ABSTRACTS

SOCIETY OF NEMATOLOGISTS
30th ANNUAL MEETING
BALTIMORE, MARYLAND
7-11 JULY 1991

ABAWI, G. S., and R. W. ROBINSON. *Reaction of selected lettuce germplasm to artificial inoculation by Meloidogyne hapla in the greenhouse.*

Cultivars of lettuce (*Lactuca sativa* L.), breeding lines, and accessions of several *Lactuca* spp. were evaluated in two greenhouse tests at 20-25 C against a New York lettuce population of *Meloidogyne hapla.* Five-week-old seedlings were transplanted into 10-cm clay pots (three per pot) filled with steam-pasteurized (30 minutes at 60 C) soil mix and were immediately inoculated with an egg suspension of *M. hapla.* Egg inoculum was prepared with the NaOCl method. In the first test, 61 lines were inoculated twice (one-week interval) with a total of 40,000 eggs/pot; in the second, 24 lines were inoculated once with 10,000 eggs/pot. Root galling severity (RGS) and total egg production per root system were recorded about 7 weeks after inoculation. RGS was assessed on a 1 (no visible galls) to 9 (>80% of the root system with galls) scale. Several lines exhibited a high level of resistance to *M. hapla* in terms of significantly lower RGS and egg production values. Among the moderately to highly resistant lines were: *L. saligna* PI 273582, NY breeding line 41-595, cv. Salinas, *L. serriola* acc. 3738, *L. virosa* PI 271938, and *L. virosa* PI 273597. *Departments of Plant Pathology and Horticultural Sciences, respectively, New York Agricultural Experiment Station, Cornell University, Geneva, NY 14456.*

BALDWIN, J. G., and C. D. EDDLEMAN. *TEM of body wall cuticle of Bellodera utahensis and Ekphymatodera thomasoni females (Sarisoderini, Heteroderinae).*

The female body wall cuticle of *Bellodera utahensis* and *Ekphymatodera thomasoni* has four concentric layers, designated from the surface exterior to the interior as A, B, C, and D. In addition, *B. utahensis* has an E layer. Surface striae of the cuticle of *B. utahensis* are transverse, whereas those of *E. thomasoni* are longitudinal. These differences affect the A layer which is thickest in the elevated regions between striae. The B layer is continuous in young females but is broken into discontinuous patches as the female increases in girth. The C layer is distinct from the adjacent D layer in *B. utahensis* but the two layers tend to merge in *E. thomasoni.* The D layer is composed of fibrils arranged in a helicoidal pattern. The layer is not resolved in newly molted females of *B. utahensis* but is present in young *E. thomasoni.* Knowledge of the body wall cuticle in females strengthens hypotheses of monophyly of Sarisoderini. *Department of Nematology, University of California, Riverside, CA 92521.*

BARILLAS, J. R., G. W. LAWRENCE, and K. S. MCLEAN. *Population development of root-knot nematode (Meloidogyne incognita) on kenaf.*

Field microplots were infested with initial population levels (Pi) of 0, 100, 500, 1,000, 2,500, and 5,000 *Meloidogyne incognita* eggs and juveniles per 500 cm^3 of soil and planted with 9 kenaf cv. Tainung 1 seeds per microplot. At harvest, increasing initial inoculum levels were negatively correlated with fresh and dry plant weights, plant heights, and stalk diameters. Dry stem weights were reduced from 23,600 to 14,950 kg/ha in the untreated control and Pi level of 5,000, respectively. Plant growth parameters were reduced by Pi levels of 500 and higher. Nematode population development increased with increasing Pi levels. The highest initial Pi produced the highest nematode population at harvest. Nematode reproduction (R = final population/initial population) decreased with increasing inoculum densities. *Department of Plant Pathology and Weed Science, Mississippi State University, Mississippi State, MS 39762.*

BECK, J. L., and B. C. HYMAN. *Transcriptional analysis of the Romanomermis culicivorax mitochondrial genome.*

Some genes that reside within the *R. culicivorax* mitochondrial genome are present as multiple, amplified copies while others are represented only once. We addressed the question of whether steady-state levels of individual, organelle-specific mRNAs are reflected in the dosage of genes from which they are derived. We have prepared a cDNA library from total cellular poly-A^+ *R. culicivorax* RNA in a bacteriophage lambda-based vector system and have screened this library for mitochondrial-specific cDNA clones with in vitro-labeled mitochondrial DNA. Preliminary hybridization studies with these clones indicate a direct correlation between the level of individual mRNAs and their gene dosages, suggesting that several representatives of an amplified coding sequence are transcriptionally active. These same experiments have enabled us to extend our genetic map of the *R. culicivorax* mitochondrial genome. *Department of Biology, University of California, Riverside, CA 92521.*

BERNARD, E. C., and K. D. GWINN. *Behavior and reproduction of Meloidogyne marylandi and Pratylenchus scribneri in roots and rhizosphere of endophyte-infected tall fescue.*

Tall fescue (*Festuca arundinacea*) infected with the endophytic fungus *Acremonium coenophialum* exhibits high resistance to parasitism by many plant-parasitic nematode species. The nature of the resistance reaction to *Meloidogyne marylandi* and *Pratylenchus scribneri* was studied in several experiments. Hatching and invasion of E+ and E- (endophyte-free) roots by *M. marylandi* were investigated over a 17-day period. Single tillers were transplanted into Conetainer® tubes. Two weeks later, 1,000 eggs were added to the soil of each of 56 tubes (28 E+, 28 E-). At 2, 4, 6, 8, 13, and 17 days after infestation, roots from four E+ and four E- plants were stained to visualize juveniles. Juveniles in the soil also were counted and extracted. A similar experiment was conducted with *P. scribneri,* except that roots and soil were processed over a 58-day period. For *M. marylandi,* soil juvenile densities were similar, but in E- roots juvenile numbers were 30× those in E+ roots 17 days after infestation. For *P. scribneri,* E+ and E- soil counts were similar throughout. Numbers of *P. scribneri* were significantly higher in E- roots after 20 days, and by 58 days after infestation were 10× as numerous as in E+ roots. Many juveniles and eggs were observed in E- roots, but few in E+ roots. In another experiment, selected E+ and E- root segments were paired and placed on 1% water agar on opposite sides of petri dishes and incubated at room temperature for 24 hours. Approximately 1,000 *P. scribneri* adults plus juveniles were added to each dish equidistant from each root segment. After 24 hours, nematodes were counted on each side of the dish. Nematodes migrated much more to the E- side than to the E+ side ($P < 1 \times 10^{-6}$), indicating a very strong repellency or attraction response. E+ tall fescue exhibits a wide array of effects upon plant-parasitic nematodes. *Department of Entomology and Plant Pathology, University of Tennessee, Knoxville, TN 37901-1071.*

BERNEY, M. F., and G. W. BIRD. *Impact of crop rotations on Heterodera carotae.*

Rotation crops were grown for one and two years between carrot crops to suppress population densities of *Heterodera carotae* (carrot cyst nematode). One year of a monocot increased carrot yields and reduced symptoms on subsequent carrot crops, compared to dicots and controls. Fewer differences between treatments were observed in carrot yield and quality following two years of the rotation crop. Population densities of *H. carotae* associated with the rotation crops closely followed the carrot yield results, with significant differences in the population size and the change in the population size by treatment. The impact of the previous year rotation crop on the carrot cyst nematode population within the treatments was still present after harvest of the first post-rotation crop of carrots. *Department of Entomology, Michigan State University, East Lansing, MI 48824.*

BINDER, B. F., and D. J. CHITWOOD. *Effects of insect growth regulators on Caenorhabditis elegans.*

Natural products and synthetic compounds that interrupt normal metamorphosis in insects were tested against *Caenorhabditis elegans.* The nematodes were assayed in a liquid medium consisting of 1 part dextrose, 3 parts soy peptone, 3 parts yeast extract, and 90 parts water and containing hemoglobin and sitosterol made to a final concentration of 0.5 mg/ml media and 10 μg/ml media, respectively. Test compounds were emulsified in Tween 80 and made to a final concentration of 100, 10, 1, 0.1, and 0 μg/ml media. The final concentration of Tween 80 was 0.5 μl/ml media. Results showed that a natural insect

juvenile hormone, juvenile hormone III, had no effect on the nematodes. Similarly, powerful synthetic juvenile hormone mimics such as methoprene or fenoxycarb or the plant-derived insect anti-juvenile hormone precocene II did not affect nematode growth, development, or fecundity. *Nematology Laboratory, USDA, ARS, Building 467, BARC-East, Beltsville, MD 20705-2350.*

BIRD, D. McK., I. KALOSHIAN, and E. van der KNAAP. *The hunt for genes that make nematodes parasites and plants hosts.*

We are interested both in the nematode signal(s) that trigger and maintain host changes associated with the feeding site and also the molecular nature of the susceptible plant response. For the root-knot nematodes, the source of the nematode signal is almost certainly the esophageal glands. At the Second International Nematology Congress, we reported the use of a degenerate oligo (designed from a short stretch of amino acid sequence obtained from R. S. Hussey, University of Georgia) in the isolation of a *Meloidogyne incognita* gene that we suspected to encode an esophageal gland protein. Much to our chagrin, sequence analysis of this clone confirmed that it did not encode the gene of interest. Rather, a pseudo, gene reconstruction experiment showed that it encodes an element tandemly repeated 35 times in the genome. A database search did not reveal any meaningful homologies. We have designed five additional oligos so as to exploit as much information as is obtainable in the peptide sequence, and we are currently using these for PCR amplification from genomic DNA and for PCR-cDNA cloning. To characterize giant cell induction and maintenance, we are endeavoring to construct giant-cell-specific cDNA libraries. Experiments have been performed to optimize library construction from small numbers of cells. We plan to use several subtractive screening strategies to isolate transcripts inappropriately expressed in giant cells. *Department of Nematology, University of California, Riverside, CA 92521.*

BIRD, G. W., R. MATHER, and J. DAVENPORT. *Economic thresholds for Pratylenchus penetrans control with ethoprop in potato production.*

The role of ethoprop in potato production has increased significantly because of the loss of several nematicides. The objective was to obtain the data necessary for determining economic thresholds for *Pratylenchus penetrans* control with ethoprop in potato production. The research involved 15 different field-scale experiments conducted during 14 growing seasons from 1976-1991. Dosages tested ranged from 1.5 to 12.0 lbs a.i./acre. Four formulations (Mocap 10G, Mocap 15G, Mocap 20G and Mocap 6EC) were evaluated in broadcast, 12-inch band, and in-fertilizer-furrow applications. Mocap 10G appeared to be the best formulation, and adjusted profit was maximized at ca. 9.0 lbs of ethoprop per acre per broadcast application. The first order derivative of the crop value and control cost intersected at a mid-season maintenance population of 16 *P. penetrans* per 100 cm^3 soil and 1.0 g root tissue. Optimal incorporation of ethoprop was important for successful use in a 12-inch band application. *Department of Entomology, Michigan State University, East Lansing, MI 48824.*

BOERMA, H. R.[1], and R. S. HUSSEY[2]. *Breeding plants for resistance to nematodes.*

Plant breeders and nematologists have been successful in developing improved cultivars of important crop species with resistance to plant-parasitic nematodes. The effectiveness of these breeding efforts is dependent on the availability of screening procedures, the availability of adequate sources of durable resistance, variation in the nematode for parasitism, and knowledge of the inheritance of resistance. These factors determine to a large degree the breeding method and potential success of the effort. When the resistance is from related species it is often necessary to overcome problems with incompatibility of the species and sterility of the resulting hybrid. Once these barriers are overcome, it is usually necessary to utilize backcrossing to incorporate the resistance genes and still recover the desirable commercial traits of the crop species. If resistance is present within the crop species the choice of breeding method will depend on the inheritance of the resistance, type of screening procedure, and other breeding objectives of the species. In the near future, plant molecular biologists will create novel sources of nematode resistance through incorporation of transgenes from other genera. These efforts will generally require conventional breeding prior to commercial utilization of an improved resistant cultivar. *Departments of [1]Agronomy and [2]Plant Pathology, University of Georgia, Athens, GA 30602.*

BRODIE, B. B.[1], and R. L. PLAISTED[2]. *Resistance in potato to Pratylenchus penetrans.*

Potato clones from 5 different breeding populations were evaluated for their ability to support reproduction of *Pratylenchus penetrans.* The breeding populations were: 1) *Solanum tuberosum* ssp. *tuberosum* clones selected for *Globodera rostochiensis* resistance; 2) a neotuberosum population of a *S. tuberosum* ssp. *andigena* derivation selected for adaptation; 3) a *G. pallida*-resistant population derived from *S. tuberosum* ssp. *andigena* and *S. vernei*; 4) an insect-resistant population of a *S. berthaultii* derivation; and 5) a heat-tolerant population derived from *S. tuberosum* ssp. *andigena, S. phureja,* and *S. sparsipilum.* Potato clones (5 replicates) were planted in a sandy loam soil in 7.5 cm pots and placed in a growth chamber at 24 C with 15-hour day length. After plant emergence, each pot was inoculated with 3,500 adults of *P. penetrans* from alfalfa callus cultures. After 70 days, the number of nematodes per pot was determined. Nematodes were extracted from soil with the pie-pan method and from roots with a shaker-incubation method. Total nematodes ranged from 204 to 4,108/pot and 3 to 238/g of root for the most resistant and susceptible clones, respectively. All of the highly resistant clones were in the breeding population that was originally selected for *G. pallida* resistance. Additional tests confirmed the existence of high resistance to *P. penetrans* in this breeding population. [1]*USDA, ARS, Department of Plant Pathology, and* [2]*Department of Plant Breeding, Cornell University, Ithaca, NY 14853.*

BROWDE, J. A.[1], L. P. PEDIGO[1], G. L. TYLKA[2], and M. D. K. OWEN[3]. *Soybean response to combined injury from soybean cyst nematode, herbicides, and insects.*

Field research was conducted to investigate individual and interactive impacts of soybean injury from soybean cyst nematode (SCN), *Heterodera glycines,* a postemergence herbicide mix (acifluorfen plus bentazon), and simulated green cloverworm defoliation. Treatments included two levels of SCN density, two levels of the herbicide mix, and four levels of defoliation. Plots were artificially infested with a cultured SCN-root-soil mix. Significant plant stress from all factors was noted. Herbicides and SCN significantly affected leaf stomatal conductance, measured immediately following herbicide application. Lower conductances (higher stress) were noted for herbicide-treated plants. Moreover, herbicides and SCN interacted synergistically to further reduce conductance. Extensive foliar injury after herbicide application substantiated plant stress from herbicides. Defoliation altered the crop canopy with reductions in leaf area index and light interception. Effects on yield were consistent with preharvest stresses. Significant main effects on yield were noted for herbicides and defoliation. Although SCN alone did not significantly reduce yield, the combination of SCN and herbicides was synergistic, reducing yield. [1]*Department of Entomology,* [2]*Department of Plant Pathology, and* [3]*Department of Agronomy, Iowa State University, Ames, IA 50011.*

BURROWS, P. R. *Molecular analysis of the interactions between cyst nematodes and their hosts.*

In order to complete its life cycle, a cyst nematode must stimulate the production of a specialized syncytial feeding site within host root tissues. This process is characterized by major changes to local root morphology, including enlargement of affected nuclei and nucleoli, cell wall degradation, and proliferation of subcellular organelles. At the molecular level very little is known about the processes involved in this host response, but recent evidence suggests that cyst nematodes are able to regulate specific host genes. The host-parasite model system provided by *Arabidopsis thaliana* and *Heterodera schachtii* will be fundamental to our future understanding of the formation of syncytia. Molecular biology now offers us the opportunity to study this complex host-parasite interaction in great detail. A better understanding of the host genes regulated by cyst nematodes and the mechanisms by which this regulation is achieved could facilitate the engineering of crop cultivars that possess novel forms of resistance to these adept parasites. *Department of Entomology and Nematology, AFRC Institute of Arable Crops Research, Rothamsted Experimental Station, Harpenden, Hertfordshire, AL5 2JQ, UK.*

CAP, G. B., P. A. ROBERTS, and I. J. THOMASON. *Inheritance of heat stable resistance to Meloidogyne incognita in Lycopersicon peruvianum.*

The inheritance of heat stable resistance to *M. incognita* was studied in crosses with different accessions and clones of *L. peruvianum.* F_1, F_2 and BC_1 generations were evaluated for index of resistance, and the segregation ratios were determined in experiments carried

out at 25 C and 30 C soil temperature. *Lycopersicon peruvianum* P.I. 270435 clones 3MH and 2R2, and *L. p.* var. *glandulosum* P.I. 126443 clone 1MH, all heat stable resistant, were crossed with *L. p.* var. *glandulosum* P.I. 126440 clone 9MH, susceptible at 25 C and 30 C. Also, *L. peruvianum* P.I. 270435-2R2 was crossed with *L. peruvianum* 128657 clone 3R4 (source of gene *Mi*) that is resistant at 25 C but susceptible at 30 C. All F_1 progeny were resistant at 25 C and 30 C. F_2 and BC_1 generations at 25 C gave 15:1 and 3:1 ratios, respectively, suggesting that resistance is conditioned by two genes. However, at 30 C, 3:1 and 1:1 ratios were observed for the F_2 and BC_1 generations, respectively, indicating that heat stable resistance is conferred by a single dominant gene. BC_1 progeny of *L. p.* P.I. 270435-2R2 × 128657-3R4 (source of gene *Mi*) crossed with susceptible *L. p.* var. *glandulosum* 126440-9MH were all resistant at 25 C and segregated in a 1:1 ratio at 30 C, also suggesting that heat stable resistance is monogenic. *Department of Nematology, University of California, Riverside, CA 92521.*

CASWELL, E. P. *The influence of Criconemella curvata on Chrysanthemum frutescens.*

A greenhouse experiment was conducted to assess the influence of *Criconemella curvata* and *Rotylenchus robustus* on the growth and flower production of marguerite daisy (*Chrysanthemum frutescens*). The soil used in the experiment originated in a commercial daisy field where the plants were growing poorly; the soil was naturally infested with the two nematode species. The treatments examined were naturally-infested field soil, steam-pasteurized field soil, and sterile soil mix. In the field soil treatment, numbers of *C. curvata* increased from nearly undetectable levels to 220 per 50 cm^3 of soil after 280 days. The numbers of *R. robustus* in the field soil declined, and the nematode was not detected after 170 days. Total plant weight and flower diameter were significantly less in the infested soil than in the steam-pasteurized soil or the sterile soil mix. Flower and bud number were significantly less in the infested soil than in the steam-pasteurized soil. *Department of Nematology, University of California, Davis, CA 95616.*

CASWELL, E. P., V. M. WILLIAMSON, and F. F. WU. *Assessing genetic variability in Heterodera schachtii and H. cruciferae using random amplified polymorphic DNA.*

We are using polymerase chain reaction (PCR) amplification of nematode DNA sequences to assess genetic variability in *Heterodera schachtii* and *H. cruciferae.* Single, random primers are used to generate PCR-amplified fragments, termed RAPD (random-amplified-polymorphic DNA) markers. These markers display size differences separable on an agarose gel. Twenty different random primers have been used to amplify genomic DNA from *H. schachtii* and *H. cruciferae.* From two to twelve fragments (with sizes ranging from 0.2 to 1.5 kb) are obtained with each primer. Reproducible differences in fragment patterns between the two species have been observed. Differences among geographic populations of *H. schachtii* have been detected using several different random primers. Several fragments that are conserved among geographic populations have also been detected. *Department of Nematology, University of California, Davis, CA 95616.*

CATALANO, L.[1], V. SAVINO[2], and F. LAMBERTI[1]. *ELISA for identifying GFLV-carrying Longidoridae.*

Longidoridae associated with grapevines infected with grapevine fanleaf nepovirus (GFLV) are commonly found in Italian vineyards. ELISA was used to ascertain the presence of GFLV particles in the body of nematodes from naturally infested fields. The longidorids recovered alone or in mixed populations were: *Xiphinema index, X. pachtaicum, X. italiae, Longidorus apulus,* and *L. euonymus.* The nematodes were extracted with Cobb's wet sieve technique, hand picked, and grouped in lots of 30 specimens per population. DAS-ELISA were carried out with nematode homogenates (3 to 8 per population) crushed in standard extraction buffer and an antiserum to GFLV raised locally. Controls consisted of non-viruliferous and viruliferous *X. index* reared on fig seedlings and GFLV-infected vines, respectively, and extracts of GFLV-infected and healthy vines. Positive results were obtained from all *X. index* tested, whereas tests with other species did not give positive ELISA responses. Preliminary results of transmission tests indicated that ELISA-negative nematodes did not transmit GFLV to Mission grape seedlings. These results seem to confirm that in Italian vineyards, *X. index* is to be considered the only GFLV vector. [1]*Istituto di Nematologia Agraria, CNR, Via Amendola 165/A, 70126 Bari, Italy, and* [2]*Dipartimento di Protezione delle Piante dalle Malattie, Bari, Italy.*

