One of the major diseases currently impacting cultivated *Agaricus bisporus* mushroom production worldwide is Trichoderma green mold, caused by fungus, *Trichoderma harzianum*. This research studied several different parameters that influenced *T. harzianum* competitiveness with *A. bisporus*. Results suggested growth of *T. harzianum* is influenced by the amount and source of nitrogen and osmotic potential. It was shown that *T. harzianum* spores did not readily germinate on the surface of the casing when the inoculum was carried in either water or nutrient broth. This lack of germination even with high spore concentrations is not understood but merits further investigation. These results suggest that secondary infection after casing is not part of the disease cycle and that fungicides applied after casing may have minimum influence in preventing spread of Trichoderma green mold.

Prevalence of Verticillium wilt of pepper in California. R. G. BHAT (1), J. C. Hubbard (1), R. F. Smith (2), S. T. Koike (2), and K. V. Subbarao (1). (1) Dept. Plant Pathology, UC Davis, 1636 E. Alisal St., Salinas, CA 93905; (2) University of California Cooperative Extension, Salinas, CA 93901. Phytopathology 90:S7. Publication no. P-2000-0044-AMA.

Verticillium wilt of pepper has become a major production problem in the central coast of California in recent years. Wilt incidence varied from 6 to 98% in fields with anaheim, jalapeno, paprika and bell peppers. Inoculum level of *Verticillium dahliae* in these fields ranged between 2.7 and 66.6 microsclerotia g^{-1} of soil, and the correlation between disease incidence and numbers of microsclerotia was high. Vegetative compatibility grouping (VCG) of 63 *V. dahliae* isolates indicated that 68% belonged to VCG 2, 21% to VCG 4, and 11% to a new VCG. One-month-old bell pepper (cv. Cal Wonder) and tomato (cv. EP 7) seedlings were inoculated in the greenhouse with four isolates from each of pepper and tomato. Bell pepper was susceptible only to the isolates from pepper whereas tomato was susceptible to both pepper and tomato isolates. Molecular characterization of pepper isolates using a RAPD-PCR technique revealed minor variations among isolates. Data suggest that pepper isolates of *Verticillium dahliae* have been selected in fields by the intensive cropping practices.

Seedborne nature of *Verticillium dahliae* in lettuce. R. G. BHAT (1), E. J. Ryder (2), and K. V. Subbarao (1). (1) UC Davis, (2) USDA-ARS, 1636 E. Alisal St., Salinas, CA 93905. Phytopathology 90:S7. Publication no. P-2000-0045-AMA.

Lettuce, once considered a nonhost to *Verticillium* species, is affected by Verticillium wilt that threatens lettuce production in the central coast of California. Only strains from lettuce, artichoke, strawberry, and watermelon are highly pathogenic on lettuce and their primary origin is not known. To determine if *V. dahliae* can be seedborne, inoculated plants of *Lactuca sativa* (cvs. Salinas and Little Gem) and *L. serriola* (PI 273597C, 491108, and 491146) were grown in the greenhouse and allowed to bolt. A few seeds collected from infected plants were discolored and microsclerotia were found on the seed coat. Both surface-sterilized and non-sterilized seeds from infected plants plated on NP-10 medium yielded *V. dahliae* colonies (44 to 100%) with microsclerotia after 2-4 weeks, implying that the pathogen can be internally seedborne. Plants grown from the infected seeds developed typical Verticillium wilt symptoms within 10 weeks after sowing. These observations suggest the possibility of long distance dissemination of *V. dahliae* through infected lettuce seeds. They also suggest that, in nature, infected wild lettuce plants can disseminate *V. dahliae* to healthy fields.

Selection of phage-display peptides that induce encystment of *Phytophthora capsici* zoospores *in vitro*. S. L. BISHOP-HURLEY (1), F. J. Schmidt (2), G. P. Smith (3), and J. T. English (1). (1) Department of Plant Microbiology and Pathology, (2) Department of Biochemistry and (3) Division of Biological Sciences, University of Missouri-Columbia, Columbia, MO 65211. Phytopathology 90:S7. Publication no. P-2000-0046-AMA.

Zoospores play an important role in the dispersal of *Phytophthora capsici* to plant infection sites. Molecules on the zoospore surface are involved in reception of environmental signals that direct pre-infection behaviour. An *in vitro* selection procedure was developed using phage-display, to identify peptides that bind to the surface molecules of *P. capsici* zoospores and disrupt pre-infection development. Peptides affinity-selected against *P. capsici* zoospores were isolated from a diverse phage-display library displaying random octapeptides on the major viral coat protein. Inserts from 24 selected clones contained an abundance of proline and polar amino acid residues. Clones that induced a high level of zoospore encystment were shown to selectively bind to *P. capsici* zoospores when compared with a phage control that lacked inserts. Approximately 50% of the phage-displayed peptides induced premature encystment of *P. capsici* zoospores *in vitro*, an effect that was species-specific since no premature encystment was observed with two other *Phytophthora* species tested. The isolation of peptides that act on pathogens could form the basis for a novel plant disease-resistance strategy.

