

The American Phytopathological Society
PACIFIC DIVISION

Annual Meeting
June 20-21, 1989

ABSTRACTS

EFFECT OF DIFFERENT INOCULUM DENSITIES AND TEMPERATURES ON THE PATHOGENICITY OF WILT/ROOT ROT FUNGI OF CHICKPEAS. M. A. Bhatti and J. M. Kraft, Washington State University and USDA-Agricultural Research Service, Irrigated Agriculture Research and Extension Center, P. O. Box 30, Prosser, WA 99350.

Wilt and root rot of chickpeas in soil artificially infested with different inoculum levels of Fusarium oxysporum f. sp. ciceri, Fusarium solani f. sp. pisi, Thielaviopsis basicola, and Pythium ultimum were severe at 30°C. The temperature optimum for plant growth (20°C) was not favorable for the development of wilt and root rot of chickpea. Fusarium oxysporum f. sp. ciceri and T. basicola caused only moderate disease at 15 and 20°C at 500 and 1000 cfu/gm of soil, but was highly pathogenic at 25 and 30°C at these inocula. Fusarium solani f. sp. pisi was not pathogenic below 20°C, but became highly virulent at 25 and 30°C even at the lowest inoculum density of 100 cfu/gm of soil. None of the four pathogens induced symptoms of wilt or root rot at 10°C even at the highest inoculum level of 5000 cfu/gm of soil.

TWO WHITEFLY-TRANSMITTED GEMINIVIRUSES ISOLATED FROM PEPPER AFFECTED WITH TIGRÉ DISEASE. J. K. Brown and M. R. Nelson. Department of Plant Pathology, University of Arizona, Tucson, AZ 85721.

Two whitefly (Bemisia tabaci Genn.)-transmitted geminiviruses were isolated from pepper affected by tigré (tiger) disease, a previously uncharacterized virus disease complex occurring in Tamaulipas, Mexico. One virus in the complex is a newly described geminivirus, pepper mild tigré virus (PMTV), which causes relatively mild but distinctive symptoms in pepper, tomato, and other hosts, and is not mechanically transmissible under our conditions (Brown, et al., 1989. Plant Dis. 73, in press). The second virus is the previously described chino del tomate virus (CdTV), which causes a severe disease in tomato, but mild to symptomless infection in pepper, and prior to this report had been documented exclusively in western Mexico (Sinaloa). Thus, the two geminiviruses have distinct, but overlapping host ranges and when co-inoculated to pepper, incite foliar symptoms only slightly more severe than does the PMTV alone. Additionally, a virus which causes symptoms in pepper similar to those of PMTV, was transmitted by whiteflies (B. tabaci) from diseased peppers obtained from Weslaco, Texas. Single-stranded DNA (ca. 2.6 Kb) was purified and visualized by gel electrophoresis from plants infected with each of the three virus isolates. The DNAs are about the same size as DNA isolated from other well-characterized whitefly-transmitted geminiviruses.

ESTIMATION OF THE MAXIMUM RELATIVE GROWTH RATE OF GRAPE POWDERY MILDEW USING COHORT LIFE TABLES. D. O. Chellemi and J. J. Marois, Plant Pathology Department, University of California, Davis, CA 95616.

Cohort life tables were constructed for Uncinula necator growing on Vitis vinifera var Carignane. The effect of temperature on survival and reproductivity was obtained from growth chamber studies. The net reproduction rate per individual growing at 19°, 22°, 26°, and 30° C was 341, 1961, 4018, and 501 conidia per generation, respectively. The mean generation time was between 19.4 and 19.7 days for all temperatures investigated except 30°, which was 16.6 days. The maximum relative growth rate per individual growing at 19°, 22°, 26°, and 30° C was 0.299, 0.39, 0.421, and 0.38 conidia per day, respectively.

AGAROSE GEL ELECTROPHORESIS OF NUCLEOPROTEINS AND NUCLEIC ACIDS OF PRUNUS NECROTIC RINGSPOT ILARVIRUSES. J. M. Crosslin, and G. I. Mink. Washington State University Irrigated Agriculture Research and Extension Center, Prosser, WA 99350-0030.

Nucleoprotein (NP) components of several Prunus necrotic ringspot ilarviruses (PNRSV) produce unique electrophoretic patterns in agarose gels, yet others appear very similar (Phytopathology 78:1605). Under nondenaturing conditions, RNAs 1-4 of most isolates display similar mobilities, however, RNAs 2, 3 and/or 4 of certain isolates exhibit unique mobilities. By using NP and RNA electrophoresis, symptomatology, and serological characteristics, nearly all PNRSV isolates can be specifically identified. Interestingly, 4 isolates each labeled as "Fulton's G" appear electrophoretically diverse. We are using electrophoresis for detection and partial characterization of pseudorecombinants produced by combining electrophoretically separated RNAs.

IN VITRO SURVIVAL OF SCLEROTIUM ROLFSII AND PYTHIUM SPP. IN SOIL AMENDED WITH COMPOSTED CHICKEN MANURE. R. A. Duncan and J. J. Stapleton, Statewide IPM Project, University of California, Cooperative Extension, 733 County Center III, Modesto, CA 95355

Aliquots of sandy soil, moistened to approximate field capacity, were amended with concentrations of composted chicken manure (3,280 mg/kg/NH₄-N) equivalent to 2,690 or 5,381 kg/ha and incubated in unsealed plastic bags. Sclerotia of Sclerotium rolfsii in nonamended soil were placed in nylon mesh bags and buried in amended or nonamended control soil. Survival of S. rolfsii, and natural populations of Pythium spp., was assayed after 1-46 days incubation. Numbers of Pythium spp. were reduced 78% (P=0.05) after 1 day, and survival of S. rolfsii decreased 95% after 2 days in the higher manure dosage. Pythium spp. were undetectable, and survival of S. rolfsii was reduced 98% after 13 days. The lower manure concentration was less effective in reducing survival of S. rolfsii, but did reduce numbers (P=0.05) of Pythium spp. Heating of amended soil further decreased numbers of Pythium spp.

FAILURE TO DETECT BEET WESTERN YELLOWS VIRUS IN POTATO LEAFROLL DISEASE SAMPLES FROM CANADA AND THE UNITED STATES. P. J. Ellis, Agriculture Canada Research Station, 6660 N.W. Marine Drive, Vancouver, B.C. V6T 1X2

Potato leafroll disease samples originating from several locations in Canada and the United States were assayed for beet western yellows virus (BWYV) and potato leafroll virus (PLRV). Assays were done using double antibody sandwich ELISA (DAS-ELISA) with polyclonal antisera, triple antibody sandwich ELISA (TAS-ELISA) with monoclonal antibodies specific for each virus, and nucleic acid hybridization methods using both cloned and random primed, 32p-labelled cDNA probes for BWYV and PLRV. None of the 165 potato leafroll disease samples tested positive for BWYV with any of the assay procedures whereas BWYV-infected Physalis floridana was readily detected. All of the samples tested positive for PLRV using both ELISA protocols and nucleic acid hybridization tests.