CHANG, S., and C. H. OPPERMAN. *Acetylcholinesterase molecular forms in Heterodera glycines differ from those of Meloidogyne spp.*

Biochemical characterization of *Heterodera glycines* acetylcholinesterase has revealed the occurrence of three separable enzyme forms. These forms fall into two discrete classes based upon kinetic properties, physical parameters, and responses to inhibitors. This distribution differs from *Meloidogyne* spp., which contains five separable acetylcholinesterase forms comprising three discrete classes: A, B, and C. *Heterodera glycines* does not contain detectable class B acetylcholinesterase. The two classes present in *H. glycines* resemble the corresponding *Meloidogyne* forms. A relatively large portion of *H. glycines* acetylcholinesterase is comprised of class C enzyme, which is remarkably insensitive to inhibitors. Class A acetylcholinesterase, on the other hand, is extremely sensitive to carbamate and organophosphate nematicides. The differential distribution and composition of acetylcholinesterase forms between *H. glycines* and *Meloidogyne* spp. may account for observed differences in nematicide efficacy. *Department of Plant Pathology, North Carolina State University, Raleigh, NC 27695-7616.*

CHEN, GENHUI, and J. M. WEBSTER. *Effect of extracts of Xenorhabdus nematophilus on soil bacteria.*

The entomopathogenic nematodes *Steinernema* spp. and *Heterorhabditis* spp. are being investigated worldwide for use in insect pest management. The bacterial associates, *Xenorhabdus* spp., of these nematodes produce substances that suppress the growth of other bacterial species. The objective of this study was to investigate the effect of these substances on soil bacteria in both laboratory culture media and in soils. In Petri dish experiments in which 15 species of soil bacteria were exposed to extracts of *Xenorhabdus*, the growth of the following bacteria was suppressed: *Bacillus subtilis, B. thuringiensis, Enterobacter aerogenes, Rhizobium phaseoli,* and *Serratia marcescens.* It appears that some but not all species of soil bacteria are affected by *Xenorhabdus* extracts. Antibiotic activity is lost quickly when released into the soil, but it is stable in storage. *Department of Biological Sciences, Simon Fraser University, Burnaby, Vancouver V5A 1S6, Canada.*

CHEN, J., and G. W. BIRD. *Influence of agroecosystem diversity on Pratylenchus penetrans.*

Potato production was used for evaluation of the influence of ecosystem diversity on *Pratylenchus penetrans.* The study consisted of experiments conducted in 1989-1990. Variations in ecosystem heterogeneity included soil texture, plant biomass, rotation crops, and nematicide use. Variations in populations of *P. penetrans* were greater in heterogeneous than in homogeneous environments, and fluctuations in populations were associated with the heterogeneous structure of the system. Presence of heterogeneity increased variance of the frequency distributions of *P. penetrans.* Dominance-diversity curves were developed as possible decision-making aides for nematode management. There was a negative relationship between *P. penetrans* population density and *Solanum tuberosum* biomass, and a positive relationship between *P. penetrans*-stressed *S. tuberosum* plants and variance among *S. tuberosum* plants. Data about other nematode species provided information about species-specific responses to variations in system heterogeneity. *Department of Entomology, Michigan State University, East Lansing, MI 48824.*

CHITWOOD, D. J.[1], and W. R. LUSBY[2]. *Long chain sphingoid bases from cerebrosides and sphingomyelins of Caenorhabditis elegans.*

Caenorhabditis elegans N2 was propagated in sterile aqueous medium containing yeast extract, soy peptone, glucose, hemoglobin, Tween 80, and sitosterol. Lipids were extracted from mixed stages of nematodes with chloroform-methanol or hexane-isopropanol. Cerebrosides were isolated from the crude lipid extract with silica column chromatography; their methanolysis products included methyl glycosides, long chain sphingoid bases (LCB), and fatty acid methyl esters. Sphingomyelins were purified with silica and DEAE-cellulose column chromatography, and LCB were released from them by methanolysis. Mass spectrometry of intact LCB from cerebrosides indicated that the major LCB was a C_{17} dihydroxysphingoid base with one double bond. The LCB were triacetylated and analyzed by gas-liquid chromatography (GLC); the same predominant peak occurred in LCB triacetates from both sphingomyelins and cerebrosides. Also, LCB were N-acetylated, the N-acetates were purified by C_{18} high performance liquid chromatography and oxidized with $KMnO_4$-$NaIO_4$, and the resultant fatty acids were methylated and analyzed by GLC. Because

the major fatty acid methyl ester comigrated during GLC with methyl *iso*-tridecanoate, the parent LCB was an *iso*-LCB with a C-4 double bond (i.e., 15-methyl-2-aminohexadec-4-en-1,3-diol). The branched structure of the LCB was consistent with nuclear magnetic resonance spectroscopic data of the parent cerebroside. [1]*Nematology Laboratory and* [2]*Insect Neurobiology and Hormone Laboratory, USDA, ARS, Building 467, BARC-East, Beltsville, MD 20705-2350.*

CIANCIO, A. *Relationship between spore dimensions and body cuticle thickness in Pasteuria penetrans-infected nematodes.*

Resting spores from thirty-three isolates of the nematode parasite *Pasteuria penetrans* (sensu Sayre & Starr), measured with light microscopy within infected nematodes or attached to the host cuticle, showed a continuous morphometric variation. Spore and endospore measurements varied respectively from 2.6 ± 0.3 μm and 1.0 ± 0.1 μm in *Aphelenchoides* sp. to 6.5 ± 0.5 μm and 2.1 ± 0.2 μm in *Xiphinema diversicaudatum.* The host nematode cuticle and hypodermis thickness measured by light microscopy varied from 1.0 μm in *Aphelenchoides* sp. to 7.7 μm in adult females and 4 μm in juveniles of *X. diversicaudatum.* Spore and endospore diameters of the *Pasteuria penetrans* isolates were significantly correlated ($r = 0.7464$; $P < 0.001$) and were also correlated with the cuticle-hypodermis thickness of the corresponding hosts ($r = 0.8205$ and $r = 0.5716$, respectively; $P < 0.001$). The observed relationships and the continuous variation in spore dimensions suggest a functional evolutive adaptation of *Pasteuria penetrans* spores to host nematode parasitism. *Istituto di Nematologia Agraria, CNR, Via Amendola 165/A, 70126 Bari, Italy.*

DAVIES, K. G., and E. B. LANDER. *Monoclonal antibodies and their use in the identification of root-knot nematodes (Meloidogyne* spp.).

Monoclonal antibodies were produced by immunizing Balb/C mice with antigen prepared from adult females and fusing splenocytes with a mouse myeloma cell line in the presence of polyethylene glycol. After selection in HAZA, the hybridoma cell lines were cloned and screened against different species and developmental stages of plant-parasitic nematodes with ELISA and immunoblotting. Screening with ELISA revealed several monoclonal antibodies with differing degrees of specificity to females from populations of *Meloidogyne* spp. An assay was developed that distinguishes the three major species of root-knot nematode: *M. arenaria, M. incognita,* and *M. javanica.* Immunoblotting confirmed the results obtained by ELISA but also showed that although some of the proteins recognized by the monoclonal antibodies were conserved between second-stage juveniles and adult females, several of the monoclonal antibodies were stage specific. Putative species-specific monoclonal antibodies are now being characterized further, and it is hoped to be able to use them not only in diagnosis but also in quantitative root and soil assays. *AFRC Institute of Arable Crops Research, Rothamsted Experimental Station, Harpenden, Hertfordshire, AL5 2JQ, UK.*

DAVIS, E. L.[1], R. S. HUSSEY[1], and L. H. PRATT[2]. *Monoclonal antibodies that bind to specific structures in Meloidogyne spp.*

Three monoclonal antibodies (MAb), specific for the excretory duct, ovary wall, or hypodermal nuclei of *Meloidogyne incognita* females, were produced by intraperitoneal immunization of Balb/c mice with homogenate of the esophageal region of *M. incognita* females. These mice were previously immunized with homogenate of the posterior two-thirds of *M. incognita* females and subsequently immunosuppressed with cyclophosphamide. The specificity of MAb binding was determined by immunofluorescence microscopy. Two of these first three MAb bound only to somatic muscles of *M. incognita* second-stage juveniles (J2). Nine additional MAb, isotyped to immunoglobulin class IgG, IgM, or IgA, were produced by intrasplenic immunization of mice with homogenate of the esophageal region of *M. incognita* females. Five of these nine were female-specific MAb that bound only secretory granules within the dorsal esophageal glands of *M. incognita, M. javanica,* and *M. arenaria,* but not *M. hapla.* Two of the nine bound to dorsal esophageal gland granules, excretory duct, and cuticle of females, but only to cuticle of J2 of the four *Meloidogyne* species listed above and the cuticle of J2 of *Heterodera glycines.* One bound specifically to dorsal esophageal gland granules of *Meloidogyne* spp. females but bound only to somatic muscles of J2 of *Meloidogyne* spp. and *H. glycines.* One bound specifically to the esophago-intestinal cells of *Meloidogyne* spp. females and J2, but not *H. glycines* J2. Hybridomas

specific to amphids, stylet and metacorpal muscles, and the extensive excretory canal system in *M. incognita* females were produced but not successfully cloned. [1]*Department of Plant Pathology and* [2]*Department of Botany, University of Georgia, Athens, GA 30602.*

DAVIS, R. F.[1], H. T. WILKINSON[1], and G. R. NOEL[2]. *Vertical distribution of four nematode genera in a bentgrass putting green in central Illinois.*

A study was conducted to determine the vertical distribution of *Tylenchorhynchus nudus, Criconemella* sp., *Helicotylenchus* sp., and *Hoplolaimus* sp. in the upper 5 cm of untreated and nematicide-treated bentgrass (*Agrostis palustris* cv. Penncross) putting green turf. A split-plot experimental design was used; whole plots were untreated or fenamiphos-treated (0.11 kg a.i./100 m^2), and sub-plots were two strata (depths of 0-2.5 and 2.5-5.0 cm). Soil samples were collected during the growing season for 2 years after treatment. Root mass and nematode population data were collected. More than 90% of the root mass was in the upper stratum on all sampling dates in both years. Numbers of nematodes in the four genera differed between strata on some sampling dates; differences were more prevalent from midsummer through the end of the growing season. When differences in population density were observed, *T. nudus, Criconemella* sp., and *Helicotylenchus* sp. were more concentrated in the upper stratum, but *Hoplolaimus* sp. was more concentrated in the lower stratum. Vertical distribution of *Helicotylenchus* sp. and *Hoplolaimus* sp. was affected by fenamiphos on some dates, whereas vertical distribution of *T. nudus* and *Criconemella* sp. was unaffected. Vertical distribution of *T. nudus, Criconemella* sp., and *Helicotylenchus* sp. was similar to the distribution of root mass, but the distribution of *Hoplolaimus* sp. was not similar to the distribution of root mass. [1]*Department of Plant Pathology, University of Illinois, Urbana, IL 61801, and* [2]*USDA, ARS, Department of Plant Pathology, University of Illinois, Urbana, IL 61801.*

DICKSON, D. W.[1], D. J. MITCHELL[2], T. E. HEWLETT[1], M. OOSTENDORP[1], AND M. E. KANNWISCHER-MITCHELL[2]. *Nematode-suppressive soil from a peanut field.*

Root-knot disease became less severe over time in a long-term monoculture of peanut in a field infested with *Meloidogyne arenaria* race 1. Soil collected 0-15 and 15-30 cm deep in January and September 1989 was subjected to four treatments: autoclaving, air drying, drenching with formalin, or storage at 10 C. The suppressiveness of each soil was bioassayed with Rutgers' tomato in pots inoculated with 0 or 1,000 second-stage juveniles (J2) of *M. arenaria.* Numbers of galls and egg masses (EM) were less ($P = 0.05$) in air-dried and stored soil collected in January from both depths compared with autoclaved and formalin-treated soil. Fewer ($P = 0.05$) galls and EM also occurred in formalin-treated than in autoclaved soil. Soil from the 0-15 cm depth was more ($P = 0.05$) suppressive than soil from the 15-30 cm depth. In September, EM counts from the different treatments were not different, but galling was less ($P = 0.05$) in soil collected at 0-15 cm deep when air-dried or stored compared with autoclaved or formalin-treated soil. The density of *Pasteuria penetrans* spores in the air-dried soil was determined by adding 1,000 J2; after 3 days 82-100% of the J2 had spores attached. In the field at harvest in 1989, 17% of *M. arenaria* females and 50% of the EM collected from roots were infected with fungi. *Paecilomyces lilacinus* and *Penicillium* sp. were the most common fungi associated with the females and EM. [1]*Entomology and Nematology Department, and* [2]*Plant Pathology Department, University of Florida, Gainesville, FL 32611.*

DI VITO, M., V. CIANCIOTTA, and G. ZACCHEO. *Population densities of Meloidogyne incognita and yield of susceptible and resistant pepper.*

Microplot experiments were designed to investigate the relationship between initial population density of *M. incognita* race 1 and yield of susceptible (cv. Yolo Wonder) and resistant (line 89422) pepper (*Capsicum annuum* L.) in Italy. Microplots were concrete tiles (30 × 30-cm cross section × 50-cm deep) filled with 40 liters of sandy soil that had been treated six months earlier with Telone at 200 liters/ha. Microplots were infested with finely chopped nematode-infected pepper roots to give a range of initial population densities of 0, 0.031, 0.062, 0.125, 0.25, 0.5, 1, ..., 128 eggs and juveniles/ml soil. A single two-month-old pepper seedling cv. Yolo Wonder or line 89422 was transplanted into each microplot. Fruits were harvested and weighed as they matured. The final nematode population density was assessed at the last harvest, when the plants were removed. The data fitted the Seinhorst equation, which indicates a tolerance limit of 0.3 eggs and juveniles/ml soil for both pepper

genotypes and minimum yield of 16 and 50% for susceptible and resistant pepper, respectively. Maximum reproduction of *M. incognita* on susceptible pepper was 584-fold with the lowest initial population densities, but less than one on resistant pepper at all initial population densities. *Istituto di Nematologia Agraria, CNR, Via Amendola 165/A, 70126 Bari, Italy.*

DUNCAN, L. W., and D. M. EISSENSTAT. *Competition between citrus fruit and the citrus nematode.*

Marble size fruit were removed from eight mature Valencia orange trees on rough lemon rootstock. Fruit were not permitted to grow on these trees for 15 months. Four months after fruit removal, feeder root density of defruited trees was 51% greater ($P < 0.05$) than on control trees whose fruit were not removed, while insoluble starch was reduced ($P < 0.05$) 24%. Fewer ($P < 0.05$) *Tylenchulus semipenetrans* hatched per unit root weight on defruited trees, but hatch per unit starch was 96% of control levels. Both feeder root density and starch levels were higher ($P < 0.05$) on defruited trees 15 months after treatment. The nematode hatch rate ($P < 0.10$) and fecundity ($P < 0.01$) were higher per unit root weight but not per unit starch weight on defruited trees. The data are consistent with the hypothesis that carbohydrate competition between developing citrus fruit and *T. semipenetrans* is one of the factors responsible for seasonal patterns of nematode population change. *Citrus Research and Education Center, University of Florida-IFAS, 700 Experiment Station Road, Lake Alfred, FL 33850.*

DWINELL, L. D.[1], and W. W. CARR[2]. *Using radio waves to eradicate Bursaphelenchus xylophilus in southern pine chips.*

Wood chip exporters need a technique for killing pine wood nematodes (PWN) in large volumes of pine chips. This study was conducted using a RF drying oven (Georgia Power, Atlanta) with parallel electrodes operating at a frequency of 27.1 MHz. For each exposure, two 1.0-kg lots of PWN-infested chips in ziplock bags were placed beneath the electrodes. The temperature was monitored by fluoroptic thermometry probes inserted in each lot. The chips were heated to 70, 80, 90, and 98 C for 3, 5, and 7 minutes. A set of samples was heated to 98 C in 90 seconds. It took an average of 90 seconds for the samples to reach temperature. Each treatment combination was replicated 3 times. After incubation at about 25 C for 5 days, nematodes were extracted from 25-g subsamples with the Baermann funnel procedure. No live nematodes of any species were recovered from the chips heated by radio waves. An average of 27 PWN/g dry wood wt were extracted from the control lots. The use of radio waves may be a viable option for decontaminating PWN-infested chips. [1]*U.S. Forest Service, Southeastern Forestry Experiment Station, Green Street, Athens, GA 30602, and* [2]*School of Textiles and Fiber Engineering, Georgia Institute of Technology, Atlanta, GA 30332.*

EISENBACK, J. D.[1], and K. R. BARKER[2]. *Challenges and innovations for teaching nematology.*

The study of plant-parasitic nematodes can be exciting and useful for undergraduate and graduate education. Exploitation of these unique pathogens and their interactions with hosts may augment enrollment in courses in nematology. Currently available information about nematode molecular or basic biology, biodiversity, complex host pathology, and multi-faceted management options can enhance the efficacy of innovative teachers. Likewise, multi-media presentations utilizing computer-assisted instruction can make the teaching of nematology more effective. Various combinations of carefully selected nematode-host systems and innovative teaching techniques are able to broaden and enrich the future teaching of nematology. [1]*Department of Plant Pathology, Physiology and Weed Science, Virginia Polytechnic Institute and State University, Blacksburg, VA 24061, and* [2]*Department of Plant Pathology, North Carolina State University, Raleigh, NC 27695.*

EISENBACK, J. D.[1], and E. C. McGAWLEY[2]. *A video cassette recording for teaching identification of the most common genera of plant-parasitic nematodes.*

Video tape recording of specimens of the most common genera of plant-parasitic nematodes facilitates teaching individuals and small groups of students how to identify nematodes under low power dissecting or inverted microscopes. The recordings effectively reveal the most useful characters to students. They also reduce or eliminate the need for fresh specimens and allow simultaneous observation by teacher and student(s). Students may also preview the recordings and review the tape as many times as necessary for them

to learn how to recognize the various common genera. [1]*Department of Plant Pathology, Physiology, and Weed Science, Virginia Polytechnic Institute and State University, Blacksburg, VA 24061, and* [2]*Department of Plant Pathology and Crop Physiology, Louisiana State University, Baton Rouge, LA 70803.*

ENDO, BURTON Y.[1], and URS WYSS[2]. *Ultrastructure of cuticular exudations in juveniles of Heterodera schachtii, as related to cuticle development.*

The development of *Heterodera schachtii* inside roots of a cruciferous host plant (*Brassica rapa* var. *silvestris* f. *campestris*) grown under monoxenic conditions in an agar medium was observed with video-enhanced contrast light microscopy. One to six days after inoculation, roots were excised and processed for electron microscopic observations. Exudates were present on the cuticle surfaces of J2 and early J3 juveniles located at feeding sites. Fibrillar and tubular exudations were correlated with similar microfibrillar patterns in the epicuticle, exocuticle, intermediate zone, and the striated endocuticle. Secretion vesicles, assembled at many Golgi sites in the hypodermis, appeared to coalesce and form large electron translucent vesicles in the cytoplasm. We propose that secretion vesicles migrate toward the cuticle, contact the plasmalemma and transfer their contents by exocytosis or a similar mechanism to a secretion accumulation site. These contents are associated with cuticle development and emerge as surface exudations. [1]*Nematology Laboratory, Plant Sciences Institute, USDA, ARS, Building 011A, Beltsville, MD 20705, and* [2]*Institute für Phytopathologie, Universität Kiel, Hermann-Rodewald-Strasse 9, 2300 Kiel 1, Federal Republic of Germany.*

ETTEMA, C. H.[1,2], P. v. d. BOOGERT[3], L. A. BOUWMAN[3], and G. HOENDERBOOM[3]. *Interactions between the nematophagous fungus Drechmeria coniospora and the bacterivorous nematode Acrobeloides buetschlii.*

A microcosm experiment with gamma-irradiated soil enriched with alfalfa meal and inoculated with soil bacteria had treatments ± *A. buetschlii* and ± *D. coniospora* (3 replicates per treatment). After three months, treatments including both *D. coniospora* and *A. buetschlii* showed significant increases in fungal spore numbers and significant decreases in nematode densities. *Acrobeloides buetschlii* appears to be a weak host for the fungus. However, because *Acrobeloides* is a dominant genus in many agricultural soils, it could contribute to the development of *D. coniospora*, resulting in enhanced fungal infection rates of phytonematodes. [1]*Department of Nematology, University of California, Riverside, CA 92521,* [2]*Department of Nematology, Agricultural University Wageningen, PB 8123, Wageningen 6700 ES, The Netherlands, and* [3]*Institute for Soil Fertility, PB 30003, Haren 9750 RA, The Netherlands.*

