Journal of Nematology 19(4):509–565. 1987.

ABSTRACTS OF PAPERS

PRESENTED AT THE

TWENTY-SIXTH ANNUAL MEETING OF THE

SOCIETY OF NEMATOLOGISTS

ALA MOANA AMERICANA HOTEL

HONOLULU, HAWAII

19-22 JULY 1987

ABAWI, G. S., and W. F. MAI. Effect of methylbromide, telone, and fenamiphos on densities of Heterodera schachtii and its damage to table beets.

Soil of field microplots (fiberglass, 4 ft in diam.) was mixed, sampled and treated with methyl bromide (MB, 504 Kg/ha), telone (292 and 584 liters/ha) or fenamiphos (6.7 Kg a.i./ha) all on a broadcast basis. Population density of H. schachtii in these plots averaged to 41 eggs and larvae/cm^3 soil. Three rows at 30.5 cm spacing were planted/plot with 20 seedballs of the cv. Ruby Queen/ft row. All treatments were replicated 5 times in a randomized block design. The following year all plots were replanted to beets and only the fenamiphos treatment was reapplied. Data obtained suggested that MB and telone did not eliminate H. schachtii, but greatly reduced its build up as compared to that in the fenamiphos and nontreated plots. Highest yield of beets with greatest value was obtained in the MB treated plots in both years. Telone treatment increased yield the first year, but only slightly the second year. Fenamiphos was ineffective at the very high H. schachtii densities of these plots. Departments of Plant Pathology, Cornell University, Geneva (14456) and Ithaca (14853), NY.

Paper Withdrawn

APT, W. J. Nemagation via drip irrigation.

In Hawaii, the application of nematicides via drip irrigation has been shown to be highly effective in management of the reniform nematode, Rotylenchulus reniformis, in pineapple culture. The success of the method requires an appreciation of a number of factors such as: life cycle of the reniform nematode; the influence of soil moisture on the life cycle; nature of the nematicide (degradation, adsorption); soil type and pH; and irrigation design. When these factors are considered in the application design, the method offers significant potential as a preplant treatment and opens the possibility of supplementary postplant treatments. It has also reduced exposure factors in handling of the nematicide and has the potential of reducing the total amount of nematicide through increased efficacy. Nematicides that were only moderately effective as granular applications were significantly improved in efficacy by application of EC formulations via drip irrigation. The soil fumigant 1,3-dichloropropene, which was previously used only as a preplant treatment because of phytotoxicity has been safely applied via drip irrigation as preplant and postplant treatments. Dept. of Plant Pathology, University of Hawaii, Honolulu, HI 96822.

BAHME, J. B., S. D. VAN GUNDY, and M. N. SCHROTH. Application of biological control agents via irrigation.

Soil application of bacteria by drip irrigation and soil incorporation of bacterial granules were evaluated on field-grown potatoes as delivery techniques for biocontrol agents. Pseudomonas fluorescens strain Al-B and Trichoderma viride strain T-1-R9 applied in water maintained high populations of the antagonists in the top 30 cm of beds, with means of 10^5 and 10^3 cfu g^{-1} soil for the bacterium and fungus, respectively. Strain Al-B was released from granules during irrigations and persisted at mean populations of 10^2 cfu g^{-1} in soil below the granule incorporated zone. Average populations (log cfu) of Al-B on roots, root tips, and progeny tubers in drip plots were 3.7 cm^{-1}, 3.8 tip^{-1}, and 5.8 g^{-1} periderm, respectively; means in granule plots were 3.4, 3.3, and 4.1 for the same respective plant parts. Population densities and uniformity of colonization were much greater with the drip and granule systems compared to seed piece inoculation. Drip introduced P. fluorescens reduced post-harvest potato lenticel populations of Erwinia carotovora and pectolytic pseudomonads by 98% and 96%, respectively, vs. controls. Depts. of Plant Pathology and Nematology, Univ. of California, Berkeley, CA 94720 and Riverside, CA 92521.

BAHME, J. B., S. D. VAN GUNDY, and M. N. SCHROTH. Population dynamics and control of Meloidogyne chitwoodi on potato in Northern California.

Meloidogyne chitwoodi was monitored on potato during the 1985 growing season and the effect of two chemical control agents on nematode populations and tuber galling was determined. High soil populations of second stage larvae (25/50 cm^3 soil) during germination resulted in general infection of newly-emerged roots (2.5 larvae cm^{-1}) 27 days after planting. The first hatch occurred 49-62 days postplant, during which time soil larvae populations

increased from 27 to 133/50 cm^3. A second hatch occurred from 94 to 138 days (harvest) as soil populations increased from 334 to 1.6 X 10^3. Soil temperatures at 20 cm averaged 24 C from 0 to 80 days, then declined to 10 C at harvest. Bi-weekly drip irrigation applications of GY81 (282 L/ha) and Standak (56 g/ha) significantly reduced (P=0.05) nematode populations in soil and roots. Control tubers showed galling on approx. 38% of their surface area at harvest. Galled surface area of tubers in GY81 (19%) and Standak (25%) plots was significantly less vs. controls, but exceeded commercially accepted levels. Soil populations declined to 38 larvae per 50 cm^3 5 months after harvest. Depts. of Pl. Path. & Nematology, Univ. of California, Berkeley, CA 94720 and Riverside, CA 92521.

BALDWIN, J. G. and L. P. SCHOUST, JR. Incorporation of fine structural data in computer assisted phylogenetic analysis of Heteroderidae.

TEM data including host response, body wall cuticle, and phasmids, as well as SEM of lip patterns, surface cuticle, and spicules are considered with classical characters in computer assisted phylogenetic analyses of Heteroderidae. Approaches include PHYLIP and PAUP parsimony programs, designed to discover trees with minimal homoplasy, as well as other PHYLIP compatibility programs which seek trees based on the largest possible sets of characters. The different approaches support similar trees but with discrepancy on the position of Hylonema, Verutus, and Rhizonema sensu Cid del Prado et al. Some characters, such as longitudinal lines on the head region of males, are too mosaic in distribution to contribute to any tree. Results are compared between traditional hypotheses of phylogeny and those generated by computer assistance. Department of Nematology, University of California, Riverside, CA 92521.

BARKER, K. R. Effects of irrigation and cultivar on growth and yield responses of tobacco to aldicarb.

Experiments in microplots focused on the impact of irrigation rates and cultivar on the growth enhancement of tobacco often associated with the use of aldicarb. Microplots with a Fuquay sand (91% sand; 6% silt, 3% clay, pH 6.1, 0.6% OM) were fumigated with 73 g of methyl bromide plus chloropicrin per M^2 prior to establishing a crop. In addition to standard management practices, about 1000 chlamydospores of Glomus macrocarpus were added to each 80 X 100-cm plot. Aldicarb was added at rates of 0, 1, 2 and 3 ppm. Rates of 1 or 2 ppm generally resulted in increased cured leaf yields up to 10-20%, whereas 3 ppm often suppressed growth. Supplemental irrigation enhanced the responsiveness of cultivars Speight G-70 and McNair-944 to aldicarb, but excessive moisture limited yields. Cutivars G-70 and NC-82 were more responsive to the pesticide than McNair 944. Plant Pathology Department, North Carolina State University, Raleigh, NC 27695-7616.

BARKER, K. R., S. R. KOENNING, A. L. BOSTIAN, and A. R. AYERS. Soybean response to the pesticide aldicarb in the absence of pest pressure.

The growth and yield of soybean treated with aldicarb were determined in phytotron, greenhouse, microplot and field experiments. Sequential applications of 1 ppm aldicarb to Ransom or Coker 156 soybean resulted in greater ($P = 0.05$) shoot and root weights compared to nontreated controls in the greenhouse. Experiments in methyl bromide fumigated microplots with applications of 0, 1, 2 and 3 ppm aldicarb at planting were conducted at 5 North Carolina locations and in six soil types at a common site. Soybean seed size was consistently increased by aldicarb treatments ($P = 0.05$). Plant height was also increased by most aldicarb treatments. Soybean yield increases varied from 0 to 20 percent in response to aldicarb treatments. Enhanced soybean shoot growth did not consistently result in increased soybean yield. The amount of yield increase depended on environmental factors such as temperature, rainfall, and soil type. Plant Pathology Department, North Carolina State University, Raleigh, NC 27695-7616.

BELAIR, G., and G. BOIVIN. The effect of two strains of Steinernema feltiae on the survival and oviposition of carrot weevils.

The effect of two strains of Steinernema feltiae, DD 136 and Listronotus, on the survival and oviposition of carrot weevils (CW), Listronotus oregonensis, of different ages and sexes were evaluated. The LT_{50} of both strains decreased as temperature increased. For both nematode strains, the LT_{50} of CW was influenced by age as overwintering adults survived much longer than adults 1, 13, and 60 days old. While the LT_{50} of males was significantly shorter than females with DD 136, no such difference was found with Listronotus strain. The availability of food decreased significantly the LT_{50} of both males and females for both strains and at 15 C and 20 C. Both nematode strains decreased the oviposition rate of infected females prior to their death. Agriculture Canada Research Station, Box 457, Saint-Jean-sur-Richelieu, Quebec, Canada J3B 6Z8.

BERGDAHL, D. R. Impact of the pine wood nematode in North America: present and future.

Bursaphelenchus xylophilus (Steiner and Buhrer) Nickle (pine wood nematode) (PWN) is the most serious pest of pine forests in Japan but in North America its role in pine wilt disease remains unclear. The PWN is known to infest many species of Pinus with P. nigra, P. sylvestris and P. thunbergii the most susceptible in the eastern United States. Because of its potential, several European countries (Finland, Norway and Sweden) have established embargos against the importation of coniferous wood from regions known to be infested with the PWN. Department of Forestry, School of Natural Resources, University of Vermont, Burlington, VT 05405.

Paper Withdrawn

BERNARD, E. C. and L. H. SELF. Nematophagous fungi in a Heterodera glycines-infested field with different cropping-tillage regimes.

The incidence of fungi invading females, cysts and eggs of Heterodera glycines in various replicated tillage plots was examined on a monthly basis. Nematodes and eggs from cysts were extracted from six tillage regimes (three no-till and three conventional tillage types) and placed on agar plates for growth of fungi within. More than 90 fungal species were identified from females and cysts, the most common being Fusarium solani, Gliocladium catenulatum, G. roseum, and Hendersonia sp. The mycoflora of the eggs was much less diverse, consisting of about 15 species. Paecilomyces lilacinus, Verticillium chlamydosporium, G. roseum, and G. catenulatum were the most frequent parasites. The percent female/cyst parasitism in June and July was similar in all tillage treatments, but in October was highest in conventional disc and long-term wheat-soybean no-till, lowest in soybean and short-term soybean-wheat no-till treatments. Department of Entomology and Plant Pathology, University of Tennessee, Knoxville, TN 37901-1071.

BESAL, E. A., T. O. POWERS, and L. J. SANDALL. A DNA hybridization probe for the detection of soybean cyst nematode.

A DNA hybridization probe, constructed from mitochondrial DNA (mtDNA), has been developed for the detection of soybean cyst nematode (SCN), Heterodera glycines. The probe can detect a single female nematode applied as an unpurified homogenate to nitrocellulose filters. Mitochondrial DNA ws extracted from nematode eggs of an Arkansas race 3 population. MboI-digested mtDNA was inserted into the BamHI site of the molecular cloning vector pBR322. Transformants were screened by colony hybridization with intact ^{32}P-nick-translated SCN mtDNA. One probe of approximately 500 bp hybridized strongly to eight widely geographically divergent SCN populations. An SCN population from Java displayed weak hybridization. No hybridization was observed with H. leuceilyma, H. weissii and Globodera virgineae. Occasional

weak cross-hybridization was observed with H. trifolii, and slightly stronger cross-hybridization was observed in three populations of H. schachtii. Pretreatment of H. schachtii filters with Proteinase K reduced this cross-hybridization. A non-radioactive labeling and detection system, biotin-streptavidin, was evaluated for its sensitivity and specificity. Biotinylated probes showed an unacceptable level of non-specific binding with filters of crude cyst macerates. Department of Plant Pathology, University of Nebraska, Lincoln, NE 68583.

BIRD, A. F. Adhesion of microorganisms to nematodes.

Studies on the nature of adhesions of various microorganisms to the surface of nematode cuticles have considerable relevance in helping to understand the mechanisms of biological control of these nematodes. This is because adhesion is the first step towards parasitism of or competition with the nematode. Adhesion of microorganisms to nematodes takes place in different ways. In the case of corynebacteria adhering to the infective juveniles of Anguina agrostis marked changes in the ultrastructure of the epicuticle and of the cortical layer beneath it can occur. However, the conidia of the fungus Dilophospora alopecuri cause no apparent structural changes to the surface cuticle of this nematode when they adhere to the infective juveniles. Similarly the spores of the actinomycete, Pasteuria penetrans do not bring about marked ultrastructural changes to the surface cuticle of the infective juvenile of Meloidogyne javanica when they adhere prior to being carried into the host plant. Division of Soils, CSIRO, Private Bag No. 2, Glen Osmond, S. A. 5064, Australia.