Effect of delays between harvest and forced-air cooling on Botrytis fruit rot and quality factors of strawberry. R. W. BLACHARSKI (1) D. E. Legard (1) and J. A. Bartz (2). Univ. of Florida (1) GCREC-Dover (2) Dept. of Plant Pathology, Gainesville. Phytopathology 90:S7. Publication no. P-2000-0047-AMA.

The effect of delays between harvest and forced-air cooling on Botrytis fruit rot and flavor components (soluble solids content and titratable acidity) of strawberry were evaluated under commercial handling conditions in Florida. Fruit of 'Sweet Charlie,' 'Camarosa' and 'Carlsbad' were collected from commercial farms and cooled to 1C within 1 to 8-hr after harvest. Containers were inspected for incidence of Botrytis daily for 14 days of storage at 4C. Cooling delays of 4 hr or more led to an increase in the incidence of Botrytis only with 'Sweet Charlie' and only during the late season. In contrast, delays of up to 8-hr were not associated with an increase in the incidence of Botrytis in fruit from the other 14 combinations of cultivar, location and harvest date. Taste panels were unable to detect flavor differences among fruit cooled within 1-hr of harvest and those cooled up to 8 hr after harvest. Few chemical differences were detected and they did not correlate with perceived flavor differences. Delaying cooling up to 8 hrs versus the 2 hr industry standard had minor effects on postharvest quality.

Phenazine biosynthesis in *Pseudomonas aureofaciens* is regulated by RpoS in a nutrient-dependent manner. F. M. BLACHERE and L. S. Pierson III. Department of Plant Pathology, University of Arizona, Tucson, Arizona, 85721. Phytopathology 90:S7. Publication no. P-2000-0048-AMA.

Pseudomonas aureofaciens strain 30-84 is a rhizosphere-colonizing biocontrol bacterium. Production of phenazine antibiotics by strain 30-84 suppresses the fungus Gaeumannomyces graminis var. tritici, the causal agent of take-all in wheat. Induction of phenazine gene expression is dependent upon a complex signal transduction cascade, including a two-component sensory system, an AHL quorum sensing system, and the stationary sigma factor RpoS. Mutation of *rpoS* results in differential production of the AHL signal required for phenazine gene expression. Under nutrient-limited conditions, AHL signal is not produced in a *rpoS* mutant and phenazines are not produced. The addition of exogenous AHL restores phenazine expression. Likewise, supplementation of nutrient-limited conditions with casamino acids or the AHL intermediate AdoMet restores phenazine gene expression. These results suggest a model in which rpoS affects substrate flow to the AHL synthase thus altering the levels of AHL signal and phenazine expression.

Wood deterioration in the historic huts of Antarctica. R. A. BLANCHETTE (1), B. W. Held (1), R. L. Farrell (2), and S. Duncan (2). (1) Dept. Plant Pathology, Univ. of Minnesota, St. Paul, MN 55108; (2) Dept. Biological Sciences, Univ. of Waikato, Hamilton, New Zealand. Phytopathology 90:S7. Publication no. P-2000-0049-AMA.

Early explorers of Antarctica's heroic era erected buildings and brought large quantities of supplies to survive in Antarctica during their exploration and scientific studies. Three huts in the Ross Sea region of Antarctica, built by R. F. Scott in 1901 and 1910 and E. Shackleton in 1908, are now protected international historic sites. Despite Antarctica's extreme environment, deterioration has taken place in the huts. Soft-rot was the major type of fungal attack in wood that was in ground contact. Wind abrasion to exterior woods has caused erosion of the earlywood cells more rapidly than latewood cells. Deterioration by high concentrations of salts has occurred resulting in an unusual defibration of exterior wood surfaces. During the Antarctic summer, temperatures rise above freezing in the huts and relative humidity is elevated. These conditions favor fungal growth on interior woods, leather, and other artifacts. From these results, management plans will be developed for long-term preservation of these historic huts and their contents.

* **Improved medium for cultural detection of *Sphaeropsis sapinea* from asymptomatic red pine stems.** J. T. BLODGETT and G. R. Stanosz. Dept. Plant Pathology, Univ. of Wisconsin-Madison 53706. Phytopathology 90:S7. Publication no. P-2000-0050-AMA.

