666 µg/m³ by 200 µg/m³ O₃. There was clearly a synergistic effect when O₃ and SO₂ were combined. Ozone alone decreased bud formation by 14%, but SO₂ treatments generally stimulated bud formation by 32%. Provenances differed in their responses to gas treatments. Sources from Norway, "Nye Branch" (USA), Poland, and England were most resistant to necrosis, and those from "Nye Branch" (USA), Scotland, "Norwest" (USA), and "Nelson-King" (USA) were most resistant to mottling.

VARIABLE ANTAGONISTIC REACTION IN VITRO OF TRICHODERMA HARZIANUM AGAINST SEVERAL PATHOGENS. Homer D. Wells and Durham K. Bell. USDA, SEA, AR, University of Georgia Coastal Plain Experiment Station, Tifton, Georgia 31794.

Antagonistic reactions of seventy-six *Trichoderma harzianum* isolates against representatives of *Sclerotium rolfsii*, *Ceratobasidium* spp., *Phytophthora parasitica* var. *nicotianae*, *Pythium aphanidermatum*, *P. myriotylum* and four anastomosis groups of *Rhizoctonia solani* were compared on 20% V-8 Juice agar in 9 cm petri dishes. Each pathogen isolate was susceptible to antagonism by one or more *T. harzianum* isolates. There were highly significant differences in antagonistic reactions by *T. harzianum* isolates and in overall susceptibility by pathogen species and isolates. However, the greatest difference was reflected in *Trichoderma* x pathogen isolate interactions indicating that a given antagonist isolate can be highly effective against a given isolate of a pathogen species but have minimal effect on other isolates of the same species. This was especially evident with *R. solani* reactions.

NITROGEN FIXATION EFFICIENCY AND FUNGI ASSOCIATED WITH SOYBEAN NODULES IN FUMIGATED AND NON-FUMIGATED FIELD SOIL. K. D. Widin and B. W. Kennedy. Department of Plant Pathology, University of Minnesota, St. Paul, MN 55108.

To determine if soil fungi have an effect on nodule efficiency, Hodgson soybeans were grown in paired plots established in four replicates on field soil cropped to soybeans for 35 years. One plot (7.5 m²) of each pair was fumigated with Vapam (125 ml/l [168 l/ha]). Samples were taken five times during the season (immature, pre-flowering, flowering, pod-forming and pod-filling stages). Acetylene reduction values (umoles ethylene/g fresh wt nodule/hr [bare root samples]) and leg-hemoglobin values (mg/g nodule fresh weight) for fumigated were greater than those for non-fumigated plots at season's end. Soybeans in fumigated soil also had higher mean dry weights of shoots than plants in non-fumigated soil. Throughout the season, more nodules and roots from plants in non-fumigated plots had fungi sporulating on them than those from fumigated plots and nodules and roots in non-fumigated plots were colonized by more fungal species. Fungi on surface-sterilized nodules in non-fumigated plots were *Helminthosporium* sp., *Gliocladium* sp., *Fusarium episphearia* and *Trichoderma* sp. Some of these fungi were also found on nodules from fumigated plots. *Gliocladium* sp. and *F. episphearia* were rarely found on roots of either treatment.

THE INFLUENCE OF DIFFERENT LEVELS OF SOIL MOISTURE ON PHYTOPHTHORA ROOT ROT AND CROWN ROT OF MAHALEB CHERRY ROOTSTOCK. W. Wilcox and S. M. Mircetich, USDA, SEA, Department of Plant Pathology, University of California, Davis 95616.

Phytophthora sp. and *P. cambivora* cause serious losses in California's commercial sweet cherry orchards, particularly when trees are planted on Mahaleb rootstock and subjected to periodic soil saturation. To determine the influence of different levels of soil moisture under controlled conditions, *Prunus mahaleb* seedlings were grown in a growth chamber in soils artificially infested with *Phytophthora* sp. or *P. cambivora*. One of 4 levels of soil moisture (soil water matric potential, ψ_m) was then imposed and maintained by a sintered glass plate: 1) $\psi_m = -25$ millibars (mb) constantly; 2) $\psi_m = -25$ mb, interrupted by saturation ($\psi_m = 0$) 4 hr every 14 days; 3) $\psi_m = -25$ mb, interrupted by 48 hr saturation every 14 days; 4) $\psi_m = -10$ mb constantly. When subjected to the 48 hr saturation regime, both pathogens induced severe root and/or crown rot in all plants and death in 80% of plants. In all other treatments plants were infected by both species, but *Phytophthora* sp. induced a negligible level of root rot and such plants did not differ significantly from controls in shoot or root weights. In contrast, *P. cambivora* induced 20-40% crown rot and moderate root rot although shoot and root weight of such plants were significantly greater than those subjected to 48 hr saturation. These results indicate prolonged and periodic saturation favors *Phytophthora* root and/or crown rot, and that proper soil water management may minimize losses due to these diseases, depending upon the rootstock and fungal species involved.