BIRD, DAVID M., and DONALD L. RIDDLE. Genes encoding C. elegans RNA polymerase subunits.

As an approach toward understanding gene expression, we are examining structure/function aspects of RNA polymerase II (RNAP II). In this laboratory, the gene encoding the large subunit of RNAP II has been identified and characterized genetically (as ama-1 IV), including the generation of 22 lethal alleles. We have cloned the wild-type gene (and also an RNAP III gene) using a heterologous probe from Drosophila and have used DNA from a mutant strain to confirm that the RNAP II clone encodes ama-1 IV. Transcript mapping has been used to delineate the extent of the 5.9 kb transcript. Other nearby transcripts over a 30 kb region have also been detected, thereby identifying two collagen genes and two, as yet unidentified, genes. DNA sequence analysis reveals that the ama-1 IV product has features in common with the analogous peptides from other species, in particular, the presence of a tandemly, highly repeated heptapeptide at the COO^- terminal. We currently are turning our attention toward DNA sequence analysis of some of the ama-1 IV mutants. Division of Biological Sciences, University of Missouri-Columbia, MO 65211.

BOLLA, R. I. Aspects of the biochemistry of Bursaphelenchus xylophilus.

The tylenchid nematode Bursaphelenchus xylophilus can survive either as a mycophagous or a plant parasitic nematode. We have recently obtained a nonpathogenic isolate of this nematode which only survives mycophagously. The difference in survival strategies suggests that this isolate may maintain alternative metabolic pathways. Therefore carbohydrate metabolism of pathogenic isolates of B. xylophilus was compared to the nonpathogenic isolate of this nematode and to B. mucronatus. Nonpathogenic B. xylophilus and B. mucronatus utilize an anaerobic pathway of carbohydrate metabolism, and produce ethanol as a primary end product, whereas pathogenic isolates of B. xylophilus produce succinate and glycerol as end products. Enzyme activities suggest that these latter isolates use a fumarate reductase pathway of energy metabolism. Although there are genotypic differences between pathotypes of the pathogenic isolates of B. xylophilus, these pathotypes do not differ metabolically. Metabolic differences between pathogenic and nonpathogenic isolates of this nematode are reflected in molecular differences in the gene encoding the enzyme alcohol dehydrogenase. Dept. of Biology, University of Missouri-St. Louis, 8001 Natural Bridge Rd., St. Louis, MO 63121.

BRIDGE, J. An overview of plant-parasitic nematode problems in the Pacific Islands.

The Pacific Islands have a diverse range of food and cash crops with associated nematode problems, both indigenous and introduced. The staple food crops have serious nematode pests, e.g. Meloidogyne spp. on sweet potato, Hirschmaniella miticausa causing corm rot of taro; Pratylenchus coffeae and Radopholus sp. producing tuber dry rot of yams. Bananas are infested with P. coffeae or R. similis, citrus with Tylenchulus semipenetrans, rice with Aphelenchoides besseyi, ginger with Meloidogyne spp. and R. similis. Rotylenchulus reniformis, P. zeae, P. brachyurus and Helicotylenchus spp. are important on the above and other crops, e.g. sugarcane, passion fruit, pawpaw and cassava. Meloidogyne spp. cause serious damage to local and introduced leaf and fruit vegetables and other crops, e.g. tobacco, sugarcane, pawpaw, black pepper, and pyrethrum. Many other plant-parasitic nematode genera and species, some undescribed, occur in the Pacific and there are many islands still to be investigated. CAB International Institute of Parasitology, 395A Hatfield Road, St. Albans, AL4 OXU, U.K.

BRODIE, B. B. Population development of Globodera rostochiensis on susceptible potatoes following resistant potatoes.

Field plots (9X15 M) naturally infested with Globodera rostochiensis (GN) were planted to the GN resistant potato cultivar Hudson for 1 to 7 years. Afterwards, the plots were planted to the GN susceptible cultivar Katahdin for 1 to 5 years. GN population densities were estimated each year after harvest (October) from soil samples (1875 cc) taken 5 cm deep at 0.8 M intervals from each plot. Development of GN on the susceptible cultivar was negatively correlated with the number of years the resistant cultivar was

previously grown. The final population/initial population ratios after one year of Katahdin following 6 or 7 years of Hudson were <1, indicating no reproduction. After 5 years of Katahdin following 7 years of Hudson, the GN population had increased from 0.22 eggs/cm^3 of soil to 12 eggs/cm^3 of soil. In plots where no resistant cultivar had been grown, the GN population increased from 0.03 eggs/cm^3 of soil to 115 eggs/cm^3 of soil in 5 years. These data suggest that repeated exposure of GN to resistant cultivars significantly impairs its ability to develop on a susceptible cultivar. USDA, ARS, Dept. of Plant Pathology, Cornell University, Ithaca, NY 14853.

BRODIE, B. B., and R. L. PLAISTED. Resistance to Meloidogyne chitwoodi in potatoes.

Tubers of 110 potato clones derived from crosses of Solanum tuberosum ssp. andigena X S. tuberosum ssp. tuberosum were planted in 7.5 cm clay pots filled with a 1:1 soil:sand mixture in a greenhouse at 21-25 C. One week after plant emergence 10,000 second stage juveniles of Meloidogyne chitwoodi in 10 ml of water were added to each pot. The pots were hand watered once daily for 4 days after inoculation. Afterwards, they were automatically watered 4 times daily. Sixty days after inoculation, the plants were removed, eggs were extracted from the roots with sodium hypochlorite, and collected in 200 ml of water. Populations of M. chitwoodi/plant were estimated from counts of viable eggs in three 1 ml samples. Resistance was based on the final population/initial population (Pf/Pi) ratios with a Pf/Pi <1 indicating resistance. In the first test, 15 clones were rated resistant. Seven clones were retested and 5 again tested highly resistant. We believe that this is the first report of resistance to M. chitwoodi in tetraploid potatoes. USDA, ARS, Dept. of Plant Pathology, Cornell University, Ithaca, NY 14853.

BURR, A. H. The phototaxis of Mermis nigrescens.

This nematode parasite of grasshoppers, after it emerges from the soil to lay its eggs on vegetation, was shown to have a strong attraction to light in the wave length range 350 - 540 nm. Since this is the range of absorption of hemoglobin, the dense accumulation of this pigment as crystals in the head of this species (Burr and Harosi, Biophys. J. 47, 527. 1985) is implicated in a shadowing mechanism for detection of light direction. During phototaxis on a horizontal surface, the worm adopts a remarkable posture. The anterior is held well above the surface while the head is aimed directly at the light source. The remainder of the body, with numerous body waves, propels the animal towards the light. Periodically, a circular sweeping motion of the anterior interrupts the locomotion. Phototaxis towards horizontal light is equally strong on a vertical surface. The phototaxic behavior appears to be turned off after a certain time, after which other behavior takes over. This time can be extended by storage in the refrigerator in soil at 5 C. Worms collected in the field vary greatly in phototaxic tendency: from zero (in most cases) to one example which persisted strongly for 15 hours. Laboratory of Sensory Physiology, Simon Fraser University, Burnaby, B. C., Canada V5A 1S6.

CAMPOS, V. P., and P. A. A. LOOF. Criconematidae from Brazil.

Criconematidae have been studied in samples collected from different parts of Minas Gerais State in connection with Dr. Loof of Wageningen (Holland) and the literature surveyed for species that occur in other states of Brazil. A brief commentary will be made on the distribution of them in Brazil. Macroposthonia ornata and M. onoensis have been very common in Minas Gerais state. Neolobocriconema cataracticum has been found on vegetable fields and M. xenoplax on coffee plantations. Discocriconemella repleta always has been associated with forest plants. Others species such as Criconema mutabile, Ogma decalineata also have been identified. One population of Lobocriconema and Discocriconemella seem to be new species. Morphological remarks of the brasilian populations of different species of Criconematidae that occur in Brazil will be made. A list of new hosts and the population distribution from the samples studied will be presented. Dep. de Fitossanidade/ESAL-37200 Lavras-MG, Brazil.

CARTA, L. K. and J. G. BALDWIN. Fine structure of phasmid development in males of Meloidodera floridensis.

The fine structure of the phasmid of M. floridensis is morphologically most complex in second stage juveniles. At this stage a large ampulla is recognized as the "lens-shaped" structure seen by light microscopy. Here the sheath cell, which surrounds the neuron receptor cavity, reaches its greatest size. The sheath cell contains numerous multivesicular bodies and the plasma membrane of the receptor cavity increases in surface area and becomes infolded. The sheath cell is least developed in the third stage when no infoldings of the plasma membrane of the receptor cavity are seen. The sheath cell of adult males is smaller and the receptor cavity less elongate than in second stage juveniles. The phasmid of Meloidodera charis differs little from M. floridensis. This study has significance for functional and phylogenetic inferences in Heteroderidae. Department of Nematology, University of California, Riverside, CA 92521.

CASWELL, E. P., and W. J. APT. Nematode management on pineapples in Hawaii - past, present, and future.

The first written record of pineapple in Hawaii is from 1813. In 1901 the first commercially successful pineapple operation started, and in 1924 the Pineapple Research Institute (PRI) was established. Nematodes were recognized as important early on, as N.A. Cobb had studied nematodes of Hawaii's sugarcane in the early 1900's. Working at the PRI in the 1920's and 30's G.H. Godfrey conducted research on nematodes and their influence on pineapple growth, the life-history of the root-knot nematode, and cultural control practices. In the 1930's and 40's M.B. Linford researched biological

control and described several new species of nematodes, including Rotylenchulus reniformis. In 1941 nematology and nematode management were dramatically advanced by Walter Carter's discovery of the soil fumigant, D-D. Subsequently DBCP was discovered and developed by Carl Schmidt at the PRI. Soil fumigation has been, and remains, the mainstay of nematode management in Hawaiian pineapple production. In recent years research on nematode management has focused on the development of the non-volatile nematicides, their potential as systemic nematicides and their application via drip-irrigation systems. Research is underway to assess the potential for incorporation of biological and cultural management strategies into standard plantation practice. Dept. of Plant Pathology, 3190 Maile Way, Univ. of Hawaii, Honolulu, HI 96822.

CHITWOOD, D. J., M. A. McCLURE, and W. R. LUSBY. Sterols and ecdysteroid content of eggs of Meloidogyne incognita and M. arenaria.

Twenty-three sterols were identified by gas-liquid chromatography-mass spectrometry in eggs of M. incognita races 2 and 3 and M. arenaria race 1. Egg sterols of each race predominantly consisted of 24-ethylcholesterol (33.4 to 38.8%), 24-ethycholestanol (18.3 to 25.3%), 24-methylcholesterol (8.6 to 11.7%), 24-methylcholestanol (7.7 to 12.5%) and cholesterol (4.6 to 11.6%). The major metabolic transformation performed by Meloidogyne females or eggs upon host sterols is probably saturation of the sterol nucleus. The sterol compositions of eggs of each race were very similar. Ecdysteroids (hormonal compounds in insects) were not detected by radioimmunoassay (RIA) as either free ecdysteroids or polar conjugates. A compound that comigrated with ecdysone during TLC occurred in the eggs; but it was not immunoreactive during RIA, possessed an apparent molecular weight of 811, and yielded a 27-carbon saturated aliphatic alcohol plus an as yet unidentified compound upon acid hydrolysis. Insect and Nematode Hormone Laboratory, Plant Protection Institute, USDA-ARS, Building 467, BARC-E, Beltsville, MD 20705.

Paper Withdrawn

DAVIDE, R. G. Nematode problems affecting agriculture in the Philippines.

Nematodes are considered major pests on most economic crops in the Philippines particularly on banana, pineapple, citrus, tomato, ramie, sugarcane and others. Radopholus similis is the most destructive nematode on banana, while Meloidogyne spp. are more serious on various vegetable crops like tomato, okra, celery and on fiber crops such as abaca, and ramie. Tylenchulus semipenetrans is a problem on citrus and Rotylenchulus reniformis is on pineapple and some legume crops. Hirschmanniella oryzae and Aphelenchoides besseyi are becoming more serious on rice while Pratylenchus zeae is affecting corn in some areas. Lately, Globodera rostochiensis is causing serious damage on potato in the highland. Control measures such as crop rotation, planting resistant varieties, chemical or nematicide application and biological control have been recommended to control these nematodes. College of Agriculture, University of the Philippines at Los Banos.

DUSENBERY, D. B. Behavioral responses of Meloidogyne incognita to temperature and carbon dioxide.

Infective juveniles of root-knot nematodes have been found to migrate in thermal gradients toward a preferred temperature several degrees above the temperature to which they are acclimated. They are able to migrate in very shallow gradients of less than 0.001 C/cm. Computer tracking experiments demonstrate responses to temperature changes of 0.001 C. The nematodes also exhibit behavioral responses to very small changes in CO_2 concentration. They move up concentration gradients of less than 1% change/cm. Theoretical calculations indicate they are potentially able to follow CO_2 gradients to a plant from as far away as a meter or more. School of Biology, Georgia Inst. of Technology, Atlanta, GA 30332.

