

# APS Pacific Division

## Abstracts

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Alphabetized by first author's last name.

RELATIVE RESISTANCE OF 13 APPLE ROOTSTOCKS TO THREE SPECIES OF *PHYTOPHTHORA*. G.T. Browne and S.M. Mircetich, USDA ARS, Department of Plant Pathology, University of California, Davis 95616

Thirteen apple rootstocks (Antonovka (Ant.) 313, Bud.490, Bud.118, Bud.9, M.4, EMLA.111, EMLA.106, EMLA.7, EMLA.26, EMLA.9, MAC-9, P.18, and domestic seedling (*Malus pumila*) were evaluated for resistance to *Phytophthora cactorum* (*Pcc*), *P. cambivora* (*Pcm*), and *P. cryptogea* (*Pcr*) in artificially infested soil and in excised and intact stems. In soil infested with *Pcc*, EMLA.9, Bud.118, Bud.9, and MAC-9 were highly resistant (mean percent of crown circumference girdled (MPCG) 2-15%); EMLA.106, Ant.313, and domestic seedling were highly susceptible (MPCG, 76-95%); and the remaining rootstocks were intermediate. With *Pcm*, MAC-9 and Bud.118 were highly resistant (mean root rot (MRR) 8-9%); Bud.9, EMLA.7, and P.18 were intermediate, and the other rootstocks were moderately to highly susceptible (MRR 47-98%). With *Pcr*, most rootstocks were relatively resistant (MRR 1-10%), except EMLA.111, Ant.313, M.4, and P.18 (MRR 20-45%). The measurements of rootstock resistance in infested soil were not always well correlated with measurements of cankers in excised or intact stems inoculated with mycelium of *Pcc* or *Pcm*. Thus, comparative resistance of apple rootstocks to root and crown rots can vary with species of *Phytophthora* and may not be adequately predicted by stem inoculation procedures.

DEVELOPMENT AND SUSCEPTIBILITY OF *ABIES* SPP. TO GROVESIELLA CANKER. G. A Chastagner, J. M. Staley and K. L. Riley, Washington State University, Puyallup, WA 98371.

Grovesiella canker, caused by *G. abieticola*, is one of several diseases that cause branch flagging and mortality of *Abies* spp. in Christmas trees and ornamental plantings in the Pacific Northwest. In March 1986, 330 healthy appearing 4-year-old *A. concolor* trees were obtained from a commercial nursery which was experiencing problems with Grovesiella canker and transplanted to WSU-Puyallup. Branch symptoms were evident on 71.2% of the trees by July 1986. Mortality due to Grovesiella canker increased from 4.2 to 84.7% between July 1986 and May 1990. To determine the susceptibility of 4 *Abies* spp. to *G. abieticola*, the main stems on 5 pot-grown trees of each species were wound inoculated with mycelial plugs during April and October 1988. Cankers were evident within 2 months and apothecia with septate ascospores were evident within 7 months of inoculation. Significantly larger cankers and greater numbers of apothecia developed on *A. concolor* than *A. magnifica*, *A. grandis* and *A. procera*.

RACE-SPECIFIC RESISTANCE GENES IN WHEAT TO STRIPE RUST. Xianming Chen and Roland F. Line. USDA/ARS, Department of Plant Pathol., Washington State Univ., Pullman, WA 99164.

At least 33 different genes for race-specific resistance to *Puccinia striiformis* were identified in 26 wheat cultivars. Among the identified genes, 21 have not been previously named. *Yr1*, *Yr5*, *Yr7*, *Yr8*, *Yr9*, *Yr10*, a gene in Lemhi, one of three genes in Paha, and one of two genes in Tres are dominant. *Yr2*, *Yr3a*, *Yr3c*, *Yr4a*, *Yr4b*, *Yr6* and one gene each in the cultivars Compair, Clement, Druchamp, Fielder, Heines Kolben, Hybrid 46, Lee, Minister, Moro, Nord Desprez, Stephens, Paha, Tres, Tyee, Vilmorin 23 and Yamhill are either dominant or recessive depending upon the test race and/or genetic background of the host. The reversal of dominance can be interpreted by epistatic interactions as well as other mechanisms. Epistatic interactions among the genes for resistance and susceptibility were common. The maternal cytoplasm of certain cultivars affected the expression of resistance to stripe rust by interacting with the nuclear genes.

THE SUPPRESSION OF VERTICILLIUM WILT OF POTATO WITH COVER CROPS. James R. Davis<sup>1</sup>, Oen C. Huisman<sup>2</sup>, Leland H. Sorensen<sup>1</sup>, and Ann T. Schneider<sup>1</sup>. <sup>1</sup>University of Idaho Research and Extension Center, Aberdeen, Idaho, 83210, and <sup>2</sup>University of California, Plant Pathology Dept., Berkeley, CA 94720.