The potential to increase the frequency of cultural detection of the shoot blight and canker pathogen *S. sapinea* from asymptomatic red pine stems was tested using media amended with tannic acid (TA). Radial growth of 15 rapidly growing fungal isolates from stems/branches of red or jack pines were compared on 2% water agar (WA) and WA with 0.5% TA. The addition of TA had little or no effect on the growth of two RAPD marker group A and

* two group B isolates of *S. sapinea*, but inhibited 11 isolates of other species, each of which grew more slowly than *S. sapinea* on WA with TA. Efficacy of TA amended WA was compared with previous methods of cultural detection of the pathogen using surface-disinfested stem segments from asymptomatic red pine nursery seedlings. Methods tested included: plating the segments on WA with TA or on potato dextrose agar with streptomycin sulfate; or identification of *S. sapinea* pycnidia produced from segments incubated on WA in tubes. Preliminary results show increased detection of *S. sapinea* (i.e., a reduction of false negatives) using WA with TA compared with the other methods (37 vs. 11 and 23% detection; $P < 0.001$ & $P = 0.031$, respectively).

Characterization of *Collectotrichum* species by analysis of a 1 kb intron of the glutamine synthetase gene. Li Bo and J. C. Correll. Department of Plant Pathology, University of Arkansas, Fayetteville, AR 72701. Phytopathology 90:S8. Publication no. P-2000-0051-AMA.

Accurate identification and characterization of *Colletotrichum* species often is problematic. In addition to morphological characters, sequence variation in a 1 kb intron of the glutamine synthetase gene was examined (Stephenson et al., Curr. Genet. 31:447). Specific primers (supplied by Dr. John Manners) were used to amplified the 1 kb intron. The intron was then digested with various restriction enzymes or enzyme combinations. In addition, fragments from selected isolates were sequenced. Considerable sequence diversity was observed in the intron making it a useful piece of DNA to examine within and between species variation. Species in the *C. orbiculare* "complex" (*C. orbiculare, C. lindemuthianum, C. trifolii, and C. malvarum*), which all share a common or very similar mtDNA haplotype, could be distinguished based on intron RFLP variation. In addition, multiple intron RFLP groups were identified among isolates within *C. gloeosporioides* and *C. acutatum*. Mating studies also were conducted to determine how the intron variation was inherited.

A species-specific molecular diagnostic to detect and quantify *Monilinia fructicola* on California stone fruits. E. W. BOEHM, Z. Ma, and T. J. Michailides. University of California, Kearney Agricultural Center, Parlier, CA 93648. Phytopathology 90:S8. Publication no. P-2000-0052-AMA.

The California *Prunus* industry suffers severe annual losses due to the brown rot pathogen *Monilinia fructicola*. A partial genomic library was screened using total DNA to develop a molecular diagnostic capable of detecting and quantifying latent spore load and/or latent infection. Three species-specific, tandemly arranged, non-ribosomal, high copy sequences were cloned from the *M. fructicola* genome: two cross-hybridized and were of extra-chromosomal origin, while the third migrated with uncut DNA. The three repetitive clones proved to be species specific to 60 *M. fructicola* isolates with worldwide distributions (CA, OR, MI, GA and Australia), to the exclusion of *M. laxa* (n=12) and other stone fruit fungal pathogens (n=24). The clones were sensitive enough to detect between 10 - 50 pg of fungal DNA in dot blot hybridizations. Copy number estimates from reconstruction experiments indicated that these sequences comprise roughly 2% of the genome. Sequence information, species-specific primer design and detection/quantification from the fruit surface will be presented.

Systemic effects of Heterobasidion annosum infection on the secondary metabolism of ponderosa pine. P. BONELLO (1), T. R. Gordon (2), W. Heller (3), A. J. Storer (4), and D. L. Wood (4). (1) Dept. Plant Pathology, Ohio State Univ., (2) Dept. Plant Pathology, Univ. of California, Davis, (3) Inst. Bioch. Plant. Path., GSF Forschungszentrum, Munich, Germany, (4) Div. Insect Biology, Univ. of California, Berkeley. Phytopathology 90:S8. Publication no. P-2000-0053-AMA.

In 1997, ponderosa pines were artificially inoculated with the root and butt rot fungus, Heterobasidion annosum to study the systemic effects of infection on the phenolic makeup of the phloem. Ten trees were inoculated at the collar, ten mock-inoculated and ten used as controls in each of two adjacent, even aged plantations in the central California Sierra Nevada. The phloem of the trees was sampled at breast height over a period of two years and analyzed to determine pathogen-induced changes in soluble and cell wall-bound phenolics. No significant changes were observed in the west plot over time. However, in the east plot, ferulic acid glucoside, a lignin precursor, accumulated transiently over a period of one year in the phloem of inoculated trees compared with the mocks and the controls. Concurrently, a non significant reduction in lignification of the cell walls was observed. Destructive sampling revealed that the inoculations had been largely ineffective, perhaps explaining this lack of strong effects. On the basis of the data available, it is hypothesized that root infection serves as a sink of lignin precursors away from other trunk areas. This will be tested in the near future. Lower lignification levels may help explain the higher success of bark beetle infestation of root diseased trees.