DWINELL, L. D. Incidence of the pine wood nematode Bursaphelenchus xylophilus in exported southern pine chips.

The incidence of the pine wood nematode in southern pine chips from input onto chip piles, output from chip piles to ship, to discharge of chips in Sweden was studied. Samples from randomly selected truck and railcar shipments from mills to the terminal where the chips were piled for six sampling periods from July 1985 through August 1986 revealed that the pine wood nematode is frequently found in chips and the population levels vary over time. Samples taken when the ships were being loaded revealed that the population level of the nematode declined or remained unchanged in the piled chips. Samples taken when the chips were discharged were returned for processing. It appears that the nematode population increases significantly during the 17-19 days of the trans-Atlantic voyage. Data from one shipment indicated that 90% of the nematodes were in the bottom 40% of the chips in the holds. Distribution of pine wood nematodes in the holds could be related to the tem-

perature of chips during transit. USDA Forest Service, Southeast. For. Exp. Stn., Athens, GA 30602.

DWINELL, L. D. Role of Bursaphelenchus xylophilus in the mortality of sand pine in a seed orchard in central Georgia.

During the summer of 1986, four 11-year-old sand pines (Pinus clausa) in a seed orchard wilted and died. The symptoms were characteristic of the pine wilt disease; however, two of the trees had not been colonized by the southern pine sawyer (Monochamus titillator), a vector of the pine wood nematode (Bursaphelenchus xylophilus). The trees were felled and examined for presence of oviposition pits and for visual evidence of bluestain development. Sections of the bolts, as well as branch samples, were assayed for nematodes. The pine wood nematode was not found in the two trees that were not colonized by sawyers. The nematode was extracted only from the trees in which the sawyers had oviposited. Many of the primary roots were resin soaked and Verticicladiella procera was isolated from these roots. Apparently the sand pines, which are planted outside their natural range, succumbed to root rot and drought. The pine wood nematode was a secondary parasite and did not contribute to tree mortality. USDA Forest Service, Southeast. For. Exp. Stn., Athens, GA 30602.

Paper Withdrawn

ENDO, B. Y. Ultrastructure of esophageal gland secretory granules in juveniles of Heterodera glycines.

Ultrastructural observations of the feeding sites of the soybean cyst nematode juveniles, 3 days after inoculation of soybean roots, revealed the presence of feeding tubes in the host cell syncytium. Feeding tubes, which were

extruded from the stylet tips, were formed by products of secretory granules that originated in the dorsal esophageal gland and accumulated in the ampulla of the gland extension. Granules traversing the space between the gland cell and the ampulla were regulated in their movement by two sets of sphincter-like muscles located anterior and posterior to the metacorpus pump chamber. Sections through the sphincter muscles revealed obliquely arranged fibers, which in a contracted mode, caused microtubules in the gland extension to be tightly packed and devoid of granules. Secretory granules restricted to the gland extension of the procorpus were variable in size and electron density. USDA, ARS, Plant Protection Institute, Beltsville Agricultural Research Center, Beltsville, MD 20705.

FAGHIHI, J., J. M. FERRIS, and V. R. FERRIS. Relationship between greenhouse and field susceptiblity tests of SCN-resistant soybean lines.

To assess for Heterodera glycines the validity of comparing field results (comprised of nematode counts and/or yield data) with greenhouse susceptibility rankings of resistant soybean lines, a four-inch plastic pot was buried (and planted with 3 seeds) alongside each 10-seed hill-plot entry in field test variety trials. Cyst and egg counts were made at planting and before harvest to determine development of SCN under field conditions. yield, in grams per hill, was recorded for each entry. Soil from the same field was used to obtain inoculum to infest greenhouse seedlings of each entry with approximately 2000 eggs and juveniles. Cyst and egg counts were made after 6 weeks. Regression analyses, using means of data from 5 replicates of each field and greenhouse entry, showed correlations between greenhouse cyst and egg counts (R = 1.00), greenhouse and final field egg counts (R = 0.90), yield and final field egg count (R = 0.68) and yield and greenhouse cyst counts (R = 0.62). Department of Entomology, Purdue University, West Lafayette, IN 47907.

FERRIS, H., B. A. JAFFEE, M. V. McKENRY, and C. E. ANDERSON. Analysis of nematode stress-dosage trajectories in perennials: Criconemella xenoplax in almonds and peaches.

Soil samples were collected for 18 mo. at approximately monthly intervals, to 60-cm depth in a young peach orchard on alternating strips of Nemaguard and Lovell rootstocks, and to 90-cm depth in an established almond orchard on Nemaguard rootstock. Population density totals of C. xenoplax were assessed as the sum of numbers in each life-stage, weighted for body size. Nematode stress-dosage to the tree was calculated as the cumulative product of the concentration (density) of nematodes and the physiological time (base 10 C) over which that concentration is effective, that is, cumulative nematode degree-days (y). Data from each orchard and rootstock were used to determine parameter values for the model $y = ax^b$, where x is the elapsed time in degree days. The b parameter indicates the rate of increase of the stress dosage and is affected by plant host status and nematode management. Simulations revealed that at least three sampling dates over a 1-yr time span were necessary to assess reliably the stress-dosage trajectory. Division of Nematology, University of California, Davis, CA 95616.

FERRIS, V. R., J. M. FERRIS, and J. FAGHIHI. Two-dimensional protein patterns of strains and pathotypes in Heterodera avenae.

Two-dimensional (2-D) protein patterns were compared for 10 geographical isolates of H. avenae from Sweden (selected by A. Ireholm), comprising 2 strains ("strict avenae" and Gotland strain) and 5 different pathotypes (Hall, Hal2, Vaxtorp, "West" Gotland, and "East" Gotland), plus an isolate from Oregon, U.S.A. Four strict avenae isolates (2 of Hall and 2 of Hal2) resembled each other very closely; the 5 Gotland strain isolates (2 of West Gotland and 3 of East Gotland) closely resembled each other; whereas 2-D patterns for the 2 strains (strict avenae and Gotland) differed greatly from each other. The Vaxtorp isolate and the Oregon isolate were most like the strict avenae isolates, but had marked differences from them and from each other. Unique combinations of spots characterized most isolates, but no unique pattern characterized all isolates of any nominal pathotype. Department of Entomology, Purdue University, West Lafayette, IN 47907.

FLEMING, M. W. In vitro and in vivo hormonal effects on the development of larval Ascaris suum, the swine intestinal roundworm.

An in vitro bioassay, which previously demonstrated enhanced molting and growth of larvae by ecdysteroids, was utilized to examine the effects of octopamine and juvenile hormone (JH). Third-stage larvae of Ascaris suum were recovered from rabbits and placed in multi-well plates with RPMI-1640 and test compound for 24 h. Larvae were rinsed with medium, returned to new plates for 6 days, and then fixed in hot formalin for measurement. Octopamine and JE had a dose-response increase in length over the ranges of 10 to 50 and 1 to 10 nmol/ml, respectively. Ecdysone did not appear to synergize with JH. Ecdysone infused (12.5 ug/h) into rabbits for 10 days reduced lengths and infectivity of lung larvae in a dose-related fashion 7 days post-inoculation. Thus, these classes of bioregulators are further implicated in the development of nematodes. Helminthic Diseases Laboratory, Animal Parasitology Institute, A.R.S., U.S.D.A., Beltsville, MD 20705.

FORTNUM, B. A., and R. E. CURRIN III. Effects of soil temperature on the development of Meloidogyne arenaria on tobacco.

The Meloidogyne incognita resistant flue-cured tobacco cultivar 'NC95' was used to evaluate the effects of initial population (Pi) and temperature on the reproduction of Meloidogyne arenaria races 1 and 2. Seedlings were placed in 15-cm pots and inoculated with Pi levels 0, 1500, 3000 and 6000 eggs/plant. Soil temperature was held constant at 20, 25, 30, and 35 C in a greenhouse using water-filled baths. M. arenaria race 1 produced fewer eggs than M. arenaria race 2 at all temperatures. Reproduction of M. arenaria race 1 was positively correlated ($P = 0.01$) $r = .59$ with temperature with the highest levels of egg production at 35 C. M. arenaria race 2 produced fewer

eggs as the temperature increased to 30 C however the egg production increased at 35 C. Egg production was positively correlated (P = 0.01) r = 0.49 and 0.64, respectively, to the Pi at 20 and 25 C for M. arenaria race 2. Clemson University , Pee Dee Research and Education Center, P.O. Box 271, Florence, SC 29503.

FORTUNER, R. The future of nematode identification.

Theoretical and practical problems raised by identification of plant nematodes are discussed. It is shown that traditional identification devices (dichotomous and tabular keys) are useful only for expert identifiers. An alternate system, using computer artificial intelligence (expert-system) is proposed. The new identification method, which could be built at the end of a four-year study, could be used by nematologists with a minimum level of expertise (to be defined during the study). It would help teaching as well as routine identification. California Department of Food & Agriculture, Analysis & Identification, Room 350, 1220 N Street, Sacramento, CA 95814.

FRECKMAN, D. W., W. G. WHITFORD, and R. A. VIRGINIA. Soil microarthropods and nematodes in deep desert soils.

The seasonal depth distribution of soil fauna under the woody legume mesquite (Prosopis glandulosa) was studied at 4 sites of decreasing water storage and potential rooting depth (playa>wash>dunes>grassland) at the Jornada LTER (Las Cruces, NM). Three soil cores/site/season were analyzed for microarthropods and nematodes to depths of 15, 9, 7, and 5 m, respectively. Fauna numbers and diversity decreased with depth at all sites. Mites occurred at depths >5 m at the playa, with Tydeid mites at 12-13 m. Nematode densites decreased in order grassland (5100/kg soil) >playa>dunes>wash (1471/kg soil). Nematode densities and community structure were dependent on the extraction technique used. Bacterivores were the most abundant tropic group except at the wash, where plant feeders dominated. Soil fauna are a component of these deep soil communities. University of California, Riverside, CA 92521; New Mexico State University, Las Cruces, NM 88003; and San Diego State Univ., San Diego, CA 92182.

GEORGIS, R. and W. WOJCIK. The effect of entomogenous nematodes Heterorhabditis heliothidis and Steinernema feltiae on selected predatory soil insects.

Under laboratory conditions Heterorhabditis heliothidis NC strain and Steinernema feltiae All strain applied at different concentrations caused little or no infection in various stages of the following predatory soil insects: Carabid beetles, Staphylinid beetles, Cicindelid beetles, and Labidurid earwigs. Similar results were obtained when insect hosts infected with nematodes were exposed to their predators. The use of nematodes against insect pests should have little detrimental effect upon populations of these

beneficial insects. Biosis, 1057 East Meadow Circle, Palo Alto CA 94303.

GIBLIN, R. M., K. GERBER and R. GRIFFITH. Comparison of Rhynchophorus species as vectors of the Red Ring Nematode, Rhadinaphelenchus cocophilus.

Experiments were conducted to compare the ability of Rhynchophorus cruentatus and R. palmarum palm weevil larvae to remove live juveniles of Rhadinaphelenchus cocophilus from their hemocoels. Pairwise comparisons within the same weevil species were made with larvae of similar wet weights. One larva of the pair was boiled for 3 min and cooled to ambient temperature. Both larvae were injected with 10,768 ± 1,580 R. cocophilus in a 100 ul volume of cooled physiological saline and incubated for 30 min at 35 C. The larvae were then dissected and the nematodes counted. At the end of the incubation, live larvae yielded 1.4 ± 1.9 and 2.3 ± 3.3, and boiled larvae yielded 3529 ± 2129 and 6614 ± 1845 nematodes for R. palmarum and R. cruentatus, respectively. These data suggest that R. cruentatus has a heat sensitive defense mechanism against R. cocophilus in all or most of its populations and may be similar to R. palmarum in its vector potential for the Red Ring Nematode. IFAS, University of Florida, Ft. Lauderdale Research and Education Center, 3205 College Ave., Fort Lauderdale, FL 33314.

GIBLIN, R. M., B. B. NORDEN, and S. W. T. BATRA. The association of Bursaphelenchus sp. with the digger bee, Anthophora abrupta.

An undescribed species of Bursaphelenchus, resembling the pinewood nematode, B. xylophilus, was recovered from the reproductive tracts of males and females of the soil-dwelling bee, Anthophora abrupta. Adult A. abrupta were dissected and examined from two locations in Maryland in June, 1986. Dauer juveniles were recovered from 3% (n=30) of the male bees from Baltimore Co. and 79% (n=29), of female bees from Prince Georges Co. The dauers were confined to the aedegus of males, and the oviducts, Dufour's gland, and poison sac of female bee. This species of Bursaphelenchus was cultured from bees into xenic culture on glycerol supplemented (5% v/v) potato dextrose agar (GPDA). Monoxenic cultures of this nematode have been established on GPDA with Monilinia fructicola, Botrytis cinerea and a species of Monilia isolated from the body of A. abrupta. Comparisons will be made between this species of Bursaphelenchus and B. seani, an associate of the digger bee, A. bomboides. IFAS, University of Florida, 3205 College Ave., Ft. Lauderdale, FL 33314.