FERRIS, H. *New directions in nematode ecology.*

Areas of emphasis are suggested by pressing agricultural and environmental issues, by new directions in applied nematology, and by technological advances. Studies in nematode ecology must go beyond observation, counting, and statistical analysis. Experimentation and testing of hypotheses are needed for understanding of the mechanistic biology of ecological systems. Community relationships in rhizosphere biology and suppressive soils present challenges in experimental methodology for which new approaches are emerging. The expression of genetic diversity of nematode species through their parasitic competence, their physiology, and their behavior is essential information for non-pesticide management decisions. Biochemical and molecular diagnostic methods will be necessary. Understanding the function of nematodes in soil and aquatic food chains will have applications in agricultural and environmental monitoring and sustainability. *Department of Nematology, University of California, Davis, CA 95616.*

FERRIS, H.[1], and J. C. PROT[2]. *Interpreting crop yield-nematode and nematode-nematode relationships from field data.*

Nematode population and plant data from a field experiment were subjected to a range of analyses in an attempt to reveal underlying trends and relationships. Rank correlation was useful for preliminary indication of relationships. Several moving-average techniques were easily computed but introduced significant bias. A robust, locally-weighted regression procedure, although computationally intensive, was the most useful tool for revealing the relationships among plant-parasitic nematode populations at different densities and the relationships between crop yield and nematode population density. In a field in

which cotton and cowpea were grown in rotation, cotton yield had a stronger negative relationship to total numbers of plant-parasitic nematodes than to numbers of any individual species. Analyses indicated incompatible or antagonistic associations among the plant-parasitic nematode species, especially at higher population densities. These interactions would not have been revealed by more conventional analyses and may suggest new hypotheses and additional experiments. [1]*Department of Nematology, University of California, Davis, CA 95616, and* [2]*Department of Plant Pathology, International Rice Research Institute, P.O. Box 933, 1099 Manila, Philippines.*

FINETTI SIALER, M.[1], F. DE LUCA[2], M. DI VITO[2], C. DE GIORGI[1], and F. LAMBERTI[2]. *The presence of cuticlin genes in plant-parasitic nematodes.*

The cuticlins are insoluble, non-collagenous components of the nematode cuticle. By using cuticlin genes (*cut*) isolated from *Caenorhabditis elegans*, we have been able to identify homologous genes in plant-parasitic nematodes. Southern blots of *Meloidogyne artiellia* genomic DNA were probed with *cut-1* and *cut-2* genes. The results indicate that the *cut-2* gene is present in a Eco RI fragment of 6,600 bp. Moreover, the last exon of *cut-2* from *C. elegans* seems to be present in more hybridization bands. Similar experiments showed that the *cut-1* gene from *C. elegans* is also conserved in *M. artiellia* DNA. Therefore, we constructed a genomic library from this nematode, with lambda Gem-11 as the vector. Positive clones are under investigation. Preliminary observations seem to suggest that this species also contains cuticlin genes as a gene family, as reported for *C. elegans*. Also, similar experiments with *Xiphinema index* are in progress. [1]*Dipartimento di Biochimica e Biologia Molecolare, Università di Bari, Italy, and* [2]*Istituto di Nematologia Agraria, CNR, 70126 Bari, Italy.*

GARNER, E. R., and J. D. MUELLER. *Differential infection rates of Hoplolaimus columbus on soybean seedlings.*

Host suitability of tolerant and intolerant soybean cultivars to controlled inoculum levels of Columbia lance nematode (*Hoplolaimus columbus*) (CLN) were compared under controlled environmental conditions in DisPo growth pouches. Levels of infection of tolerant (Coker 317 and Foster) and intolerant (Cobb and Braxton) cultivars (two plants per pouch) were evaluated two weeks after inoculation with 2,000 CLN/pouch. Levels of infection were determined by recovery of CLN in a modified mist apparatus. The mean recovery of CLN per pouch for three replicates was 69 for Braxton, 69 for Cobb, 60 for Centennial, and 14 for Foster. Recovery of CLN from Foster was significantly less in all three replicates. Differences in early season infection rates may be a mechanism for tolerance or reflect levels of resistance not evident under field conditions. *Edisto Research and Education Center, Clemson University, P.O. Box 247, Blackville, SC 29187.*

GARNER, E. R., J. D. MUELLER, C. E. DRYE, and R. M. DAVIS. *Effect of aldicarb on soybean cultivars with varying levels of resistance to Heterodera glycines and Meloidogyne incognita.*

The cultivars Braxton (*Heterodera glycines*-susceptible and *Meloidogyne incognita*-resistant), Coker 6738 (*H. glycines*-resistant and *M. incognita*-resistant), Kirby (*H. glycines*-resistant and *M. incognita*-resistant) and Asgrow 7986 (*H. glycines*- resistant and *M. incognita*-susceptible) were established in a field infested with both nematodes. Cultivars were treated with 0, 0.59, and 1.18 kg aldicarb/ha applied in furrow at planting. Differences in yield (kg/ha) among aldicarb rates within cultivars were not significantly different. Asgrow 7986 (1,210, 1,256, 1,314) and Braxton (865, 1,070, 1,082) had incremental increases in yield as the aldicarb rate increased. Kirby (1,679, 1,948, 1,418) and Coker 6738 (1,685, 1,723, 1,678) did not express a positive response to increased rates of aldicarb. Cultivars resistant to *H. glycines* had yields greater than the susceptible cultivars treated with aldicarb. Yield and profit potential was greater in untreated resistant cultivars than in treated susceptible cultivars. *Edisto Research and Education Center, Clemson University, P.O. Box 247, Blackville, SC 29187.*

GEORGI, LAURA L., and DONALD L. RIDDLE. *The daf-1 receptor kinase.*

We have cloned and sequenced *daf-1*, a gene controlling dauer larva development in *Caenorhabditis elegans*. Based on the DNA sequence (Cell 61:635-645), the *daf-1* gene product appears to be an integral membrane protein whose putative cytosolic domain shows all the hallmarks of a serine/threonine protein kinase. This novel kinase is most closely related to the cytosolic *raf* proto-oncogene family. The *daf-1* protein may be a cell-surface

receptor, and like other receptor protein kinases, it may be activated when bound to its ligand (the identity of which is unknown). The mutant phenotypes suggest that kinase activity is needed to inhibit dauer larva development and/or to promote growth. Previously described receptor protein kinases are tyrosine kinases. In order to study the *daf-1* gene product, we have produced polyclonal antibodies directed against a fusion protein containing most of the putative extracellular domain, and also against a synthetic peptide consisting of the twelve carboxyl-terminal amino acids. These antibodies detect an 88-kD protein in extracts of all growing stages of wild-type *C. elegans*. This protein was not detected in extracts of strains carrying either of the transposon-insertion alleles of *daf-1* or in seven other *daf-1* mutant strains. However, it was detected in six *daf-1* mutants, including a strain carrying the point mutation *m213*, which results in a serine substitution for a conserved proline. The antibodies will be used for immunolocalization of the protein in the nematode. We also plan to test immunoprecipitates for kinase activity and determine the substrate specificity of the *daf-1* kinase. *Division of Biological Sciences, University of Missouri, Columbia, MO 65211.*

GRIFFIN, G. D. *Pathological differences of Pratylenchus penetrans and P. neglectus populations on alfalfa.*

Populations of the root lesion nematode *Pratylenchus penetrans* (PP1, PP2) from alfalfa growing in southern and central Utah were more virulent ($P < 0.05$) to Lahontan alfalfa than were populations of *P. neglectus* (PN1, PN2) from alfalfa growing in northern and central Utah. *Pratylenchus penetrans* PP1 and PP2 did not differ in virulence and reproduction, but PN1 was more virulent ($P < 0.05$) and had a greater reproductive index (Pf/Pi) than PN2 at 26 ± 2 C. At a Pi of 18.5 nematodes/cm^3 soil, the mortality rate of Lahontan was 50, 45, 25, and 10% for PP1, PP2, PN1, and PN2, respectively. Dry shoot weights at a similar Pi were reduced 63, 60, 47, and 30% by the same nematode populations. Dry root weights were similarly reduced by 66, 62, 52, and 35%. The reproductive indices for the same populations at a Pi of 9.3 nematodes/cm^3 soil were 12.8, 14.1, 9.3, and 4.5. Comparable data were obtained in a growth chamber study. *Pratylenchus penetrans* populations were more virulent than *P. neglectus* populations, and PN1 was more virulent than PN2. Plant growth reduction and nematode reproduction for all populations were greatest at 30 C. *USDA, ARS, Forage and Range Research Laboratory, Utah State University, Logan, UT 84322-6300.*

GRUNDLER, F. M. W., and U. WYSS. *Development of sedentary root nematodes in roots of Arabidopsis thaliana.*

Arabidopsis thaliana was shown to be a suitable host of several sedentary nematodes of the genera *Heterodera* and *Meloidogyne*. Its thin and translucent roots allowed a detailed in vivo analysis of the entire life cycle of *H. schachtii* and the early infection period of *M. incognita*, where, however, root galling prevented further observations. Screening of selected ecotypes and phytohormone mutants with *H. schachtii* revealed a large range of genetic variability of plant response to nematode infection, either supporting or suppressing nematode development. Nevertheless, complete resistance has not yet been detected. Manipulations of *A. thaliana* and variations in medium conditions in tissue culture also resulted in effects on nematode development. *Institut für Phytopathologie, Universität Kiel, 2300 Kiel, Hermann-Rodewald-Strasse 9, Federal Republic of Germany.*

HADDEN, J. F., and J. L. CRAWFORD. *Initial survey of plant-parasitic nematode distribution in Georgia cotton fields.*

A survey was conducted in six cotton-producing counties in southwest Georgia (ca. 15% of the total cotton acreage) to determine the distribution and population levels of plant-parasitic nematodes. Growers were queried on production practices in surveyed fields to evaluate the possible implications of these practices on nematode population dynamics. In-row soil samples were collected in late August. Nematodes were extracted with centrifugal flotation and hand sieving. Plant-parasitic nematodes were identified in 55 of 57 samples. Genera of nematodes identified ranked in decreasing order of occurrence included *Criconemella* spp., *Meloidogyne* spp., *Helicotylenchus* spp., *Trichodorus* spp., *Pratylenchus* spp., and *Tylenchorhynchus* spp. Root-knot (*Meloidogyne* spp.) nematodes were extracted from 58% of the samples. Root-knot nematode densities ranged from 2 to 516 juveniles/100 cm^3 of soil, with a mean of 88 juveniles/100 cm^3 of soil. Crop rotation was a common

practice in most fields with only 4% planted in continuous cotton. Seventy-eight percent of the rotations included peanuts at least once every three years. Nematicides had been applied to over three-quarters of the surveyed fields. Aldicarb and 1,3-dichloropropene had been applied to 78% and 2% of the fields, respectively. *Extension Plant Pathology Department, University of Georgia Cooperative Extension Service, Tifton, GA 31793.*

HAFEZ, S. L.[1], and D. MILLER[2]. *The effect of Pratylenchus penetrans on different alfalfa cultivars.*

This study was conducted to determine the effect of the lesion nematode *Pratylenchus penetrans* on foliage and roots of different alfalfa cultivars, each with varying degrees of nematode resistance. Three commercial alfalfa cultivars (Baker, Ranger and Nevada Syn-XX) and two experimental cultivars (AP 8831 and AP 8821), all with varying levels of resistance, were evaluated for their response to lesion nematode infestations under greenhouse conditions. Cultivar foliage and root weight (fresh and dry) were obtained from inoculated (3,000 nematodes/10 cm pot) and non-inoculated plants, with a minimum of 30 plants in each cultivar treatment. In all cultivars foliage and root fresh and dry weight were significantly reduced due to nematode infection. The magnitude of foliage and root reduction appeared to be influenced by cultivar resistance levels. Foliage and root fresh and dry weight of the three commercial cultivars (Baker, Ranger and Nevada Syn-XX) were significantly lower than the two experimental ones (AP 8831 and AP 8821) in the inoculated treatments. [1]*University of Idaho, Department of Plant, Soils and Entomological Sciences, Southwest Idaho Research and Extension Center, Parma, ID 83660, and* [2]*AGRIPRO, Nampa, ID 83653.*

HALBRENDT, J. M.[1], and D. J. F. BROWN[2]. *Morphometric variability of Xiphinema americanum descended from single females.*

Nematodes were extracted from two soil samples both known to contain *Xiphinema rivesi* and *X. americanum.* A total of 420 dagger nematodes were hand picked and placed in individual pots of fumigated soil with sudangrass. Remaining nematodes were preserved for reference. After two years, most nematodes had died but 48 pots yielded "families" (i.e., descendants of a single female). Families ranged from 2-1,659 nematodes. Standard morphometric data were collected from adults of four families identified as *X. americanum* and compared to data taken from the reference population for each family. Two families were less variable than the original field specimens for 12 of 15 measurements. The other families were less variable than the reference population for the odontostyle and total stylet measurements, but 13 other measurements showed little difference in the degree of variability. [1]*The Pennsylvania State University, Fruit Research Laboratory, P.O. Box 309, Biglerville, PA 17303, and* [2]*The Scottish Crop Research Institute, Invergowrie, Dundee, DD2 5DA, Scotland.*

HANDOO, Z. A., and A. M. GOLDEN. *A key and diagnostic compendium to the species of the genus Hoplolaimus Daday, 1905 (lance nematodes).*

An identification key to 29 valid species of *Hoplolaimus* was given. A diagnostic compendium to be used in identification of each species was presented as a practical alternative and supplement to the key. Principal differentiating characters include: stylet length; number of lateral incisures, labial annules, longitudinal striations on basal lip annule, esophageal gland nuclei, and tail annules; position of excretory pore in relation to hemizonid; and location of phasmids. *Basirolaimus* was confirmed as a synonym of *Hoplolaimus* and its species were referred to the latter genus. The diagnosis of *Hoplolaimus* was emended in order to accommodate all species of *Basirolaimus. Hoplolaimus sheri, H. chambus, H. casparus,* and *H. capensis* were recognized as valid species. A list of species of the genus, their synonymies, species inquirendae, nomina nuda, and species transferred to other genera were included. *Nematology Laboratory, USDA, ARS, Building 011A, BARC-West, Beltsville, MD 20705-2350.*

HAROON, S.[1], and R. N. HUETTEL[2]. *Effect of extracts from some medicinal plants on soybean cyst nematode.*

Studies were conducted under laboratory conditions to observe the effect of root exudates of some medicinal plants on hatch rate and mortality of soybean cyst nematodes (SCN), *Heterodera glycines.* These plants were *Alemites moluccama, Hyoscyamus niger, Calendula officinalis, Ambrosia trifida,* and *Origanum vulgare.* Hatch rate was increased in

the presence of exudates of *A. moluccama, H. niger, C. officinalis* and *O. vulgare* when compared to the controls, whereas a lower hatch rate occurred with exudates of *A. trifida.* Survival of hatched juveniles was significantly reduced after 24 hours in exudates of *A. trifida, C. officinalis,* and *O. vulgare* when compared to the controls. Juveniles, inoculated onto soybean root explant cultures with plant exudates added, failed to penetrate and/or develop. These results were similar to those obtained under field conditions in Egypt. Furthermore, these results indicated that some medicinal plants may be effective as natural nematicides in the control of SCN. [1]*Cairo University, Faruum Branch, Cairo, Egypt, and* [2]*Nematology Laboratory, USDA, ARS, Beltsville, MD 20705.*

HARRIS, T. S., and T. O. POWERS. *Testing a PCR protocol to identify Meloidogyne species.*

In blind tests and greenhouse trials, we have been testing PCR identification of single second-stage juveniles or individual eggs. The steps of the identification protocol are: 1) manual disruption of the nematode, 2) co-amplification of DNA with two primer sets, 3) screening of amplified DNA by agarose gel electrophoresis, and 4) restriction digestion and evaluation of amplified DNA. In all cases where scorable fragments were produced, the protocol could reliably identify three of the major *Meloidogyne* species. Drawbacks of the protocol include a 14% failure rate in which no amplification products were produced, the inability to amplify some *M. hapla* isolates and *M. chitwoodi,* and a lack of discrimination between *M. javanica* and *M. hapla.* Tests on naturally mixed field populations consisting of *M. incognita* and *M. arenaria* indicate that the procedure can provide an estimate of the percentage of each species in the field. *Department of Plant Pathology, University of Nebraska, Lincoln, NE 68583-0722.*

HASHMI, G.[1], S. HASHMI[1], R. N. HUETTEL[2], and L. R. KRUSBERG[1]. *Comparison of techniques for screening corn breeding lines for resistance to corn cyst nematode.*

An in vitro screening method was developed to determine reproduction of the corn cyst nematode (CCN), *Heterodera zeae,* on 25 corn (*Zea mays*) lines. Two root explants of each corn line were placed on petri plates containing Gamborg's B-5 medium, inoculated with 5 mature CCN cysts (Maryland isolate), and incubated at 28 C in the dark. Each corn line was tested 15 times. Visual observations on nematode development were made at 10, 12, 15, and 35 days. A significantly higher number of CCN reproduced on cv. IO-Chief, used as the control, when compared to all other corn lines. When the same corn lines were tested under greenhouse conditions, the highest counts of CCN again were recovered on IO-Chief, though it was not significantly different than 4 other lines tested. However, the other 21 lines supported CCN numbers similar to in vitro tests. These results indicated that in vitro screening is a valid approach for rapidly characterizing new breeding lines of corn as resistant or susceptible to CCN based on nematode reproduction. [1]*Department of Botany, University of Maryland, College Park, MD 20742, and* [2]*Nematology Laboratory, USDA, ARS, Beltsville, MD 20705.*

HASHMI, S., L. R. KRUSBERG, and S. SARDANELLI. *Influence of temperature on the pathogenicity and reproduction of the corn cyst nematode.*

We determined the effect of temperature on the reproduction and pathogenicity of the corn cyst nematode, *Heterodera zeae,* on corn in plant growth chambers. The Kent County, Maryland population of the corn cyst nematode used as inoculum was raised in the greenhouse. Experiments were performed at 24, 27, 30, 33, and 36 C. Each pot containing 2 corn seedlings was inoculated with 5,000 second-stage juveniles. After 8 weeks, data were recorded on fresh and dry weights of corn shoots and roots and the numbers of nematodes in each pot. Nematode reproduction increased directly with increase in temperature from 24 to 36 C. At 36 C corn plants were temperature stressed, so that total fresh plant weights were significantly lower than weights of plants grown at lower temperatures. No difference occurred in plant weights at 24-30 C. At 27 C the corn cyst nematode suppressed plant fresh weight by 36% and at 33 C by 28%. *Department of Botany, University of Maryland, College Park, MD 20742.*

HEWLETT, T. E., and D. W. DICKSON. *Population dynamics of Meloidogyne arenaria race 1 in peanut.*

Two field sites with natural populations of the peanut root-knot nematode were sampled monthly at five depths over 3 years beginning January 1985. Site 1 was cropped continuously to peanut and site 2 was planted with bahiagrass for 1 year, after which the

field was divided and one-half was planted to soybean in 1986 followed by peanut in 1987. Soil samples were taken monthly at each site at 15-cm intervals to a depth of 75 cm with the use of a 10-cm-d bucket auger. Second-stage juveniles (J2) and egg masses (EM) were each extracted from 250 cm^3 soil and a bioassay with Rutgers tomato was run (1985-1986) with 450 cm^3 soil taken 0-15, 30-45, and 60-75 cm deep. Under peanut, J2 and EM densities were greatest ($P = 0.05$) in September (harvest) 0-45 cm deep. J2 were found consistently at all depths sampled throughout the year, whereas EM numbers dropped to zero in December-February each year at the 0-15 cm depth. Although the density of J2 dropped under bahiagrass, low levels were consistently recovered at all depths over the 3-year sampling period. EM numbers dropped to zero after 12 months, but low numbers were again detected after 33 months. The soil bioassay confirmed that the J2 remained infective at all depths sampled in both the bahiagrass and the peanut sites. *Entomology and Nematology Department, University of Florida, Gainesville, FL 32611-0740.*

HIATT, E. E.[1], S. A. LEWIS[2], and A. G. ABBOTT[3]. *Characterization of a ribosomal gene cloned from Meloidogyne arenaria DNA.*

Studies have been initiated to clone and characterize single copy and intermediately repeated sequence classes in the *M. arenaria* genome. A *M. arenaria* probe, denoted pE1.6A, has been shown to carry an interspersed repeated sequence. The 1.6-kb, Eco RI clone taken from a shotgun pUC8 library of total genomic *M. arenaria* DNA has homology to as many as 40 bands when probed to total genomic *M. arenaria* DNA. pE1.6A has provided restriction fragment length polymorphism (RFLP) data on several geographic isolates of *M. arenaria* (race 2). Hybridization with the soybean 26S ribosomal subunit was confirmed when soybean RNA was probed with pE1.6A. The cloned insert of pE1.6A has been further restriction-digested with Sau 3A into four smaller fragments and probed with total *M. arenaria* RNA. One predominant band, presumably the region coding for the 26S subunit, was observed. pE1.6A is currently being sequenced to allow for a more thorough characterization of the cloned insert. [1]*Department of Agronomy and Soils,* [2]*Department of Plant Pathology, and* [3]*Department of Biological Sciences, Clemson University, Clemson, SC 29634.*

HUSSEY, R. S., and C. W. MIMS. *Ultrastructure of feeding tubes formed by Meloidogyne incognita.*