INTRODUCTION TO THE COTTON SYMPOSIUM. IX INTERNATIONAL CONGRESS OF PLANT PROTECTION. Stephen Wilhelm, Dept. of Plant Pathology, University of California, Berkeley, CA. 94720

The average annual production of cotton fiber worldwide for the crop years 1974/75 to 1976/77 was 57.6 million bales, or about 6.3 million metric tons. If sold at the average price in the United States this cotton would have represented a value of nearly \$16 billion. The future of cotton is, of course, closely linked to the general economy, and major efforts in promotion, research and development are continually directed towards stabilizing and expanding the position of this important commodity on the world market. But of equal urgency in the pursuit of bright prospects for cotton is the need for stability

in production. Owing to various influences, cotton, perhaps more than any other major world crop, is subject to great inconsistencies in annual yield. As an example, in 1978/79 the average cotton yield per acre in California was about 3/4 bales, one of the lowest on record. Since farming by nature focuses on production, nothing hurts a farmer, and ultimately a nation, more than poor harvests. An apt description of the cotton grower's plight comes from the pen of an unknown observer: "Last year he made a bumper crop, paid every man his due; but the weevil's snout has cleaned him out--ate crop and credit, too." Thus, in this symposium our two-fold purpose is to look critically at the cotton plant and to investigate how crop management and protection systems may be employed to remove or minimize the uncertainties caused by well-known pests and diseases; and to explore ways of optimizing the cotton yield potential. We welcome each one of you in anticipation of learning from every quarter.

VA MYCORRHIZAL FUNGI STARTER CULTURES, S.H. Woodhead, D.S. Kenney, Abbott Research Center, Oakwood Road, Box 173, Long Grove, IL 60047/USA.

Vesicular-arbuscular mycorrhizal fungi are propagated in pot cultures on the roots of living plants. Through the cooperation of researchers at various universities throughout the United States, twenty-three isolates representing fifteen species of these fungi are being maintained by Abbott Laboratories on various host plants. These hosts are rotated to reduce root pathogen build-up. The plants are maintained in a healthy condition for three to four months and then harvested. A soil sample is wet sieved and checked for spore number and contamination by other mycorrhizal species. The cultures are stored at cool temperatures until use. As a service to investigators interested in endomycorrhizal research, Abbott Laboratories is distributing starter cultures of these fungi for a modest fee. The starter cultures consist of living fungal spores of a single species, root tissue of the previous host and soil.

THE EFFECT OF KINETIN ON PATHOGENICITY OF *MACROPHOMINA PHASEOLINA*. T. D. Wyllie and S. Gangopadhyay. Dept. of Plant Pathology, 108 Waters Hall, University of Missouri-Columbia, Columbia, MO 65211.

The presence of normal sclerotia of *M. phaseolina* has been used as a criterion for pathogenicity in soybean. Kinetin was extracted from 6-day-old radicles of 1000 Hill (resistant), Clark (intermediate), and Amsoy (susceptible) soybean seedlings and bioassayed by measuring chlorophyll retention in detached oat coleoptiles. There was a direct relationship between resistance and kinetin content. Serine, a kinetin repressor, was extracted using perchloric acid. The glyoxalate formed by sodium metaperiodate was measured quantitatively at 365 μ m. Twelve day old soybean seedlings cv. Williams were fed 10 ppm serine. The controls were not. *M. phaseolina* was inserted into the hypocotyl region and observed for 10 days. Plants treated with serine solution showed a more rapid infection rate and more damage as measured by chlorosis and accelerated tissue invasion by the fungus. This suggests that kinetin may be one of the factors determining the response of soybean tissue to fungus invasion.

EFFECT OF WESTERN GALL RUST [*ENDOCRONARTIUM HARKNESSII* (J. P. MOORE) Y. HIRATSUKA] ON HEIGHT GROWTH OF *RADIATA* PINE. D. Zagory, Department of Plant Pathology, University of California, Berkeley, CA. 94720.