Camera-ready abstracts are published as they were submitted by the Division. The abstracts are not edited or typed in the APS headquarters office.

IDENTIFICATION AND INCIDENCE OF CARROT VIRUSES IN CALIFORNIA. B. W. Falk and M. Piechocki. Department of Plant Pathology, University of California, Davis, CA 95616.

Analysis of carrots from California's three major carrot production areas showed that distinct virus diseases occurred in each area. Lettuce infectious yellows virus, transmitted by *Bemisia tabaci*, was associated with a root discoloration of carrots in the Imperial Valley desert areas. A potyvirus, identified as a California isolate of carrot thin leaf virus (CA-CTLV), caused a thin leaf symptom in commercial carrots and was common in the San Joaquin Valley. CA-CTLV was transmitted by *M. persicae* and *Cavariella aegopodii* in a nonpersistent manner. Carrot motley dwarf viruses (CMDVs) were isolated from fresh market carrots showing stunting and leaf reddening in the Salinas Valley. The CMDVs were transmitted in a persistent-circulative manner by *C. aegopodii*. The properties and importance of these viruses will be discussed.

THE EFFECT OF BARLEY STRAW MANAGEMENT ON RHIZOCTONIA CROWN AND ROOT ROT OF SUGARBEET. J. A. Fernandez, University of Hawaii at Hilo, Hilo, HI 96720, F. A. Gray, and P. C. Vincelli, University of Wyoming, Laramie, WY 82071.

In a sugarbeet-barley rotation, barley straw management can influence Rhizoctonia crown and root rot of sugarbeet. In 1985, a sugarbeet-barley rotation was established in two tiers of identical plots alternately planted to beets or barley annually. The following treatments were applied to plots artificially infested with *Rhizoctonia solani*: 1) barley straw incorporated into soil, 2) straw burned, and 3) straw removed. Plots containing uninfested soil in which straw was removed were included as checks. Sugarbeet crown and root rot was rated annually on a scale of 1-7 at harvest. Percentages of harvestable beets (rated <4) for 1986, 1987, and 1988 were 51, 93, and 100% for treatment #1; 55, 99, and 100% for treatment #2; 46, 89, and 100% for treatment #3; and 100, 100, and 100% for the checks.

THE INTERRELATIONSHIP OF *MELOIDOGYNE HAPLA* AND *PHYTOPHTHORA MEGASPERMA* F. SP. *MEDICAGINIS* ON ROOT INFECTION IN ALFALFA. E.A. Gray, G.D. Griffin, D.A. Johnson and J.E. Kazimir. Univ. Wyo., POB 3354, Laramie, WY 82071 and Utah State Univ., Logan, UT 84322.

The interrelationship between *Phytophthora megasperma* f. sp. *medicaginis* (Pmm) and *Meloidogyne hapla* was studied in three alfalfa cultivars: Nevada Synthetic XX, resistant to Pmm and highly resistant to *M. hapla*; Apollo II, resistant to Pmm and susceptible to *M. hapla*; Deseret, susceptible to Pmm and *M. hapla*. Inoculation with both pathogens 7 wk after planting resulted in an increase in Pmm infection (assessed 6 mo later) of roots of Deseret (59% increase) and of Rhizobium nodules in Deseret and Apollo II (87 and 13% increase, respectively). The number of Rhizobium nodules was reduced by *M. hapla* in Deseret (67% decrease) and in Apollo II (68% decrease) and by Pmm in Deseret (23% decrease). The benefit of dual resistance in preventing loss from *Phytophthora* root rot was shown in Nevada Synthetic XX, which had no detectable Pmm infection of nodules and only slight root infection when Pmm was applied alone or in combination with *M. hapla*.

THE BIOLOGY AND PATHOGENICITY OF *PRATYLENCHUS NEGLECTUS* ON ALFALFA. G. D. Griffin*, and F. A. Gray**. *USDA-ARS, Forage and Range Research, Utah State Univ., Logan, UT 84322-6300, and **Plant Science Dept., Univ. Wyoming, Laramie, WY 82071.

Pratylenchus neglectus affected the growth of alfalfa in both greenhouse and growth chamber temperature studies. Inocula (1,000 and 5,000 nematodes/plant) reduced Lahontan and Nevada Synthetic XX (Nev Syn XX) dry shoot weights by 16 and 18%, and 32 and 26%, respectively, at 26 ± 2 C. *P. neglectus* (1,000 nematodes/plant) reduced the dry shoot weight of Ranger by 5, 12, 18, and 27% at 15, 20, 25, and 30 C, respectively. Similar results were observed on Nev Syn XX at the same inocula level and soil temperatures. The nematode reproductive indices (Pf/Pi) at inocula of 1,000 nematodes/plant were 3.2, 9.7, 15.9, and 19.8 on Ranger, and 3.6, 9.4, 16.9, and 21.3 on Nev Syn XX at 15, 20, 25, and 30 C, respectively.

BARLEY YELLOW DWARF VIRUS INFECTIVITY OF DIURAPHIS NOXIA AND OTHER CEREAL APHIDS IN SOUTHWESTERN IDAHO. Susan Halbert, June Connelly and Richard Lister. University of Idaho, SW Idaho R/E Center, 29603 U of I Lane, Parma, ID 83660-9637.

Diuraphis noxia (Modvilko), the recently introduced Russian wheat aphid, has been reported to be a vector of barley yellow dwarf virus (BYDV) in South Africa. Natural populations of *D. noxia* and other cereal aphids were sampled in 1987 and 1988 to compare infectivity of

D. noxia with that of other species. More than 1300 *D. noxia* have been tested, and so far, only one indicator plant has acquired recoverable BYDV. In that case, the virus isolate was consistently transmissible by *S. graminum*, but never by *D. noxia* in subsequent assays. Serologically, the isolate resembles SGV. In comparison with *Rhopalosiphum padi*, *Schizaphis graminum*, *Rhopalosiphum maidis* and *Sitobion avenae*, *D. noxia* is currently not important in BYDV epidemiology in southwestern Idaho in spite of the fact that it is now by far the most abundant cereal aphid in the area.