GORDON, R. and M. E. BROSNAN. Polyamines in the mermithid nematode, Romanomermis culicivorax.

Mosquitoes (Aedes aegypti) were experimentally infected with preparasites of the mermithid nematode Romanomermis culicivorax and the polyamine and free amino acid composition of parasitic juveniles, post parasitic juveniles, adults and eggs determined using an amino acid analyzer. Putrescine, cada-

verine, spermidine and spermine were present in the nematodes, along with traces of N^1-acetyl spermidine and N^8-acetyl spermidine. The highest concentrations of polyamines and free amino acids were found in the egg stage. Polyamines, important compounds for nucleic acid and protein synthesis, may constitute necessary components of in vitro culture systems. Department of Biology and Department of Biochemistry, Memorial University of Newfoundland, St. John's, Newfoundland, Canada.

GREEFF, M. S. Spectroradiometry in research and management of nematodes.

A new and unique research program has been established in South Africa to evaluate and implement the use of a portable spectroradiometric system for identification and monitoring of crop stress induced by biotic and environmental factors. Primary emphasis in the program is directed at the assessment of crop stress induced by nematodes and by the interacting effects of nematodes with soil type and soil moisture status. Trials are being conducted in the greenhouse and microplots using cotton tobacco and maize as host plants. This research will contribute toward a data base for the interpretation of remotely sensed images, as well as the definition of improved crop management strategies. Tobacco and Cotton Research Institute, Private Bag X82075, Rustenburg, 0300, Republic of South Africa.

GRIFFIN, G. D., D. L. CREBS, M. D. RUMBAUGH, and D. A. JOHNSON. Resistance and susceptibility of different leguminosae species to Meloidogyne hapla and M. chitwoodi populations.

Species of Astragalus, Coronilla, Hedysarum, Lathyrus, Lotus, Medicago, Melilotus, Onobrychis, Trifolium, and Vicia differed in plant growth and nitrogen fixation to inoculations of three populations of Meloidogyne hapla and one population of M. chitwoodi. The nematode populations also differed in the degree of root galling and nematode reproduction. A. falcata, A. cicer, L. corniculatus, and Melilotus officinalis were the best hosts of M. chitwoodi, M. hapla (CA), M. hapla (UT), and M. hapla (WY), respectively. Lathyrus sp. was the only nonhost of all the nematode populations. The average percentage reduction of nitrogen fixation for whole plants of all the plant species was 11, 14, 44, and 44% for M. chitwoodi, and the CA, UT, and WY M. hapla populations, respectively. Nitrogen fixation reduction, when calculated on a root basis was 01, 24, 46 and 58% for M. chitwoodi and the CA, UT and WY populations, respectively. USDA-ARS Forage and Range Research Laboratory, Logan, UT 94322-6300.

GRIFFIN, G. D., F. A. GRAY, and D. A. JOHNSON. The effect of Meloidogyne hapla on resistance and susceptibility of alfalfa to Phytophthora megasperma.

There was a synergistic interaction ($P < 0.05$) between M. hapla and P. megasperma on Deseret alfalfa, susceptible to both M. hapla and P. megasperma, and Apollo II alfalfa, susceptible to M. hapla and resistant to P. megasperma. Plant mortality and plant growth suppression were significantly increased when inoculation with M. hapla preceded that of P. megasperma. The greatest mortality rate and growth suppression occurred in clay soil. M. hapla galling was not affected by P. megasperma, but nematode reproduction was significantly increased with simultaneous or preinoculation with P. megasperma. P. megasperma did not affect the resistance of Nevada Synthetic XX to M. hapla, and M. hapla did not increase the susceptibility of Nevada Synthetic XX to P. megasperma. USDA-ARS Forage and Range Research Laboratory, Logan Utah 84322-6300; Plant Science Department, University of Wyoming, Laramie, Wyoming 82071.

HAFEZ, S. L., D. MILLER and K. HARA. Yield response due to nematode resistance in alfalfa cultivars when infected with Ditylenchus dipsaci and Meloidogyne hapla.

The purpose of this study was to determine the effects of stem and Northern root-knot nematodes on the yield of different alfalfa cultivars, each with varying degrees of nematode resistance. Four commercial alfalfa cultivars (Apollo II, Lahonton, Ranger, and Washoe) and two experimental cultivars (Exp. 49 and Exp. 107), all with varying levels of resistance, were evaluated for their response to infestations of stem and Northern root-knot nematodes under greenhouse conditions. Cultivar foliage yield data were obtained from inoculated and non-inoculated plants, with a minimum of 60 plants in each cultivar treatment. Except for root fresh weight of the root-knot nematode study, the magnitude of the yield reductions appeared to be influenced by cultivar resistance levels. University of Idaho, Department of Plant, Soil and Entomological Sciences, SW Idaho Research and Extension Center, Parma, Idaho.

HARRIS, A. R. Resistance to Xiphinema index and field performance of Vitis rootstocks.

Thirty-eight grapevine (Vitis spp.) rootstocks, including 23 previously untested Californian hybrids, were screened in pots for resistance to an Australian population of the dagger nematode, Xiphinema index. Resistance ratings were based on visible root symptoms and on changes in the nematode populations over 16 months. Nineteen of the Californian hybrid rootstocks were resistant, as were Harmon, Freedom, Schwarzmann and 3309. The phylloxera (Daktulosphaira vitifoliae) - resistant rootstocks ARG 1, 110 R, 1202 and 1616 were susceptible to X. index. Thirty-five rootstocks were also screened over 10 years by planting in a vineyard infested with X. index and grape phylloxera in north-eastern Victoria. Most of the California hybrid rootstocks produced significantly higher yields on their Chasselas scions

than the traditional phylloxera-resistant rootstocks. Five new hybrids plus Dog Ridge and Ramsey produced high yields of high quality fruit, and were vigorous and easy to propagate; they also have resistance to X. index or phylloxera, so they deserve further testing. Department of Agriculture, Sunraysia Horticultural Research Institute, Irymple, Victoria, 3498, Australia. Present address: Department of Plant Pathology, University of California, Davis, CA 95616.

HARTMAN, K. M., and K. R. BARKER. Influence of temperature on motility of Sphaeronema sasseri and Pratylenchus macrostylus, and aspects of their population dynamics.

A study of Sphaeronema sasseri and Pratylenchus macrostylus focused on the effects of temperature on their motility, and their temporal and spatial population dynamics at Black Mountains, NC. Soil samples from Fraser fir trees were processed via modified Baermann trays at different temperatures. Nematodes were collected from the trays at 1, 2, 3, 6, 9, and 11 days, identified, and counted. S. sasseri was motile over a temperature range of 2.5 to 22 C. The greatest yield of S. sasseri occurred between 13 and 18.5 C. P. macrostylus exhibited a similar trend in response to temperature as that of S. sasseri. Population studies included a general survey and monitoring of twelve, 2-m-diam, single-tree plots from August through October of 1986. Both nematodes occurred in declining forests, especially at higher elevations. Based on soil elutriation and sugar flotation-centrifugation assays, population levels of S. sasseri did not change significantly between sampling dates. However, levels of P. macrostylus increased from the first to the second sampling date and then declined ($P = 0.05$). Preliminary results indicate that both root and soil assays are needed in population studies of these nematodes. Department of Plant Pathology, North Carolina State University, Raleigh, NC 27695-7616.

Paper Withdrawn

HEALD, C. M., B. D. BRUTON, and R. M. DAVIS. The influence of Glomus intraradices, Meloidogyne incognita, and soil phosphorus levels on Cucumis melo.

The effects of Glomus intraradices and Meloidogyne incognita on cantaloup at 3 soil phosphorus levels were studied in a greenhouse. Cantaloup growth was significantly increased in soil inoculated with G. intraradices at soil phosphorus levels of 50 and 100 ppm compared to growth in noninoculated soil. Meloidogyne incognita significantly reduced the measured growth parameters of plants grown in soil amended with 50 and 100 ppm phosphorus. At all soil phosphorus levels the growth parameters of cantaloup infected with G. intraradices and M. incognita were equal to or greater than the growth parameters of the control plants. Mineral levels in plant tops generally declined as phosphorus levels increased. Neither phosphorus soil amendment nor mycorrhizae reduced nematode infection. Subtropical Agricultural Research Laboratory, P. O. Box 267, Weslaco, TX 78596.

HYMAN, B. C., J. J. PELOQUIN, and E. G. PLATZER. Physical constitution of the Meloidogyne chitwoodi mitochondrial genome: Application for molecular diagnostics.

M. chitwoodi, the Columbia root-knot nematode, results in severe wheat and potato crop losses in the Pacific Northwest. Because of similarities in general morphology and pathogenic symptoms, diagnosis of M. chitwoodi infections is difficult to distinguish from other closely related Meloidogyne spp., M. hapla and M. incognita in particular. As we have previously demonstrated the diagnostic utility of mitochondrial DNA (mtDNA) for nematode identification, we have begun to physically characterize the M. chitwoodi mitochondrial genome. Restriction enzyme analysis has revealed that this mtDNA is ~20 kb and shares many DNA fragments in common with M. incognita, M. arenaria, and M. javanica. However, restriction products are distinctly different between M. chitwoodi and M. hapla, and useful diagnostic bands have been identified between M. chitwoodi and M. incognita. Molecular cloning and sequence analysis of these individual DNA fragments will confirm the diagnostic potential of these diverging mtDNA loci in a rapid soil DNA hybridization assay that we have developed. Departments of Nematology and Biology, University of California, Riverside, CA 92521.

HYMAN, B. C. and K. C. WEISS. Physical and genetic constitution of the Romanomermis culicivorax mitochondrial genome.

R. culicivorax, an obligate parasitic nematode of mosquitoes, contains a remarkably large (26 kb) mitochondrial DNA (mtDNA) that is present within field populations as three separate but closely related size polymorphisms (Powers et al. Curr. Genet. 11, 71, 1986). A 3.2 kb EcoRI restriction fragment has been isolated by molecular cloning that contains DNA sequences which contribute to the large mtDNA size and its polymorphisms. Hybridization analysis has revealed the presence of at least two independent DNA sequence elements within this fragment, each repeated twice in the mitochondrial genome. Distinct from these reiterated sequences is 600 base

pairs of DNA not found in cognate regions derived from other polymorphic forms of the mtDNA present in the original field population. Available DNA sequences information reveals that this locus is A+T rich and is populated by poly-dA and poly-dT tracts. Additional sequencing information will reveal the fundamental structure of the various DNA elements contributing to this unique mitochondrial genome. Department of Biology, University of California, Riverside, CA 92521.

HUETTEL, R. N. In vitro screening of Radopholus citrophilus and R. similis to soybean cultivars.

Radopholus citrophilus and R. similis from Florida were screened in vitro to determine their pathogenicity to 15 cultivars of soybean, Glycine max. Three petri plates (replicated 4X) containing Gamborg's B5 medium and two roots of each host plant were inoculated with ca 50 nematodes. After 5 wks incubation at 25 C, counts were determined for mixed life stages and eggs from roots that had been removed from the agar, stained in acid-fuchin and homogenized. Two black-seed varieties known to be resistant to other nematodes were highly susceptible to R. citrophilus and moderately susceptible to R. similis. Counts from the other 13 varieties were, in general, lower for R. similis than R. citrophilus. These results indicate that these two species could be potential problems on soybeans grown in subtropical and tropical areas of the world. USDA ARS, Nematology Laboratory, Beltsville Agricultural Center-West, Beltsville, MD 10705.

IBRAHIM, I. K. A., M. A. REZK, and A. A. M. IBRAHIM. Resistance of barley and wheat cultivars to Meloidogyne spp.

The reactions of 5 barley and 8 wheat cultivars to the root-knot nematodes Meloidogyne renaria race 1 (MA), M. incognita race 1 (MI-1) and race 3 (MI-3), and M. javanica (MJ) were determined in the greenhouse. Seeds of the tested cultivars were sown in 20-cm-d clay pots containing autoclaved sandy loam soil. A week after emergence, seedlings were thinned to six/pot and the soil was infested with 10,000 nematode eggs per pot. Nematode treatments and untreated control were replicated 5 times. Plants were assessed for nematode infestation 70 days after inoculation. The results showed that barley cvs Bonus, CC 89, CC 163, Giza 121 and Sahrawy were resistant to MA but susceptible or moderately susceptible to the other nematode populations except cvs Bonus and CC 163 were resistant to MI-3 and MI-1, respectively. The wheat cvs Giza 155, Giza 157, Sakha 8, Sakha 61, Sakha 69, Sakha 80, Stork and Line 2188 X 1131 were resistant to the tested root-knot nematodes except cvs Giza 155 and Giza 157 were susceptible to MJ. Department of Plant Pathology, College of Agriculture, Alexandria University, Alexandria, Egypt.

ICHINOHE, M. Development and current status of nematology in Japan.