Field studies to investigate the effects of continuous planting of specific cover crops on Verticillium wilt of potato were made at Aberdeen, ID. Cover crops investigated were: *Sorghum vulgare* var *sudanense*, *Pisum sativum*, *Brassica napus*, *Avena sativa*, *Secale cereale*, and *Zea mays*. When compared with a fallow treatment, Verticillium wilt of the Russet Burbank potato (*Solanum tuberosum*) was suppressed by all cover crops following either 2 or 3 years of continuous cropping and incorporation into soil each year. Following the use of *S. vulgare* var *sudanense*, there was less colonization of roots by *V. dahliae*, populations of soilborne *V. dahliae* were reduced, *V. dahliae* biomass in apical stem tissue was reduced, and wilt was controlled. Wilt reduction was closely correlated to benefits of both yield and quality of potato.

BACTERIAL GROWTH ON INOCULATED SUGARBEET SEED IN SOIL AND ITS EFFECT IN CONTROLLING INFECTION BY *PYTHIUM* SPP. Ryo Fukui, Eva I. Poinar and Milton N. Schroth. Dept. Plant Pathology, 147 Hilgard, University of California, Berkeley, CA. 94720

Growth of pseudomonads on sugarbeet seed (inoculated singly or in combination) was monitored for 3 days after planting into the soil. All strains increased from an initial density of  $10^4$  to approx.  $10^6$  CFU/seed by 24 hr. Soil type, temperature and moisture did not affect growth of any strain. When two or more strains were inoculated together, no inhibitory or synergistic effects were detected in terms of population density, regardless of their antagonistic behavior on culture media. Scanning electron micrographs of surfaces of bacteria-treated seeds revealed that colonies developed as individual clusters.

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Among strains tested, two different patterns of growth were observed. Some strains had very short lag phases, whereas others had long (up to 12 hr) lag phases; stationary phase was reached within 24 hr for both growth patterns. In naturally infested soil, incidence of pericarp invasion by *Pythium* spp. was lower in seeds treated with strains with short lag phase.

THE POTENTIAL USE OF BACTERIA AS BIOLOGICAL CONTROL AGENTS FOR *PYTHIUM* IN HYDROPONICS. N. P. Goldberg and M. E. Stanghellini. Department of Plant Pathology, University of Arizona, Tucson, AZ 85721.

Six different bacteria were evaluated for their ability to inhibit the growth of ten different *Pythium* spp. on artificial media, to colonize roots of hydroponically-grown cucumbers and to protect hydroponically-grown lettuce and cucumbers from root diseases caused by *Pythium dissotocum* and *Pythium aphanidermatum*, respectively. Inhibition of fungal growth was evaluated on six different artificial media. Each bacterium was able to inhibit the growth of at least one of ten species of *Pythium* tested. Additionally, the ability of bacteria to inhibit fungal growth on artificial media varied depending upon which media was used for the assay. All of the bacteria were capable of completely colonizing the roots of hydroponically-grown cucumbers within 24 hr after adding 100 bacterial cells to the nutrient solution. However, despite colonization of the entire root system by the bacteria, none of the bacteria inhibited root infection by the pathogen.

FILTRATION AS A STRATEGY FOR CONTROL OF *PYTHIUM* IN RECIRCULATING HYDROPONICS. N. P. Goldberg, M. E. Stanghellini and S. L. Rasmussen. Department of Plant Pathology, University of Arizona, Tucson, AZ 85721.

An experiment was conducted to test the efficacy of filtration of zoospore infested water for the control of root rot of cucumber caused by *Pythium aphanidermatum*. Cucumber seedlings were transplanted into separate hydroponic tanks. Each tank received water from a zoospore-infested source tank which was (a) recirculated through a 20- $\mu$ m filter or (b) first through the 20- $\mu$ m filter and then through a 7- $\mu$ m filter. Recirculation of infested water was conducted every other day for 5 days at a flow rate of 114 L/min for 30 min. Within 24 hr after the first recirculation cycle, 67% of the plants in the tank receiving water passed only through the 20- $\mu$ m filter were infected and within 3 days, all plants were infected. None of the plants in the tank which received water passed through the 20- $\mu$ m and then the 7- $\mu$ m filter were infected until 5-days after the first recirculation cycle. The fungus was recovered from the surface (0 mm) and middle (8 mm depth), but not from the inner core (16 mm depth) of the 7- $\mu$ m filter. It was concluded that the 7- $\mu$ m filter was effective in removing zoospores from infested water. Although plants in the tank receiving water passed through the 7- $\mu$ m filter eventually became infected, shore flies (*Scatella stagnalis*) were identified as the source of introduction of the pathogen into this tank.

PHYTOPHTHORA DISEASE OF BRASSICA CROPS IN WYOMING. A. Karakaya, F. Gray, D. Koch, and L. Hicks. PS&S Dept., University of Wyoming, Laramie, WY 82071-3354.