EFFECTS OF NURSERY FUMIGATION AND COVER CROPS ON SOIL-BORNE PATHOGENS AND CONIFER SEEDLING QUALITY. E. M. Hansen, D. D. Myrold and P. B. Hamm, Dept. of Botany & Plant Pathology (1st & 3rd) and Dept. of Soil Science, Oregon State Univ., Corvallis, OR 97331-2902.

Soil management in forest tree nurseries in the western U.S. commonly includes a green manure cover crop and fall fumigation before sowing the next spring. The interactive effects of cover crop treatments and fumigation were examined in 3 nurseries. Populations of *Fusarium* and *Pythium* were dramatically reduced by fumigation and stayed significantly below unfumigated plots throughout the two-year crop cycle. Grass or legume cover crops increased pathogen levels over bare fallow treatments before fumigation and the differences persisted throughout the crop cycle in unfumigated beds. By the end of the crop cycle *Fusarium* and *Pythium* populations in bare fallow, unfumigated beds were similar to levels in cover cropped, fumigated beds. There was less seedling mortality in beds that had been fallow prior to sowing and in beds that had been fumigated than following cover crops or in unfumigated beds.

EVALUATION OF TETRACYCLINE, COPPER, AND STREPTOMYCIN RESISTANCE OF *ERWINIA AMYLOVORA* STRAINS FROM PEAR ORCHARDS IN WASHINGTON STATE. M.D. Henkels¹, J.E. Loper¹, and R.G. Roberts², USDA, ARS, ¹HCRL, Corvallis, OR 97330, and ²TFRL, Wenatchee, WA 98801.

Fireblight disease, caused by *Erwinia amylovora*, was responsible for serious economic losses to pear growers in Washington state in 1988. Tetracycline, fixed copper compounds and streptomycin are commonly used for disease control, but the sensitivities of indigenous *E. amylovora* strains to these compounds are unknown. 138 pathogenic strains were isolated from water-soaked cankers of pear trees from 44 orchards in the major pear growing regions of Washington state. None of the strains tested were resistant to tetracycline (25 ug/ml) or CuSO₄ (0.16 mM). However, spontaneous mutants with resistance to 0.16 mM CuSO₄ were observed at a frequency of 10⁻⁶ to 10⁻⁷ in most strains. Ninety eight strains, representing 38 of the orchards sampled, were resistant to streptomycin (1 mg/ml). No relationship between streptomycin resistance and usage or orchard location was observed. Results suggest that streptomycin resistant *E. amylovora* are ubiquitous in Washington state.

GENETIC ANALYSIS OF THE AEROBACTIN IRON UPTAKE SYSTEM OF AN *ENTEROBACTER CLOACAE* STRAIN ANTAGONISTIC AGAINST *PYTHIUM* SPP. C.A. Ishimaru¹, A. Vanavichit², and J.E. Loper¹. ¹USDA, ARS, HCRL, and ²Oregon State University, Corvallis, OR, 97330.

Aerobactin is a hydroxamate siderophore produced by clinical isolates of the enterobacteria, *Escherichia coli* and *Enterobacter cloacae*, and by certain strain(s) of the phytopathogen, *Erwinia carotovora*. Six *E. cloacae* strains, which inhabit the rhizosphere and control damping-off diseases caused by *Pythium* spp., were tested for aerobactin production. All six strains produced aerobactin, as determined colorimetrically and by bioassay with the aerobactin indicator strain LG1522. Aerobactin biosynthesis genes from *E. cloacae* strain EcCT-501 were identified from a genomic library by expression of aerobactin production in *E. coli* DH5a. Southern hybridization analysis and restriction enzyme mapping revealed structural heterogeneity among the aerobactin genes of *E. coli*, *E. carotovora*, clinical *E. cloacae* isolates, and *E. cloacae* EcCT-501. Future studies will evaluate the role of aerobactin production in the biocontrol activity of strain EcCT-501 against *Pythium* spp.

INFLUENCE OF THE *AGROBACTERIUM RADIOBACTER* STRAIN K84 NOPALINE PLASMID, pAt84b, ON CONJUGAL TRANSFER OF PLASMIDS BETWEEN *AGROBACTERIUM* STRAINS. M.D. Kawalek¹, J.E. Loper², L.W. Moore³, and V.O. Stockwell¹. ¹Oregon State University, Dept. Botany and Plant Pathology, and ²USDA-ARS, HCRL, Corvallis, OR 97331.

A. radiobacter strain K84 controls crown gall disease, caused by *A. tumefaciens*, by production of agrocin 84. K84 harbors two conjugal plasmids, pAgK84 that confers synthesis of and immunity against agrocin 84 and pAt84b that confers nopaline catabolism. Conjugal transfer of pAgK84 to virulent *A. tumefaciens* strains, or transfer of Ti plasmids from *A. tumefaciens* strains to K84, may produce tumorigenic strains that are resistant to biocontrol. Mobilization or incompatibility functions of pAt84b influencing transfer of

plasmids pAgK84 and pTi, transposon-tagged with Tn5, were evaluated *in vitro* and *in planta*. Plasmid pTiB49c::Tn5, a Tn5-tagged pTi of *A. tumefaciens* strain B49c, transferred *in vitro* to *A. radiobacter* strain NT-1 with and without pAt84b at the similar frequencies (1.8×10^{-5} and 2.9×10^{-5} transconjugants per recipient, respectively). Plasmid pAgK84::Tn5 transferred at similar frequencies from donors with and without pAt84b, *in vitro* to NT-1 (pTiB49c) (5.8×10^{-5} and 2.6×10^{-5} t/r, respectively), and *in planta* to B49c (3.0×10^{-4} and 1.0×10^{-4} t/r, respectively). These data indicate that pAt84b plays a minimal role as a conjugal helper of plasmid pAgK84 and does not prevent the transfer of pTiB49c into K84 through incompatibility.

SIDEROPHORE PRODUCTION BY FLUORESCENT PSEUDOMONADS UNDER CONTROLLED ATMOSPHERES. D. H. Kim and I. J. Miasghi, Department of Plant Pathology, University of Arizona, Tucson, AZ 85721.

The effects of controlled atmospheres on the growth and fluorescent siderophore production by four strains of fluorescent pseudomonads were studied at pH 6.0 and 7.8. Bacterial strains were grown in liquid King's Medium B for 48 hr in the presence of O₂/CO₂ combination percentages of 21.0/0.03, 18.0/3.0, 15.0/6.0, 12.0/9.0, and 9.0/12.0. The bacterial biomass was determined after centrifugation and the siderophores were isolated, partially purified, and quantified spectrophotometrically. Results showed a steady decline in growth and in siderophore production per unit biomass with decreases in the O₂/CO₂ ratio at pH 7.8 and to a lesser extent at pH 6.0. The average percent changes in siderophore production levels, relative to control, were +0.8, -1.2, -18.2, and -40.6 at pH 6.0; -33.0, -50.4, -66.8, and -64.1 at pH 7.8 in the presence of O₂/CO₂ levels of 18.0/3.0, 15.0/6.0, 12.0/9.0, and 9.0/12.0, respectively.