Bibliography of nematology in Japan compiled by Minagawa et al contains 6,624 references since 1879, of which 5,492 or 83% are those during the last 30 years (1955-84). 1) The first nation-wide nematode inspection program started in 1959, and 36 nematode species in 30 genera were considered important. 2) Since 1968, an extensive study on the biology of the rice root nematodes revealed that every rice paddy in Japan is heavily infested by Hirschmanniella spp., but reduction in yield remained controversial. 3) Association of pine wood nematode, Bursaphelenchus xylophilus, with the pine wilt disease demonstrated a typical symbiosis between a nematode and an insect with a common host plant in 1971. 4) Potato cyst nematode, Globodera rostochiensis, occurred in 1972, and subsequent research has been conducted. 5) Japanese Nematological Society was founded in 1972, and 16 vols. of Japanese J. of Nematology included nearly 200 articles on taxonomy, bionomics, and control of various nema groups. 6) New approaches to nematology appear on studies of insect-parasitic nematodes, biological control utilizing microorganisms, isolation of hatching substance of soybean cyst nematode, physiology of Caenorhabditis, and so forth. Hokkaido National Agricultural Experiment Station, Hitsujigaoka, Sapporo 004, Japan.

Paper Withdrawn

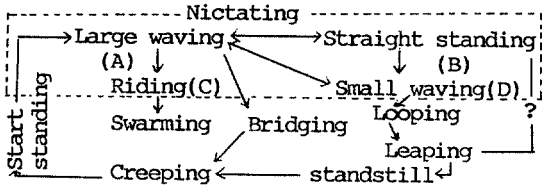
Paper Withdrawn

INGHAM, R. E., J. M. SCHROEDER and R. GARREN. Seasonal, vertical and horizontal distribution of plant parasitic nematodes in Oregon highbush blueberry.

Population dynamics of plant parasitic nematodes were followed in three Oregon highbush blueberry fields by taking 10 samples from each field each month for one year. Pratylenchus populations reached peak densities in July and August but declined rapidly in the fall. Xiphinema numbers were moderately high from January to April, increased in May and then decreased sharply by July. Trichodorus was abundant between February and May and between August and November but densities were very low during the summer. Few nematodes were found in the top three inches of soil or in the sawdust mulch. Pratylenchus densities were not different between 3-9 in. and in 9-15 in. depths but Trichodorus was more abundant at 9-15 in. Numbers of Pratylenchus at 1 foot and 2 feet from the base of the plant were similar but Trichodorus was more abundant at 1 foot. Little difference was noted between densities within rows and densities between rows at the same distance from the plant base. Departments of Botany and Plant Pathology and Horticulture, Oregon State University, Corvallis, OR 97331.

ISHIBASHI, N., T. TABATA, and E. KONDO. Movements of Steinernema feltiae infective juveniles with emphasis on nictating behavior.

Movements of S. feltiae infective juveniles (Ji3) were observed on various media comparing with propagative 3rd stage (J3). 1. Undulations; 80-90, 50 and 5,3 per min for Ji3, J3 in saline liquid, and on 2% agar at 25C respectively. J3 ceased movements after 12 days in liquid. Ji3 kept still 50/min. With narrower amplitude, Ji3 moved twice as distant as J3 on agar. 2. Nictating; occurred in Ji3 only, depending on texture/moisture of substratum, composed of 4 basic patterns. Straight standing Ji3 is sensitive to chemical stimulus, displaying quick falling down or small waving to the access of the stimulus. 3. Leaping; often induced by rapid change of milieu. Loop-like formation following small waving (like trembling) led to leaping. Department of Horticultural Sciences, Saga University, Saga 840, JAPAN.



ISHIBASHI, N., D-R. CHOI, and E. KONDO. Integrated control of insects/nematodes by mixing application of steinernematid nematodes and chemicals.

Application of entomogenous nematodes and chemicals together achieved control of soil insects, which was not possible with either alone. Agrotis segetum was killed by a dosage below 5 kg a.i./ha of oxamyl, and is extremely resistant to the steinernematids. The mixture of Vydate granules (3.5 kg a.i./ha) and DD-136 (2.5 X $10^5/m^2$) gave 70-99% mortality while DD-136 alone gave only 22-78% depending on the larval stage of insects. The mixture of DDVP (50%, X 2,000 dil.) and All (3-5 X 10^3/ml) against cabbage worms also gave the best results for the harvest of cabbage and control of insects. DDVP

alone at this dosage became ineffective after two applications. In addition the effective control of invading soil insects by mixing application of Vydate and nematodes (1-5 X $10^6/m^2$) to the soils treated by fumgants (Telone-II), inundative application of steinernematid nematodes into such treated soils delayed the recovery of root-knot nematodes. Soil fumigation should be compensatorily follwed by the application of beneficial nematodes. Dept. Horticulture, Saga Univ., Saga 840, Japan.

JAFFEE, B. A., D. M. GLENN, L. B. FORER, and R. L. SHAFFER. Soil texture and population densities of Xiphinema americanum (Xa) and X. rivesi (Xr).

Xa and Xr often occur in mixed populations in Pennsylvania orchards. Based on observations, we hypothesized that Xa or Xr would predominate in sandy or silty soil, respectively. Orchard soil (loam) containing both Xa and Xr (33% Xa to 67% Xr) was unamended or amended with sand or silt and planted with sudan grass in the greenhouse. After 9 or 14 mo. Xa predominated over Xr regardless of treatment, but the ratio of Xa to Xr increased most rapidly in sand-amended soil. Increase in population density of Xa was more affected by position in pot (top vs bottom half) than by amendment. Higher population densities of Xa, more roots and greater macroporosity occurred in the top position. Amendment and position had little effect on Xr. Division of Nematology, University of California, Davis, CA 95616; USDA Appalachian Fruit Research Laboratory, Kearneysville, WV 25430; Pennsylvania Department of Agriculture, Harrisburg, PA 17110; Pennsylvania State University, Biglerville, PA 17307.

JATALA, P., and C. GARZON. Detection of the potato cyst nematode Globodera pallida in pre-colombian agricultural terraces of Peru.

The center of origin of potato cyst nematodes is considered to be in the highlands of Peru where a major diversification of races of these nematodes occurs around Lake Titicaca at an altitude of about 3900 meters. There is no report of the occurrence of cyst nematodes from the Peruvian agricultural terraces, uncultivated since pre-Inca periods. Soil samples were collected from several of the numerous terraces near the city of Arequipa particularly those in the district of Mellebaya where there was intensive agricultural activities during the pre-colombian period. These terraces are located 5-6 km from the nearest agricultural activities. Potato culture, predominant in this area during ancient times, continues to the present. Globodera pallida was found in 2 of 28 terraces examined and in both cases the associated plant was S. acaule. Because of the distance of the terraces from the nearest agricultural activities and the long history of disuse of these terraces, the G. pallida found in these samples may have originated with primitive agricultural activities and survived on wild potatoes. International Potato Center, Apartado 5969, Lima, Peru.

JENNINGS, P. L. and E. C. BERNARD. Effect of wheat on Heterodera glycines under greenhouse conditions.

Wheat can suppress Heterodera glycines (Hg) juvenile densities when grown as a cover crop preceding soybean. Greenhouse experiments were conducted to determine the duration and nature of the wheat effect. In one study, wheat was planted in steam-sterilized soil infested with Hg eggs and allowed to grow 15, 30, or 60 days, then excised. Soybean seedlings were then planted and grown 20, 40, or 60 days, after which yellow females and juveniles in roots were counted. In 30 and 60-day wheat + 20-day soybeans, female and juvenile numbers were strongly reduced compared to all other combinations. In another experiment, soybeans were grown in nylon-screen soil cylinders surrounded by Hg-infested soil planted with wheat or sunflower, amended with nylon fibers, or otherwise undisturbed. Females were counted six weeks later. Hg female numbers were significantly lower in pots with wheat and sunflower than in soybean-only controls. The fiber-amended treatment was intermediate. Reduction in Hg invasion may be due to a combination of root exudate activity and mechanical interference with host-finding. Department of Entomology and Plant Pathology, University of Tennessee, Knoxville, TN 37901-1071.

JOHNSON, A. W. Nemagation via overhead irrigation.

Many growers are using irrigation systems to apply agricultural chemicals with the water. The method, called chemigation, initially included only materials such as plant nutrients that generally required incorporation into the soil for effectiveness. Chemigation technology including irrigation system design, improved chemical injection equipment, and widespread development and use of agricultural chemicals is expanding. Since 1978, a small-plot irrigation simulator, a solid-set irrigation system, and a center-pivot irrigation system have been used to compare "nemagation" with conventional application method. No differences in efficacy of fenamiphos or crop response have been observed. Fenamiphos has been applied via nemagation to many vegetable and agronomic crops, and yields have been increased 3 - 1170% over those in untreated plots infested with nematodes. Ths new methods of application suggests that nematicides could be used as a salvage alternative when nematodes are detected in crops soon after planting. In addition, cochemigation of nematicides with other pesticides is promising for multiple pest control in crop production systems. USDA, ARS, Coastal Plain Experiment Station, Tifton, GA 31703.

JOHNSON, A. W., A. S. CSINOS, N. C. GLAZE AND A. M. GOLDEN. Cochemigation for multiple pest control on tobacco.

Nematodes, insect, the black shank fungus and weeds are major pests of tobacco. Herbicides (isopropalin, pendimethalin, pebulate), an insecticide (chlorpyrifos), a fungicide (metalaxyl), and a nematicide (fenamiphos) were tank mixed and applied 1) preplant incorporated with a conventional sprayer-rototiller, 2) preplant incorporated with an irrigation simulator in 0.25 inches of water, and 3) post plant (3 days after transplanting) as in 2. K-326, McNair 944, NC 2326 and Speight G-7 that vary in resistance to Meloidogyne incognita and Phytophthora parasitica var. nicotianae were

transplanted in treated plots. Root-gall indices of K-326, but not other cultivars, were lower (P=0.05) in treated plots than in untreated plots. Percent disease and disease index of NC 2326 and K-326 were lower in treated plots than in controls. Acceptable weed control resulted in all plots. Yield increase from treatments varied with cultivar, but was greatest in NC 2326. Cochemigation for multiple pest control on tobacco is promising. USDA, ARS, Coastal Plain Experiment Station, Tifton, GA 31793.

KALOSHIAN, I., P. A. ROBERTS, and I. J. THOMASON. Expression of resistance to Meloidogyne javanica in a synthetic allohexaploid developed from durum wheat and Aegilops squarrosa.

A synthetic allohexaploid wheat line made from a cross of durum wheat (Triticum turgidum 'Produra') and Aegilops squarrosa was compared with its parents for resistance to Meloidogyne javanica. Produra and Ae. squarrosa were used as susceptible and resistant parents to the nematode, respectively. Wheat seedlings, in 500 cc sandy soil, were inoculated with 5000 eggs and maintained at 25-27 C for 70 days. The reproductive rate of M. javanica, expressed as eggs per gm of fresh root, was highest on Produra (7970), followed by Chinese Spring (Triticum aestivum)(4207), and very low on the synthetic allohexaploid (174) and Ae. squarrosa (194). Chinese Spring lines are used for their genetic markers to study the location(s) of the resistant gene(s) on chromosome(s) of the DD genome. The DD genome in the synthetic allohexaploid is from Ae. squarrosa. Department of Nematology, University of California, Riverside, CA 92521.

KAYA, K. H., H. Y. CHOO, and T. M. BURLANDO. Influence of plant roots on the infectivity of Heterorhabditis heliothidis to insect hosts.

The ability of the entomogenous nematode, Heterorhabditis heliothidis, to find and infect its insect host was not impaired by the presence of sparse corn roots (0.33 g dry weight). Five infective nematodes placed on the soil surface dispersed 8 cm downwards and infected the host within 48 hours. No significant difference in nematode mortality of the insect host was observed between soil with or without sparse roots. However, high root density (1.55 g dry weight) affected host mortality. Insect mortality by H. heliothidis was significantly lower in the high root density treatment than no roots at all. Division of Nematology, University of California, Davis, CA 95616 and Department of Plant Protection, Gyeongsang National University, Jinju 620, Republic of Korea.

KHAN, B. A., A. DEVAUX, and P. JATALA. Presence of Globodera pallida in some potato growing areas of Pakistan.

Occurrence of Globodera rostochiensis in certain potato growing areas of Pakistan has been reported, however, no mention of the presence of G. pallida was made. In serial sampling of the G. rostochiensis infested areas we

suspected the presence of G. pallida. To confirm our findings, soil samples were collected from potato growing areas of Kalam, Gabral, Bafer, Matiltan, Malam Jaba, and Utrore in the North West Frontier Province at altitudes of 1850-2460 meters above sea level. Cysts were extracted and processed for taxonomic identification. G. pallida was found in the areas of Kalam, Gabral, Matiltan, and Utrore with the same frequency as G. rostochiensis. Cysts of a Heterodera species were found in some samples. Additional surveys are warranted to determine the extent of the distribution of these nematodes in Pakistan as well as their economic importance. CDRI, NARC, Pakistan Agricultural Research Council, Islamohad, Pakistan Swiss Potato Development Project, PARC Islamahad, and International Potato Center, Apartado 5969, Lima, Peru.