In a 1989 trial conducted at Powell, Wyoming, uneven stands, smaller plants, wilting and dying of kale (*Brassica oleraceae*) plants, seeded in a field previously planted to alfalfa, were observed. Some plants showed root rot symptoms from which a *Phytophthora* sp., morphologically similar to *P. megasperma* f. sp. *medicaginis*, was isolated. Experimental plots were established following plowdown of old alfalfa stands at Powell and Riverton, WY. Cultivars of three forage *Brassica* species, 'Premier' kale (*B. oleracea*), 'Emerald' rape (*B. napus*) and 'Tyfon' (*B. campestris* X *B. pekinensis*) were seeded. Generally, plots treated with metalaxyl had more plants and higher yields. Mean number of plants in the late planting at Powell in treated plots of kale, rape and tyfon were 329, 220 and 117 compared to 158, 159 and 48 in untreated plots, respectively. The *Phytophthora* isolate from kale was pathogenic to seedlings of kale, rape, tyfon and alfalfa in growth chamber tests.

EFFECTS OF COVER CROPS ON POPULATIONS OF FUNGI IN SOILS AND ON FUNGAL COLONIZATION OF POTATO ROOTS. O.C. Huisman and J.R. Davis. Univ. of California, Plant Pathology Dept., U.C. Berkeley, CA 94720 and Univ. of Idaho Research and Extension center, Aberdeen, ID 83210.

Growing and incorporating specific cover crops into soil for 2 or 3 years had major effects on the colonization of potato roots by soil borne fungi. Compared with a fallow treatment, colonization of potato roots by some fungi (eg. *Fusarium equiseti*) was increased from 5 to 10 fold in plots previously cropped to sudangrass (*Sorghum vulgare* var. *sudanense*), it was unaffected in plots previously cropped to pea (*Pisum sativum*) and moderately increased in plots previously cropped to several other plants (ex. oats, corn). Several other fungi (eg. *F. oxysporum*) exhibited little or no differences in root colonization among the cover crop treatments. For most fungi, differences in frequency of root colonization reflected differences in soil populations which had developed in response to the cover crop treatments.

QUANTITATIVE RELATIONSHIPS BETWEEN LEVELS OF VERTICILLIUM DAHLIAE IN POTATO TISSUE AND SUBSEQUENT INOCULUM DENSITIES IN SOIL. O.C. Huisman and J.R. Davis. Univ. of California, Plant Pathology Dept., U.C. Berkeley, CA 94720 and Univ. of Idaho Research and Extension center, Aberdeen, ID 83210.

In a study involving continuous cropping of potato clones in infested soil, a high correlation between pathogen levels in apical stem tissues and subsequent soil inoculum densities (ID) was observed. A model was developed which related pathogen biomass in tissue to ID which subsequently developed in the soil. Data inputs consisted of the 1st year ID and the colony forming units per gram apical tissue observed over the next 4 years. When appropriate rates for inoculum attrition and dispersal were estimated, high correlations ( $r = 0.97$ ) were observed between predicted and observed soil ID over a four year period. The data are most consistent with annual attrition rates of 53 %, a dispersal of 43 % of the inoculum during the first season, and a maximum contribution to soil of 220 microsclerotia / g soil by highly infested tissue. The predicted soil inoculum values mirrored observed values both during periods of increasing and decreasing ID.

SURVIVAL OF *ERWINIA CAROTOVORA* IN FUMIGATED SOIL. <sup>1</sup>T. Isakeit, <sup>1</sup>M. Ferri, <sup>2</sup>P. Beckman, <sup>1</sup>A. R. Weinholt, <sup>1</sup>J. G. Hancock, <sup>1</sup>M. N. Schroth, <sup>1</sup>Dept. of Plant Pathology, University of California, Berkeley, CA 94720 and <sup>2</sup>Golden State Bulb Growers, Watsonville, CA 95077

The efficacy of methyl bromide fumigation of soil for control of *Erwinia carotovora* pv. *carotovora*, causing soft rot of calla (*Zantedeschia* spp.), was determined in a commercial field in Monterey county. Survival was measured using a soil enrichment technique and by isolation from infected bulbs buried 25 and 35 cm deep. The pathogen was found in 86% of non-fumigated soil samples. It was recovered immediately after treatment from 20% of samples fumigated at 335 kg/ha, but not in samples treated at higher rates. Seven weeks after fumigation, the pathogen was recovered from 19% of soil samples representing all treatment levels. The recovery of the pathogen from bulbs buried in fumigated soil was 87%, 67%, and 50% at levels of 335, 420, and 532 kg/ha, respectively. Survival was greater in samples buried at 30 cm than at 25 cm.

POSTHARVEST CHEMICAL CONTROL OF *ALTERNARIA*, *BOTRYTIS*, AND *PENICILLIUM* ROT OF APPLES IN CALIFORNIA. B.T. Manji, J.M. Ogawa, and Y. Wu. Dept. Plant Pathology, Univ. of California, Davis 95616.

Fuji and Granny Smith apples were inoculated in puncture wounds with conidial suspensions (50,000 conidia/ml) of *Penicillium expansum*, *Botrytis cinerea*, or *Alternaria alternata*, treated with either Iprodione (Rovral 4F at 2.4 g/L) or thiabendazole (Mertect 340F at 2.4 g/L), and stored for 4 months at 1 C. Both fungicides were effective in the control of postharvest decay by most of the fungi evaluated. Iprodione, however, was more effective against *A. alternata*; while TBZ was more effective against *P. expansum*. Control fruit without injuries were free of decay. Inoculated, non-treated fruit were severely decayed by all test fungi. In fruit with natural cracks on the stem end, *Alternaria* rot frequently developed on Fuji, whereas *Penicillium* rot occurred more commonly on Granny Smith. Regardless of an iprodione-wax treatment, fruit with cracks developed *Alternaria* rot. After 2 yrs of observation of postharvest decay of apples grown in the arid climate of California, *P. expansum* and *A. alternata* are the primary storage pathogens on Granny Smith and Fuji apples, respectively; *B. cinerea* was found less frequently.