TN5 INSERTION MUTANTS OF *PSEUDOMONAS FLUORESCENS* PF5 ALTERED IN PRODUCTION OF THE ANTIBIOTICS PYRROLNITRIN AND PYOLUTEORIN. J. Kraus and J. E. Loper, USDA, ARS, HCRL, Corvallis OR 97330.

Pseudomonas fluorescens PF5 protects cotton seedlings from damping-off diseases caused by *Rhizoctonia solani* and *Pythium ultimum*, and produces two antibiotics, pyrrolnitrin (PN) and pyoluteorin (PL), which inhibit *R. solani* and *P. ultimum*, respectively (Howell and Stipanovic, 1980, *Phytopath* 70:712). PF5 also produces a third uncharacterized antibiotic that is inhibitory towards both fungi. Tn5 insertion mutants of PF5 were generated and screened for antagonism against *R. solani* and *P. ultimum*, or for PN and PL production. Screening for altered antagonism yielded mutants that were (1) super-antagonistic to both fungi and overproduced PL and the third antibiotic, and (2) not antagonistic towards either fungus and produced no antibiotics. Screening of 6286 mutants for PN and PL production yielded 13 PN⁺PL⁺ mutants, 6 PN⁺PL⁻ mutants, several overproduction mutants, and 1 PN⁺PL⁺ mutant. These mutants will be useful in future studies determining the roles of specific antibiotics in the biocontrol activity of PF5.

Population genetics of *Inonotus tomentosus* by vegetative compatibility and total protein profiles. Kathy J. Lewis and Everett M. Hansen. Botany and Plant Pathology, Oregon State Univ., Corvallis, Or. 97331.

Inonotus tomentosus is a basidiomycete fungus which causes root disease of conifers in the boreal forest. The involvement of basidiospores in disease spread, in addition to root contacts between diseased and healthy trees, is an important question with management implications. The size and distribution of single genotypes (clones) was determined by pairing isolates collected from adjacent and distant disease centres in several locations. Total protein profiles of isolates from a variety of locations were compared using SDS PAGE. Each disease centre was found to consist of one or several genotypes different from that of surrounding disease centres, suggestion that spores are important in disease spread. Protein profiles suggest a wide variety of genotypes in the N. American population of *I. tomentosus*.

SPRINKLER IRRIGATION EFFECT ON HEAD ROT (*ERWINIA CAROTOVORA* SUBSP. *CAROTOVORA*) AND YIELD OF BROCCOLI. R. L. Ludy, D. D. Hemphill, Jr., and M. L. Powelson*. Depts. of Horticulture and Botany and Plant Pathology*, Oregon State University, Corvallis, OR 97331-2911.

Head rot is a serious disease of broccoli in the Northwest, but severity varies from year to year and field to field. A two-year study was conducted using a line-source irrigation system to test the effect of irrigation frequency and amount on two broccoli cultivars, 'Gem' and 'Citation'. In 1987, the incidence of head rot was less than 7.5% and did not differ significantly between cultivars or amounts of water. In 1988, the incidence of rot was twice as great in 'Citation' as in 'Gem'. A three-fold increase in head rot occurred when the crop was irrigated three times per week compared to once a week. Yields increased as the amount of applied water increased but marketable yield remained constant because of the increase in disease. Reducing irrigation frequency was most effective in reducing the incidence of head rot while maintaining adequate yields.

A SPHERICAL VIRUS ASSOCIATED WITH SCORCH DISEASE OF HIGHBUSH BLUEBERRY. S.G. MacDonald and R.R. Martin, Agriculture Canada Research Station, 6660 N.W. Marine Drive, Vancouver, B.C. V6T 1X2

During a survey of blueberry fields in British Columbia, Washington, and Oregon, blueberry bushes with scorch symptoms were found in all areas. Some of these bushes were infected with blueberry scorch carlavirus (Phytopathology 78:1636-1640). Others, uninfected with the carlavirus, contained a second virus which was sap transmissible to *Nicotiana clevelandii*, *N. benthamiana*, and *N. tabacum* cv. Havana 425. This virus was purified from *N. clevelandii* and had spherical particles of approximately 30 nm in diameter, a coat protein of 28,000 daltons and a tripartite genome. Serological tests of this blueberry virus with antisera against members of the ilar, cucumo, bromo or nepovirus groups failed to indicate any relationship.

RELATIVE VIRULENCE OF *PHYTOPHTHORA PARASITICA* ISOLATED FROM SEVERAL HOSTS TO ROUGH LEMON AND TOMATO. M. E. Matheron and J. C. Matejka. Univ. of Ariz., Yuma Ag. Ctr., Yuma, AZ 85364

Phytophthora parasitica has been isolated from declining citrus, jojoba, and several landscape plants in Arizona. Inoculation studies using zoospores were initiated to examine the relative virulence of *P. parasitica* isolated from several hosts to rough lemon and tomato, two crop plants with measurable susceptibility to this pathogen. Isolates of *P. parasitica* originating from citrus were highly virulent to rough lemon seedlings, causing crown rot and significant reduction of root weight. Isolates of the pathogen from non-citrus hosts demonstrated low virulence to rough lemon, inducing no crown rot and minor reduction of root weight. All tested isolates of *P. parasitica* were highly virulent to tomato seedlings, causing stem lesions and usually plant death. Severe losses could result in tomato plantings cultivated on sites formerly occupied by citrus or near landscape plantings that may be infected with *P. parasitica*.

FACTORS AFFECTING SOIL EXTRACTION EFFICIENCY OF PHYTONEMATODES. Merrifield, K., Ingham, R., and Newcomb, G. Oregon State University Department of Botany and Plant Pathology, Corvallis, Oregon 97330-2902

Baermann funnels (BF) and wet sieving/sucrose centrifugation (SC) were compared as soil nematode extraction methods. More nematodes were extracted with BF using glass than plastic funnels and milk filters than Kimwipes. Ninety percent of nematodes recovered in six days in BF were recovered in the first three days. When soil was stored for 70 days, *Criconebella* sp. counts from BF extractions on four dates changed significantly ($p = .05$), whereas those of *Pratylenchus penetrans* and *Paratylenchus* sp. did not. Over the same 70 day period, *P. penetrans* and *Criconebella* sp. counts from SC changed significantly ($p = .05$ and $.0001$, respectively), while those of *Paratylenchus* sp. did not. SC was more efficient for extraction of *Paratylenchus* sp. and *Criconebella* sp., but BF was more efficient for *P. penetrans*.