Meloidogyne incognita forms conspicuous tubular structures, referred to as feeding tubes, in giant-cells. Feeding tubes are formed by nematode secretions injected into giant-cells via a stylet and possibly function to facilitate withdrawal of soluble assimilates by the parasite. Feeding tube morphology was identical in giant-cells in roots of tomato, garden pea, common bean, and balsam. Tubes were straight to slightly curved structures just less than 1 μm wide and up to 110 μm long. At the ultrastructural level, tubes consisted of an 190-290 nm thick, electron-dense crystalline wall surrounding an electron-transparent lumen ranging in diameter from 340 to 510 nm in different tubes. In any one tube, the lumen diameter was relatively uniform throughout its length and the distal end was sealed with wall material. Older tubes were found free in the host cytoplasm, while the proximal end of each young tube was attached to the host cell wall via a short wall ingrowth through which the nematode's stylet was inserted. An elaborate, dense membrane system enveloped the feeding tubes and was most extensive around newly formed tubes. Contiguous to the feeding tube wall, this membrane system consisted of strands of smooth endoplasmic reticulum, while rough endoplasmic reticulum predominated toward the outer margin of the membrane system. Vacuoles and mitochondria were excluded from a zone of cytoplasm surrounding feeding tubes. This zone of exclusion, as well as the membrane system noted above, tended to be less pronounced or absent around older tubes no longer being used by the nematode. *Department of Plant Pathology, University of Georgia, Athens, GA 30602.*

HUSSEY, R. S.[1], C. W. MIMS[1], and S. W. WESTCOTT, III[2]. *Ultrastructure of food cells in roots parasitized by Criconemella xenoplax.*

Individuals of *Criconemella xenoplax,* monoxenically cultured on root explants of clover, carnation, and tomato, continuously fed as sedentary ectoparasites for up to 8 days from a single cell in the outer root cortex. Cortical cells fed upon by nematodes were modified into discrete food cells in all hosts examined. The nematode's stylet penetrated between epidermal cells and frequently through one subepidermal cortical cell. Food cells

were typically located in the first or second layer of the cortex. Callose-like deposits enveloped the portion of the stylet that had traversed subepidermal cortical cells and were deposited around the stylet tip except at its aperture. Plasma membranes of food cells were invaginated by the stylet tip, and the cytoplasmic layer of the cell was greatly expanded around the stylet. The plasma membrane was appressed to the wall of the stylet aperture creating a hole in the membrane which provided continuity between the lumen of the stylet and the cytosol of the food cell. A circular zone of cytoplasm around the stylet tip was densely particulate and contained clusters of electron-dense structures. In the center of the dense zone of cytoplasm, the cytosol closest to the stylet aperture was less dense and contained fibrillar material. In carnation, plasmodesmata between the food cell and adjacent cells were greatly enlarged. The nucleus of the food cell was enlarged and atypically shaped. *Criconemella xenoplax* feeding activities induce an adaptive cellular response in host tissue. [1]*Department of Plant Pathology, University of Georgia, Athens, GA 30602, and* [2]*Department of Plant Pathology and Physiology, Clemson University, Clemson, SC 29634.*

INGHAM, R. E. *Impact of nematodes on the rhizosphere community.*

The diversity and importance of soil food webs in terrestrial ecosystems is becoming widely recognized. Densities of these organisms, on a per gram soil basis, are often much higher in the root-influenced zone of the rhizosphere. Nematodes occupy a central role in rhizosphere-based food webs by feeding on bacteria, saprophytic, pathogenic and mycorrhizal fungi, roots, protozoa, and other nematodes. Resources consumed by nematodes are passed on to higher trophic levels when nematodes are preyed upon by mites and to lower trophic levels through waste products and death. Nematodes may influence system productivity directly by feeding on roots and mycorrhizae or indirectly by mineralizing nutrients immobilized in the biomass of primary consumers. Biological relationships between plants and other microorganisms, such as plant pathogens, mycorrhizae or rhizobia, may be influenced by nematode activities. In addition, nematodes may transport microorganisms and nutrients when they migrate between rhizosphere and bulk soil. *Department of Botany and Plant Pathology, Oregon State University, Corvallis, OR 97301-2902.*

INGRAHAM, APRIL E., and JOHN M. WEBSTER. *Efficacy of cold-active strains of Steinernema spp. against the black vine weevil, Otiorhynchus sulcatus, and the wax moth, Galleria mellonella, at different temperatures.*

Cold soil temperatures severely limit host finding and infection by *Steinernema carpocapsae* (NC-all strain), which is presently being used in the Pacific Northwest for control of the black vine weevil, *Otiorhynchus sulcatus.* Two experiments are reported on the use of three cold-active strains of *Steinernema* spp. in comparison with *S. carpocapsae* (NC-all strain) against *O. sulcatus* and *G. mellonella* larvae. In Petri plate bioassay experiments, larvae were exposed to 8, 10, and 12 C. Each cold-active strain tested infected the *G. mellonella* larvae at all three temperatures, but the rate of mortality varied with temperature and strain. In a second experiment cold-active strains of *Steinernema* spp. and *S. carpocapsae* (NC-all strain) were sprayed at field rate onto columns (15 cm high) of two types of soil containing *O. sulcatus* or *G. mellonella* larvae, and their efficacy was compared at 8 and 12 C. Each cold-active strain tested infected *G. mellonella* at both temperatures and in both soil types. Infection of black vine weevil was minimal in all instances. *Department of Biological Sciences, Simon Fraser University, Burnaby, Vancouver V5A 1S6, Canada.*

ISHIBASHI, N., W. KHLIBSUWAN, and E. KONDO. *Attraction of Steinernema carpocapsae infective juveniles to serum as affected by surface treatments with lectins and enzymes.*

Exsheathed infective juveniles of *S. carpocapsae* (strain All) were positively attracted to insect sera on 0.6% agar plates. Nematodes were more attracted to the serum of suitable hosts (over 80% for *Pieris rapae cruicivora* and *Spodoptera litura*) than serum of a less suitable one (ca. 64% for *Agrotis segetum*). Treatments at 20 or 30 C for 1 hour with lectins (concanavalin A, soybean agglutinin, and wheat germ agglutinin, each 500 μg/ml, pH 7.2) and with α-mannosidase (2 U/ml, pH 4.5), lipase (1,000 U/ml, pH 7.7), neuraminidase (1 U/ml, pH 5.5), and chondoroitinase (1 U/ml, pH 8.0) had no effect on the attraction. Contrarily, treatments at 37 C for 1 hour with protease (1 mg/ml, pH 7.2) and phospholipase

(10 U/ml, pH 7.2) and a treatment with 0.2% NaOCl at 20 C for 5 minutes significantly lowered the nematode attraction and increased the numbers of wandering nematodes not moving to the source of attraction. Attraction behavior was restored in these nematodes after being washed 24 hours in the buffered saline (pH 7.2) used as a control. Based on these results, the possible effect of lectin and enzyme treatments on the nematode recognition of attractive stimuli was discussed, with an emphasis on cuticle surface modification. *Department of Applied Biological Sciences, Saga University, Saga 840, Japan.*

JOHNSON, A. W., R. D. WAUCHOPE, and B. BURGOA. *Effect of simulated rainfall on leaching and efficacy of fenamiphos.*

Fenamiphos 15G was broadcast at 6.7 kg a.i./ha and incorporated into the top 15-cm soil layer with a tractor-mounted rototiller. Rainfall was applied via a multiple-intensity rainfall simulator at 5 cm/hour, and 2.5 cm and 5.0 cm were applied 1 day and 3 days after nematicide application. Four 5-cm-d soil cores 90-cm deep were collected 4 days after nematicide application from each plot, divided into 0-15, 15-30, 30-45, 45-60, and > 60 cm increments, and analyzed for parent fenamiphos, fenamiphos sulfoxide, and fenamiphos sulfone. Most of the fenamiphos was found in the top 15-cm soil layer, and concentrations were not affected by 5 cm rainfall applied either 1 day or 3 days after fenamiphos application. As expected, the plots treated with fenamiphos and no rainfall contained the highest concentration. Sixty percent of the fenamiphos applied to those plots was recovered. The percent of fenamiphos recovered from rainfall treatments ranged from 20 to 35. Based on root galls and yield of squash, the efficacy of fenamiphos was not affected by rainfall amount or time of event. *Nematodes, Weeds and Crops Research Unit, USDA, ARS, P.O. Box 748, Tifton, GA 31793.*

KAPLAN, D. T.[1], and E. COHN[2]. *Influence of root exudates on Tylenchulus semipenetrans egg hatch and juvenile activity.*

Egg hatch and activity of second-stage juveniles of the citrus nematode, *Tylenchulus semipenetrans*, are stimulated by root exudates. The stimulatory effect of root exudates on hatch and activity were non-specific. Sterile root exudates from axenically grown seedlings of *Citrus aurantium* (host) and *Zea mays* (non-host) stimulated comparable levels of egg hatch. Juveniles incubated for 24 hours in sterile distilled water were significantly less active than juveniles incubated in sterile root exudates collected from either *C. aurantium* (host), *Poncirus trifoliata* (resistant or poor host), or *Z. mays* (nonhost). [1]*Subtropical Plant Pathology Research Unit, USDA-ARS, 2120 Camden Road, Orlando, FL 32803, and* [2]*Division of Nematology, The Volcani Center, Bet Dagan, Israel.*

KAPLAN, M.[1], J. P. NOE[1], and P. G. HARTEL[2]. *Effects of chicken litter soil amendment on Meloidogyne arenaria.*

The effect of chicken litter soil amendment on life stages of *Meloidogyne arenaria* and the role of chicken litter microbes in the suppression of *M. arenaria* were investigated in greenhouse and laboratory studies. A loamy sand was amended with chicken litter at six rates (0.5 to 3% w/w). 'Rutgers' tomato seedlings were transplanted into amended and unamended soils in 15-cm-d pots and inoculated with 2,000 *M. arenaria* eggs. After 10 days, numbers of developing juveniles per gram root fresh weight decreased in a quadratic response (R^2 = 0.67, P = 0.0001) to increasing litter rates. After 46 days, numbers of eggs decreased in a linear response (R^2 = 0.69, P = 0.009) to increasing litter rates. 'Rutgers' tomato seedlings were transplanted into combinations of sterile and nonsterile litter and soil and were inoculated with 2,000 *M. arenaria* eggs. After 10 days, significantly fewer juveniles had penetrated roots from soils amended with nonsterile litter than sterile litter. Amendment of soil with chicken litter affects *M. arenaria* rate of development, and litter microbes play an important role in the suppression of *M. arenaria*. [1]*Department of Plant Pathology and* [2]*Department of Agronomy, University of Georgia, Athens, GA 30602.*

KIM, D. G., and R. D. RIGGS. *Efficacy of selected fungi for the control of juveniles of Heterodera glycines and Meloidogyne incognita.*

Eight fungi, *Arthrobotrys conoides, A. oligospora, A. robusta, Dactylaria brochopaga, D. candida, Hirsutella rhossiliensis, Meria coniospora*, and *Nematoctonus pachysporus*, were selected because of their frequent occurrence in the literature and were tested for infectivity to juveniles (J2) of *Heterodera glycines* and *Meloidogyne incognita*. Mycelial growth rate and parasitism of J2 were examined in Petri dishes. The growth rates of the different species of

fungi varied from 0.1 to 2.5 cm in 5 days, and J2 infectivity varied from 0 to 98% in 10 days. Juveniles of *M. incognita* were infected more readily than *H. glycines* J2. Three fungi, *A. oligospora, D. brochopaga,* and *H. rhossiliensis,* are the most efficient parasites of both nematodes and are easy to culture. The three fungi and an additional egg parasite, ARF18, were cultured on rice grains and tested in 10-cm-d pots. A mixture of *D. brochopaga* and ARF18 (5 g each) suppressed *H. glycines* egg production by 95% compared to the control ($P = 0.01$). *Department of Plant Pathology, University of Arkansas, Fayetteville, AR 72701.*

KO, M. P., and D. P. SCHMITT. *Influence of selected plant species on the population dynamics of plant-parasitic nematodes in a pineapple field.*

Changing population densities of *Rotylenchulus reniformis, Helicotylenchus dihystera,* and *Paratylenchus* spp. were monitored in a pineapple field planted with oat 'Hazel', marigold 'Boy O Boy', rhodes grass 'Katambora', and soybean 'Kirby'. Bare fallow and fallow mulched with pineapple residue were used as controls. Numbers of *R. reniformis* and *Paratylenchus* spp., but not *H. dihystera,* declined in all treatments over the 6-month period. Rate of decline for *H. dihystera* or *Paratylenchus* spp. was similar among the treatments. *Rotylenchulus reniformis* decreased the most in the marigold plots and the least in the fallow plots covered with pineapple residue. Similar soil samples were also assayed concurrently for biological antagonistic activities against *R. reniformis.* Preliminary data indicated little stimulation of such activities by the four plant species. *Department of Plant Pathology, University of Hawaii, Honolulu, HI 96822.*

KOENNING, S. R.[1], K. R. BARKER[1], and D. P. SCHMITT[2]. *Effects of soybean maturity group and time of planting on Heterodera glycines final population densities and soybean yield.*

Field experiments conducted at several locations with a variety of soil types concerned the effects of soybean maturity groups and date of planting on Heterodera glycines (SCN) population levels. Factorial experiments during 1986-1987 focused on maturity group V and VII soybean seeded in May versus June with or without the nematicide fenamiphos at 2.35 kg a.i./ha or aldicarb at 1.68 kg a.i./ha. Studies in 1989 and 1990 involved no nematicides and soybean maturity groups IV-VII with three dates of planting—late April, mid-May and late June. Population densities of *H. glycines* eggs and juveniles decreased from May to June. Rates of decline for eggs ranged from 5-245 eggs/day, depending on location, year and time interval. Final population densities of *H. glycines* were consistently greater ($P = 0.0002$) in plots planted to late-maturing cultivars. Effects of soybean planting date on final *H. glycines* levels varied with year and location. Late planting sometimes resulted in high final SCN population densities compared with early seeding. Nematicides enhanced soybean yield ($P = 0.05$), although increases were less substantial in late plantings in 1986. [1]*Department of Plant Pathology, North Carolina State University, Raleigh, NC 27695, and* [2]*Department of Plant Pathology, University of Hawaii, Honolulu, HI 96822.*

KOTCON, J. B. *Assessment of nontarget impacts of fenamiphos on nematode biocontrol agents in orchard soils in West Virginia.*

Three orchard sites with replicated, multi-year nematicide trials were used to assess the impact of repeated use of fenamiphos on nematode predators and parasites. Population densities of predatory nematodes (mostly *Clarkus papillatus*) were lower in plots treated with annual applications of fenamiphos than in untreated plots ($P < 0.05$). Overall activity of nematode biocontrol agents, determined as percent survival of *Pratylenchus penetrans* in sterilized and unsterilized soil samples, was 26% greater in fenamiphos-treated plots (mean of 4 experiments) than in untreated plots. Nematophagous fungi baited from soil on water agar using *P. penetrans* tended to be more prevalent in fenamiphos-treated soil than untreated soil, but differences were not statistically significant. Results suggest that proliferation of some nematode biocontrol agents compensated for suppression by fenamiphos of other nematode predators. *Division of Plant and Soil Sciences, West Virginia University, P.O. Box 6057, Morgantown, WV 26506-6057.*

KRUSBERG, L. R., and S. SARDANELLI. *Pathogenicity of Heterodera zeae to Zea mays in field microplots.*

Field microplots constructed of 60-cm-long × 45-cm-d fiberglass cylinders inserted into the soil to 45 cm deep were filled with methyl bromide-fumigated Matapeake silt loam or Sassafras sandy loam soil. Inoculum of *H. zeae* was from greenhouse cultures on corn.

Microplots were inoculated a single time, in spring 1986. Appropriate microplots were fertilized based on soil tests. Treatments were replicated 10 times, and the test ran for 5 seasons. *Heterodera zeae* was more pathogenic to corn in sandy than in silty soil. Fertilizer decreased the pathogenicity of *H. zeae* to corn. *Heterodera zeae* was most damaging to corn in hot, dry seasons and least damaging in cool, wet seasons. Total soil cyst numbers increased in years 1 and 2, plateaued in year 3, and decreased in years 4 and 5. *Department of Botany, University of Maryland, College Park, MD 20742.*

LAWRENCE G. W.[1], B. B. JOHNSON[2], and K. S. MCLEAN[1]. *Nematode population development as influenced by soybean tillage systems.*

Five tillage systems were evaluated for long range effects on plant-parasitic nematode management on soybean. Treatments included 1) disk, hip, chisel, do-all; 2) disk, hip, do-all; 3) disk, chisel, do-all; 4) disk, do-all; and 5) no-till. Each tillage system was applied with and without aldicarb at 1.18 kg/ha. The test was conducted on a Prentiss fine sandy loam soil naturally infested with *Heterodera glycines, Helicotylenchus* sp. and *Quinisulcius acutus.* After two years *H. glycines* final populations were significantly higher with maximum tillage compared with the no-till system (2,148 and 678 nematodes/500 cm^3 of soil, respectively). *Helicotylenchus* and *Q. acutus* populations were significantly higher in the no-till system. The addition of aldicarb did not lower nematode population development within a tillage system. [1]*Department of Plant Pathology and Weed Science, Mississippi State University, Mississippi State, MS 39762, and* [2]*Coastal Plains Experiment Station, Newton, MS 39345.*

LINDGREN, P. B., J. L. JAKOBEK, and J. A. SMITH. *Molecular analysis of plant defense responses to plant pathogens.*

Plants respond to invasion by incompatible pathogens with the activation of a number of inducible responses that have been implicated as disease defense mechanisms. These include the production of the hypersensitive response (HR), synthesis of phytoalexins, deposition of hydroxyproline-rich glycoproteins (HRGP) into the plant cell wall, and production of chitinase and glucanase. Because of the coordinate induction of these responses, it has been difficult to determine if they are functional defense responses and, if they are, how they specifically contribute to disease resistance. Due to recent advances in molecular biology, techniques are now available which may reveal how each of these putative defense responses specifically contributes to disease resistance. The long-range goal of our laboratory is to understand the molecular and biochemical basis of the HR. We have been using wild-type and Hrp mutants of *Pseudomonas syringae* pv. *tabaci* to study defense responses of bean (*Phaseolus vulgaris* L.). Although *P. s.* pv. *tabaci* induces a HR on bean, the latter mutants do not. Transcripts for phenylalanine ammonia lyase, chalcone synthase and isomerase, chitinase, glucanase, and HRGP accumulate in bean after inoculation with these Hrp mutants, even though a HR does not occur. The same transcripts accumulate in bean after inoculation with wild-type *P. s.* pv. *tabaci,* before a HR occurs. This suggests that there are genes that encode products specifically expressed during a HR. We have made a cDNA library complementary to mRNA isolated from bean tissue undergoing a HR and have devised a strategy to isolate HR-specific genes using a differential hybridization probe. *Department of Plant Pathology, North Carolina State University, Raleigh, NC 27695.*

MACGUIDWIN, A. E. *Targeting the rhizosphere for nematode control.*

Protecting young plants from nematode damage is an important goal of nematode management programs. This goal can be accomplished in several ways, such as the application of biocontrol agents or bioregulators to seeds or by the use of systemic nematicides. Research goals to increase the efficacy of these strategies, to manipulate the indigenous microbial community to enhance antagonism, or to develop new strategies can be identified. One of the foremost needs is to better understand the temporal and spatial aspects of nematode activities on and near roots. We are using a *Pratylenchus penetrans-Pisum sativum* system for that purpose. *Pratylenchus penetrans* was recovered in the rhizosphere of pea regardless of plant age and many nematodes moved freely between rhizosphere and root habitats. Mating, oviposition, and feeding occurred outside as well as inside roots. Factors that elicited the egress of nematodes from roots included, but were not limited to, overcrowding and attraction to the opposite sex. Understanding the timing and

conditions conducive to habitation of the rhizosphere by nematodes should be useful to target the rhizosphere for nematode control. *Department of Plant Pathology, University of Wisconsin, Madison, WI 53706.*

MACGUIDWIN, A. E., D. J. WIXTED, and B. D. HUDELSON. *Infection of snapbean by Ditylenchus destructor, the potato rot nematode.*

Despite a high reproductive potential, *Ditylenchus destructor* is often recovered in very low numbers from plants grown in the greenhouse and field. Traditionally, only below-ground plant parts are assayed for *D. destructor.* The objective of our research was to examine the suitability of all parts of snapbean, both above- and below-ground, for infection and reproduction by *D. destructor. Ditylenchus destructor* were recovered from seedcoats, fibrous roots, hypocotyls, cotyledons, epicotyls, and leaves of 'Amity' snapbean grown in soil microcosms infested with nematodes at the time of planting. Over seven weeks, numbers of nematodes increased in soil, fibrous roots, and hypocotyls and decreased in cotyledons, epicotyls, and leaves. Hypocotyls supported more nematodes than the other plant parts assayed. Soil moisture at the time of planting, the age structure of the inoculum, and the placement of inoculum influenced the number of nematodes recovered from all plant parts three weeks after planting. Field trials and sampling of commercial snapbean fields indicate that the incidence of above-ground infection is low. *Department of Plant Pathology, University of Wisconsin, Madison, WI 53706.*