COMPARISON OF SODIUM TETRATHIOCARBONATE TO METALAXYL FOR CONTROL OF PHYTOPHTHORA CROWN AND ROOT ROT OF CHILI PEPPER. M.E. Matheron and J.C. Matejka, University of Arizona, Yuma Agricultural Center, Yuma, AZ 85364

Greenhouse studies were initiated to compare the efficacy of sodium tetrathiocarbonate (STTC) to metalaxyl for control of crown and root rot on chili pepper plants caused by *Phytophthora capsici*. Two-month-old chili pepper plants planted 7 days after treatment of naturally infested soil with STTC at 4,900  $\mu$ g/ml had root and shoot weights comparable to those grown in soil treated with 10  $\mu$ g/ml metalaxyl. When roots of chili pepper plants were inoculated with zoospores of *P. capsici* in the presence of STTC at 245  $\mu$ g/ml or metalaxyl at 10  $\mu$ g/ml, resultant fresh weights of shoots and roots were similar to those from noninoculated plants, whereas inoculated plants without chemical treatment died rapidly. STTC applied as a soil drench at 4,900  $\mu$ g/ml was lethal to *P. capsici* on colonized root pieces of pepper. STTC, at an appropriate concentration, apparently can control crown and root rot on chili pepper as well as metalaxyl.

ABILITY OF TRANSGENIC CHITINASE-PRODUCING TOBACCO TO FORM MYCORRHIZAL ASSOCIATIONS. Valerie J. Mellano, University of California Cooperative Extension, 5555 Overland Ave., Bldg. 4, San Diego, CA 92123.

Two varieties of tobacco (*Nicotiana tabacum*) which had been modified to produce additional chitinase were tested for their ability to form associations with vesicular-arbuscular mycorrhizae (VAM). Varieties Kentucky 14 and Wisconsin 38 had been transformed with the *chiA* gene from *Serratia marcescens*, using petunia small subunit and CaMV 35S promoters to obtain differential expression. The modified tobacco varieties and their non-modified controls were grown in the presence of VAM for 16 weeks. Every two weeks the plants were assessed for percent VAM infection and the dry weights of the plants recorded. Throughout the 16 week trial, there was no significant difference between the modified tobacco and the controls with respect to VAM associations or dry weight.

INDUCTION OF RUSSET SCAB WITH CUPRIC HYDROXIDE (KOCIDE 101) AND MISTING DURING FULL-BLOOM/PETAL-FALL STAGES OF FRENCH PRUNE. Themis J. Michailides and David P. Morgan, University of California, Berkeley, Kearney Agricultural Center, Parlier 93648.

Russet scab (RS) incidence and severity, respectively, on green (73% and 2.0), ripe (60% and 1.7), and dehydrated French prunes (28% and 0.6) were significantly ( $P < 0.05$ ) increased by the application of cupric hydroxide (Kocide 101) at full bloom on misted trees as compared to non-sprayed trees. Application of IAA-producing strains (R299 and T565) of fluorescent *Pseudomonas* spp. did not increase RS on misted trees. Cupric hydroxide applied on nonmisted trees during full bloom also significantly increased the RS incidence and severity, respectively, on green (68% and 1.6) and dehydrated fruit (23% and 0.4). Significantly ( $P < 0.05$ ) greater RS incidence (29%) and severity (0.7) occurred on dehydrated fruit when trees were misted at petal-fall stage as compared to misting at full bloom. In all cases, fruit collected near (< 0.5 m) the misters developed significantly ( $P < 0.05$ ) greater RS than those collected at 0.6 to 1.2 m from the misters. These results suggest that RS is triggered by the presence of free water on the young developing prune ovary, especially during the petal-fall stage, or by the application of cupric hydroxide in both misted and nonmisted prune trees.

FUNGICIDAL AND BIOLOGICAL CONTROL OF EUTYPA DIEBACK OF GRAPEVINES. G.P. Munkvold and J.J. Marois, University of California, Davis, CA 95616.

The fungicides benomyl, triadimefon, fenarimol, and myclobutanil were evaluated for their efficacy against *Eutypa lata* (syn. *E. armeniacae*) *in vitro* and in the field. All four fungicides had EC50 values of less than 1 ppm for inhibition of mycelial growth. However, the fungicides differed widely in their effect on ascospore germination. Fenarimol and myclobutanil had substantially lower EC50 values than benomyl and triadimefon for inhibition of ascospore germination. In field tests, all four fungicides treatments reduced the number of infections of grapevine pruning wounds inoculated with *E. lata* ascospores. Benomyl was the most effective, reducing the number of infections by more than 50% compared to the control. Epiphytic microorganisms were isolated from grapevine pruning wounds and 755 of these isolates were screened in the laboratory for their ability to inhibit colonization of excised grape stems by *E. lata*. Of these isolates, 10 were chosen for further evaluation. Two of these isolates were more effective than benomyl at inhibiting the pathogen on inoculated pruning wounds, reducing the number of infections by more than 66% compared to the control.