THE ROLE OF INSECTS IN FRUIT DECAY WITH SPECIAL REFERENCE TO MUCOR PIRIFORMIS. T. J. Michailides¹, R. A. Spotts², and J. M. Ogawa³. ¹Univ. of California, Berkeley, Kearney Ag. Center, Parlier, 93648, ²Oregon State University, Mjd-Columbia Ag. Res. and Ext. Center, Hood River, OR 97031, and ³Univ. of California, Department of Plant Pathology, Davis, 95616.

In California, *Drosophila melanogaster*, *Carpophilus hemipterus*, and *C. freemani* acquired propagules of *M. piriformis* and transferred them to 75-100% of injured peach fruit with *C. hemipterus* transmitting the fungus more efficiently than *C. freemani*. Propagules of *M. piriformis* persisted for at least 18 days on *D. melanogaster* and for 11 days on the species of *Carpophilus*. In addition, when given access to uninjured peach fruit, nitidulid beetles transmitted the fungus, causing 42-75% fruit rot. In Hood River, Oregon, 68-94% of vinegar flies collected from three peach orchards showed contamination with propagules of *M. piriformis*. From 3 to 38% of these flies carried propagules of both + and - mating types of the fungus, producing zygospores on agar media. The role of these insects in the life cycle of the fungus will be discussed.

DISEASE LOSSES TO CALIFORNIA-TYPE RESISTANT AND SUSCEPTIBLE ICEBERG LETTUCE CULTIVARS CAUSED BY INFECTIOUS CORKY ROOT. R. Douglas O'Brien and Ariena H. C. van Bruggen, Department of Plant Pathology, University of California, Davis, CA 95616.

A 2 x 2 factorial experiment in 1 x 2 m microplots compared an F-5 pedigree lettuce selection of 'Green Lake' x 'Salinas' named '440-8' (Dr. E. Ryder, USDA, Salinas, CA) with its susceptible parent, 'Salinas' in noninoculated plots and plots inoculated with the corky root bacterium at 8×10^{10} cfu/m². In inoculated plots, percentages of taproot affected at the 8-leaf stage were 95.5% and 10.4% for 'Salinas', and 4.6% and 2.3% for '440-8', in fall 1988 (ave soil temp=22C) and spring 1989 (ave soil temp=17C), respectively. Disease onset on '440-8' was 4 and 10 days later than on 'Salinas' in fall and spring, respectively, and progress rates were slower. Fresh wt 15 days before harvest of inoculated 'Salinas' were 16% and 65% of the control in fall and spring, respectively. Fall inoculated 'Salinas' produced no marketable heads. Neither fresh wt nor marketable yields of '440-8' were affected by inoculation. Higher soil temp appeared to increase disease in both cvs.

ELISA TESTING PROGRAM FOR STONE FRUIT VIRUSES INITIATED IN CALIFORNIA. D.C. Opgenorth and J. Smith, Analysis and Identification Branch, California Department of Food and Agriculture, Sacramento, California. 95814

Testing of dormant buds of almond, apricot, nectarine, peach and plum trees from eight orchards was performed in 1987. Use of ELISA tests confirmed the presence of Prunus Necrotic Ringspot and Prune Dwarf viruses in each fruit type, except that no Prune Dwarf virus was detected in apricot trees. Additional testing was done on samples from 140 trees representing three commercial peach orchards. The highest percentage of positive trees was found after the first flush of growth in the spring. The plant tissue from an infected tree found to test positive most consistently was the terminal meristem including attached, unexpanded leaves. Preliminary data indicates the viruses in Prunus are not uniformly distributed in peach trees. Thus, samples should be taken from several scaffolds to avoid "misses." A total of 7,187 samples from 16 nurseries were tested in 1988.

PRODUCTION OF MONOCLONAL ANTIBODIES TO STRAINS OF PRUNUS NECROTIC RINGSPOT VIRUS. D.C. Opgenorth, J. Smith, Analysis and Identification Branch, California Department of Food and Agriculture, Sacramento, California; A. Karu, J. Lilliental, University of California, Berkeley, California; J. Crosslin, G. Mink, Washington State University, Prosser, Washington.

Antigens of the symptomless (CH 39) and rugose mosaic inducing (CH 38) strains of Prunus Necrotic Ringspot Virus (PNRSV) were purified from *Chenopodium quinoa*. Each antigen was injected subcutaneously into a Swiss Webster mouse. Hybridomas were produced after blood samples from the mice indicated high antibody titers. Approximately 7,600 hybridoma cultures were initiated by fusion of mouse splenocytes with myelomas (P3X63A68.653). Preliminary testing of 560 successful cultures indicated 90% produced IgG. A total of 1,428 hybridoma lines and supernatants were saved. Screening of frozen culture supernates against CH 38 and CH 39, isolates of serotype CH 9, and 4 other serotypes of PNRSV is in progress. Hybridoma cell lines exhibited both broad spectrum and specific viral antibodies.

VERTICILLIUM DAHLIAE, MELOIDOGYNE CHITWOODI, AND IRRIGATION LEVEL AS FACTORS IN POTATO EARLY DYING. J. I. Orlowsky, M.L. Powelson, and R.E. Ingham, Dept. of Botany & Plant Pathology, O.S.U., Corvallis, OR 97331.

A factorial set of treatments consisting of three levels each of *V. dahliae*, *M. chitwoodi*, and irrigation were established in 1987 and 1988 in field microplots in Oregon's Columbia Basin. The relationship of the treatments to potato early dying (PED) and yield was assessed on cv. Russet Burbank. Onset of disease symptoms was earlier, disease severity, as measured by AUDPC, was greater, and yield was reduced as initial inoculum density of *V. dahliae* was increased. High irrigation levels interacted with high *V. dahliae* levels to increase disease severity and reduce yield. *M. chitwoodi* had little effect on PED in 1987 yet had significant interactive effects on date of disease onset and significant main effects on AUDPC and yield in 1988.