KIM, D. G. and R. D. RIGGS. Control of Heterodera glycines by a fungus parasite.

During a survey for antagonists of Heterodera glycines (SCN) in Arkansas, an unidentified fungus was found parasitizing eggs of SCN. This fungus grew well at 25 C on cornmeal agar and has a wide pH range. The fungus parasitized eggs within cysts of SCN on agar and in pots when inoculated with pelleted fungus or rice grain cultured inoculum. In 10 days, 54 and 50% of eggs in cysts were parasitized at 20 and 25 C, respectively with less at 15 or 28 C and 2 - 25% more larvae emerged in fungus treated dishes. About 30% of Meloidogyne incognita eggs were diseased. SCN-inoculated Lee soybeans had fewer females and eggs in fungus-treated soil than in control. Pelleted fungus (PF)-15g + 10g cornmeal or PF-25g was better than PF-15G alone. SCN females were reduced 99, 88 and 76%, respectively, by the three treatments. PF-15g applied 1 week pre-plant and at-plant was more effective than 1 week post-plant. A mycelium suspension was least effective. This fungus may be a useful biocontrol agent against H. glycines. Dept. of Plant Pathology, University of Arkansas, Fayetteville, AR 72701.

KING, PEGGY S., and R. RODRIGUEZ-KABANA. Metam-sodium for control of nematodes in peanut and soybean.

The efficacy of Busan® 1020 (32.7% metam-sodium) for control of Meloidogyne arenaria in Florunner peanut was studied for 2 years in southeast Alabama. Preplant applications at rates of 0-280 L/ha resulted in increased yields. The relation between yield (Yp) in Kgs/ha and fumigant rate in L/ha could be described (R^2+0.98**) by $Yp=3371e^z$ where $z=(x-215.70)^2/(-191895.6)$. Busan 1020 treatments reduced numbers of M. arenaria juveniles in soil both years of the study. Results of a study in southwest Alabama on the effects of preplant applications of Busan 1020 on soybean nematodes evidenced a linear equation (R^2+0.98**) between Ransom soybean yields (Ys) in Kgs/ha and fumigant rates in the range of 0.234 L/ha; the equation was Ys=327.351 + 1.766x. Busan 1020 had no effect on juvenile populations of Heterodera glycines in soil; however, application rate was related (R^2=0.99**) to numbers of M. incognita juveniles in 100 cm^3 soil (J) by: $J=518.83e^t$ where $t=(x-103.15)^2/(-34143)$. Dept. of Plant Pathology, Ala. Agric. Exp. Stn., Auburn University, AL 36849.

KINLOCH, R. A. The population dynamics of Criconemella sphaerocephala and the nematode's relationship to sorghum yield.

The numbers of C. sphaerocephala per 10 cm^3 soil were monitored every 20 days in replicated plots planted to sorghum for two years in Santa Rosa County, Florida. Average numbers at planting (Apr) were 54 and 86 in the successive years. A maximum of 356 was recovered 65 days following planting in the first year and 510 after 85 days in the second. These were followed by rapid declines in numbers, suggestive of biological control, such that nematode numbers were approximately the same at planting as at 140 days when sorghum roots were still viable. In a third year, plant heights (Y), which ranged from 18-38 cm among 28 plots 33 days following planting of cv. Seedtec 686, were related ($P<0.01$) to preplant nematode numbers (X) which ranged from 0-116: $Y = 30.09 - 0.09X$, $r = -0.7$. Seed yields (Y), which ranged form 2931-7273 kg/ha 107 days after planting, were related ($P<0.01$) to the same numbers: $Y = 6226 - 18.9X$, $r = -0.7$. University of Florida, AREC, Route 3, Box 575, Jay, FL 32565-9524.

KO, M. P., and S. D. VAN GUNDY. An alternative gelling agent for culturing and studies of nematodes.

Aqueous solutions of Pluronic polyol F127 may gel at room temperature but liquefy at lower temperatures, and therefore may become embedding substrates for the in vivo studies of nematode-plant-microbe interactions. As a preliminary to such usage, the effects of the polyol on the growth of selected species of nemtodes, soil microorganisms, and/or plant tissues were investigated. Growth of fungi, bacteria, and actinomycetes in culture media were found to be generally less sensitive to various polyol concentrations than were nematodes and plant tissues. However, almost all of the test organisms developed comparably for at least 2 weeks in 20% (w/v) polyol culture media as in similar 1.5% (w/v) agar media. A plain 20% polyol medium was found to be more transparent, more premeable to air or non-polar chemicals, and less prone to microbial contamination than a plain 1.5% agar medium, especially under non-aseptic conditions. Thus, the polyol gelling agent has potential as a useful tool for short term studies of rhizosphere microbe-nematode interactions. Department of Plant Pathology, Cornell University, Ithaca, NY 14853.

KOTCON, J. P. Association of soil type and texture with population density and distribution of Pratylenchus and Xiphinema species in peach orchards.

Nematode population denstiy was determined in spring, 1986 from 205 peach orchard blocks located in Jefferson, Berkeley, and Hampshire counties in West Virginia. Samples from 14 soil series were grouped into three classes based on texture: silt loams (SL), rocky, gravelly, or cherty fine sandy loams and silt loams (RG), and clay loams (CL). The most common plant parasitic nematodes extracted were Xiphinema spp. and Pratylenchus spp. X. americanum was most numerous in eroded RG in ridgetop orchards but also was common in other

soil types. X. rivesi was limited to valley orchards; population densities were greater in SL than RG or CL. Population densities of P. penetrans and P. crenatus were greatest in CL while those of P. neglectus were greater in SL than in RG or CL. Orchard soils conducive to pathogenic nematodes require more intensive nematode management. Div. of Plant and Soil Sciences, West Virginia Univ., P. O. Box 6057, Morgantown, WV 26506.

KRECEK, R. C., R. M. SAYRE, H. J. ELS, J. P. VAN NIEKERK, and F. S. MALAN. Fine structure of the bacterial community associated with cyathostomes of zebras.

Microorganisms that attached to the posterior and anterior extremities of zebra cyathostomes were studied with scanning electron and transmission electron microscopy. The predominant constituent of the microbial community was a filamentous prokaryotic organism which bears resemblance to Arthromitus Leidy, 1849. The organism was associated with the vulvar and anal openings of the female's posterior end. The other organisms in the community included those with a filamentous-cross wall, a distinct double-cell wall, a blunt-end and spiral in shape. While these microbes were not observed to invade tissues of the cysthostome hosts, they may partially block the reproductive tract of nematodes limiting their reproductive capacity. The prokaryotic organisms largely appeared to be commensals living in the effluent of the nematodes. Department of Parasitology, University of Pretoria, Onderstepoort 0110, South Africa and Nematology Laboratory, ARS USDA, Beltsville, MD 20705.

LAWSON, E. C. and M. J. BRACKIN. Bacterial adhesion to Meloidogyne cuticle and egg surfaces.

Many bacteria produce adhesion molecules which serve to assist in colonization of surfaces and environments, particularly those in which they may be washed away from food sources. We have identified a number of enteric bacteria and pseudomonads which agglutinate yeast cells (S. cerevisiae 20 B12), acridine orange stained manno-gel microbeads (E-Y labs) and bind to M. incognita larvae and eggs. A cell free extract, labeled with biotin/fluorescent avidin, agglutinated yeast cells and was observed microscopically to adhere to nematode egg surfaces. Partial purification by HPLC gel filtration followed by SDS-PAGE identified a prominent protein peak associated with yeast agglutination. Buffers, salts and sugars were observed to have various effects on yeast agglutination and egg binding. Dept. of Biological Sciences. Monsanto Co. 700 Chesterfield Village Pkwy., St. Louis, MO.

LEHMAN, P. S. and N. DWYER. Evaluation of techniques for extracting nematodes from rockwool.

Rockwool, a fibrous material spun from volcanic rock, is widely used as an insulation material. I has become increasingly popular in recent years as a horticultural growing medium. Because of the unique properties of this

medium, the efficiency of four methods for extracting nematodes from rockwool was evaluated. Rockwool blocks were initially inoculated with 200 Meloidogyne incognita juveniles. Following are the methods that were tested and the percentage of nematodes recovered: 1) Slicing rockwool in 1 cm slabs and placing slices on a Baermann funnel (48%), 2) Blending rockwool for 3 sec. followed by Baermann funnel processing (9%), 3) Blending followed by centrifugation sugar flotation (0%), 4) High pressure water extraction and sieving followed by centrifugation-sugar flotation (0%). Blending rockwool or using high water pressure during processing resulted in final sample solutions with hundreds of nematode sized rockwool particles that interfered with microscopic observations of nematodes. Florida Dept. of Agric. & Consumer Services, D.P.I., Bureau of Nematology, P.O. Box 1269, Gainesville, FL 32602.

LEHMAN, P. S. and N. DWYER. Movement of nematodes in rockwool during watering.

One thousand nematodes were injected into the center of rockwool cylinders, 14 cm diameter, 7 cm high. After 10 liters of water were added to the cylinders, vertical and hortizontal movement of nematodes was evaluated by dividing the cylinder into 18 zones and subsequently extracting nematodes from each zone. Water that leached through the cylinders was checked for nematodes. Tylenchulus semipenetrans and Meloidogyne incognita were tested. Similar results were obtained for both nematodes. After cylinders were watered, 84 to 85% of the nematodes remained in the injection zone. About 13% moved into the zone below the injection site and 2 to 3% moved horizontally and/or diagonally into lateral zones. No nematodes were recovered from the leachate. These studies indicate that nematodes are not readily leached from rockwool, nevertheless, with frequent watering of rockwool in the greenhouse there may be significant cross-contamination, especially if rockwool slabs are used. Florida Dept. of Agric. & Consumer Services, D.P.I., Bureau of Nematology, P.O. Box 1269, Gainesville, FL 32602.

LINIT, M. J. The role of insects in pine wilt disease transmission.

Pine wilt disease is spread when insects carry pinewood nematode, Bursaphelenchus xylophilus, dauerlarvae to non-infested host trees. Dauerlarvae of the pinewood nematode have been recovered from more than 20 species of beetles. The principal vectors are long-horned beetles in the genus Monochamus (Coleoptera: Cerambycidae). Dauerlarvae move into the respiratory trachea of newly formed adult beetles prior to beetle emergence from its host tree. Individual Monochamus adults can carry more than 200,000 dauerlarvae; however, mean nematode densities reported in North American and Japanese studies are typically about 10,000 nematodes per beetle. Dauerlarvae can enter healthy trees through Monochamus feeding wounds on young twigs and branches, or stressed trees and recently cut logs through Monochamus oviposition sites. Entomology Department, University of Missouri, Columbia, MO 65211.

Paper Withdrawn

MACGUIDWIN, A. E. and D. I. ROUSE. Influence of Pratylenchus penetrans, Meloidogyne hapla, and Verticillium dahliae on Russet Burbank potato.

In 1986, microplots in a Plainfield loamy sand soil were inoculated with two levels of Pratylenchus penetrans and Meloidogyne hapla, alone and in combination with two levels of Verticillium dahliae to evaluate the role of nematodes in the Potato Early Dying (PED) disease of Russet Burbank potato. Levels of P. penetrans, M. hapla, and V. dahliae were 25 or 75 nematodes/100 cm^3 soil, 70 or 144 eggs/100 cm^3 soil, and 71 or 355 propagules/g soil, respectively. P. penetrans, but not M. hapla, increased the symptom expression of PED. Nematodes alone did not cause PED. Only the treatment combination of high levels of P. penetrans + V. dahlae significantly reduced ($P = 0.05$) tuber weights as compared to noninoculated controls. In a separate microplot experiment, an interaction between M. hapla and V. dahliae was observed. Department of Plant Pathology, University of Wisconsin, Madison, WI 53706.

MAMIYA, Y. History of pine wilt disease in Japan.

Pine wilt disease induced by the pine wood nematode, Bursaphelenchus xylophilus, is a great threat to pine forests in Japan. The first occurrence of the disease was reported at a locality in Kyushu. During the 1930's the disease extended into 12 prefectures. During the 1940's extensive disease spread resulted in infestation of 34 prefectures, and the annual loss of pine trees increased from 30,000 m^3 to 1.2 million m^3 through these two decades. An enormous increase in timber loss in the 1970's resulted in recorded 2.4 million m^3 of annual loss. The infested areas expanded into 45 out of 47 prefectures in Japan. The disease, in cool areas, shows fairly different aspects in epidemiology from that of heavily infested areas in the warm regions. A national project for controlling pine wilt disease lays special emphasis on the healthy pine forests extending in large scale throughout cool areas in northern Japan. Forestry and Forest Products Research Institute, P. O. Box 16, Tsukuba Norin Kenkyudanchinai, Ibaraki, 305 Japan.