POTENTIAL INOCULUM SOURCES FOR EUTYPA DIEBACK IN THE CENTRAL VALLEY OF CALIFORNIA. G.P. Munkvold and J.J. Marois, University of California, Davis, CA 95616.

Development of perithecia of *Eutypa lata* (syn. *E. armeniacae*) is favored by high rainfall. Precipitation in California's Central Valley is generally believed to be insufficient to support perithecial formation, yet incidence of *Eutypa* dieback is high. Apricots in San Benito, Santa Clara, and Solano Counties have been suggested as the main inoculum sources for Central Valley orchards and vineyards, but apricot acreage in these counties has declined drastically over the last 20 years. Recently, we have discovered substantial numbers of perithecia in several Central Valley locations. These include several sprinkler-irrigated sweet cherry orchards in San Joaquin County, a Chenin blanc vineyard in Sacramento County, an apricot orchard in Yolo County, a single almond tree in an orchard in Yolo County, and a single apricot tree in Davis (Yolo County). *Eutypa lata* has not previously been reported from sweet cherry or almond in North America. Perithecia of the fungus have previously been reported in the Central Valley only from a single backyard grapevine in Davis.

SHOOT BLIGHT OF HYBRID POPLAR IN THE PACIFIC NORTHWEST. George Newcombe and Gary Chastagner, Washington State Univ., Puyallup Res. & Ext. Center, Puyallup 98371.

Shoot blight of hybrid poplar is a serious disease in the Pacific Northwest. Breeding for resistance to this disease would be facilitated by laboratory or greenhouse assays for resistance and an understanding of variation for pathogenicity in the population of the causal organism. However, a clear understanding of the etiology of shoot blight is lacking. Both *Venturia populina* and *Glomerella cingulata* (not recorded before on any *Populus* spp.) have been found on overwintering shepherd's crooks associated with shoot blight. Both *V. populina* and *G. cingulata* were found in hybrid poplar plantations affected by shoot blight in Oregon and British Columbia, but only *G. cingulata* was present in Washington. Inoculations of greenhouse-grown plants show that *G. cingulata* can cause lesions on leaves, petioles and young stems. Partially expanded leaves are more susceptible than fully expanded ones. Differences in aggressiveness of single-ascospore isolates of *G. cingulata* from Oregon, Washington and British Columbia have been observed. In the field, differences in host resistance to shoot blight have been noted. A disease survey is currently underway.

CYTOSOLIC MACULOSIN BINDING PROTEINS OF SPOTTED KNAPWEED (*CENTAUREA MACULOSA* L.). S. H. Park and G. A. Strobel, Department of Plant Pathology, Montana State University, MT 59717.

Maculosin [the diketopiperazine cyclo (-L-tyro-L-Pro)] is a host specific toxin produced by *Alternaria alternata* and causes black, necrotic symptoms on spotted knapweed (*C. maculosa* L.). Host leaves possess the toxin binding activity in the cytosolic fraction obtained by centrifugation at 100,000 x g. This activity was reduced or destroyed by treatment with protease or heat, suggesting that the toxin binding receptor is a protein. Purification of the receptor was carried out by ammonium sulfate fractionation, Sephadex G-200 column chromatography, and affinity column chromatography. The affinity column was prepared with epoxy activated Sepharose 6B to which the phenolic group of synthetic maculosin was attached. Furthermore, the free phenolic group of tyrosine, of which alpha amino group was coupled to CNBr-activated Sepharose 4B, did not bind any cytosolic proteins. By gel filtration and SDS PAGE, it was estimated that the receptor contained more than one protein. Recently, one of the receptors was deduced as Rubisco by the electrophoretic behavior of its subunit and by a double immunodiffusion test.

ROLE OF PYRROLNITRIN IN ANTAGONISM OF *PYRENOPHORA TRITICI-REPENTIS* BY *PSEUDOMONAS FLUORESCENS* STRAIN PF-5. W. Pfender, J. Kraus\*, and J. Loper\*. Dept. Plant Pathology, Kansas State University, Manhattan, KS 66506; and \*USDA-ARS Hort. Crops Lab, 3420 NW Orchard Ave., Corvallis, OR 97330.

Strain Pf-5 of *Pseudomonas fluorescens* inhibits a number of soil-borne plant pathogenic fungi and produces several antifungal antibiotics, including pyrrolnitrin (Pn) and pyoluteorin (Plt). Pf-5 or purified Pn inhibited mycelial growth of *Pyrenophora tritici-repentis* (Ptr), a residue-borne wheat pathogen, on culture media. Several Tn5 mutants of Pf-5, deficient in antibiotic production, were tested for inhibition of Ptr. On dilute cornmeal agar medium, Pf-5 and a Plt-nonproducing mutant inhibited Ptr, whereas a Pn-nonproducing mutant was not antagonistic. Sterilized wheat straw was colonized with Ptr, then treated with Pf-5, its Tn5 mutants, or purified Pn. Treated straw was incubated 2 wk at 22 C in closed dishes containing moist perlite. Pf-5, Plt-nonproducing mutants, and purified Pn suppressed asco-carp formation by Ptr; the Pn-nonproducing mutant did not.