Systemicity in almond blossoms and efficacy of E-0858 and iprodione for control of brown rot blossom blight. J.M. Osorio, R.M. Bostock, and J.M. Ogawa. Dept. Plant Pathology, University of California, Davis 95616

Alternative fungicides to benomyl for use in commercial almond

orchards are needed due to the development of benomyl-resistant (BR) populations of *Monilinia laxa*. Comparisons of the currently registered iprodione with the experimental fungicide E-0858 (ICI) indicate that these compounds differ in their systemicity in almond blossoms. Radioisotope-labelled chemicals were applied to either petals or sepals of closed blossoms on detached branches (cv. Drake) or potted trees (cv. NePlus). Following petal application, E-0858 was detected in sepals and stamens, while iprodione was detected only in sepals. Following sepal application, E-0858 was detected in petals, stamens, and pistil, whereas iprodione was detected in petals and stamens. In all cases, E-0858 displayed greater systemicity than iprodione. In detached blossom efficacy tests, anthers were equally protected from infection with either iprodione, E-0858, or benomyl. In an orchard where disease control with benomyl failed due to the presence of BR *M. laxa*, E-0858 and iprodione provided disease control; however, in an orchard with benomyl-sensitive *M. laxa*, benomyl but not E-0858 was significantly better than iprodione.

THE ROLE OF SIDEROPHORES IN THE BIOLOGICAL CONTROL OF PYTHIUM DAMPING-OFF OF CUCUMBER BY *PSEUDOMONAS PUTIDA*. T. C. Paulitz, C. A. Ishimaru, and J. E. Loper, USDA-ARS, Horticultural Crops Research Lab, 3420 NW Orchard Ave, Corvallis, OR 97330

Pseudomonas putida strain N1R, which produces a fluorescent siderophore, protected cucumber seedlings against damping-off caused by *P. ultimum*. Derivatives of N1R, deficient in fluorescent siderophore production, were obtained by Tn₅ mutagenesis following matings of N1R with various *E. coli* strains harboring the plasmids pSUP1011, pSUP2021 or pLG221. Ten non-fluorescent (Flu-) mutants were selected and their Tn₅ insertions were further characterized by Southern blot analysis with biotin labelled Tn₅ as a probe. The *in vitro* growth rates and rhizosphere populations of nine of the single-insertion mutants did not differ from the parent N1R. The ability of Flu- mutants to protect cucumber seedlings against damping-off was investigated in a non-sterile sandy loam (pH 6.0) limed with Ca(OH)₂ to pH 7.4. Both the Flu- mutants and N1R gave equal control of the pathogen, indicating that iron competition was not important for biological control in this soil.

CHARACTERIZATION OF DNA BINDING, UPTAKE, AND DEGRADATION BY *CLAVIBACTER MICHIGANENSE* PV. *SEPEDONICUM*. B.J. Schneider and C. S. Orser, Department of Bacteriology & Biochemistry, University of Idaho, Moscow, ID 83843.

The conditions for DNA binding and uptake of exogenously supplied [³²P]-labeled DNA by cells of *Clavibacter michiganense* pv. *sepedonicum* (Cms) were investigated. Cells, suspended in sucrose buffered TES (10% sucrose in 50 mM TES, pH 7.3) and treated with lysozyme and EDTA, exhibited maximum uptake and binding of nick-translated pSP10 DNA within five minutes of treatment. Production of acid-soluble degradation products was greatest for untreated cells. Lysozyme and EDTA treatment of Cms cells minimized the acid-soluble counts. Stable maintenance of pSP10, as judged by inheritance of chloramphenicol resistance, was not observed. Chloramphenicol acetyl transferase assays are in progress to determine if transient expression of the foreign DNA is occurring.

HIGH FREQUENCY INSERTION SEQUENCE-MEDIATED DELETION OF THE IAA OPERON IN *PSEUDOMONAS SAVASTANOI*. Scott Soby and Tsune Kosuge (posthumously), Dept. of Plant Pathology, University of California, Davis 95616

The IAA operon of *Pseudomonas savastanoi* is deleted at high frequency from the IAA-containing plasmid pIAA2 by two large consensus deletions. The termini for both deletions have been mapped to a hot-spot 11.5kb 5' to the IAA structural genes in several independently isolated mutants. The deletions are mediated by a complex insertion sequence (CIS-1), which appears to be composed of the insertion sequence IS51 and a second IS element, 2.7kb in length (tentatively designated IS53). IS51 has been shown to cause polar mutations in the IAA operon, and has only exhibited deletion activity when IS53 is inserted. Insertion of the left end of CIS-1 into the target sequence results in a 16.6kb deletion, while the larger deletion may be a result of the insertion of the right end, resulting in loss of the element. The presence of active IS elements flanking the IAA region may suggest a mechanism for transposition of the phytohormone genes.

ISOLATION OF A VIRUS FROM DRAINAGE WATER IN BRITISH COLUMBIA. Richard Stace-Smith, Agriculture Canada Research Station, 6660 N.W. Marine Drive, Vancouver, B.C. V6T 1X2

Water samples of 250 ml each were collected from several locations in the Fraser delta region of British Columbia,

ultracentrifuged and the resuspended pellet was mechanically inoculated to a range of test hosts. A virus that induced a few necrotic local lesions on inoculated cucumber cotyledons was isolated from one drainage canal. The virus was readily sap-transmissible from cucumber to a range of test plants (*Gomphrena globosa*, *Nicotiana benthamiana* and *Vigna unguiculata*) in which it caused local lesions only with no systemic invasion. Inoculated cucumber cotyledons were used as a source of virus for purification. Purified preparations sedimented on a sucrose gradient as a single component containing bacilliform particles measuring 25 nm X 60 nm.

TWO NEW DISEASES OF *SALICORNIA* SP. CAUSED BY *BACILLUS SUBTILIS* AND *MACROPHOMINA PHASEOLINA*. M.E. Stanghellini, and S.L. Rasmussen, Department of Plant Pathology, University of Arizona, Tucson, AZ. 85721

A halophytic species of *Salicornia* is currently being evaluated on the seacoast of the state of Sonora, Mexico for its potential as a forage and oilseed crop. The crop is seeded in February and March, irrigated daily with undiluted sea water, and harvested in September and October. In August 1986 numerous wilted plants exhibiting root rot were observed in flood-irrigated plots located in Puerto Penasco, Mexico. At harvest in September, ca. 25% of the plants in many plots were dead. *Macrophomina phaseolina*, was consistently isolated from rotted roots and confirmed by pathogenicity tests as the cause of the disease. In September 1987, a soft-rot disease which resulted in the liquefaction of almost all above ground parts of mature plants was observed in overhead-irrigated plots. Within one month after the onset of the disease, almost all of the plants in the plot (0.5 ha) were dead. A bacterium, tentatively identified as *Bacillus subtilis*, was consistently isolated from symptomatic plant tissues and demonstrated to cause the disease. This is the first report of these two microorganisms as pathogens of *Salicornia*.