MANKAU, R. and E. W. BARTNICKI. Studies on the biology of nematode-trapping fungi associated with the citrus nematode, Tylenchulus semipenetrans.

Populations of T. semipenetrans in established Southern California citrus groves are generally associated with an abundant and highly varied flora of nematodetrapping fungi (NTF) which include at least six Arthrobotrys spp. and a few Monacrosporium and Dactylaria spp. The fungi have complex relationships with the citrus rhizosphere and rhizoplane and with the nematode population. When isolated on agar media they exhibit a wide variety of growth responses, sporulation and trap formation behavior. Various amounts of specific sugars tested in a basal medium caused increased trap formation, sporulation or hyphal biomass in various species. Inorganic nitrogen caused the formation of large numbers of chlamydospores in some species, while media pH levels during initial growth interacted with low carbohydrate and organic nitrogen content to influence trap formation and sporulation in a variety of ways with different isolates. Most of the NTF trap and consume citrus nematode larvae effectively in vitro but in nature they may play an incidental cumulative antagonist role which results in the equilibration of the citrus nematode population by subtle uncontrollable interactions. Department of Nematology, University of California, Riverside, CA 92521.

Paper Withdrawn

Paper Withdrawn

MARSHALL, J. W. and A. M. CRAWFORD. A cloned DNA fragment that can be used as a sensitive probe to distinguish Globodera pallida from Globodera rostochiensis and other common cyst forming nematodes.

A small fragment of DNA (approx. 400 base pairs) from the genome of the potato cyst nematode Globodera pallida was cloned in a bacterial plasmid. The cloned DNA when used as a probe in DNA hybridizations against a range of nematodes bound only to G. pallida pathotypes Pa_1, Pa_2 and Pa_3 but not to the other potato cyst nematode species G. rostochiensis pathotype Ro_4, the cereal cyst nematode Bidera avenae, the clover cyst nematode Heterodera trifolii, the root knot nematode Meloidogyne hapla and M. incognita or the beet cyst nematode Heterodera schachtii. This test makes the rapid identification of individual nematode cysts feasible. Entomology Division, DSIR, Private Bag, Christchurch, New Zealand.

MARTYN, R. D., J. L. STARR, and M. J. JEGER. The Fusarium/root knot disease complex in cotton: Effects on plant stunting and mortality.

The individual and combined effects of Fusarium oxysporum f. sp. vasinfectum (FOV) and Meloidogyne incognita (MI) on plant stunting and mortality of two cotton cultivars (Tamcot SP37 and Tamcot CAB-CS) were assessed in field microplots. The FOV levels (0, 2.3, and 4.3 X 10^3 cfu/g soil) and 5 MI levels (0, 0.1, 1.0, 10, and 50 nematodes/100 cm^3 soil) were used in a factorial design. Assessments were made at weekly intervals beginning 2 weeks after emergence and continuing until harvest. The disease complex was manifested as both an increase in plant stunting and death, and an earliness of symptom development. There was a significant effect of MI on stunting throughout the season on each cultivar. FOV affected stunting very early but stunting was no longer apparent by the third assessment period. FOV had a significant effect on mortality of each cultivar. There were also significant effects on MI, time, and FOV X MI interaction on plant mortality. Department of Plant Pathology and Microbiology, Texas A & M University, College Station, TX 77843.

Paper Withdrawn

Paper Withdrawn

MCGAWLEY, E. C. and K. L. WINCHELL. Greenhouse reproduction of single and combined Meloidogyne incognita and M. javanica populations on soybean.

Analysis of host differential test and perineal pattern morphology data for single egg mass progeny derived from a field of severely stunted and galled 'Centennial' ('C') soybeans suggest they were coinfected with population mixtures containing Meloidogyne incognita (M.i.) and M. javanica (M.j.). Single 10 d old 'C' seedlings were transplanted to the center of 15-cm-d clay pots containing 1.5 kg of a 3:2:1: mixture of steam-sterilized soil, sand and Weblite and inoculated in quadruplicate with 2 ml water controls or root knot nematode egg suspensions (5,000/pot) containing only M.i., only M.j., or both (2,500 M.i. + 2,500 M.j.). Over 3 separate greenhouse experiments, varying in duration from 30-90 d, galling indices (0 [no galling] - 10 [severe galling]) for M.i. only, M.j. only, and M.i. plus M.j. treatments differed significantly (P = 0.05) and averaged 0, 4-6, and 7-9, respectively. Dept. Plant Path. & Crop Physiol., La. Agri. Expt. Stn., L.S.U. Agri. Ctr., Baton Rouge, LA 70803.

MCKENRY, M. V. and T. BUZO. Root lesion nematode, a major component of the walnut replant problem.

Walnut seedlings, Juglans regia and J. hindsii had reduced growth when planted to fumigated soil along with various inocula of Pratylenchus vulnus. Reduction in tree growth was apparent whether the P. vulnus inoculum was a soil extract or included roots of walnut or peach, Prunus persica. Fumigated soil inoculated with soil, walnut or peach roots free of P. vulnus tended to produce larger trees than those receiving fumigation only. Soil fumigation followed by a 3 or 18 month replanting interval provided uniform but relatively mediocre tree growth whereas non-fumigated trees or inoculated trees showed greater growth variability. Trees in fumigated soil that received inoculum of walnut soil or roots free of P. vulnus grew 75% more and were significantly larger than those receiving inoculum with P. vulnus. Trees grown in fumigated soil without any subsequent inoculum do not always grow significantly better than those non-fumigated. There must be an unknown biological factor which enhances growth of walnut trees. P. vulnus is a major parasite of walnut seedlings. Department of Nematology, University of California, Riverside, CA 92521.

MELAKEBERHAN, H. and H. FERRIS. Energy requirements of Meloidogyne incognita in grapes.

Thirty-two one-month-old French Colombard and Thompson Seedless plants were each inoculated with 2000 or 8000 Meloidogyne incognita juveniles and maintained at a constant 17.5 DD/day until 560 DD were accumulated. At 70 DD intervals, two plants from each treatment and cultivar were harvested for nematode volume measurements. Nematode volumes were determined with a digitizer and computer algorithm and fresh biomass (micrograms) was calculated. Nematode growth and food consumption (calories) rates were calculated based on biomass increase, respiratory requirements, and an assumption of 75% assimilation efficiency. Nematode growth was similar in both cultivars and inoculum levels, and most of the growth occurred between 70 and about 490 DD in a logistic form. There was no increase in size after 490 DD. The growth cost to the host for a single juvenile from penetration to maturity was approximately 0.0741327 and 0.0658309 calories in French Colombard and Thompson Seedless, respectively. The data allow consideration of nematode energy requirements, and the impact of these requirements on host physiological processes. Department of Nematology, University of California, Davis, CA 95616.

MELTON, T. A. and K. D. SIMCOX. Effects of 2,4-Dihydroxy-7-methoxy-2H 1,4-benzoxazin-3(4H)-one (DIMBOA) in corn lines on reproduction of Pratylenchus hexincisus.

The effects of DIMBOA on reproduction of Pratylenchus hexincisus on corn was observed using F2 near-isogenic lines with normal or high (BX), or low (bx) levels of DIMBOA. The lines Oh43, Oh43bx (low DIMBOA), A632, A632bx (low DIMBOA), C123 (excellent host, bx/bx (very low DIMBOA), and BX/BX (high DIMBOA), inoculated with 475 Pratylenchus hexincisus/15 cm dia pot, differed (P = 0.05) in host suitabilities. Low DIMBOA lines were good hosts, whereas normal or high DIMBOA lines were poor hosts. Oh43bx and bx/bx final nematode populations were greater than our action threshold of 1000 nemas/g dried root, whereas Oh43 and BX/BX were less. A632bx populations were below the threshold, but more than double the size of the A632 populations. Department of Plant Pathology, University of Illinois, Urbana, IL 61801.

MEYER, S. L. F. and R. M. SAYRE. Isolation and evaluation of selected fungal species potentially pathogenic on soybean cyst nematode.

Cysts of Heterodera glycines race 3 were collected from field soil and surface sterilized. Fungi were isolated from cysts on the following media: V8, potato dextrose, chitin, cornmeal, peptone yeast extract glucose, and water agar. Isolated fungi included Phoma, Neocosmospora, Epicoccum, Cylindrocarpon, and Scytalidium. These fungi, and fungal strains of Meria, Verticillium, and Trichoderma obtained from ATCC, were tested for pathogenicity on eggs of race 3. The procedure for the bioassay was as follows: Egg-producing brown and yellow cysts grown in tissue culture were placed onto

water agar and inoculated with an aqueous suspension of conidia, ascospores, and/or hyphal fragments. Control were treated with distilled water. One to two weeks after inoculation, the cysts and egg masses were suspended in water, homogenized, mounted on slides and examined for viability and for internal hyphae. Fungi with the greatest virulence on eggs will be used in further studies to attempt to improve their usefulness as biocontrol agents. Nematology Laboratory, USDA ARS, Beltsville, MD 20705.

MINTON, N. A., R. A. LEONARD and M. B. PARKER. Concentration of phenamiphos in the profile of a sandy loam soil as affected by tillage and time.

Persistence and vertical movement of phenamiphos in Dothan loamy sand (thermic Pinthic Paleudults) was studied. Phenamiphos at 2.2 kg a.i./ha was applied in 1984 and 1985 in an 18 cm wide band (10.0 kg a.i./ha broadcast equivalent) in a moldboard plow prepared soil and by the subsoil-plant method in rye stubble when soybean was planted. Irrigation was applied immediately after treatment. Soil collected at 0-10, 10-20, 20-30, 30-40, 40-50, 50-75 and 75-100 cm depths one day and 1, 3, 5, 7 and 22 wks after treatment was assayed for total toxic residues (TTR) which included phenamiphos, phenamiphos sulfoxide and phenamiphos sulfone. Phenamiphos (TTR) was detected in all depths one day and one wk after treatment in 1984 and in all depths on all sampling dates in 1985. Soil preparation methods had little effect on phenamiphos (TTR) concentrations which were greatest in the upper depths and least in the lower depths and decreased at all depths with time. The data indicate that low amounts may have moved below 75-100 cm depths. USDA, ARS and Departments of Plant Path. and Agronomy, Univ. of Georgia, Coastal Plain Expt. Stn., Tifton, GA 31793.

MOJTAHEDI, H., J. N. PINKERTON, G. S. SANTO, and R. N. PEADEN. Reproductive efficiency on Meloidogyne chitwoodi race 2 and its pathogenicity on alfalfa cultivars.

The reproductive factor (R = egg production at 55 days/5000 Pi) of Meloidogyne chitwoodi race 2 (MC2 - alfalfa race) on 54 alfalfa cultivars ranged from 1.6 to 40. W12SR2W1, an experimental alfalfa line, exhibited the highest degree of resistance to MC2. The R values for this line in three tests were 1.1-1.6. MC2 increased efficiently on commercially grown cultivars WL312 and Vernal with R values of 3.2 and 9.0, respectively. MC2 significantly ($P = 0.05$) reduced the hay dried weight by 18% at the second cutting, however, no significant differences were observed in the third cuttings. MC2 did not have a detrimental effect on the growth of WL312. M. hapla reduced plant dried weight of WL312 and Vernal by 14 to 34% depending on the time of inoculation. Damage by M. hapla was more severe when inoculated at seeding compared to 10 or 20 days after seeding. Washington State University, College of Agriculture and Home Economics, and U.S. Dept. of Agriculture-ARS. Irrigated Agriculture Research and Extension Center, Prosser, WA 99350.

MOJTAHEDI, H., G. S. SANTO, and J. H. WILSON. Host range of Meloidogyne chitwoodi race 2 (alfalfa race).

The reproductive factor (R = final egg production at 55 days/5000 Pi) of Meloidogyne chitwoodi race 2 (MC2 alfalfa race) on 44 crop cultivars was determined. The R values ranged from 0 to 130. The nonhost crops (R = 0) included asparagus, cowpea, lima bean, peanut, spearmint, strawberry, and a hybrid turnip. The reproduction efficiency of MC2 and M. chitwoodi race 1 (MC1 non-alfalfa race) was also compared on selected crop cultivars. Both races failed to increase on sugarbeet (R = 0.2), 9 onion cultivars (R = 0-0.2), and 'Style Pack' sweet corn (R = 0.2-0.6). Differences in R values for MC1 and MC2 were observed on 'Thor' alfalfa (R < 0.1 vs R = 2), 'Chantenay Red Cored' carrot (R = 6.5 vs R < 0.1) and 'Jubilee' sweet corn (R = 1.4 vs R = 3.0). Currently 'Thor' alfalfa and 'Chatenany Red Cored' carrot are being used as differential hosts to distinguish between MC2 and MC1. Contrary to previous reports, MC1 reproduced well on 'Idahybrid 303' and 'Northrup King 492' field corns (R = 6.5 and 2.2, respectively). Washington State University, I.A.R.E.C., Prosser, WA 99350.

MUNDO, M. and J. G. BALDWIN. Physiological homogeneity of the burrowing nematode in Mexico.