ELIMINATION OF VIABLE TELIOSPORES OF *TILLETIA TRITICI* AND *T. CONTROVERSA* ON WHEAT SEED USING GAMMA IRRADIATION. T. R. Schultz and J. D. Maguire, Seed Technology Laboratory, Washington State University, Pullman, WA 99164-6420

Certain countries have quarantines against wheat grain contaminated with teliospores of the dwarf bunt pathogen, *T. controversa*. Postharvest treatment of the grain is one means of eliminating teliospores to meet quarantine restrictions. Soft white winter wheat seed artificially infested with teliospores of *T. controversa*, or *T. tritici*, which causes wheat common bunt, were irradiated at dosages of 0 to 10 KGy using a cobalt-60 gamma source. Teliospore viability was determined by germination on 2% soil extract agar. Flour yield, flour protein, cookie diameter and cookie texture were evaluated to determine the effects of irradiation on the milling and baking quality of wheat seed. Germination of *T. controversa* and *T. tritici* teliospores was reduced to zero at a dose of 10 KGy. The milling and baking quality of wheat seed irradiated at 10 KGy was not materially affected and no significant differences were observed for any of the parameters measured. These results indicate that gamma irradiation of wheat seed may effectively eliminate pathogens on wheat seed while not reducing the quality of the wheat flour.

INTERCROPPING OF SAINFOIN AND BROMEGRASS FOR THE CONTROL OF NORTHERN ROOT-KNOT NEMATODE. T. Shigaki, F. Gray, and R. Delaney. PS&IS Dept., University of Wyoming, Laramie, WY, 82071-3354.

Studies were conducted in 1990-91 to test the effectiveness of intercropping sainfoin (*Onobrychis viciifolia*) with bromegrass (*Bromus biebersteinii*), cultivar Regar, for the control of the northern root-knot nematode (*Meloidogyne hapla*). In growth chamber and greenhouse studies with a high preplant inoculum level of 5,000 eggs and juveniles per liter of soil, no protection against the nematode damage was observed. Percent stand reduction in a select sainfoin line (WY-PX1-84) grown alone and with bromegrass was 5.8, 3.3 and 70.8, 91.7 for root-knot uninoculated and inoculated plants, respectively. Bromegrass was compatible with sainfoin under relatively low nitrogen fertilization levels. WY-PX1-84 showed some tolerance to *M. hapla* compared to the non-selected sainfoin cultivar Remont. In a field study with a lower natural soil population, no seedling death or stunting of sainfoin was observed after one year.

INFLUENCE OF SODIUM POLYGALACTURONATE SOURCES AND IMPROVED RECOVERY OF *VERTICILLIUM* SPP FROM SOIL. Leland H. Sorensen, Ann T. Schneider, and James R. Davis. University of Idaho Research and Extension Center, Aberdeen, Idaho, 83210.

Recovery of *Verticillium dahliae* (Vd) and *V. tricorpus* (Vt), when using NPX medium and the Andersen Sampler technique (*Phytopathology* 67:1073-1078), was significantly influenced by sodium polygalacturonate (PGA) sources and modifications made to the medium to adjust for those differing sources. Sunkist's PGA has been the preferred source, since it has consistently produced high recovery of *Verticillium* spp. However, the depletion of this unique source has prompted the search for an alternative PGA source that would be readily available. When comparing three sources of PGA [Sunkist, Maria Burger (Madison, Wisconsin), and Sigma], the best recovery and colony vigor of Vd and Vt from soil were obtained from a medium utilizing Sigma's PGA and modified by deleting guanidine HCl and adding  $\text{KNO}_3$  and  $\text{MgSO}_4$ .

MANAGEMENT OF OMNIVOROUS LEAFROLLER, SUMMER BUNCH ROT, AND LEAFHOPPERS IN WINE GRAPES BY LEAF REMOVAL AND USE OF *BACILLUS THURINGIENSIS*. J.J. Stapleton and W. W. Barnett, Statewide IPM Project, Univ. of California, Kearney Ag Center, Parlier, CA 93648.

A field experiment near Livingston, CA was done in 1990 to evaluate contributions of leaf removal and the biological insecticide *Bacillus thuringiensis* (BT) in managing omnivorous leafroller (*Platynota stultana* = OLR) in a 'Chenin blanc' vineyard. Incidence of sour rot and Botrytis bunch rot (summer rot complex), and seasonal dynamics of grape (*Erythro-neura elegantula*) and variegated (*E. variabilis*) leafhopper also were determined. Leaf removal reduced incidence of sour rot and Botrytis bunch rot ( $P=0.05$ ). Both leaf removal and BT reduced incidence of OLR ( $P=0.01$ ). A consistent trend toward reduced numbers of leafhopper nymphs during the growing season was found following leaf removal.