Identification of bacterial communities associated with disease suppressive soils using a novel DNA microarray approach. J. BORNEMAN (1), J. O. Becker (2), R. J. Hartin (1), and B. Yin (1). (1) Department of Plant Pathology, (2) Department of Nematology, University of California, Riverside, CA 92521. Phytopathology 90:S8. Publication no. P-2000-0054-AMA.

Disease suppressive soils are remarkable resources for agriculture that have not been fully utilized. For many soils, the nature of the suppression appears to be biological as soil fumigation eliminates or reduces the suppressiveness. Since most microorganisms are not easily cultured, analysis of ribosomal RNA genes (rDNA) isolated from soil provides an attractive strategy to examine the potential contributions of these organisms to suppression. To enable thorough and well-replicated investigations of soil microbial communities, we developed a new DNA microarray-based approach to analyze rDNA molecules. High throughput methods were used to sort rDNA clones into operational taxonomic units (OTUs) by individual hybridization experiments to a series of short DNA oligonucleotides. The potential of this new approach was demonstrated by examination of bacterial communities associated with several disease suppressive soils.

Effect of harvesting processes on aflatoxin contamination of peanuts. K. L. Bowen (1), T. W. ALLEN, Jr. (1), K. B Burch (1), and J. P. Bostick (2). (1) Dept. Entomology and Plant Pathology, Auburn University, AL 36849 and (2) Alabama Crop Improvement Association, Headland, AL 36345. Phytopathology 90:S8. Publication no. P-2000-0055-AMA.

Peanut pods were sampled from several growers' fields during various stages of harvest. Samples were collected: i) by hand immediately prior to digging, ii) from inverted rows immediately following digging, iii) from inverted rows after two days of drying, iv) from combined harvested air-dried samples, and v) from combined harvested samples held with harvest moisture. Aflatoxin levels were consistently higher in combined harvested samples that were held with harvest moisture, with an average of 37 ppb over all sites. Combined harvested air-dried samples tended to have more contamination (1.8 ppb average over all sites) than samples taken directly from inverted rows (no detectable aflatoxins). Over all sampling times, the proportion of pods with cracks and with any fungi present were correlated to aflatoxin levels ($r = 0.46$ and $r = 0.64$, respectively; $P < 0.02$). No other evaluative factors were correlated to aflatoxin levels. More specifically, aflatoxin levels in air-dried samples were best correlated to the proportion of cracked pods in samples taken from inverted rows.

Effect of botanical extracts in combination with biocontrol organisms on control of Fusarium wilt of muskmelon. J. H. BOWERS (1) and J. C. Locke (1). USDA, ARS, USNA, Floral & Nursery Plants Research Unit, Beltsville, MD. Phytopathology 90:S8. Publication no. P-2000-0056-AMA.

Plant extracts in combination with biocontrol organisms were evaluated in greenhouse tests for control of Fusarium wilt. Formulated extracts (10% aqueous emulsions of cassia tree extract or chili pepper extract mixed with essential oil of mustard) or biocontrol fungi (SoilGard, RootShield, *Trichoderma* sp. 5c, or nonpathogenic *Fusarium oxysporum* CS-20) were incorporated into infested soil. After 7 days, biocontrol fungi were incorporated into extract-treated soil, and all treatments planted 3 days later. There were no significant effects ($P = 0.05$) of biocontrol fungi alone on disease incidence. Cassia extract alone significantly reduced disease incidence. There was no further control with the addition of the biocontrol organisms. Disease control with the pepper/mustard mixture was significantly less than with the cassia treatment, but the addition of *F. oxysporum* CS-20 statistically further reduced disease incidence. This demonstrates the principle that a combination of a natural plant extract with a biocontrol organism may be a viable strategy to control soilborne pathogens.

***Aspergillus* section Flavi and aflatoxins in common shrubs and trees of the Sonoran desert.** M. L. BOYD and P. J. Cotty. USDA-ARS-SRRC, P.O. Box 19687, New Orleans, LA 70179. Phytopathology 90:S8. Publication no. P-2000-0057-AMA.

Fungi within *Aspergillus* section Flavi are known for their ability to produce aflatoxins in diverse crops. The distribution of *Aspergillus* section Flavi associated with plants in undisturbed areas of the Sonoran desert was determined in order to assess the potential for aflatoxin production and accumulation in plants other than traditional crops. A total of 245 samples of plant debris and fruits were analyzed for colony forming units, and 2,868