MASHELA, P.[1], L. W. DUNCAN[1], J. H. GRAHAM[1], and R. McSORLEY[2]. *Leaching soluble salts increases population densities of the citrus nematode.*

The effect of salinity on population densities of the citrus nematode, *Tylenchulus semipenetrans,* was measured on Rangpur lime, *Citrus reticulata* var. *austera* Swingle, in clay, sand, and organic soils and on sweet lime, *C. aurantifolia* Swingle, in organic soil. In each experiment, salinity was imposed on 3-month-old plants, beginning with 25 mol/m^3 NaCl + 3.3 mol/m^3 $CaCl_2$ daily for 3 days and then 50 mol/m^3 NaCl + 6.6 mol/m^3 $CaCl_2$ every other day for a week. At that point, salinity was discontinued in one treatment (DC) by leaching with tap water prior to inoculation with nematodes. A continuous salinity treatment (C) was unchanged. Nonsalinized control (NSC), DC and C treatments were inoculated with 84,000 *T. semipenetrans* juveniles per plant. For Rangpur lime, DC salinity resulted in the highest ($P \leq 0.05$) population densities of *T. semipenetrans* in all three soil types. Nematode population levels in the NSC and C treatments were not different. Similarly, DC salinity treatment of sweet lime resulted in the largest ($P \leq 0.05$) populations. Apparently elevated salt levels ($P \leq 0.01$) in the plant resulting from DC salinity treatment predisposed citrus to nematode infection, whereas high levels of salt in the soil solution inhibited nematode infection. [1]*Citrus Research and Education Center, University of Florida-IFAS, 700 Experiment Station Road, Lake Alfred, FL 33850, and* [2]*University of Florida-IFAS, Department of Entomology and Nematology, Gainesville, FL 32611.*

MASHELA, P.[1], L. W. DUNCAN[1], and R. McSORLEY[2]. *The citrus nematode alters sodium and chloride partitioning in citrus.*

The effect on salt partitioning of the citrus nematode, *Tylenchulus semipenetrans,* was tested on three nematode-susceptible citrus varieties rated as highly tolerant (Rangpur lime, *Citrus reticulata* var. *austera* Swingle), moderately tolerant (sour orange, *C. aurantium* L.), or highly sensitive (sweet lime, *C. aurantifolia* Swingle) to salt under greenhouse conditions. Pre- and post-transplant inocula comprised 90,000 and 96,000 nematodes/plant, respectively. Two months after transplanting, half of the plants received 17 mol/m^3 NaCl + 3 mol/m^3 $CaCl_2$ in irrigation water for 1 month, while non-salinized controls were watered with tap water. The nematode increased ($P \leq 0.01$) Na and Cl levels in shoots and decreased ($P \leq 0.01$) these elements in roots of both salinized and non-salinized control plants regardless of their salt tolerance level. The nematode also altered ($P \leq 0.01$) carbohydrate partitioning in the three varieties. Because slow decline and citrus replant symptoms are typically similar to those of Cl or Na toxicity, our results support observations that *T. semipenetrans* causes these symptoms in either syndrome by increasing the accumulation of these ions in leaves. [1]*Citrus Research and Education Center, University of Florida-IFAS, 700 Experiment Station Road, Lake Alfred, FL 33850, and* [2]*University of Florida-IFAS, Department of Entomology and Nematology, Gainesville, FL 32611.*

MATHER, R. L., and G. W. BIRD. *Nemacast-Potato: An application of expert system technology in plant nematology.*

Nemacast-Potato is a prototype decision-support aide designed to assist in the diagnosis and management of the potato early-die disease complex caused by the joint action of *Pratylenchus penetrans* and *Verticillium dahliae.* The program is developed as an expert system that attempts to capture the intuition and experience of an agricultural nematologist. Inputs include the identification of visual symptoms, cropping history, nematicide usage, and laboratory soil assays for *P. penetrans* and *V. dahliae.* Outputs include probability of risk based on visual symptoms and laboratory assays, predicted yield loss, and expected yield gains from a variety of management options. The program can be used on an IBM-compatible computer or hand-held calculator. It was designed for use by Michigan potato growers and extension agents. Currently, it is undergoing alpha testing. *Department of Entomology, Michigan State University, East Lansing, MI 48824.*

McKENRY, M. V., and T. BUZO. *Selection of a cover crop and nematode management.*

Microplots were planted to grape, *Vitis vinifera* cv. Colombard, rootings and individual cover crops. Host status of the following nematodes was evaluated: 1) *Meloidogyne hapla,* 2) *M. incognita,* 3) *M. javanica,* 4) *M. arenaria,* 5) *Xiphinema americanum,* 6) *X. index,* 7) *Pratylenchus vulnus,* 8) *Paratylenchus hamatus,* 9) *Tylenchulus semipenetrans,* and 10) *Criconemella xenoplax.* Sudangrass, *Sorghum halepense* cv. Sudanense, hosted populations 2, 3, and 4, whereas 1, 5, 7, 8, 9, and 10 declined in numbers. Chlorosis and stunting occurred on the vine. Barley, *Hordeum vulgare* cv. Columbia, supported populations 1, 2, 3, 4, 8, and 10 but reduced populations of 7 and 9. By incorporating refuse before temperatures exceed 15 C, it can be a useful cover crop. *Bromus mollis* cv. Blando hosted 1, 3, 5, and 10; it was a poor host for 2, 4, 6, and 8; but it was antagonistic to 7 and 9 with only slight antagonism to the vine. *Vicia* sp. cv. Cahaba White was an excellent host for 1, 8, and 10. Adult stages of 7 and 8 were endoparasitic, but only 8 reproduced within roots. Populations 2, 3, 5, 6, and 9 were not hosted by this legume, which is nonantagonistic to grape. Any cover crop should be rotated every second or third year to avoid pest build-up. In a pre-plant setting, rotations with sudangrass and barley or vetch have the potential to gradually reduce soil populations of nematodes. *Department of Nematology, University of California, Riverside, CA 92521.*

MCLEAN, K. S., and G. W. LAWRENCE. *Effect of Heterodera glycines on severity of sudden death syndrome.*

Half-root tests were established to examine the association between the blue form of *Fusarium solani* (FSA, the causal organism of sudden death syndrome of soybean) and the soybean cyst nematode (SCN). Two independent root systems were established for each plant, and the two halves from each plant were inoculated with either FSA/control, SCN/control, FSA/SCN, FSA + SCN/control, and control/control. Root necrosis was significantly more severe for all half-roots inoculated with FSA. Foliar symptoms occurred earlier and were significantly more severe for plants inoculated with FSA + SCN on the same half-root. SCN population development was significantly reduced in the FSA + SCN treatment compared to the FSA/SCN and SCN/control treatments. SCN increased susceptibility of soybeans to FSA. *Department of Plant Pathology and Weed Science, Mississippi State University, Mississippi State, MS 39762.*

MELAKEBERHAN, H.[1], G. W. BIRD[1], P. SOBICZEWSKI[2], and A. L. JONES[2]. *Occurrence of plant-parasitic nematodes and bacterial canker on northwest Michigan sweet cherries.*

The relationship between bacterial canker caused by two pathovars of *Pseudomonas syringae* and the presence of plant-parasitic nematodes in three northwest Michigan sweet cherry orchards of mazzard rootstock was studied. More than 900 trees comprising Emperor Francis and Nelson varieties in Orchards No. 1 and 2 and Sam in Orchard No. 3 were visually evaluated for severity of bacterial canker (0-4 index). Orchard 1 had the highest and orchard 3 the least amount of bacterial canker. Nelson was more affected than Emperor Francis. Nematode population density in each orchard and in trees with high bacterial canker ratings was monitored from bulk soil samples at ca. 30-day intervals, whereas roots were sampled only once. *Pratylenchus penetrans* was the most prominent nematode in soil and root samples of all three orchards. Population densities in Orchards 1 and 2, however, were greater than that of Orchard 3. *Criconemella xenoplax* and *Xiphinema americanum*

were present in modest numbers in Orchards 1 and 2, whereas these taxa were found only in trace numbers in Orchard 3. The results indicate that the incidence of bacterial canker may be related to the presence of *P. penetrans, C. xenoplax* and *X. americanum* and suggest that the role of these nematodes in the decline of sweet cherry orchards merits further investigation. [1]*Department of Entomology, and* [2]*Department of Botany and Plant Pathology, Michigan State University, East Lansing, MI 48824.*

MEYER, R. J., and R. N. HUETTEL. *Analysis of PCR-amplified DNA fragments from Radopholus species.*

Two sibling species, *Radopholus similis* and *Radopholus citrophilus,* are morphologically indistinguishable and separated by involved procedures such as karyology. It would be helpful to identify DNA characters that would provide rapid, unequivocal identification of small samples of these species. *Heterodera glycines* was used in preliminary studies because of the ease of manipulating individual cysts. Work focused on a portion of the nuclear ribosomal DNA (rDNA) that extends from the middle of the 5.8S rDNA gene to the middle of the 26S rDNA gene. DNA from individual cysts was extracted by a newly developed mini-extraction procedure and the rDNA fragment was successfully amplified by the polymerase chain reaction. However, a number of non-specific fragments were also amplified. Studies indicated that revised primer sequences should solve this problem. *Nematology Laboratory, USDA, ARS, Building 011A, Beltsville, MD 20705.*

MEYER, S. L. F., and R. N. HUETTEL. *Comparisons of fungi and fungus-bioregulator combinations for control of Heterodera glycines, the soybean cyst nematode.*

A wild-type strain of the fungus *Verticillium lecanii* and a mutant with increased benomyl tolerance were tested in the greenhouse for ability to reduce numbers of soybean cyst nematode (SCN) cysts in the soil. In steamed soil at application rates of less than 0.6-g dry weight fungus/pot, the mutant strain was more efficacious than the wild type strain at reducing SCN numbers. At higher application rates of approximately 0.6 g fungus/pot to 1.75 g/pot, the mutant and wild type strains gave similar results. Both fungal strains also reduced cyst numbers in unsteamed soil. The mutant fungus, the pheromone vanillic acid, an analog of the pheromone, a mutant fungus-vanillic acid combination, and a mutant fungus-analog combination were compared for ability to act as antagonists to SCN. All treatments reduced numbers of cysts formed in the soil. *Nematology Laboratory, USDA, ARS, Building 011A, Room 153, BARC-West, 10300 Baltimore Avenue, Beltsville, MD 20705-2350.*

MILLER, L. I. *Morphological comparisons of the cyst perineal region of Globodera tabacum virginiae and G. t. solanacearum cultured on Solanum carolinense and Nicotiana tabacum.*

Comparisons were made of the cyst perineal region of young brown cysts, retained on a 250-μm-pore sieve, of type locality isolates of *Globodera tabacum virginiae* (N1) and *G. t. solanacearum* (N2) when cultured on horsenettle (P1), *Solanum carolinense,* and tobacco (P2), *Nicotiana tabacum* cv. VA 312. P1 and P2 were efficient hosts for N1 and N2. Mean dimensions in μm or ratio values of 125 specimens were as follows—distance from anal pore to the nearest margin of the fenestra (B): N1P1 52.1, N2P1 47.9, N1P2 48.3, N2P2 51.1; fenestral length (L): N1P1 19.7, N2P1 23.7, N1P2 19.8, N2P2 24.9; Hesling's ratio (B/L): N1P1 2.7, N2P1 2.4, N1P2 2.6, N2P2 2.1. Comparisons between the subspecies on P1 or P2 were significantly different ($P = 0.05$) for the L dimension and B/L ratio but not for the B dimension. Dimensions of B for N1 were greater when cultured on P1 than on P2, but for N2 they were greater on P2 than on P1 ($P = 0.05$). The L dimensions for N1 on P1 and P2 were not significantly different, but dimensions for N2 cultured on P2 were greater than on P1 ($P = 0.01$). Hesling's ratio values for both N1 and N2 were greater when cultured on P1 than on P2 ($P = 0.01$). *Department of Plant Pathology, Physiology and Weed Science, Virginia Polytechnic Institute and State University, Blacksburg, VA 24061.*

MILLER, L. I., and M. M. MOTA. *Morphological comparisons of certain characters of second-stage juveniles, males, and females of Globodera tabacum virginiae and G. t. solanacearum on two hosts.*

Comparisons were made of certain characters of second-stage juveniles, males and females of type locality isolates of *Globodera tabacum virginiae* (N1) and *G. t. solanacearum* (N2) when cultured on horsenettle (P1), *Solanum carolinense,* and tobacco (P2), *Nicotiana tabacum* cv. VA 312. P1 and P2 were efficient hosts for N1 and N2. Mean dimensions in

μm of 115 specimens were as follows—second-stage juvenile tail length (JTL): N1P1 50.3, N1P2 50.9, N2P1 50.0, N2P2 50.3; second-stage juvenile stylet length (JSL): N1P1 23.7, N1P2 23.8, N2P1 23.9, N2P2 23.7; male tail length (MTL): N1P1 2.7, N1P2 3.0, N2P1 4.3, N2P2 4.3; male DGO (MDGO): N1P1 3.5, N1P2 3.7, N2P1 2.3, N2P2 2.3; width of female stylet knobs in lateral view (FSK): N1P1 5.7, N1P2 5.5, N2P1 4.9, N2P2 5.0; female stylet length (FSL): N1P1 25.0, N1P2 24.7, N2P1 26.2, N2P2 26.0. The JTL and JSL dimensions for N1 and N2 on P1 and P2 were not significantly different. The dimensions on P1 and P2 of MDGO and FSK for N1 were greater than for N2, but MTL and FSL dimensions on P1 and P2 for N2 were greater than for N1 ($P = 0.01$). There was no significant influence of P1 and P2 on the dimensions of characters compared on either subspecies. *Department of Plant Pathology, Physiology and Weed Science, Virginia Polytechnic Institute and State University, Blacksburg, VA 24061.*

MINTON, N. A., T. B. BRENNEMAN, G. A. HERZOG, G. J. GASCHO, and S. H. BAKER. *Rotation for management of nematodes in cotton and nematodes and soil borne diseases in peanut.*

A peanut-cotton-rye rotation was conducted during 1989-90 on Tifton loamy sand infested with *Meloidogyne incognita, Belonolaimus longicaudatus, Criconemella ornata, Sclerotium rolfsii,* and *Rhizoctonia solani.* Whole plots were continuous peanut, continuous cotton, cotton-peanut, and peanut-cotton. Subplots were winter rye and fallow. Sub-sub plots were aldicarb (3.4 kg a.i./ha) and control for cotton and aldicarb (3.4 kg a.i./ha) plus flutolanil (1.1 kg a.i./ha) and control for peanut. Two-year mean peanut yields across all treatments were 18.8% greater after cotton than continuous peanut and 10.0% greater after rye than fallow. Aldicarb plus flutolanil increased yield 39.6%. Cotton yield was 15.4% greater after peanut than continuous cotton. Cotton yield after rye in 1989 was 13.5% greater than fallow. Aldicarb increased yield 15.7%. Peanut reduced *M. incognita* and *B. longicaudatus*; cotton reduced *C. ornata.* Incidences of white mold caused by *S. rolfsii* and *Rhizoctonia* limb rot caused by *R. solani* on peanut were unaffected by rotations. Both diseases were reduced by aldicarb plus flutolanil. *USDA, ARS, and Departments of Plant Pathology, Entomology, and Agronomy, University of Georgia Coastal Plain Experiment Station, Tifton, GA 31793.*

MOHAN, S. K, S. L. HAFEZ, E. FALLAHI, and M. COLT. *The role of plant-parasitic nematodes in apple orchard replant problems.*

Field trials at Payette, Idaho were initiated in 1987 to study the effects of pre-plant application with methyl bromide (fumigant) and fungicides (metalaxyl, fosetyl-Al or thiabendazole) as a root dip or sprays on tree growth, soil nematode populations, and leaf mineral content of 6 apple cultivars planted in an old apple orchard site. Soil samples collected in 1990 from non-fumigated sites contained 6 times more lesion, 3 times more stubby root, 29 times more dagger and 87 times more ring nematodes than those from fumigated sites. There were statistically significant differences in trunk cross sectional area among different cultivars. Growth of all trees in fumigated plots was from 64% to 106% higher than that in non-fumigated plots. Trees in fumigated plots yielded more than those in the non-fumigated plots. Fungicide treatment did not affect tree growth in either the fumigated or the non-fumigated plots. Leaf mineral content of trees in fumigated plots were different from those in non-fumigated plots. *Southwest Idaho Research and Extension Center, Parma, ID 83660.*

MOJTAHEDI, H., and G. S. SANTO. *Enhanced biodegradation of ethoprop under field conditions.*

Field observations indicated that repeated applications of ethoprop reduced its efficacy in control of *Meloidogyne chitwoodi.* Soil collected from a commercial field with a history of ethoprop applications (exposed) was used immediately or stored at 15-18 C. Exposed, unexposed (no history of ethoprop application) and steam-sterilized exposed soil were treated with ethoprop before infesting soil with second-stage juveniles (J2) of *M. chitwoodi.* Ethoprop efficacy was measured by bioassaying soil treatments with tomato seedlings. Ethoprop at 1.8 μg/g soil killed 90-100% of J2 in unexposed and sterilized exposed soil but was not effective in exposed soil. Ethoprop at 7.2 μg/g improved control in exposed soil but was still not as effective as in sterilized exposed soil. The enhanced biodegradation property of the exposed soil lasted for 17 months after the last application of ethoprop.

Washington State University, Irrigated Agriculture Research and Extension Center, Route 2, Box 2953-A, Prosser, WA 99350-9687.