ISOLATION OF *DICTYOSTELIUM SPHAEROCEPHALUM* FROM FIELD-GROWN WINTER WHEAT PLANTS. C. M. Stiles, L. M. Carris, and T. D. Murray. Dept. of Plant Pathology, Washington State University, Pullman, WA 99164-6430.

*Dictyostelium sphaerocephalum* was isolated from winter wheat plants that were removed from field plots during the fall and winter of 1990-91. Plants were surface-sterilized (70% EtOH for 2 sec followed by 1% NaOCl for 30 sec or 2 min) and placed on a medium semi-selective for *Cephalosporium gramineum*. *Dictyostelium* sorocarps developed from roots, subcrown internodes, and stems after incubation at 15 C for two to three weeks. The frequency of plants observed with sorocarps of *D. sphaerocephalum* ranged from 6.3% to 9.4% for sample dates in October and November to 18.8% in January. Isolation of the cellular slime mold from surface-sterilized plant material suggests that this organism had colonized portions of the plant and may be capable of surviving as an endophyte. This appears to be the first report of a cellular slime mold isolated from living plant tissue.

VEGETATIVE COMPATIBILITY OF *VERTICILLIUM DAHLIAE* ISOLATES FROM IDAHO POTATOES. C. A. Strausbaugh. University of Idaho, Research and Extension Ctr., Kimberly, ID 83341.

Thirty-three isolates of *Verticillium dahliae* were isolated from diseased potato (*Solanum tuberosum*) plants growing in three regions of southern Idaho. The vegetative compatibility of the isolates was established using nitrate-nonutilizing mutants and tester strains previously used to establish the vegetative compatibility groups (VCGs) of *Verticillium dahliae* (*Phytopathology* 80:1160-1166). All the Idaho isolates were strongly compatible only with testers from VCG 4. Further testing may reveal subgroups within VCG 4, since there was variability with respect to how different VCG 4 testers reacted with the isolates.

EFFECT OF INFECTION OF ALMOND FRUIT BY *WILSONOMYCES CARPOPHILUS* B.L. Teviotdale and D.H. Harper, University of California, Berkeley, Kearney Agricultural Center, 9240 South Riverbend Avenue, Parlier, California 93648.

Almond fruit, infected by *Wilsonomyces carpophilus*, may bear many shot hole lesions on the hull without sustaining any apparent damage. Almond flowers (at full bloom) then fruit were inoculated at weekly intervals for 9 wk with  $10^3$ ,  $10^4$ , and  $10^5$  conidia/ml suspensions of the pathogen. Inoculation was followed by a 48-hr misting period. Significantly larger percentages of fruit were dropped from trees in treatments inoculated with  $10^5$  conidia/ml at shuck split and shuck fall stages of fruit development than with other concentrations or the noninoculated control. There were no significant differences in percent fruit dropped among treatments at other inoculation dates. Most dropped fruit bore a large, slightly sunken brown lesion and *W. carpophilus* was recovered from 80% of these lesions. Percent infected fruit and number lesions per fruit increased significantly with increasing levels of inoculum.

BARLEY STRIPE RUST RACE 24 RESISTANCE IDENTIFIED IN FIELD SCREENING TRIALS IN BOLIVIA. S.A. V. Velasco, W.M. Brown, Jr., J.P. Hill, H.E. Bockleman and D.M. Wenberg. Dept. of Plant Pathology, Colorado State University, Fort Collins, CO 80523 and ARS/USDA, National Small Grains Germplasm Research Facility, Aberdeen, ID 83210.

Over 7,000 National Small Grains Collection barley accessions from throughout the world and 527 elite lines from the 1990 i) Western Spring Barley Nursery, ii) Mississippi Barley Nursery, iii) Western Winter Barley Nursery, and iv) 82 lines from Germany were field evaluated for resistance to race 24 of *Puccinia striiformis* in Cochabamba, Bolivia, S.A. Plots were planted late December 1990 and evaluated three times. Border rows of a susceptible Bolivian variety were naturally infected. Race 24 was identified as the major component of the local stripe rust population. Seventy-nine lines from the collection and 25 lines from the elite collections were identified as resistant.

TOBACCO STREAK VIRUS (TSV) AND HOST GENETICS OF INFECTION AND SEED TRANSMISSION IN BEAN AND OTHER HOSTS. M. H. Walter, S. D. Wyatt, and W. J. Kaiser. Dept. of Plant Pathology, Washington State University, Pullman, 99164-6430.

Virus and host genetics of infection and seed transmission are being studied using TSV isolates Mel 40 and Mel F. The two isolates are seed transmitted in *Phaseolus vulgaris* cultivar Black Turtle Soup (BTS) at about 26% and 0.5% respectively. Virus RNAs 1,2,3 and 4 were electrophoretically separated and recovered from 1.5% "low-melt" agarose gels. Pseudorecombinant genomes were constructed, inoculated on *Chenopodium quinoa* and are being characterized as to genetic stability, phenotype (including seed transmission) and physical properties. The inheritance of nonsusceptibility to TSV Mel 40 seed transmission was studied using hybrid progeny from crosses of BTS and Dubelle Witte beans (Mel 40 seed transmission 0%). Inoculations were made on F1 plants and progeny seedlings were assayed for virus infection. The lack of infection of progeny seedlings suggests that nonsusceptibility to seed transmission is dominantly inherited.