A demonstration stand of 7-year-old *Pinus radiata* D. Don provenances from California and New Zealand at the University-owned Russell Tree Farm was surveyed for numbers of galls on the mainstem and on branches of each tree. Number and location of galls were analyzed with respect to tree spacing and provenance for effect on tree height and diameter at breast height. Number of stem galls had a highly significant effect on tree height, apparently through formation of multiple leaders and consequent damage to tree form. Number of branch galls had no statistically significant effect on height. Neither branch nor stem galls had significant effect on DBH. Fast growing New Zealand selections had fewer stem galls and consequently greater height and better form than native California populations. Since these New Zealand trees were not selected for rust resistance, it seems possible that fast growth alone is important in reducing rust damage.

EFFECT OF AN APHID-TRANSMITTED, YELLOWING VIRUS ON YIELD AND QUALITY OF STAKED TOMATOES. T.A. Zitter, Univ. Fla., AREC, Belle Glade, FL 33430, and P.H. Everrett, ARC, Immokalee, FL 33934.

Tomato seedlings ("Walter") were transplanted in the fall to plots 3½ weeks after seeding. Treatments 1-4 consisted of inoculating plants at 2, 3, 4, and 5 weeks after setting with a

yellowing-type virus recovered from tomato in 1978. Green peach aphids were given 24 hr. acquisition periods on tomato and individual leaflets with aphids attached were cut and laid on plant tops to achieve infection. Treatment 5 was a noninoculated control, and it and the other 4 treatments were sprayed weekly with JMS Stylet-Oil. Treatment 6 consisted of noninoculated plants, not sprayed with oil and located at the end of the plot. Only 4 of 187 inoculated plants failed to develop symptoms. No symptoms developed in treatment 5 and only 2 infected plants in treatment 6. Reduced yields were in direct response to the length of infection (7.0, 16.1, 24.8, and 30.3 metric tons/ha for treatments 1-4, and 40.3 and 34.5 for treatments 5 and 6). Ribbiness, puffiness, immature seed development and thinner walls were common among fruit from treatments 1, 2, and 3.

BLOSSOM POPULATIONS OF *ERWINIA AMYLOVORA* IN PEAR ORCHARDS VS ACCUMULATED DEGREE HOURS OVER 18.3C (65F), 1972-1976. B. G. Zoller and J. Sisevich, PO Box 952, Yuba City, Ca. 95991.

One hundred and forty-nine bi-weekly sample (100-200 blossoms/sample) series were collected from Bartlett pear orchards in 3 climatically distinct districts during Spring 1972-1976. In total, 2793 samples were assayed for *Erwinia amylovora* (EA), using selective media. All suspect colony types developing from the washate of a sample were verified by pathogenicity on green pears and designated EA. EA was detected in 690 samples. Thermograph records were used to log the degree hours accumu-

lated above 18.3C (65F) prior to sampling since the last 3 day period of no temperatures above 18.3C. A tabulation of accumulated Celsius degree hours above 18.3C (1 degree hour C = 1.80 degree hour F) vs the % of samples collected in that period with EA is as follows: 0-55.6 (0.3%), 56.2-111.2 (2.6%), 111.8-166.8 (5.4%), 167.4-222.4 (10.2%), 223-278 (16.4%), 278.6-333.6 (25.0%) and over 333.6 (40.0%). Observations during 1972-1979 indicate that new infections develop at increasing distance from old infections as degree hours accumulate.

APPLE SCAB MANAGEMENT USING PREDICTION OF INFECTION PERIODS AND ASSESSMENT OF INOCULUM LEVELS. M.G. Zuck and D.C. McGee, Dept. of Botany and Plant Pathology, University of Maine, Orono, ME 04473, and Dept. of Botany and Plant Pathology, Iowa State University, Ames, IA 50011.

Modified hygrothermographs in which hemp string leaf-wetness sensors replaced the relative humidity sensors were used to detect Mills, apple scab infection periods in several apple orchards in Maine in 1976, 77 and 78. The amount of inoculum of *Venturia inaequalis* (Cke.) Wint. present during the primary infection period also was measured by sampling leaf litter and counting the number of ascospores discharged from a standard area of leaf surface in an ascospore discharge tower. In each orchard, one block of McIntosh trees was sprayed with fungicide during primary scab, only when infection periods were detected by the leaf-wetness, temperature recorder, while another block was sprayed on a full-season basis with the same fungicide. Both blocks were sprayed on a full-season basis during the secondary infection period. Leaf and fruit scab were evaluated. In orchards with a low level of inoculum, up to four sprays were saved by following the infection period spray program, compared to the full-season program with no loss in disease control. However, in orchards with a high level of inoculum, the infection period program sometimes gave an inferior degree of control compared to the full-season program. Provided a check is maintained on the amount of ascospore inoculum in an orchard, this instrument could provide growers with an inexpensive and reliable method of reducing the number of fungicide applications needed to control apple scab.