MOLINARI, S. *Physiological adaptations of tomato roots to metabolic events related to root-knot nematode attack.*

Roots from young tomato seedlings have been proven to undergo marked variations in their oxidative metabolism and in the activities of some key peroxidase isoenzymes after attack of the root-knot nematode *Meloidogyne incognita.* Six days after nematode inoculation, the capability to produce ATP (ADP/O ratio) of isolated mitochondria was consistently affected in roots of the resistant cultivar Rossol, while it increased in the susceptible cv. Roma VF. In an attempt to produce a sufficient amount of ATP for the incompatible reaction, resistant roots were found to react to this lowered capability in ATP production by increasing the number of mitochondria per gram fresh weight and the respiration rate of the roots. Before nematode infection, cyanide-resistant respiration was involved more markedly in the overall respiration of resistant than susceptible mitochondria. No additional variation resulted from infection. Furthermore, paraquat was added to tomato root cultures to generate oxygen radicals and mimic the same event related with nematode entry. Surprisingly, the enzyme system for detoxification of these radicals was repressed in the resistant cultivar after two days of incubation with paraquat and unaffected in the susceptible cultivar. *Department of Nematology, University of California, Riverside, CA 92521.*

MOTA, M. M., and J. D. EISENBACK. *Morphological comparisons of males of the tobacco cyst nematode complex, Globodera tabacum sspp. tabacum, virginiae, and solanacearum.*

Morphological comparisons with light microscopy (LM) and scanning electron microscopy (SEM) were made between one isolate each of males of the tobacco cyst nematode complex, *Globodera tabacum tabacum* 'Hazardville' isolate (GTT), *G. t. virginiae* 'Horton' isolate (GTV), and *G. t. solanacearum* 'Fisher-Nottoway' isolate (GTS), reared on 'Rutgers' tomato plants. Observations were made on the stylet morphology (LM and SEM), lip region (SEM), tail region (LM), and spicules (LM and SEM). No major morphological differences of the characters compared were found among the three subspecies. Measurements in μm (n = 30 ± 2) refer to mean and standard deviation and include: stylet length, GTT = 27.1 ± 1.5; GTV = 25.9 ± 0.9; and GTS = 24.5 ± 3.5; stylet knobs width, GTT = 5.2 ± 0.4; GTV = 5.2 ± 0.4; and GTS = 4.6 ± 0.6; stylet knobs height, GTT = 3.2 ± 0.4; GTV = 3.1 ± 0.4; and GTS = 3.0 ± 0.5; DEGO, GTT = 4.1 ± 0.7; GTV = 3.5 ± 0.6; and GTS = 2.9 ± 0.9; distance of head tip to median bulb center, GTT = 101.7 ± 12.1; GTV = 94.3 ± 6.1; and GTS = 86.6 ± 12.2; and spicule, GTT = 29.9 ± 3.2; GTV = 28.1 ± 2.2; and GTS= 27.3 ± 5.5. In general, dimensions for GTT were greater than those for GTV and GTS. *Department of Plant Pathology, Physiology and Weed Science, Virginia Polytechnic Institute and State University, Blacksburg, VA 24061.*

MOUSA, E. M. *Biological control of the root-knot nematode Meloidogyne javanica on tomato.*

Biocontrol agents (the fungus *Arthrobotrys robusta* and *Pasteuria penetrans*) were used for the suppression of root-knot nematode populations in experiments in pots under greenhouse conditions. In soil treated with the plant product sincocin AGTM, a highly significant reduction of the nematode population occurred in pots infested with both *A. robusta* and *P. penetrans* compared with pots containing *A. robusta* or *P. penetrans* alone. The number of *A. robusta* propagules obtained from the plant rhizosphere was greatly influenced by sincocin treatment of soil, although no effect of sincocin was observed on the *P. penetrans* populations. The *A. robusta* and *P. penetrans* combination resulted in great effects on nematode development and total population size, regardless of the sincocin presence. In the second season, the number of galls was greatly decreased in all treatments with both *A. robusta* and *P. penetrans*; more than 50% of the tomato plants were not infected by root-knot nematodes. The results may emphasize that the suppression of root-knot nematode populations in soil attributed to the role of sincocin may enhance the projected synergistic effects of the biocontrol agents *A. robusta* and *P. penetrans.* *Department of Agricultural Botany, Faculty of Agriculture, Menoufiya University, Shebin El-Kom, Egypt.*

MRACEK, Z.[1], A. BEDNAREK[2], and J. M. WEBSTER[3]. *Cuticular structures of J2 and J3 juveniles of the entomophilic family Heterorhabditidae.*

In the entomophilic family Heterorhabditidae the preparasitic J2 and invasive J3

juveniles have a characteristic cuticular ornamentation. In the J2 the head and cervical regions have a cuticular network of longitudinal and transverse grooves that extend for approximately one-quarter of the body length. Thereafter, only the longitudinal ridges and grooves continue to the tail. The cuticle of J3 forms show two very distinct ridges in the lateral fields and there is slight annulation. [1]*Department of Insect Pathology, Institute of Entomology CSAS, Ceske Budejovice, Czechoslovakia,* [2]*Department of Zoology, Agricultural University, Warsaw, Poland, and* [3]*Department of Biological Sciences, Simon Fraser University, Burnaby, British Columbia V5A 1S6, Canada.*

MUELLER, J. D., and S. B. MARTIN. *Efficacy of granular nematicides for control of Columbia lance and reniform nematodes on cotton.*

Granular and fumigant nematicides were evaluated in separate tests on PD-3 cotton planted in a field infested with 204 *Rotylenchulus reniformis* and 28 *Hoplolaimus columbus* per 100 cm^3 soil. In the fumigant test, yields were greatest ($P = 0.05$) for 1,3-dichloropropene applied preplant at 26 L/ha + 0.59 kg/ha aldicarb, which resulted in greater yields than 26 L/ha alone, which resulted in greater yields than 52 L/ha either alone or in combination with aldicarb, aldicarb alone, or the untreated check. Recovery of *R. reniformis* from soil was lowest from fields treated with 26 L/ha and 26 L/ha + aldicarb. All nematicide treatments reduced recovery of *H. columbus* from soil. Recovery of either nematode from roots was not affected by nematicide treatment. In the granular nematicide evaluation, 0.84, 1.18, and 1.68 kg/ha of aldicarb or fenamiphos increased yields above the untreated check. Sequential treatments of aldicarb (0.59 kg/ha at planting and 0.59 kg/ha 6 weeks after planting) or 0.59 kg/ha each of aldicarb + fenamiphos at planting did not significantly increase yields. All treatments except 0.59 or 1.18 kg/ha aldicarb decreased midseason recovery of *R. reniformis* from soil. No treatment reduced recovery of *H. columbus* from soil or roots. Recovery of *R. reniformis* from roots was lowest from plots treated with the highest rates of aldicarb or fenamiphos. *Clemson University, Edisto Research and Education Center, P.O. Box 247, Blackville, SC 29817.*

MYERS, R. F. *Axenic propagation of nematodes in oligidic media.*

Aphelenchoides rutgersi, A. cibolensis, A. sacchari, A. dactylocercus, and *Aphelenchus avenae* were the first stylet-bearing nematodes reared axenically in oligidic culture media. Only *A. rutgersi* is presently available in axenic culture. Microscopic observations on *Aphelenchoides fragariae, A. ritzemabosi, Bursaphelenchus xylophilus, Tylenchorhynchus claytoni, Pratylenchus penetrans,* and a few additional tylenchids incubated in culture media revealed the following phenomena. Median bulbs of these nematodes pulsated only occasionally rather than with normal, periodic, sustained pulsations; instead of normal reproduction, often few or no eggs were deposited; and limited maintenance was achieved, not continuous propagation. Problems in culturing additional nematodes included the physical (environmental) parameters of the diet, failure of nematodes to recognize surrounding fluids as nutriment or to ingest it, lack of or imbalance of specific nutrients, nutrient solubility, and other factors. These problems are currently being investigated. *Department of Plant Pathology, Rutgers University, Cook Campus, New Brunswick, NJ 08903-0231.*

NIBLACK, T. L.[1], G. S. SMITH[2], and R. D. HEINZ[1]. *Determination and distribution of races of Heterodera glycines in Missouri.*

During 1990, the known distribution of *Heterodera glycines* increased by 6 to 76 (of 114) counties and now includes all soybean production areas in Missouri. Typical levels of infestation were 5,000 to 50,000 eggs/250 cm^3 in soil submitted to the Nematode Diagnostic Laboratory for analysis. Soil samples submitted for race determination, mostly from north or central Missouri, were processed by semi-automatic elutriation for cyst extraction. Eggs were mechanically freed from cysts and were used to infest sterilized sand at 1,000 eggs/100 cm^3 in 15 cm by 2.5-cm-d polyvinylchloride tubes. Seed of the soybean differential lines ('Pickett', 'Peking', PI 88788, and PI 90763), the susceptible standard 'Lee', and the susceptible control 'Essex', were pregerminated in sterilized germination paper. For each test, seedlings were selected for uniformity (3 replications for each line) and transplanted singly into infested tubes. All tubes comprising a single race test were packed upright with sand in a large crock that was lowered into a 27 C water bath in a greenhouse. Tests were maintained for 30 days, at which time white females were counted following removal from

each root system with a high pressure water spray. Races were assigned according to Riggs and Schmitt (Journal of Nematology 20:392-395). Of 198 race tests, 45% were race 3, 25% race 1, 8% race 5, 7% each races 2 and 6, 5% race 4, and 1% each races 7, 9, and 14. In the soybean maturity groups most suitable for north or central Missouri, MG IV and below, genetic resistance is reportedly not available to races other than 3 and 14; thus, research on management of *H. glycines* should emphasize approaches other than the use of resistant cultivars alone. [1]*Department of Plant Pathology, and* [2]*Integrated Pest Management, University of Missouri, Columbia, MO 65211.*

NICKLE, W. R.[1], and W. J. CONNICK, JR[2]. *A new process to make a granular product, PESTA, containing Steinernema carpocapsae (strain All).*

A process based on the binding properties of wheat gluten has been developed for producing dry granules that contain *Steinernema carpocapsae* (strain All). A patent has been filed for this granular product called "PESTA". Soon after the granules become wet, up to 80,000 viable nematodes/gram of pellets are released. Survival of the nematodes in the pellet formulation after 9 weeks refrigerated storage was as high as 60%. This PESTA nematode formulation was tested against the western corn rootworm, *Diabrotica virgifera*, in the greenhouse, and a 63% reduction in emergence of adult *Diabrotica* beetles occurred. This test and others with wax moth larvae, *Galleria mellonella*, indicated that the bacterial associate survived the procedure. This new pelletized delivery system for entomopathogenic nematodes may prove useful against soil-inhabiting insects. [1]*Nematology Laboratory, USDA, ARS, Building 011A, BARC-West, Beltsville, MD 20705-2350, and* [2]*Southern Regional Research Center, USDA, ARS, P.O. Box 19687, New Orleans, LA 70179.*

NILES, R. K.[1], J. M. FERRIS[2], and V. R. FERRIS[2]. *Nematode community structure on corn and soybean cropping gradients.*

A popular view is that structure in nematode communities varies with individual cropping sites in ways not related to management practices imposed on the sites. To test this possibility, a field experiment was conducted to determine the changes in nematode diversity and abundance that are induced by agronomic management regimes that combine a tillage practice of conventional moldboard plowing or no-tillage with one of seven corn-soybean rotation schedules. Abundances of all nematode species in four replicate plots of each regime were monitored in the springs and falls of consecutive years. Rotation schedules were interpreted as the positions on cropping gradients. Nematode communities were structured on a corn cropping gradient in a sequential progression of species abundances. On corn and soybean gradients, negative associations of community similarity and gradient position were more frequent than would be expected with random variation. A negative relationship between similarity and position was stronger with conventional tillage on a corn gradient and with no-tillage on a soybean gradient. Thus, the crop grown and tillage practice affected nematode community structure and apparently resulted in an inverse relationship between community structure and cropping gradient position. [1]*Department of Nematology, University of California, Riverside, CA 92521, and* [2]*Department of Entomology, Purdue University, West Lafayette, IN 47907.*

NOE, J. P. *Variability among populations of Meloidogyne arenaria race 1 with respect to reproduction and pathogenicity on various crops.*

Twelve populations of *Meloidogyne arenaria* race 1 were collected from infected peanut roots in four states in the Southeastern U.S. and were maintained on peanut in greenhouse pots. Morphology, host range, and isozyme analysis were used to characterize the populations. Each population was inoculated on peanut, soybean, tomato, tobacco, and pepper in 15-cm-d pots. Nematode reproduction and plant growth were assessed 40 days after inoculation. Reproduction of the *M. arenaria* populations differed on each of the crops, with generally a three-fold difference from lowest to highest (e.g., range of 3,400 to 11,500 eggs/g root fresh weight on peanut). Relative rankings of the populations in numbers of eggs produced changed considerably among crops. There also were differences in the effects of the populations on top dry weights of peanut, ranging from 5.6 to 8.2 g at 40 days. Effects on plant growth varied among the other crops. Differences in reproduction and effects on plant growth among these populations would impact the selection of optimal management recommendations. *Department of Plant Pathology, University of Georgia, Athens, GA 30602.*

NOLING, J. W. *Chemigational use of metham sodium in Florida multiple-cropping systems.* Metham sodium was evaluated in five field experiments for crop destruction purposes, crop yield increase, and *Meloidogyne incognita* control. Treatments included metham sodium injection periods of 30 to 180 minutes and broadcast equivalent rates of 90 to 356 kg a.i./ha. Differences in crop response and nematode control were related to initial soil moisture conditions, drip-irrigation system design, injection period, and application rate. Metham sodium provided control ($P = 0.05$) of *M. incognita* at application rates as low as 90 kg a.i./ha. Crop response and nematode control ($P = 0.05$) increased with length of injection period. Two parallel drip lines per bed provided better ($P = 0.05$) control and crop response than did a single drip line per bed. With two lines per bed and drip emitter spacing of 20 cm, metham sodium was dispersed throughout the entire plant bed. Application rates of 36-56 kg a.i./ha generally resulted in near complete mortality of post-harvest tomato and pepper crops. *Department of Entomology and Nematology, University of Florida, IFAS, Citrus Research and Education Center, 700 Experiment Station Road, Lake Alfred, FL 33850.*

NOVITSKI, C. E.[1], R. CHEN[1], S. BROWN[2], M. J. McPHERSON[2], and H. J. ATKINSON[2]. *The nucleotide sequence of a member of the major sperm protein gene family from Globodera rostochiensis.* Major sperm protein (MSP) genes have been isolated from a lambda library of genomic DNA from the potato cyst nematode, *Globodera rostochiensis.* In contrast to the single gene in *Ascaris lumbricoides* var. *suum* and the more than 50-member gene family in *Caenorhabditis elegans,* the MSP gene family in *G. rostochiensis* consists of about five members. The MSP gene contains a single intron, the location of which is conserved. The amino acid sequence deduced from nucleotide sequence data indicates that MSP protein in *G. rostochiensis* exhibits striking amino acid residue differences from the consensus sequence of non-plant-parasitic nematode species. [1]*Department of Biology, Central Michigan University, Mt. Pleasant, MI 48859, and* [2]*Centre for Plant Biochemistry and Biotechnology, The University, Leeds, LS2 9JT, England.*

OLTHOF, Th. H. A.[1], D. L. RINKER[2], and J. DANO[2]. *The effect of entomophilic nematodes on a sciarid fly, Lycoriella mali, and on growth and yield of mushrooms, Agaricus bisporus.* In vitro experiments to date have shown that some strains of *Heterorhabditis heliothidis* and *Steinernema feltiae* (*bibionis*) provide best control of the mushroom-infesting fungus gnat, *Lycoriella mali* (Diptera: Sciaridae), when applied to casing 12-13 days after fly introduction. *Heterorhabditis heliothidis* NC, reared on *Galleria mellonella,* and *S. bibionis* (Biosys #27) were applied at 0, 140, 280, 560, 840, and 1,120 per cm^2 of casing 12 days after introduction of 20 female flies per tray in small-scale (20 m^2) commercial mushroom production rooms. With both nematodes, all rates reduced first generation fly populations by 86-100% compared to the untreated control ($P = 0.05$). There was no difference in fly mortality among rates. A negative correlation was observed among nematode rates and mycelial development on the casing layer at primordia initiation. Nevertheless, under the high fly pressure in the experiments, *S. bibionis,* but not *H. heliothidis,* caused a net increase in total mushroom weight over a 4-week harvest. Experiments with lower rates are in progress to determine optimum fly control measures that do not adversely affect yields. [1]*Research Branch, Agriculture Canada, Research Station, Vineland Station, Ontario L0R 2E0, Canada, and* [2]*Horticultural Research Institute of Ontario, Ontario Ministry of Agriculture and Food, Vineland Station, Ontario L0R 2E0, Canada.*

OPPERMAN, C. H., and C. A. PARKER. *Isolation and characterization of a nematode neurohormone receptor gene.* We have previously demonstrated that neuroactive drugs can interfere with discrete nematode behaviors, including feeding, chemotaxis, and molting. Compounds that interact with adrenergic receptors alter normal nematode molting patterns. A receptor protein with high affinity for β-adrenergic ligands has been isolated from *Caenorhabditis elegans* and *Meloidogyne incognita.* Based on these studies, we devised a strategy to isolate the receptor protein gene using degenerate oligonucleotide primers based on mammalian gene sequences and the polymerase chain reaction. Under high stringency reaction conditions, a single amplification product of approximately 2,000 bp was obtained from genomic DNA. Sequence analysis of this DNA fragment suggests that it is related to the G-protein-coupled

receptor gene superfamily. Deduced amino acid sequence homology between the nematode clone and mammalian adrenergic receptor gene ranges from 50-80% in the conserved membrane spanning regions so far analyzed. *Department of Plant Pathology, North Carolina State University, Raleigh, NC 27695-7616.*

OSBORNE, W. WYATT. *ASCS-USDA rules governing flue-cured tobacco facilitate the spread of Osborne's cyst nematode.*

Prior to 1988, federal law allowed flue-cured tobacco allotments to be leased and transferred off the owner's farm. Now the law requires tobacco to be grown on the farm that owns the allotment. To gain an economical production quota of tobacco, many farmers lease and cultivate OCN-infested fields. This practice transports OCN (*Globodera solanacearum*) over long distances and causes rapid spread of the OCN disease. Tomato and eggplant are increasingly grown as supplemental crops on tobacco farms. There are no tomato, tobacco, or eggplant cultivars resistant to the OCN. Therefore, high rates of environmentally harmful nematicides must be used annually. A reinstatement of pre-1988 law is practical and would help alleviate the rapid spread of this severe plant disease. *IAI Inc., 1319 Main Street, South Boston, VA 24592.*

OVERHOFF, A. *Vertical distribution of the plant-parasitic nematode community and nematophagous fungi under different tillage regimes.*

Abundance of nine plant-parasitic nematode species and five species of nematode-trapping fungi were examined under long-term management regimes. Three tillage systems incorporating different amounts of residue to depths of 10 inches were compared to a no-till regime at three soil depths (0-5 inch, 5-10 inch, and 10-15 inch). Prominent nematodes were *Merlinius brevidens, Pratylenchus neglectus,* and *Helicotylenchus digonicus. Arthrobotrys robusta, A. oligospora, Verticillium chlamydosporium* and *Dactylaria* sp. were the nematophagous fungi. Fungal spores (cfu) did not differ in depth. However, the abundance of nematode species varied with depth. Nematode densities were greater in conventional than in no-tillage systems and were related to crop rotations. There appears to be a relationship between tillage practice and root distribution that affects the abundance of the nematode community. *Department of Nematology, University of California, Riverside, CA 92521.*

PERRY, R. N. *Enzymes released during hatching of Globodera rostochiensis and Meloidogyne incognita.*

An analysis of lipases released during hatching of *Meloidogyne incognita* and *Globodera rostochiensis* showed that hatching of *M. incognita* was accompanied by considerable lipase activity which correlated with the percentage hatch. By contrast, no lipase activity was detected during the hatching of *G. rostochiensis.* The protein substrates azocasein and azocoll revealed marked enzymic activity during hatching of *M. incognita.* Virtually no chitinase activity was detected during hatching of *G. rostochiensis,* in contrast to the very high activity during hatching of *M. incognita.* The presence of leucine aminopeptidase could not be correlated with the hatching of either species. The results support and extend inferences from previous studies illustrating the contrasting hatching mechanisms of the two species. *Entomology and Nematology Department, AFRC Institute of Arable Crops Research, Rothamsted Experimental Station, Harpenden, Hertfordshire AL5 2JQ, England.*

PHILLIP, D. R., J. C. BOWER, and P. M. TEFFT. *Biological activity of egg homogenates in Heterodera glycines.*

Egg homogenates from *Heterodera glycines* caused significant increases in eggshell permeability but failed to increase hatching rates in eggs. The ability of homogenate to increase permeability was unaffected by the addition of sodium azide (0.6%) but was lost by heating. Active homogenate from eggs hydrolyzed azocoll at pH 5.6 and 8.0. The homogenates tested were from eggs pre-treated in zinc chloride (3.0 mM) and water for a 14-day period. Permeability was assessed by fluorescence microscopy. In addition, eggs were treated exogenously with three enzymes implicated in the hatching of nematodes. Two of these, trypsin and leucine aminopeptidase, caused significant increases in permeability, whereas only leucine aminopeptidase increased hatching. The third enzyme, collagenase, did not alter hatching or permeability. *Department of Biology, St. Joseph's University, Philadelphia, PA 19131.*

POWERS, T. O., D. SUI, and T. S. HARRIS. *Genetic analysis of individual juvenile nematodes with RAPD PCR.*

RAPD PCR is a new genomic fingerprinting technique that may be used in genetic mapping, population genetics, and systematics. Its advantages over conventional RFLP-based techniques include speed, simplicity, lack of a requirement for a radioisotope, and ability to work with minute concentrations of DNA. It uses a single, short oligonucleotide primer and reduced annealing temperatures. We have generated fingerprinting patterns for a broad taxonomic range of plant-parasitic nematodes. A single juvenile nematode manually squashed in a drop of water on a coverslip provides sufficient template for 1-2 reactions. Fingerprints from *Meloidogyne javanica* juveniles hatched from single egg masses exhibit consistency within egg masses but variation among isolates from different geographic locations. In experiments with 10-bp primers, we have noticed a general lack of repeatability when more than two reactions are attempted on a single juvenile. *Department of Plant Pathology, University of Nebraska, Lincoln, NE 68583-0722.*

QIU, J.[1], B. B. WESTERDAHL[1], C. A. ANDERSON[1], and D. GIRAUD[2]. *Hot water and chemical treatments for management of Ditylenchus dipsaci and fungi in California daffodils.*

Experiments were conducted to determine: (1) whether the standard hot water (44 C)/1% formalin (a.i. = 37% formaldehyde) exposure (4-hour) for control of *D. dipsaci* in daffodil (*Narcissus* sp.) could be shortened with higher temperatures, (2) whether control could be obtained with water alone, and (3) whether formalin could be replaced by commercial bleach or Ucarcide. Extracted nematodes exposed in water to 44, 46, and 48 C required 150, 60, and 15 minutes, respectively, for 100% mortality. In water, 15 to 45 minutes were required to elevate temperatures from 21 to 44 C in the center of 8-18 cm circumference bulbs. In the cultivars Fortune, Golden Harvest, and Dutch Master, 1% formalin resulted in a 99-100% nematode mortality after 150 minutes at 44 C, 90 minutes at 46 C, 45 minutes at 48 C, and 30 minutes at 50 C. Without formaldehyde, dipped bulbs continued to deteriorate even with a 99% reduction in nematodes. Fungi associated with this deterioration were *Penicillium* sp., *Fusarium* sp., and *Mucor* sp. After the standard treatment, fungal growth from internal bulb tissue on potato dextrose agar was suppressed 50%. After treatment of bulbs in 0.3, 0.5, 0.75, 1.0, and 1.5% Ucarcide (a.i. 50% glutaraldehyde) at 44 C for 4 hours, fungal growth was suppressed 70, 73, 70, 60, and 97%, respectively. Similar treatments with 5, 7.5, and 10% commercial bleach (a.i. 5.25% sodium hypochlorite) suppressed fungal growth by 22, 72, and 68%, respectively. Nematode mortality after treatment with Ucarcide or commercial bleach was 99-100%. [1]*Department of Nematology, University of California, Davis, CA 95616, and* [2]*University of California, Cooperative Extension, 5630 S. Broadway, Eureka, CA 95501-6998.*