FIELD EVALUATION OF ANTIBIOTIC-RESISTANT MUTANTS OF *AGROBACTERIUM* SPP. V.O. Stockwell¹, L.W. Moore¹, M.D. Kawalek¹, J.E. Loper², ¹Dept. of Botany & Plant Pathology, Oregon State University, and ²USDA-ARS, HCRL, Corvallis, Oregon, 97331.

Spontaneous antibiotic-resistant mutants of *Agrobacterium tumefaciens* and *A. radiobacter* K84 were compared to parental strains in laboratory, greenhouse, and field experiments. Strains included: (i) *A. tumefaciens* C58, B6, and B49c and derivatives resistant to 300 µg/ml naladixic acid (C58) and 100 µg/ml rifampicin (B6, B49c), and (ii) K84 and K84 resistant to rifampicin or 500 µg/ml streptomycin. Strain K84 Rif no longer produced agrocin 84, the bacteriocin encoded by pAgK84 and involved in biocontrol activity of strain K84, although pAgK84 was still present. Mutant strains that were selected for field studies were similar to parents in growth rates and pathogenicity or biocontrol activity. No significant difference in disease incidence on cherry seedlings was observed among B6 and derivatives at 4 of 4 locations nor C58, B49c, and their respective derivatives at 3 of 4 locations. Biological control effected by K84 and K84 Sm^r did not differ significantly at 4 locations. Naladixic acid did not afford adequate selection for reisolation of C58 Na^r, due to large populations of indigenous resistant agrobacteria. Streptomycin and rifampicin resistant mutants were reisolated selectively from roots and galls and should be useful tools for ecological studies.

EFFECT OF SODIUM/CALCIUM RATIO AND IONIC CONCENTRATION OF A NUTRIENT SOLUTION ON PHYTOPHTHORA ROOT ROT OF TOMATO. Ariena H. C. van Bruggen and Nacera Bouchibi, Department of Plant Pathology, University of California, Davis, CA 95616.

In two sets of greenhouse experiments, the effects of four Na/Ca ratios (0, 1, 5, 10) on *Phytophthora* root rot of tomatoes were studied at two ionic concentrations (2.5 vs. 25 mEq/L, or 25 vs. 50 mEq/L) in a modified Hoagland's solution. After two weeks, plants were either kept at the same ionic concentration or were shifted from low to high or from high to low concentration, and half of the plants were inoculated with zoospores of *P. parasitica* (10³-10⁶ per liter). Two weeks after inoculation, percent root rot was assessed visually. Root rot increased significantly with increasing Na/Ca ratios at ionic concentrations of 2.5 or 25 mEq/L before and after inoculation. In the second experiment, salt stress (50 mEq/L) before inoculation increased root rot, but after inoculation, it reduced root rot, particularly at higher Na/Ca ratios (5 and 10). *In vitro*, percentages of zoospores that encysted or burst increased at increasing salt concentrations and Na/Ca ratios.

EFFECT OF PHYTOPHTHORA ROOT ROT ON SODIUM UPTAKE IN SAFFLOWER. T. R. Weicht and J. D. MacDonald, Department of Plant Pathology, University of California, Davis, CA 95616.

Salt accumulation in irrigated soils is a serious problem, and sodium exclusion mechanisms in plant roots may be compromised by root disease. The effect of *Phytophthora* root rot on Na uptake in safflower was determined by growing plants in nutrient solution amended with 0, 50 or 100 mEq of NaCl plus CaCl₂ in a 10:1 ratio, and inoculating half with zoospores of *P. cryptogea*. Leaf and root tissues were harvested 26 days after inoculation and analyzed by atomic absorption

spectrophotometry. There was a positive correlation (r=0.98, P<0.01) between root rot severity and leaf Na concentration. ²²Na was added to 50 mEq salt-amended nutrient solutions to compare rates of ion influx and efflux in healthy and infected root systems. Disease greatly increased short-term influx and efflux rates, indicating loss of selective permeability in root cell membranes.

INCIDENCE AND SEVERITY OF STEM RUST (*PUCCINIA GRAMINIS* GRAMINICOLA) IN *LOLIUM PERENNE* 'LINN' TREATED WITH PROPICONAZOLE. R. E. Welty, USDA ARS, National Forage Seed Production Research Center, Corvallis, Oregon 97331-7102

Propiconazole was applied at 252 and 126 g a.i./ha in 1986 and 1988, respectively, to perennial ryegrass to control stem rust. The fungicide was applied 1 to 6 times at 12-14-day intervals, beginning mid-April. Stem rust was scored on July 3, 1986, and July 1, 1988, 1 day before harvest. In 1986, rust severity was an avg. estimate (%) of seed head rusted. In 1988, rust severity was the avg. estimate (%) of rust on stems and heads. Rust severity was 2 and 0% in 1986 and 1988, respectively, in plots sprayed twice in late season (June 2 & 16, 1986; June 9 & 23, 1988). In plots sprayed once (June 16, 1986; June 23, 1988), rust severity was 17% and 22%. In both years, rust severity was 0% in plots receiving 3-6 late-season (mid-April to mid-May) applications of propiconazole. In both years, propiconazole applied earlier than mid-May provided inadequate protection from stem rust.

INDUCTION OF PEAR BLOSSOM INFECTION CAUSED BY *PSEUDOMONAS SYRINGAE*. S. K. Whitesides and R. A. Spotts, Oreg. St. Univ., Mid-Col Ag Res and Ext Center, Hood River, OR 97031.

Conditions were established for inducing pear blossom infection caused by *Pseudomonas syringae* pv. *syringae* (Pss) on both attached and detached shoots. The optimal infection threshold population of Pss was >10⁴. Infection required temperature reduction to the low temperature exotherm (-2.0 to -4.5 C). Wetness during and following treatment influenced Pss infection severity. This method was used for pathogenicity tests of Pss isolates and agreed with tests using pear and cherry fruitlets. Inoculation of cuttings at several stages of bloom showed that full bloom and open cluster were more susceptible to infection than tight cluster stage. Red cultivars of Bartlett and d'Anjou were less susceptible to blossom infection than green cultivars. Antibiotics provided protection when applied up to 1 hr prior to cold treatment but were less effective when applied 1 or 24 hr after treatment.

A CONSERVED REGION IN CARLAVIRUSES DETECTED BY A MONOCLONAL ANTIBODY. Andrew Wiczorek and Richard Stace-Smith, Agriculture Canada Research Station, 6660 N.W. Marine Drive, Vancouver, B.C. V6T 1X2.