EFFECT OF SEED TREATMENT AND SOIL DRENCH FUNGICIDES ON ESTABLISHMENT AND PRODUCTION OF ALFALFA. J. E. WATKINS, Dept. Plant Path. and B. Anderson, Dept. Agron., Univ. of Nebr., Lincoln, NE 68583-0722

Plots were planted in April, 1988 into a Sharpsburg silty loam soil. The site had been planted previously to alfalfa, but *Phytophthora* root rot (*Phytophthora megasperma*) caused severe stand loss. The surviving alfalfa plants were killed with

herbicide, and the site was rototilled in October. Seed treatment chemicals were applied using a Gustafson Batch Lab Treater. All seed received Rhizobium inoculant prior to planting the following May. Ridomil 2E was applied as a soil drench shortly after planting. Plots were sprinkler irrigated 2 wk after planting, and soils were kept moist for 6 wk. Cuttings were taken in July, August and October in the year of seeding and in May, June, July and September of the following year. Yield, stand, plant height or frequency of the resistant cultivar 'Duke' were not influenced by fungicide treatments. On the susceptible cultivar 'Riley', plots treated with Apron FL, Apron FL+Ridomil 2E and Apron FL+Magnum had stands with significantly higher yields than nontreated control plots in both 1988 and 1989. Plant stand and plant height in the year of establishment were significantly different between treated and nontreated plots.

THE ROLE OF THE CHRYSANTHEMUM FOLIAR NEMATODE IN THE STEM NEMATODE DISEASE OF ALFALFA. J.L. Williams, F.A. Gray, and G.D. Griffin, PS&IS Dept., Univ. of Wyo., Laramie, WY 82071 and USDA-ARS, Forage & Range Res. Lab, Utah State Univ., Logan, UT 84322.

The chrysanthemum foliar nematode, Aphelenchoides ritzema-bosi was first reported on alfalfa in California by Grundbacher and Standford in 1962. Our studies were initiated to determine the distribution of A. ritzema-bosi in alfalfa in the western states, its association with the alfalfa stem nematode, Ditylenchus dipsaci, and effect of environmental factors on its survival and development. Of 50 plant samples collected in eight states exhibiting typical stem nematode symptoms, 46 had both nematodes present. Of the total nematodes recovered, the composition of A. ritzema-bosi ranged from 0% to 94%. Soil and tissue samples were collected monthly from Apr 1990 to Mar 1991 near Big Horn, WY. A. ritzema-bosi was dramatically influenced by all environmental factors monitored, whereas, D. dipsaci was relatively unaffected. A. ritzema-bosi could not be detected in 4 of the 12 months.

Biological control of kudzu: Induction of peroxidase isozymes upon inoculation with Pseudomonas syringae pv. phaseolicola.

N. K. Zidack, S. Tuzun and P. A. Backman. Department of Plant Pathology, Auburn University, AL 36849.

Pseudomonas syringae pv. phaseolicola (Psp) is a bioherbicide candidate for kudzu (Pueraria lobata). However, development of resistance in young leaves of previously infected plants has been observed in nature and greenhouse studies. Peroxidase isozyme patterns, as indicators of host defense responses, were studied on Psp-infected kudzu under greenhouse and field conditions. Activity of peroxidases increased upon infection in young and mature leaf tissues. At least 10 peroxidase isozymes were detected in infected leaves with drastic increases in an anionic isozyme (pI 3.5) during lesion development of infected leaves and upon aging of uninfected controls. Systemic increases in anionic isozymes were also detected in uninfected leaves of previously infected plants. These results suggest that the activation of host responses due to either aging or previous infection should be considered in biological weed control with plant pathogens.

DETECTION OF CLAVIBACTER MICHIGANENSE SUBSP. SEPEDONICUM (SPIECK & KOTTH.) (CARLSON & VIDAUER) IN COMMON WEED SPECIES FOUND IN COLORADO POTATO FIELDS. James D. Zizz, and Monty D. Harrison. Colorado State University, Dept. Plant Pathology and Weed Science, Fort Collins, CO. 80523.

Three weed species Chenopodium album L. (common lambsquarters), Amaranthus retroflexus L. (redroot pigweed), and Solanum sarrachoides Sendt. (hairy nightshade) commonly found in Colorado potato fields were assayed for the presence of Clavibacter michiganense subsp. sepedonicum (CMS). CMS was isolated from S. sarrachoides plants collected in the field in the San Luis Valley in south central Colorado during 1989. Approximately 14 percent of the S. sarrachoides plants collected were shown to be infested with CMS. In most cases, a series of sap reinoculations into eggplants was required to increase CMS cell numbers to a point where they could be confirmed by Gram staining and ELISA. CMS was never found in C. album, or A. retroflexus plant samples assayed.

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