

screening of bacteria isolated from turf roots. The Kentucky bluegrass cultivar Baron was grown in an 80:20 mix of sand:peat in 164 cm<sup>3</sup> containers. Tall fescue seed colonized by *M. poae* was placed 1.3 cm below the Baron seed. Bacterial suspensions (50 ml of 10<sup>9</sup> to 10<sup>11</sup> cfu) were applied to 4 to 5 wk old turf grown in a greenhouse at 24 C. RCA was determined 2 wk later on rhizosphere soil and roots. Remaining plants were then moved to a 28 C growth chamber. Symptoms developed in 2 to 4 wk and were reduced by some bacteria. Populations of selected bacteria applied in the field were correlated with RCA in controlled environments.

EFFECT OF INITIAL POPULATION DENSITIES OF MELOIDOGYNE HAPLA ON GROWTH OF LETTUCE IN ORGANIC SOIL. N. M. M. Viaene and G. S. Abawi. Dept. of Plant Pathology, Cornell Univ., Geneva, N.Y. 14456.

Lettuce cv. 'Montello' was direct-seeded in 500 cc pots and 15,000 cc microplots in greenhouse and field tests, respectively. Pots and microplots were filled with nontreated or methylbromide-treated organic soil that was infested with *Meloidogyne hapla* at initial population densities (Pi) of 0, 1, 2, 4, 6, 8, 16, and 32 eggs/cc soil. Plant weight, root galling severity (RGS), and number of eggs per root system (Pf) were determined after 8 weeks. Plant weight declined linearly as Pi increased. In fumigated soil, the tolerance limits (T), calculated by fitting the data to the Seinhorst equation, were 3.75 eggs/cc soil in the microplot tests and 7.75 eggs/cc soil in the greenhouse tests. The T value was lower in nontreated soils. The RGS increased with increasing Pi's and reached a maximum (>80% roots with galls) at Pi's of 8 and 32 eggs/cc soil in greenhouse and microplot tests, resp. The reproduction rate (Pf/Pi) of *M. hapla* was highest at the lowest Pi's. Total egg production was greater in fumigated than in nontreated soil.

\* SPECIES OF *ARMILLARIA* CAUSING ROOT DISEASE OF BLUEBERRY IN MASSACHUSETTS. Philip M. Wargo, USDA Forest Service, Hamden, CT 06514, Frank L. Caruso, U.M.A., East Wareham, MA 02538 and James T. Blodgett, U.WI., Madison, WI 53706.

Dieback and mortality of blueberry bushes, planted on former mixed oak-pitch pine forested areas in two locations in eastern MA, was attributed to *Armillaria* root disease. Most cultivars were susceptible to the fungus. Diploid (dip) isolates captured from blueberry bushes in one field and from oak and pine trees in the adjacent forest were paired on malt agar (MA) with haploid tester strains (HTSs) from known Eastern species of *Armillaria*. Isolates from both oak and pine trees were compatible with HTSs of *A. mellea* (Vahl:Fr) Kummer, Bio-species (BS) VI. Isolates from blueberry were not compatible with any HTSs of any species. Compatibility testing (dip x dip) of these isolates among themselves and with the forest isolates compatible with *A. mellea* indicated that the blueberry isolates are of the same genus but not genotype and are most closely related to BS VI. Mycelial and rhizomorph morphology formed on MA also are similar to *A. mellea*.

COMPARATIVE EFFICACY OF BRAVO® 825 AND BRAVO® 720 IN CONTROLLING CYCLANEUSMA NEEDLECAST. N. G. Wenner and W. Merrill, Penn State, 211 Buckhout Laboratory, University Park, PA 16802.

In 1992 the efficacy of Bravo® 825 WDG was compared with that of Bravo® 720 F in a Christmas tree plantation in Clearfield Co., PA. The trees were 1.5-2 m Scots pine of Spanish seed source. Sprays were applied by Solo® backpack mist blower on 10 April and 12 May 1992 during the spring infection period. Application rates were 4620 g a.i./ha and 2304 g a.i./ha for the two products, respectively. Levels of *Cyclaneusma minus* infection were determined by direct isolation before the sprays on 10 April and 12 May, and on 16 June 1992, and recorded as the percentage of the 1991 needle complement infected. Details of isolation techniques have been previously reported. Bravo® 720 and 825 prevented infection throughout the study with increases of infection of 0.25% and 7.0%, respectively, as compared to 72.2% in the unsprayed check trees (significant at  $P < 0.0005$ ). However, Bravo® 720 provided significantly better protection than Bravo® 825 ( $P = 0.018$ ).

BANNER® AND RUBIGAN® FUNGICIDES INEFFECTIVE IN CONTROLLING RHABDOCLINE NEEDLECAST. N. G. Wenner and W. Merrill, Penn State, 211 Buckhout Laboratory, University Park, PA 16802.

In 1991-92, two sterol-biosynthesis-inhibiting fungicides were compared to chlorothalonil in controlling *Rhabdocline pseudotsugae* in a Christmas tree plantation of 2-3 m severely infected "Coconino" Douglas-fir in Columbia Co., PA. Applications were made with a Solo® backpack mist blower at the following rates: Bravo® 720 at 3.26 liter f.p./ha, Banner® 1.1 EC at 1.19 liter f.p./ha, and Rubigan® at 0.44 and 0.89 liter f.p./ha. The first scheduled spray (at 10% budbreak) was missed due to poor weather; the second and third sprays were applied on 8 and 22 May, 1991. The study was evaluated on 13 April 1992 during peak symptom expression. From each of 10 permanently tagged samples trees per treatment, one 1991 shoot was removed at each

cardinal direction 1.4 m from the ground. The percentage of infected needles was determined for each shoot. Bravo 720® gave significant control, permitting 13% infection, compared to 65% in the unsprayed check ( $P = 0.05$ ). Banner® and Rubigan® treatments did not differ significantly from the check.