In the production of monoclonal antibodies against potato virus M (PVM), an antibody was isolated that reacted against three carlaviruses (potato virus S, carnation latent and blueberry scorch) but not against potexviruses (potato virus X, narcissus mosaic) and potyviruses (zucchini yellow mosaic and turnip mosaic). The antiserum did not react with PVM particles dissociated with sodium dodecyl sulfate but reacted in double antibody sandwich ELISA tests with whole virus. This evidence suggests that the epitope involved is located on the surface rather than on an internal site. Although further testing is required, preliminary evidence suggests that this clone may recognize an epitope shared by and unique to carlaviruses.

DOUBLE-STRANDED RNA IN PALLIDOSIS-DISEASED STRAWBERRY AND *FRAGARIA* SPECIES. N. Yoshikawa, Fac. of Agric., Iwate Univ., Morioka, Japan, and R. H. Converse, USDA ARS, Oregon State Univ., Corvallis

Pallidosis Disease Agent (PDA) causes a graft transmissible, viruslike strawberry disease of unknown etiology and is identified by symptom production on grafted *F. virginiana* cv UC-10, while grafted *F. vesca* cvs UC-4, 5, and 6 remain symptomless. Seven PDA isolates (3 from strawberry cvs and 4 in *F. vesca* plants from Dr. N. W. Frazier) were tested for associated dsRNAs by standard extraction methods, then polyacrylamide gel electrophoresis and silver stain. All 7 produced two-four dsRNAs (4.3 - 4.8 x 10⁶ daltons) and, depending on the isolate, smaller (1.1 - 2.6 x 10⁶ daltons) dsRNAs. Similar-sized dsRNAs were detected in ungrafted UC-4, 5, and 6, but not in UC-10. Grafting of these UC-4, 5, and 6 clones produced very faint PD symptoms on UC-10. Thus, PD is consistently associated with the presence of specific dsRNAs.

SUSTAINING ASSOCIATES

- ABBOTT AGRIC. RES. CTR., Long Grove, IL
 ADVANCED GENETIC SCIENCES, INC., Oakland, CA
 AGRI-DIAGNOSTICS ASSOCIATES, Cinnaminson, NJ
 AGRICULTURE CANADA, Vineland Station, Ontario
 ALF CHRISTIANSON SEED CO., Mount Vernon, WA
 AMERICAN CYANAMID CO., Agriculture Center, Princeton, NJ
 BASF CORPORATION, Parsippany, NJ
 BOTANIC GARDENS OF ADELAIDE, Adelaide, Australia
 BUCKMAN LABORATORIES, Memphis, TN
 CALGENE, INC., Davis, CA
 CARGILL HYBRID SEEDS, Aurora, IL
 CHEVRON CHEMICAL CO., Richmond, CA
 CHEVRON CHEMICAL CO., San Ramon, CA
 CIBA-GEIGY CORPORATION, Agric. Div., Greensboro, NC
 DEKALB-PFIZER GENETICS, DeKalb, IL
 DEKALB-PFIZER GENETICS, Groton, CT
 DEL MONTE FOODS USA, Walnut Creek, CA
 E. I. DUPONT DE NEMOURS & CO., INC., Agric. Chem. Dept.,
 Newark, DE
 ELI LILLY & CO., Lilly Res. Labs, Greenfield, IN
 FERMENTA PLANT PROTECTION CO., Mentor, OH
 FERRY MORSE SEED CO., San Juan Bautista, CA
 FUNK SEEDS INTERNATIONAL, INC., Bloomington, IL
 GREAT LAKES CHEMICAL CORPORATION, West Lafayette, IN
 GRIFFIN AG. PRODUCTS CO., Valdosta, GA
 GUSTAFSON, INC., Des Moines, IA
 HARRIS MORAN SEED CO., Hayward, CA
 HARTMAN'S PLANTS, INC., Sebring, FL
 H. J. HEINZ CO., Bowling Green, OH
 HOECHST ROUSSEL AGRIC. VET. CO., Somerville, NJ
 ICI AMERICAS, INC., Richmond, CA
 ICI AMERICAS, INC., Mountain View, CA
 ILLINOIS CROP IMPROVEMENT ASSOCIATION, Urbana, IL
 ILLINOIS FOUNDATION SEEDS, INC., Champaign, IL
 ISTITUTO DI FITOVIROLOGIA, Torino, Italy
 JANSSEN PHARMACEUTICA, Piscataway, NJ
 LANDIS ASSOCIATES, INC., Valdosta, GA
 LOXTON RESEARCH CENTRE, Loxton, S. Australia
 MERCK & CO., INC., Rahway, NJ
 MOBAY CORPORATION, Kansas City, MO
 MONSANTO CO., St. Louis, MO
 NOR-AM CHEMICAL CO., Wilmington, DE
 NORTHERN MARIANAS COLLEGE, Saipan, GU
 NORTHFIELD LAB, Adelaide, Australia
 NORTHROP KING CO., Woodland, CA
 PENNWALT CORPORATION, Ag. Chem. Div., Philadelphia, PA
 PEST PROS, INC., Plainfield, WI
 PETOSEED CO., INC., Woodland, CA
 PFIZER, INC.-TEKCHEM, Chem. Div., New York, NY
 RHONE-POULENC AG. CO., Research Triangle Park, NC
 RICERCA, INC., Painesville, OH
 ROHM & HAAS CO., Philadelphia, PA
 ROTHAMSTED EXP. STATION, Herts, England
 SAKATA SEED AMERICA, INC., Salinas, CA
 SANDOZ CROP PROTECTION CORP., Des Plaines, IL
 O. M. SCOTT & SONS, Marysville, OH
 UNIROYAL CHEMICAL CO., INC., Middlebury, CT
 UNOCAL CHEMICALS, West Sacramento, CA
 USDA FOREST SERVICE, Ogden, UT
 W-L RESEARCH, INC., Evansville, WI

**You and APS:
 4 Reasons to
 Apply for
 Membership
 Now.**

- **Journals.** Choose *Plant Disease* or *Phytopathology*; either is included with your membership. Add **MPMI** at member savings.
- **Monthly Newsletter.** *Phytopathology News* informs you about APS happenings.
- **FREE Job Placement Service.**
- **Discounts on APS Press Books.** Save 15% to 25% and be among the first to know about new books as you enjoy introductory savings.



**APS Helps You Excel in Your Career.
 Call Now for an Application:**

**Toll Free in the U.S. 1-800-328-7560
 Minnesota Residents: 1-612-454-7250**

The American Phytopathological Society
 3340 Pilot Knob Road ■ St. Paul, Minnesota 55121 ■ U.S.A.