REDMOND, C. T.[1], and R. GEORGIS[2]. *Aspects of the use of entomopathogenic nematodes as IPM agents in the control of turfgrass insect pests.*

The targeting and application procedures for the successful use of entomopathogenic nematodes (family Steinernematidae) as agents in turfgrass integrated pest management systems will be discussed from an applied point of view. Recent advancements in technology have increased the availability of these entomopathogenic nematodes to the turfgrass industry, and education of the industry is essential. The proper timing and dosages for applying nematodes against several turfgrass pests, including white grubs, cutworms and billbugs, will also be discussed. The need for standardization of pesticide and bio-pesticide screening, in relation to university and industrial turfgrass pesticide screening, will also be considered. [1]*BIOSYS, 116 Granville Street, Gahanna, OH 43230, and* [2]*BIOSYS, 1057 E. Meadow Circle, Palo Alto, CA 94303.*

REISE, R. W.[1], K. HACKETT[2], AND R. N. HUETTEL[1]. *Limited in vitro cultivation of Pasteuria nishizawae.*

Pasteuria nishizawae, an actinomycete parasite of several *Heterodera* spp., has been successfully maintained for up to 6 transfers over an 8-month time period in vitro. A complex undefined medium containing 111 ingredients has been developed to propagate this organism. To obtain inoculum, surface sterilized infected female nematodes were crushed initially into small wells. After 4-6 weeks, one-third of the well contents was transferred to a new well. Transfers were continued based on visual observation of increased growth of the bacteria in the wells. All wells containing bacteria were fed with

fresh medium at regular intervals. All stages of the life cycle of this organism appeared to be produced by this method. Vegetative stages such as doublets and triplets and 'cauliflower', sporangia, endospores, and immature and mature spores can be observed. Spores produced in wells in passage 4 (5 months) attached in low numbers to soybean cyst nematode juveniles. Continued improvements on ingredients and methods of propagation are being carried out at this time. [1]*Nematology Laboratory, and* [2]*Insect Biocontrol Laboratory, USDA, ARS, Building 011A, Beltsville, MD 20705.*

RIDDLE, D. L., M. ESTEVEZ, L. GEORGI, W.-H. YEH, and P. S. ALBERT. *Molecular basis of the dauer larva switch in Caenorhabditis elegans and parallels with parasitic nematodes.*

The dauer stage of *C. elegans* is an example of facultative diapause. Environmental factors act on the L1 larva, resulting in altered physiology and developmental potential that leads to formation of a third-stage dauer larva specialized for dispersal and long-term survival. The amphids mediate the sensory cues. More than twenty genes (called *daf*) have been ordered in a pathway based on the genetic relationships between mutants. The genetic pathway is thought to represent the events in dauer larva development, including pheromone biosynthesis, neural reception and processing of environmental cues, and implementation of the appropriate developmental program.

We are cloning *daf* genes in order to understand what these genes do. Initially, we have concentrated on the later steps in the pathway to determine what cellular events may translate the sensory signals into the developmental response. The *daf-1* gene specifies an intermediate step in signal processing, and it encodes a transmembrane receptor/protein kinase (see Georgi and Riddle, this meeting). The *daf-4* gene defines a subsequent step in the pathway and encodes another receptor/protein kinase required to bypass the dauer stage in a favorable environment. The last step in the signal processing pathway involves *daf-12*, which encodes a protein homologous to the steroid hormone receptor superfamily. Considering developmental and anatomical analogies between *C. elegans* and certain animal and plant-parasitic nematodes, it seems reasonable that the mechanisms of signal transduction and hormonal response may be quite similar but simply tied to different sets of environmental cues. *Molecular Biology Program and Division of Biological Sciences, University of Missouri, Columbia, MO 65211.*

RIGA, E., and J. M. WEBSTER. *The nature of the sex pheromone of Bursaphelenchus xylophilus, the pine wood nematode.*

The sex pheromone of *Bursaphelenchus xylophilus* was investigated. Males and females of *B. xylophilus* are attracted to chemicals released by their respective females and males but not attracted to the chemicals released by males or females of *B. mucronatus, B. fraudulentus* and *Aphelenchoides rhyntium.* Similarly, the sexes of *B. xylophilus* were attracted to a water extract of the crude pheromone and to the lyophilized, reconstituted crude pheromone. The pheromone is a water-soluble chemical with an ether-insoluble phase; it is stable at -20 C, 4 C and 24 C for up to 4 days; and it has an approximate molecular weight of 300. The isolation and characterization of the sex pheromone is progressing. *Department of Biological Sciences, Simon Fraser University, Burnaby, Vancouver, British Columbia, V5A 1S6, Canada.*

ROBBINS, R. T. *Comparative reproduction of Rotylenchulus reniformis on three soybean and three cotton cultivars.*

Reproduction of a population of *Rotylenchulus reniformis* from Jefferson County, Arkansas was measured after 60 days on three soybean cultivars—Kirby (KI), Forrest (FO), and Davis (DA)—and three cotton cultivars—L-910 (L9), Auburn-56 (AU), and DPL-20 (DP). Plant weight was also recorded. The Pi was 500 vermiform *R. reniformis* suspended in water placed about the radicle of a seedling as it was transplanted to a 10-cm-d clay pot containing 500 cm^3 of fine river sand; there were 8 replications per treatment. Total fresh plant weight (TFPW) in grams of soybean with and without *R. reniformis*, respectively, were KI = 51.6 and 48.4 (NS), FO = 26.2 and 38.1 ($P \leq 0.06$), and DA = 47.4 and 37.1 (NS). TFPW of cotton with and without *R. reniformis*, respectively, were L9 = 30.4 and 40.6 ($P \leq 0.06$), AU = 29.0 and 32.7 (NS), and DP = 28.7 and 31.3 (NS). Soybean Pf/Pi ratios were KI = 4.5, FO = 9.9, and DA = 217.6 ($P \leq 0.0001$). Cotton Pf/Pi ratios were L9 = 284.3, AU = 282.1, and DP = 213.1 (NS). The soybeans KI and FO show much less *R. reniformis* reproduction. Both have been shown to be resistant to the soybean cyst nematode, whereas DA is susceptible.

Department of Plant Pathology, Nematology Laboratory, University of Arkansas, Fayetteville, AR 72701.

ROBERTS, P. A. *Current status of host plant resistance use for nematode control.*

Host plant resistance (HPR) to nematodes has been identified in many but not all major or common crops and (or) related wild germplasm. Most HPR is to the more specialized endoparasitic genera and species, particularly sedentary types, e.g., *Globodera, Heterodera, Meloidogyne, Nacobbus, Rotylenchulus,* and *Tylenchulus.* However, the spectrum of HPR in commercial use remains limited, despite significant advantage to crop production when deployed appropriately. Difficulties in gene transfer to acceptable cultivars or rootstocks due to incompatibility barriers to hybridization, for example in cucurbitaceous and solanaceous crops or due to linkage to undesirable traits, are biological constraints requiring resolution. Specificity of HPR to only one species or one or few pathotypes or races also limits availability and utility. Non-biological issues also have influenced the current status of HPR usage, including heavy reliance on nematicide programs and lower priority of nematode HPR in breeding programs. Cooperation between breeders and nematologists and local regulation of crop varietal standards are other limiting factors. A renewed interest in use of HPR is linked to reduction in nematicide programs. *Department of Nematology, University of California, Riverside, CA 92521.*

ROBINSON, A. F., and C. M. HEALD. *Movement of Rotylenchulus reniformis through soil as influenced by static temperature gradients and gravity.*

The movement of vermiform stages of *Rotylenchulus reniformis* in response to temperature was monitored within columns of agar, sand, and sandy loam soil inside horizontal and vertical acrylic tubes. Patterns of movement in relation to the gradient, adaptation temperature, and ambient temperature were similar to patterns of *R. reniformis* movement on agar. The stimulus threshold for maximal response (ca. 0.5 C/m) was higher than reported for nematodes on transparent gels but of the same order as temperature gradients that influence Baermann funnel extraction. In moist sand of particle size 250-425 μm, 95% of all motile nematodes moved downward more than 8 cm within 18 hours regardless of temperature and moisture gradients; heat-killed nematodes did not move. When 1,000 motile nematodes were videotaped through a horizontally positioned microscope while they sank through still water within a vertical channel 2 mm thick, 80% crossed a reference line head-first at 45 μm/second. Results suggest that the difference between specific gravities of the muscular, esophageal anterior and the lipid-rich posterior parts of the body of a plant-parasitic nematode can alter orientation and direction of movement through a porous matrix. *Southern Crops Research Laboratory, USDA, ARS, Route 5, Box 805, College Station, TX 77845.*

ROCCUZZO, G., A. CIANCIO, and R. BONSIGNORE. *Population density and fungal parasitism of Meloidogyne hapla eggs in an infested kiwifruit field.*

The development of a *M. hapla* population parasitizing kiwifruit (*Actinidia deliciosa*) was studied at Metaponto, Italy. Average nematode density increased during winter months, reaching $10.5 \pm 6.9 \times 10^3$ eggs/g of roots and 93.8 ± 88.8 females/g of roots in November and September 1990, respectively. Three nematode-capturing fungi (*Arthrobotrys dactyloides, A. oligospora* and *Monacrosporium* sp.), two fungal egg parasites (*Verticillium chlamydosporium* and a mycelia sterilia), and the endoparasite *V. balanoides* were isolated from soil and *M. hapla* eggs. Other nematode antagonists recovered from soil included the aquatic fungus *Catenaria anguillulae* and the predacious nematode *Mylonchulus brachyurus.* The monthly average rates of *M. hapla* egg parasitism decreased from $17.6 \pm 14.3\%$ in June 1990 to $4.2 \pm 2.2\%$ in November 1990. The density of *M. hapla* and the rate of parasitized eggs for all the replicated measurements and months were inversely correlated ($r = 0.508$; $P < 0.001$). The complex of egg parasites and predators did not appear capable of controlling nematode population development, whereas a water agar plate method with increasing quantities of soil revealed the occurrence of a soil mycostatic effect on nematode-capturing fungi when the inoculum level per plate was 2.30 ml or higher. *Istituto di Nematologia Agraria, CNR, Via Amendola 165/A, 70126 Bari, Italy.*

RUFF, R. L., and G. L. TYLKA. *Development of inbred isolates of soybean cyst nematodes on resistant soybean genotypes.*

Genes for parasitism in soybean cyst nematode (SCN), *Heterodera glycines,* have not

been identified primarily because of the genetic heterogeneity of field populations and the difficulty in making controlled crosses with the nematode. SCN isolates have been inbred on resistant soybean genotypes to stabilize alleles for reproduction. SCN field populations were found to have low to moderate reproduction on the resistant soybean genotypes Peking, Pickett, and PI 88788. Adult SCN females were collected from these resistant genotypes. The adult females were crushed individually, and the eggs from individual females were inoculated on a plant of the same genotype as the plant from which the eggs were recovered. The inoculated plants were grown at 25-27 C, and eggs were collected from females on the roots after approximately 60 days. The cycle was repeated, maintaining SCN isolates on the same soybean genotype from which they were recovered. Phenotypic homogeneity of reproduction was evaluated on standard susceptible genotypes and SCN race differential genotypes. A SCN isolate selected on Pickett appeared stable for reproduction on Pickett after the eighth cycle, but SCN isolates selected on Peking and PI 88788 remain variable for the reproductive phenotype. *Department of Plant Pathology, Iowa State University, Ames, Iowa 50011.*

SANTO, G. S., H. MOJTAHEDI, and J. H. WILSON. *Effect of rapeseed and sudangrass green manure on Meloidogyne chitwoodi.*

Amending *Meloidogyne chitwoodi*-infested soil with shoots of rapeseed (*Brassica napus* cv. Jupiter) or sudangrass (*Sorghum vulgare* cv. Piper) in plastic bags reduced *M. chitwoodi* populations more ($P < 0.05$) than did wheat shoots. Incorporating rapeseed shoots and roots in soil in microplots infested with *M. chitwoodi* reduced ($P < 0.05$) nematode populations compared to fallow or corn treatments. In a field naturally infested with *M. chitwoodi*, fall incorporation of rapeseed and sudangrass and spring incorporation of rapeseed reduced ($P < 0.05$) *M. chitwoodi* population densities. Potato tubers grown in rapeseed- and sudangrass-amended soil were less ($P < 0.05$) severely damaged by *M. chitwoodi* than in fallow or wheat treatments. Rapeseed and sudangrass may provide an alternative method for managing nematodes. *Washington State University, Irrigated Agriculture Research and Extension Center, Route 2, Box 2953-A, Prosser, WA 99350-9687.*

SASSER, J. N. *Influence of experimental methods and/or environmental conditions on the efficacy of Paecilomyces lilacinus as a biocontrol for plant-parasitic nematodes.*

A survey of collaborators was conducted to collect information on the efficacy of *Paecilomyces lilacinus* as a biocontrol for plant-parasitic nematodes and to identify experimental methods and environmental conditions that may be associated with successes or failures. Sixty-eight questionnaires from 15 countries were returned. Target nematodes included *Meloidogyne* spp., *Tylenchulus semipenetrans, Rotylenchulus reniformis, Globodera* spp., and *Pratylenchus* spp. More than 30 different host plants were used to evaluate the degree of nematode control. Of the 68 researchers, 46 reported successes, 18 reported failures, two reported inconclusive results, one reported variable results, and one gave no answer. Forty indicated that they would recommend *P. lilacinus* to growers, 21 would not, and 7 did not respond. Thirty-three reported the fungus to be more effective or about the same as the nematicide used, whereas 11 reported the fungus as being less effective. Twenty-four either did not use a nematicide in the test or did not respond. All 22 tests conducted in arid or semi-arid regions were reported as successful. The success rate was less than 50% in the other regions (temperate, semi-tropical and tropical). The background organisms in soil from the latter regions may be antagonistic to or obscure the biocontrol activity of *P. lilacinus. Department of Plant Pathology, North Carolina State University, Raleigh, NC 27695-7616.*

SCHENCK, S.[1], and D. P. SCHMITT[2]. *Nematodes associated with coffee in Hawaii.*

Coffee production in Hawaii is expanding into land previously planted with sugarcane or pineapple. Coffee-parasitic nematodes did not increase to damaging levels, and other species gradually disappeared during three years of coffee cultivation. The *Pratylenchus zeae* and *Criconemella* spp. that were present when sugarcane was in production were no longer recoverable after several years of coffee cultivation. *Rotylenchulus reniformis*, which is found in high numbers in pineapple soils, decreased to low numbers on coffee and does not seem to damage it. *Meloidogyne incognita* and *Pratylenchus coffeae*, serious pests of coffee in some countries, have not appeared in significant numbers on coffee in Hawaii. [1]*Hawaiian Sugar Planters' Association, Aiea, HI*

96701, and [2]Department of Plant Pathology, University of Hawaii, Honolulu, HI 96822.

SCHNEIDER, R. C.[1], R. E. GREEN[1], and D. P. SCHMITT[2]. *Persistence and efficacy of 1,3-dichloropropene applied by injection and drip-irrigation in pineapple.*

The nematicide 1,3-dichloropropene (1,3-D) was injected pre-plant as a fumigant (Telone II) at a rate of 336 L/ha and by drip-irrigation at rates of 336 and 168 L/ha in a pineapple research trial in central Oahu, Hawaii for control of the reniform nematode, *Rotylenchulus reniformis.* The fumigant was injected at a depth of 30 cm; the emulsified 1,3-D was applied by drip-irrigation followed by water (1.6 cm/ha). Nematicide application was followed by intensive soil gas sampling at depths of 15, 30 and 45 cm over a 2-week period. Two hours after application, soil gas concentrations of 1,3-D were higher in the fumigant plots than the drip plots. Soil gas levels of 1,3-D peaked in the drip plots at 2 to 4 days after application. At 14 days, the soil gas levels of 1,3-D at 30 cm depth were 30 ppb (fumigant plot), 20 ppb and 10 ppb for the 336 and 168 L/ha drip treatments, respectively. At 9 days post-application, 1,3-D soil residues at the 0-30 cm depth were 5,500 and 2,500 ppb in the 336 and 168 L/ha drip treatments. Nematode samples were taken 2 months post-plant and compared with soil and soil gas levels of 1,3-D measured during the first month of the trial. [1]*Department of Agronomy and Soil Science, and* [2]*Department of Plant Pathology, University of Hawaii, Honolulu, HI 96822.*

SIJMONS, P. C. *Arabidopsis, a new model host for plant-parasitic nematodes.*

Media conditions for monoxenic culture of plant-parasitic nematodes on roots of *Arabidopsis thaliana* have been established and optimized to the extent that all individual plants showed multiple infection. Complete life cycles for the following nematode species were obtained: *Heterodera schachtii, H. trifolii, H. cajani, Meloidogyne incognita, M. arenaria,* and *Pratylenchus penetrans.*

The small crucifer *Arabidopsis* will provide an excellent model host for future molecular studies on plant-parasitic nematodes because of the small genome size, the short (6-week) life cycle and the well developed classical genetics of this species. A large number of different ecotypes from a wide range of geographical sites are available from *Arabidopsis* seed banks, as well as defined hormone and metabolic mutants. Large international cooperations in the U.S. and Europe are involved in sequencing of the complete *Arabidopsis* genome within this decade. Already dense RFLP maps are available for the rapid isolation of genes through chromosome walking. *Arabidopsis* is amenable to transformation with *Agrobacterium* and can be used to test genes coding for potentially nematicidal products. *MOGEN, Einsteinweg 97, 2333 CB Leiden, The Netherlands.*

SPIEGEL, Y.[1], E. SHARON[1], I. KAHANE[2], and M. A. McCLURE[3]. *Surface binding of red blood cells to different nematodes.*

Red blood cells (RBC) adhered to the entire bodies of second-stage juveniles (J2) of *Heterodera schachtii, Meloidogyne javanica, Pratylenchus mediterraneus,* and *Rotylenchulus reniformis.* Binding was confined conspicuously to the tail of *Longidorus cohni, Xiphinema brevicole, X. index,* and the insect parasite *Steinernema carpocapsae.* Binding to all species was Ca^{++} or Mg^{++}-dependent. *Anguina tritici, Aphelenchoides subtenius, Ditylenchus dipsaci,* and *Panagrellus redivivus* did not bind RBC, even in the presence of these cations. Pre-incubation of *M. javanica* J2 with fucose, galactose, *N*-acetylgalactosamine, mannose, or trypsin decreased the intensity of RBC binding, whereas glucose and *N*-acetylglucosamine increased binding intensity. These experiments support a working hypothesis that RBC adhesion involves carbohydrate moieties of RBC and carbohydrate recognition domains (CRD) distributed on the nematode surface. To our knowledge, this is the first report of a surface CRD on the phylum Nematoda. [1]*Department of Nematology, ARO, the Volcani Center, Bet Dagan 50250, Israel,* [2]*Department of Membrane and Ultrastructure, Hebrew University, Hadassah Medical School, Jerusalem, Israel, and* [3]*Department of Plant Pathology, University of Arizona, Tucson, AZ 85721.*

STARR, J. L., and C. E. SIMPSON. *Segregation of resistance to Meloidogyne arenaria in progeny of interspecific Arachis hybrids.*

Two lines of the root-knot susceptible *Arachis duranensis* (30069 and 30078) (female parent) were crossed with the nematode-resistant *A. cardenasii* (10017). All F_1 individuals were highly resistant to the reproduction of the nematode in greenhouse tests. In the F2 generation, plants derived from the 30069 × 10017 cross had low vigor and 49 of 80 plants

did not survive long enough to rate for resistance to nematodes. Of the surviving individuals, 3 of 31 plants were susceptible with nematode populations of 190 eggs/g roots, 3 of 31 were moderately resistant with 2.5-12.5% of the eggs per gram of roots as the susceptible parent, and 25 of 31 were resistant with less than 2.5% of the eggs per gram of roots of the susceptible parent. Plants from the F_2 generation of the 30078 x 10017 cross had greater vigor with 124 of 150 plants surviving. Of these plants, 4 of 124 were susceptible with 760 eggs/g roots, 7 of 124 were moderately resistant, and 113 of 124 were resistant. We have concluded that resistance *to M. arenaria* in *A. cardenasii* is conditioned by several dominant genes. *Texas Agricultural Experiment Station, College Station, TX 77843.*

SUDIRMAN, and J.M. WEBSTER. *Effect of ammonium ions on hatching, invasion, and development of Meloidogyne incognita.*