*DISCOSIA PINI* SEEDLING BLIGHT OF *PSEUDOTSUGA MENZIESII* IN PENNSYLVANIA. N. G. Wenner and W. Merrill, Penn State 211 Buckhout Laboratory, University Park, PA 16802.

In September 1991, a Carbon Co., PA nursery bed of *Pseudotsuga menziesii*, fall-sown in 1990, was examined. The seedlings were severely stunted, chlorotic, and dead or dying. The lower stems frequently were crooked and/or had spindle-shaped swellings and stem cracking. Primary needles were stunted or lacking. The distinctive pycnidia and conidia of *Discosia pini* Heald were abundant on the stems and cotyledons. By comparison, seedlings spring-sown in 1991 from the same seed lot in an adjacent nursery bed were healthy, with well-developed primary needles. All seedbeds had been tilled, formed, and fumigated in the same manner in early fall 1990. The fungus apparently attacked the dormant fall-sown seed during the winter months. This fungus has been reported causing seedling blight of *Pinus ponderosa* in Nebraska, *P. banksiana* in Ontario, *P. sylvestris* in Romania, and *P. densiflora*, *P. thunbergii* and *Cunninghamia lanceolata* in Japan. This is the first report of this pathogen causing mortality to *Pseudotsuga menziesii* seedlings.

*IN VITRO* MORPHOLOGICAL CHANGES IN TREE PATHOGENIC FUNGI AFTER EXPOSURE TO A FUNGAL ANTAGONIST, *PHAEOTHECA* SP., AND ITS EXTRACTS. D. Yang, L. Bernier, Y. Piché and M. Dessureault. Centre de Recherche en Biologie Forestière, Université Laval, Québec, Qc, Canada, G1K 7P4.

*In vitro* screening and evaluation of the antagonistic ability of a *Phaeotheca* sp. against several major tree pathogens was conducted by a variation of the agar layer techniques. Results showed that this *Phaeotheca* species produces antifungal metabolites which are strongly inhibitory against a wide range of tree pathogens. Light and interferential microscopy were used to detect the occurrence of hyphal changes in test fungi exposed to colonies of *Phaeotheca* sp. or to their metabolites. Four types of morphological changes were observed in the pathogens tested: swelling of hyphae, production of resting spores, extrusion of cytoplasm from hyphal tips, and bursting and destruction of mycelium. Microscopic observation of the interaction between this *Phaeotheca* and various phytopathogenic fungi confirmed that *Phaeotheca* sp. possessed both fungistatic and fungitoxic activities depending on the fungal species used.

DROUGHT PREDISPOSES BLACK SPRUCE SEEDLINGS TO INFECTION BY *BOTRYTIS CINEREA*. P. G. Zhang and J. C. Sutton, Dept. of Environmental Biology, University of Guelph, Ontario, Canada N1G 2W1.

Seedlings of black spruce (*Picea mariana*) were kept in a growth-room (16 h photoperiod, 20 C, 40-60% RH) and in a greenhouse (16-28 C, 25-80% RH) without watering for periods ranging from 0 to 16 d. Some of seedlings were used to estimate chlorophyll content (YC), and others were inoculated with *B. cinerea* and incubated in high humidity at 20 C for 36 h. Incidence of needles infected (YI) and spores produced per needle (YS) were estimated. In 3- and 4-month-old seedlings, YI was zero following drought periods of < 12 and 8 d, but 2-3% following drought periods of ≥ 13 and 10 d in growth-room and greenhouse environments, respectively. Generally, YI and YS increased, while YC of seedlings decreased with extension of the drought period (D) in seedlings of various ages (A). Regression models using the logits of YI, YS and YC as dependent variables described the levels of infection, sporulation and chlorophyll as a function of D and A. Terms in the models were A, AD, AD<sup>2</sup>, and AD<sup>3</sup>, and all estimated parameters were significant. Coefficients of determination for combined data from two repetitions of the experiment were 0.45 - 0.77.

EFFECTS OF INOCULUM CONCENTRATION AND NEEDLE AGE ON INFECTION CYCLES OF *BOTRYTIS CINEREA* IN BLACK SPRUCE SEEDLINGS. P. G. Zhang and J. C. Sutton, Dept. of Environmental Biology, University of Guelph, Ontario, Canada N1G 2W1.

Seedlings of black spruce (*Picea mariana*) were kept in the dark at 34-36 C for 96 h to predispose them to *B. cinerea*, then inoculated at 20 C with spore suspensions of the pathogen containing 0, 10<sup>3</sup>, 10<sup>4</sup>, 10<sup>5</sup>, 10<sup>6</sup>, 3.3\*10<sup>6</sup>, 6.7\*10<sup>6</sup>, and 10<sup>7</sup> conidia/ml. Incidence of infected needles (YI) was estimated after incubation on an agar medium containing penicillin. YI increased sigmoidally with inoculum concentration to a maximum of 91.7% in needles treated with 10<sup>7</sup> conidia/ml. Effects of needle age on infection were examined using non-inoculated seedlings that were surface sterilized, or autoclaved, or untreated. The seedlings were inoculated with 10<sup>6</sup> conidia/ml and needles of different developmental stages were detached and incubated on water agar at 20 C. YI and cumulative number of conidia (YC) were estimated daily. YI values for partially expanded, fully expanded, and early senescing needles of the surface-