Experiments were done on the effect of ammonium on hatching, invasion, and development of *Meloidogyne incognita* on excised tomato roots grown on Skoog, Tsui, and White (STW) medium containing 1.5 ppm (deficit), 9 ppm (normal), 54 ppm, and 324 ppm ammonium. Dispersed eggs and egg masses were used in separate experiments. The number of juveniles that hatched was counted daily for 15 days. Hatching decreased with increasing concentration of ammonium. The percentage of hatched juveniles from approximately 200 dispersed eggs ranged from 10.99% to 7.39% on STW medium alone and from 12.59% to 7.89% in the presence of excised roots on STW medium. Under similar conditions, hatching from egg masses ranged from 30.35% to 23.18% without excised roots and from 32.47% to 23.32% with excised roots on STW medium. Increasing ammonium concentrations decreased infectivity and development of *M. incognita* juveniles originating from egg masses. One week after inoculation, the percentage of juveniles that penetrated roots grown on STW medium ranged from 56.42% to 32.05%; after 2 weeks the percentage of juveniles that had developed further ranged from 53.34% to 18.59%. Dry weights of uninoculated roots were 2.9, 3.1, 2.8, and 2.9 mg, respectively. *Department of Biological Sciences, Simon Fraser University, Burnaby, Vancouver, British Columbia, V5A 1S6, Canada.*

THIES, J. A.[1], and D. K. BARNES[2]. *Differences in resistance among alfalfas and other forage species to Pratylenchus penetrans.*

Two alfalfa populations were compared with each other and with four other forages for resistance to *Pratylenchus penetrans.* Baker and MNGRN-16 alfalfas, kura clover, sainfoin, quackgrass, and perennial ryegrass were grown in individual plastic tubes (72 plants per entry) in a growth chamber (25 C). After 1 week, 36 tubes per entry were inoculated with 200 nematodes. After 15 weeks, shoot and root dry weights of all entries had been reduced ($P < 0.01$) by *P. penetrans.* Baker alfalfa, sainfoin, and kura clover had about 6,000 nematodes per root system compared to 4,000 for quackgrass, 2,600 for MNGRN-16 alfalfa, and 800 for perennial ryegrass. Differences in preference of *P. penetrans* for Baker and MNGRN-16 were evaluated by placing 150 nematodes equidistant (0.5 cm) between parallel 2.5-cm-length root sections of 4-day-old seedlings in petri dishes containing Gamborg's B-5 medium (25 C). During days 1-7, mean numbers of nematodes per root increased from 19 to 52 for Baker and from 7 to 19 for MNGRN-16. Mean numbers of nematodes were greater ($P < 0.01$) for Baker than MNGRN-16. Short-term preference for alfalfa seedlings by *P. penetrans* appeared to be related to resistance observed in long-term tests. [1]*USDA, ARS, and University of Minnesota, St. Paul, MN 55108, and* [2]*USDA, ARS, Department of Agronomy and Plant Genetics, University of Minnesota, St. Paul, MN 55108.*

THOMAS, S. H.[1], D. W. SMITH[2], and T. J. ROBERTS[1]. *Effects of Meloidogyne incognita race 3 on fiber quality and yield of selected cotton cultivars under furrow irrigation.*

The pathogenicity of *Meloidogyne incognita* to cotton results from nematode demands on photosynthates and interference with translocation of water and nutrients by roots. Similar stresses of abiotic origin are associated with reductions in lint yield and fiber quality. Two studies were conducted during 1990 to determine if *M. incognita*-induced stress would affect these parameters under typical field conditions. One experiment consisted of 8 regionally important upland cotton cultivars with previously determined differences in resistance to *M. incognita.* The other compared upland and pima cultivars under varying levels of nematode pressure. In both studies pest populations were manipulated using 1,3-dichloropropene. Although reducing *M. incognita* populations increased lint yield 10-52% among cultivars in both experiments, fiber parameters (length,

strength, micronair, etc.) were largely unaffected. [1]*Department of Entomology, Plant Pathology and Weed Science, Box 3BE, and* [2]*Department of Experimental Statistics, Box 3130, New Mexico State University, Las Cruces, NM 88003.*

TIMPER, P.[1], and H. K. KAYA[2]. *Reduction in the effectiveness of entomogenous nematodes by Hirsutella rhossiliensis.*

The impact of the nematode-parasitic fungus *Hirsutella rhossiliensis* on the effectiveness of *Steinernema carpocapsae, Steinernema glaseri,* and *Heterorhabditis bacteriophora* against *Galleria mellonella* larvae was assessed in the laboratory. The LD50s of *S. carpocapsae, S. glaseri,* and *H. bacteriophora* in sand containing *H. rhossiliensis* were not different from those in sterilized sand when *Galleria* larvae were added at the same time as the nematodes. However, when *Galleria* larvae were added three days after the nematodes, the LD50s of the nematode species were higher and the proportion of nematodes that infected larvae was lower in *Hirsutella*-infested sand compared to sterilized sand. These data suggest that the effectiveness of entomogenous nematodes may be diminished in habitats with abundant nematode antagonists. [1]*U.S. Plant, Soil and Nutrition Laboratory, Tower Road, Cornell University, Ithaca, NY 14853, and* [2]*Nematology Department, University of California, Davis, CA 95616.*

TYLKA, G. L., and N. K. BAKER. *Flow cytometric sorting of Heterodera glycines eggs.*

Flow cytometry is a rapid and precise technique for simultaneously measuring several parameters of biological cells, cell constituents, or cell aggregates. Two-parameter flow cytometry was used to sort eggs of the soybean cyst nematode (SCN), *Heterodera glycines,* according to the stage of embryonic development. Eggs were extracted from cysts collected from the roots of SCN-susceptible soybeans and sorted by a Coulter EPICS 752 flow cytometer based on forward and 90-degree light scatter. Forward light scatter is a relative indication of cell size and 90-degree light scatter is a measure of cell content granularity or density. Mature eggs containing fully-developed SCN juveniles are less granular than recently-formed eggs in the initial stages of cell division and differentiation. The difference in egg-content density allowed for sorting of the eggs by stage of embryonic development, facilitating collection of the more mature eggs. Use of the more mature eggs in the search for compounds which stimulate hatching should increase the overall sensitivity of the hatching assays. *Department of Plant Pathology, Iowa State University, Ames, IA 50011.*

UMESH, K. C., and H. FERRIS. *Effect of temperature on the biology of Pratylenchus neglectus.*

Total numbers of *Pratylenchus neglectus* on barley roots and associated soil in pots maintained at a series of temperatures were greatest at 24 C and lower at temperatures above and below that level. Nematode numbers per gram of root were not decreased by temperatures above 24 C because root mass declined at higher temperatures. Reduced root mass may contribute to the lower total nematode population levels at high temperature. In another experiment, nematode activity was measured as a function of movement through 2 cm of sand on a Baermann funnel. Maximum movement occurred at about 20 C; minimum movement occurred at 10 C and 30 C. In a petri dish study, the life cycle of the nematode was completed most rapidly at 25 C and 30 C and required longer periods at lower temperatures. Growth rate increased linearly with temperatures up to 25 C. The minimum temperature threshold for development ranged from 6.4 C to 7.9 C depending on the growth stage. *Department of Nematology, University of California, Davis, CA 95616.*

VEECH, J. A. *The effects of infection by pathogenic and nonpathogenic races of Meloidogyne incognita on cotton fiber quality.*

Cotton (*Gossypium hirsutum* L.) planted in 15 gallon microplots was inoculated with either *Meloidogyne incognita* race 1 (nonpathogenic) or race 3 (pathogenic). At harvest the number of bolls per plant was determined, the yield of seed cotton was measured, and several cotton fiber quality parameters were evaluated over two years. Most surprisingly, the number of bolls and the weight of seed cotton were reduced more by the nonpathogenic race of the nematode than by the pathogenic race. Fiber quality parameters were affected differently and suggest that the manifested effects are determined by the stage of fiber development when the infection stress is applied to the plant. *USDA, ARS, Southern Crops Research Laboratory, Cotton Pathology Research Unit, Route 5, Box 805, College Station, TX 77845.*

VENTER, C.[1], D. DE WAELE[2], and A. J. MEYER[3]. *Effect of early or late harvesting on the economic damage caused by Ditylenchus destructor to peanut in South Africa.*

Ditylenchus destructor can cause economic losses in the field of 12% to 56% on four South African peanut cultivars, with infestations of 1,000 nematodes/seedling. Therefore, the cultivars were harvested before, on and after their usual harvest dates to investigate the possibility of minimizing losses with early harvesting. The cultivars Sellie and Harts should be harvested on their usual harvest dates or earlier (with approximately 10% loss), because late harvesting may result in economic losses of 40-45%. Infested fields of cultivars Natal Common and Norden should be harvested earlier than the usual harvest date. By the usual harvest time, these two cultivars suffer severe downgrading of seed yield; and in spite of seed mass increase with time, they have net economic losses of 10-30% at or after the usual harvest date. [1]*Grain Crops Research Institute, Private Bag X1251, Potchefstroom 2520, Republic of South Africa,* [2]*Plant Genetic Systems NV, Jozef Plateaustraat 22, 9000 Gent, Belgium, and* [3]*Stellenbosch University, Stellenbosch 7600, Republic of South Africa.*

VON MENDE, N. *Development of Heterodera schachtii and Meloidogyne incognita on hormone mutants of Arabidopsis thaliana.*

Arabidopsis thaliana has proven to be a good host for several plant-parasitic nematodes. This plant has been used for experiments in classical and molecular genetics and biochemical studies and is therefore very well suited to the study of molecular events in host-parasite interactions. Phytohormones have been recognized to play an important role during the establishment and maintenance of the feeding sites of cyst-forming and root-knot nematodes. In this study a range of hormone mutants (abscisic acid, auxin, gibberellins) of *A. thaliana* has been tested with *H. schachtii* and *M. incognita* in monoxenic cultures. *Department of Entomology and Nematology, AFRC Institute of Arable Crops Research, Rothamsted Experimental Station, Harpenden, Hertfordshire, AL5 2JQ, UK.*

WALLACE, M. K. *Correlation of a Pratylenchus penetrans population with edaphic factors.*

Two hundred soil samples from the A horizon of a reed canarygrass field overlaying several different but related soils were quantitatively analyzed for plant-parasitic nematodes and several soil variables. *Pratylenchus penetrans* was the dominant plant-parasitic nematode species. Others were *Tylenchorhynchus, Tylenchus maius, Aglenchus, Heterodera trifolii, Paratylenchus,* and *Criconemella.* The *P. penetrans* population was positively correlated with fine silt and negatively correlated with calcium. *Tylenchorhynchus* was positively correlated with coarse silt and negatively correlated with medium 1 sand. *Tylenchus maius* was positively correlated with effective cation exchange capacity and negatively correlated with magnesium. *Aglenchus* was positively correlated with potassium and negatively correlated with very fine 1 sand. *Heterodera trifolii* was positively correlated with moisture content and negatively correlated with very coarse sand. *Paratylenchus* was positively correlated with sodium and negatively correlated with calcium. *Criconemella* was positively correlated with sodium and negatively correlated with effective cation exchange capacity. *Department of Plant Pathology, University of Minnesota, St. Paul, MN 55108.*

WARNER, F. W., and G. W. BIRD. *Comparisons of Pratylenchus penetrans and P. crenatus host-finding behaviors.*

A bioassay was used to compare the host-finding behaviors of *Pratylenchus penetrans* and *P. crenatus* females. The assay consisted of soaking filter paper discs (7-mm. i.d.) in potato (*Solanum tuberosum* cv. Superior) root-soil filtrate, placing them on water agar in petri plates, and adding nematodes. All studies were conducted in the dark at 25 C. Distance and time course experiments were conducted by quantifying the number of females of each species recovered from the discs at the end of each study. Females were placed 5, 10, 15, and 25 mm from the discs, and the numbers reaching the target were quantified after 24 hours. The percentages of *P. penetrans* females recovered from the discs were 33.6, 17.0, 15.4, and 0.6 for the respective distances; whereas the percentages for *P. crenatus* were 58.6, 35.8, 22.0, and 17.5. When females were placed 10 mm from the treated discs for 1.5, 4, 8, 15, and 36 hours, percentages of recovery at the respective times were 5.8, 18.6, 20.5, 28.2, and 26.2 for *P. penetrans* and 0.0, 9.1, 13.2, 11.2, and 47.6 for *P. crenatus.* *Department of Entomology, Michigan State University, East Lansing, MI 48824-1115.*

WESTCOTT, S. W., III[1], and R. S. HUSSEY[2]. *Feeding behavior of Criconemella xenoplax in monoxenic culture.*

Criconemella xenoplax fed on roots of clover, carnation, tomato, Nanking cherry and western sand cherry in agar cultures. Stylet penetration was deliberate, lasting up to 90 minutes. Initially, the stylet was inserted a few micrometers into the root tissue and then withdrawn repeatedly (1-2 thrusts per minute). After penetration of a subepidermal cortical cell, stylet insertion continued slowly with only slight backward and forward movements. Once the stylet penetrated the cortical food cell, it became stationary and an esophageal gland secretion phase of 1-3 hours followed. Secretion was accomplished by intermittent twitching of posterior metacorpal muscles and partial opening of the pump chamber. Globular secretions accumulated around the stylet tip. Ingestion was characterized by maximum dilation of the pump chamber, continuous pulsation for up to 8 days, and no plant cell necrosis. The pulsation rate varied among hosts, with slower rates for the cherry species (1.2/second) than for tomato (1.6/second). Defecation was observed during ingestion. Ingestion ceased when adults became gravid. Juveniles often molted following a single feeding period. *Criconemella xenoplax* fed as a sedentary ectoparasite from a single cortical cell. [1]*Department of Plant Pathology and Physiology, Clemson University, Clemson, SC 29631, and* [2]*Department of Plant Pathology, University of Georgia, Athens, GA 30602.*

WILLIAMS, J. L.[1], F. A. GRAY[1], and G. D. GRIFFIN[2]. *Biology of Aphelenchoides ritzemabosi and its association with Ditylenchus dipsaci in irrigated alfalfa in the western U.S.*

The chrysanthemum foliar nematode, *Aphelenchoides ritzemabosi*, was first reported on alfalfa in California by Grundbacher and Standford in 1962. Our present studies were initiated to determine the distribution of *A. ritzemabosi* in irrigated alfalfa fields in the western states, determine its association with the alfalfa stem nematode *Ditylenchus dipsaci*, and determine the effect of environmental factors on its survival and development. Of 50 plant samples collected in eight western states which exhibited typical stem nematode symptoms, 46 had both nematodes present, three had *D. dipsaci* only, and one had *A. ritzemabosi* only. Of the total nematodes recovered (*A. ritzemabosi* + *D. dipsaci*), the composition of *A. ritzemabosi* ranged from 0% to 94%. Soil and tissue samples were collected at 3-week intervals from April 1990 to March 1991 in a field near Big Horn, WY. *Aphelenchoides ritzemabosi* was detected in the soil only in 1991 (January-March), while *D. dipsaci* was recovered at all sampling dates. Tissue population of *A. ritzemabosi* was dramatically influenced by all environmental factors monitored, as well as harvesting, whereas *D. dipsaci* was relatively unaffected and increased throughout the growing season. *Aphelenchoides ritzemabosi* could not be detected in 3 of the 12 months. Plant tissue populations of *D. dipsaci* and *A. ritzemabosi* increased to 1,863 and 64/g tissue, respectively, prior to harvest on July 9, 1990. [1]*Department of Plant, Soil and Insect Sciences, University of Wyoming, Laramie, WY 82071, and* [2]*USDA-ARS, Forage and Range Research Laboratory, Utah State University, Logan, UT 84322.*

WILLIAMSON, V. M., and J.-Y. HO. *Molecular transfer of resistance genes.*

Recombinant DNA techniques have been used to introduce agronomically valuable traits such as resistance to viruses, herbicides and insects into crop plants. The application of this technology to nematode control is under investigation. One strategy is to isolate plant resistance genes and to transfer resistance to susceptible plants by transforming them with the cloned genes. Several plant genes that confer resistance to cyst or root-knot nematode species have been characterized genetically. Although none of these genes have been cloned, many research programs are currently directed toward this goal. One of the best characterized resistance genes is *Mi*, which confers resistance to root-knot nematodes in tomato. A "reverse genetics" approach is being used to isolate this gene. Several DNA markers tightly linked to *Mi* have been identified and are being integrated into a detailed map of the DNA flanking this gene. "Transposon tagging" of this region of the chromosome is also in progress. The molecular map will be used to locate the DNA corresponding to *Mi*. *Agrobacterium*-based transformation will be used to transfer the putative *Mi* gene into susceptible tomato lines. The identity of the clone will be confirmed by testing for resistance to nematodes. It is anticipated that a clone corresponding to *Mi* will be obtained in two to five years. An exciting possibility is that the transfer of this gene will confer resist-

ance to other plant species susceptible to root-knot nematodes. *Department of Nematology, University of California, Davis, CA 95616.*

WINDHAM, G. L. *Comparison of pathogenicity of Meloidogyne graminicola and M. incognita on Trifolium repens.*

White clover, *Trifolium repens*, has recently been reported as a host for *Meloidogyne graminicola*. The objective of this study was to compare the pathogenicity of *M. graminicola* and *M. incognita* on white clover in a greenhouse study. Six-week-old 'Regal' white clover plants grown in 12-cm clay pots were inoculated with either 0, 125, 250, 500, 1,000, 2,000, 4,000, 8,000, 16,000, or 32,000 eggs (Pi) of the appropriate nematode species. Ninety days after inoculation, shoot dry weights were measured and clover roots were rated for galling and nematode reproduction on a 0-5 scale. Both root-knot species severely galled clover roots at all Pi levels. Clover growth was significantly suppressed at Pi 125 and higher, and *M. graminicola* was as pathogenic as *M. incognita* on white clover and may pose a potential problem for clover production in the southeastern United States. *Forage Research Unit, P.O. Box 5367, Mississippi State, MS 39762.*

WOODS, A. C.[1], J. R. FRENCH[1], and M. ICHINOHE[2]. *Toxicology and spectrum of nematicidal and insecticidal activity of a new organophosphorus compound.*

Fosthiazate, a discovery of Ishihara Sangyo Kaisha, Ltd., Japan, has been tested for activity against significant nematode and insect pests on a broad range of crops worldwide. The compound is highly effective against root-knot, potato-cyst and several other nematode pests. Activity includes suppression of certain soil and foliar insect species. Fosthiazate is less acutely toxic to mammals than currently registered organophosphate nematicides and may provide a safety advantage as an alternative chemical treatment. An Experimental Use Permit was granted by the EPA in 1991 for its use in the U.S. on tobacco and tomato. [1]*Technical Development Department, ISK Biotech, 5966 Heisley Road, Mentor, OH 44060, and* [2]*Agrochemicals Division, Ishihara Sangyo Kaisha, Ltd., 10-30, Fujimi 2-Chome, Chiyoda-Ku, Tokyo 102, Japan.*

XUE, B. G., J. M. WEBSTER, and K. BECKENBACH. *Molecular phylogeny for Meloidogyne populations with polymerase chain reaction and DNA sequencing methods.*

The root-knot nematode, *Meloidogyne*, has world-wide distribution and is comprised of many species and races which are sometimes difficult to distinguish with certainty. Advances in DNA technology now facilitate rapid and reliable identification and clearly demonstrate the taxonomic affinities of these nematodes. Our objective was to use these methods for this purpose on *Meloidogyne*. To achieve our goal, we used polymerase chain reaction technology to amplify the 18S ribosomal gene. The primers were used on populations of *M. incognita* races 1, 2, 3 and 4 and resulted in a 1.5-kb band in all cases. The DNA sequence was determined and aligned with that of *M. arenaria, M. javanica* and *Caenorhabditis elegans*. Analysis of the sequence divergence for these species and races allowed the construction of a dendrogram which split *M. incognita* into three distinct groups. *Department of Biological Sciences, Simon Fraser University, Burnaby, Vancouver, B. C. V5A 1S6, Canada.*

YOUNG, L. D. *Problems and strategies associated with long-term use of resistant cultivars.*

Plant-parasitic nematodes are obligate parasites, and planting cultivars that are highly resistant to these organisms places tremendous pressure on target and nontarget nematode species. Problems encountered with long-term planting of cultivars resistant to nematodes include: 1) shifts in races of a nematode, 2) shifts in nematode species over time, 3) resistant cultivars having lower yield or quality than the best susceptible cultivars, and 4) multiple species of nematodes within one field. These problems can be alleviated to some extent when crop management is used to lessen the pressure for change on the nematode populations. Race shifts within populations and possibly shifts between nematode species can be slowed by rotating susceptible cultivars and nonhost crops with resistant cultivars. Nematicide and resistant cultivar may be used to suppress damage by multiple species of nematodes. Some cultivars have resistance to multiple species of nematodes, but increased effort is needed in this area. More intensive plant breeding effort will be required to make nematode-resistant cultivars competitive in quality and yield with the best susceptible cultivars. *Nematology Research, USDA-ARS, 605 Airways Blvd., Jackson, TN 38301.*