Radopholus similis causes great damage on banana in Mexico, and existing literature suggests physiological diversity of this nematode species. Populations from states of Chiapas, Tabasco, Veracruz, and Colima were tested against differential hosts. Reproduction occurred in banana (var. Valery), but not in coconut (Cocos nucifera), black pepper (Piper nigrum), pangola grass (Digitaria decumbens), sugar cane (Sacharum officinarum), sour orange (Citrus aurantifolia), Mexican lemon (Citrus aurantium) and other plant species. Although a few nematodes were observed in roots of beans, tomato, and other tropical plants, no reproduction was detected. Results do not support previous speculation that populations of R. similis in Mexico are physiologically variable or that Radopholus citrophilus occurs in Mexico. In addition, no morphological differences were observed among populations examined. Department of Nematology, University of California, Riverside, CA 92521.

MUNDO, M., J. G. BALDWIN, and J. JERONIMO-R. Distribution, morphological variation, and host range of Punctodera chalcoensis.

The cyst nematode, P. chalcoensis, causes severe damage to corn (Zea mays) in Mexico and was believed to be limited to areas around Chalco, near Mexico City. However, our surveys indicate distribution throughout eight central Mexican states. Comparative light and SEM observations of representative populations indicate no significant morphological variation among them. Host range tests demonstrate susceptibility of all corn cultivars, including 13 commonly grown in California. While Teosinte and certain dicot weed hosts are susceptible to P. chalcoensis, it is not yet clear if the dicots will support reproduction. Surveys will extend to northern states of Mexico to determine potential of P. chalcoensis to invade California; host range tests are also being expanded. Department of Nematology, University of California,

Riverside, CA 92521 and CIIDIR-IPN-U-Mich., Jiquilpan, Mich. Mexico.

MYERS, R. F. Pathogenesis of pine wilt disease caused by pine wood nematode, Bursaphelenchus xylophilus.

The progression of events in the development of pine wilt disease are reviewed from transmission to the death of pine trees. Data supporting the balance-differentiation hypothesis developed to explain bark beetle-pine tree interactions are applied to pathogenesis of pine wilt disease. Gross morphology and histology of normal and diseased trees will be stressed while considering predisposition, preformed and induced resistances in pines, production and toxicity of oleoresin, effects of climate and other factors that modify pathogenesis of pine wilt disease. Since growth and differentiation in trees occurs seasonally varying with geographical regions and species of pine, the relationship of nematodes in the pathogenic process is presented as a seasonal sequence rather than monthly events. Department of Plant Pathology, Rutgers University, Cook College, New Brunswick, NJ 08903.

NISHIZAWA, T. A decline phenomenon in a population of upland rice cyst nematode, Heterodera elachista, caused by bacterial parasite, Pasteuria penetrans.

In many cases soil sickness of upland rice in Japan had been attributed to H. elachista (HE) as a major causal agent. In 1980, newly developed experimental fields, which were reclaimed from a natural forest, were provided in the new premises of National Institute of Agricultural Sciences in Tsukuba Science City. We examined the occurrence and annual prevalence of the HE-population for six years, from 1981 to 1986, in experimental plots established within the new field and cultivated continuously with upland rice. A low level infestation of HE was recognized at the end of the first season and the population density increased exponentially until the fourth year. After that, the HE population change showed a drastic reduction. Apparently, a strain of P. penetrans was the major cause of this decline. High levels of P. penetrans were observed in 1985 and 1986. National Institute of Agro-Environmental Sciences, Tsukuba, Ibaraki 305, JAPAN.

NOE, J. P. Theory and practice of the cropping systems approach to reducing nematode problems.

Crop losses due to plant-parasitic nematodes are most severe in developing tropical countries, where management options are usually quite limited. A large portion of these losses could be avoided by an improved, systematic deployment of available management practices. The cropping systems approach begins with a derivation of nematode damage functions and reproductive curves using data obtained from naturally-infested field plots. Characteristic functions for each crop/nematode combination then are used to simulate the effects of cropping sequences and other management options. Constraint models are

formulated from economic and cultural information and applied to the simulation for determination of optimum management recommendations. Experimental methods have been developed to monitor nematode-host relationships using small plots on farms or in institutional research fields. These methods are being implemented in a cooperative international research effort coordinated by the USDAI-funded Crop Nematode Research and Control Project (CNRCP). Department of Plant Pathology, North Carolina State University, Raleigh, NC 27695-7616.

NOEL, G. R., and S. A. MAYASICH. Partial characterization of esterase from Heterodera glycines and inhibition by two nematicides.

Homogenates of Heterodera glycines race 3 white females from greenhouse cultures on Williams 82 soybean were clarified by centrifugation and supernatants were used to study activity of carboxylesterase (EC 3.1.1.1). Optimum temperature and pH were 40 C and 7.2, respectively. The inhibition of p-nitrophenyl acetate hydrolysis by acetazolamide (a carbonic anhydrase inhibitor), eserine hemisulfate (a cholinesterase inhibitor), aldicarb and phenamiphos was studied. Acetazolamide did not inhibit enzyme activity at concentrations of 10^{-6} to 10^{-3} M, indicating that carbonic anhydrase was not present. Phenamiphos reduced activity by 38% at 10^{-6} M, whereas eserine hemisulfate and aldicarb were not inhibitory at that concentration. Eserine hemisulfate, aldicarb and phenamiphos reduced enzyme activity by 6, 23 and 64%, respectively, at 10^{-4} M. These results indicate that aldicarb and phenamiphos are active against esterases other than acetylcholinesterase and may lead to a better understanding of nematicide mode of action. USDA ARS, Department of Plant Pathology, University of Illinois, Urbana, IL 61801.

NORTON, D. C. Occurrence of some nematodes by habitats in Iowa.

Based on 404, 119, and 358 samples collected from maize, prairies, and woodlands, respectively, in Iowa, many species are delimited mainly by habitat. Numbers of plant-parasitic species associated with maize, prairies, and woodlands were 27, 43, and 44, respectively. Similarity (Sorensen's index) of species was highest for the maize-prairie habitats (0.488), compared with maize-woodlands (0.225), or prairie-woodlands (0.368) habitats. Nematode communities were most diverse in prairies with a Shannon-Weiner (H') index of 2.743, compared with 1.653 and 1.068 for woodlands and maize habitats, respectively. Evenness of species (J') was 0.405, 0.784, and 0.477 for maize, prairies, and woodlands, respectively. Typically prairie species include Aorolaimus baldus, Criconemella raskiensis, Subanguina calamagrostis, and several species of Helicotylenchus. Typically woodlands species include Criconema octangulare, Criconemella incrassata, C. macrodora, C. xenoplax, Crossonema menzeli, Helicotylenchus platyurus, Hemicriconemoides nitida, Meloidogyne ovalis, Nothocroconema lamellatus, N. petasus, and Xiphinema rivesi. Department of Plant Pathology, Iowa State University, Ames, IA 50011.

NYCZEPIR, A. P. and W. R. OKIE. Evaluating Prunus spp. for tolerance to Criconemella xenoplax.

Greenhouse screening techniques were developed to determine optimum test conditions necessary for evaluating Prunus spp. for tolerance to Criconemella xenoplax (Cx); a prime factor in peach tree short life. The test procedure consists of ca. 20 lines per test and is divided into two phases; one for host suitability as measured by nematode reproduction and the other for host tolerance, as induced by nematode and pruning stress. About 2,000 and 14,000 Cx per 15-cm-d pot were determined to be optimum inoculum levels for host suitability and tolerance, respectively. Lovell and Nemaguard rootstocks are included in all screens as internal checks. A test period of six months is required to affect growth and physiological parameters. Results from our initial screens have indicated that certain lines (e.g. PI 134151 & PI 82413) were as good or better than Lovell, when rated on a Cx/g dry root weight basis. Both PI lines are also surviving well on a short life site. USDA, ARS, S.E. Fruit & Tree Nut Res. Lab., Byron, GA 31008.

NYCZEPIR, A. P. and B. W. WOOD. Influence of Criconemella xenoplax on peach leaf senescence.

Criconemella xenoplax (Cx) is a prime factor in the peach tree short life disease complex. Observations that trees growing in Cx-infested soil retain leaves longer and remain greener than trees with few or no nematodes has prompted the authors to examine endogenous cytokinins, a senescence related phytohormone. Dihydrozeatin riboside-like (DHZR) and zeatin riboside-like (ZR) compounds were quantitatively estimated using ELISA with monoclonal antibodies. Leaf tissue was randomly obtained from 24 3-yr-old trees growing in closed-system microplots; half previously inoculated with Cx. The ELISA assay was also conducted on Cx to determine the presence of zeatin-like (Z), dihydrozeatin-like (DHZ), DHZR and ZR compounds. Results indicate that leaves from trees growing in Cx-infested soil had a greater ($P = 0.01$) ZR content than the check trees. There were no differences in DHZR content. All four cytokinin-like compounds were detected in Cx with Z being present in greater levels. Parasitism by Cx appears to delay the rate of leaf senescence of Nemaguard peach. USDA, ARS, S. E. Fruit & Tree Nut Res. Lab., Byron, GA 31008.

OKU, H. Role of phytotoxins in pine wilt disease.

Pine wilt disease, the most devastating disease of trees in Japan is caused by a nematode, Bursaphelenchus xylophylus, which is transmitted by a beetle, Monochamus alternatus in Japan and M. carolinensis in the US. The characteristic rapid death of pine trees after infection suggests that some toxic metabolites are involved in this disease syndrome. From diseased pine, benzoic acid, catechol, dihydroconiferylalcohol, and 8-hydroxycarvotanacetone were isolated and identified in Japan and 10-hydroxyverbenone in the US as toxic metabolites of low molecular weight. The toxicity of some of these toxic metabolites correlate positively to the susceptiblity of pine species against the pathogenic nematode. A synergistic effect was found in the toxi-

city between these abnormal metabolites. The D-isomer of 8-hydroxycarvotanacetone, dihydroconiferylalcohol and 10-hydroxyverbenone inhibit the multiplication of the pathogenic nematode. Cellulase excreted by the pathogenic nematode has been reported to be involved in rapid wilting. Laboratory of Plant Pathology, College of Agriculture, Okayama University, Okayama, Japan 700.

OLEXA, M. T., and G. C. SMART, JR. Pesticides and public employee liability.

The liability of public employees in using pesticides or making recommendations for their use is governed largely by federal and state sovereign immunity acts. Depending upon the terms of employment at the time a wrong is committed, liability will be determined according to either the Federal Tort Claims Act or a state statute. Limits, if any, on the liability of public employees will apply only if the civil wrong was committed within the scope of the individual's employment. Traditionally, no liability is imposed for discretionary acts if the employee's job necessitates independent judgement within the course of employment. Personal liability is imposed for ministerial acts performed in a negligent manner, whether by commission or omission. Ministerial acts require only "obedience to orders or the performance of a duty to which the employee is left no choice of his own". Both federal and state acts limiting personal liability are inapplicable when the public employee acted in bad faith or with a malicious or criminal intent. The ultimate issue in determining personal liability is whether the act constituting the wrong was ministerial or discretionary in nature. A ministerial act giving rise to a civil wrong, even if the employee acted in good faith but negligently, will subject the employee to personal liability. Department of Entomology and Nematology, IFAS, University of Florida, Gainesville, FL 32611.

OMWEGA, C. O., I. J. THOMASON, and J. G. WAINES. Search for Meloidogyne javanica resistance in Phaseolus spp.

Resistance to Meloidogyne incognita in Phaseolus vulgaris (common bean) has been identified and incorporated in bean varieties. There is need to search for and incorporate M. javanica resistance in beans. In the present study, seedlings of common bean and tepary bean (P. acutifolius) cultivars were initially screened in growth-pouches placed in a growth chamber at 26 C. Cultivars with a low galling index (less than 2 on a scale of 1-4) were further screened for nematode reproduction in 600 cc pots filled with loamy sand and placed on a greenhouse bench (air temp. range 25-35 C). On the basis of Pf/Pi of less than 1, tepary cultivars PI 310800, PI 477034, PI 310606 and PI 462026 and common bean NB 86 were identified as resistant. The initial inoculum used for both experiments was 5000 eggs. These cultivars and others are being tested for resistance to M. incognita and M. arenaria. Transfer of M. javanica resistance to common bean will be attempted through interspecific hybridization. Departments of Nematology and Botany and Plant Sciences, University of California, Riverside, CA 92521.

OSBORNE, W. W. Eggplant crop failure attributed to Globodera solanacearum.

Replicated on-farm tests were conducted in a field where the OCN was diagnosed from roots of severely stunted eggplant in 1985. Nematicides were used to study the effect of OCN on eggplant yield. Two treatments, methyl bromide and Furadan 15G (carbofuran), curtailed OCN populations and doubled eggplant yield when compared to untreated plots. Temik 15G (aldicarb) and Mocap 10G (ethoprop) also were effective against OCN and increased eggplant yields. Pathological and histological studies on the host-parasite relations are in progress. International Agricultural Institute, Inc., 1319 Main Street, South Boston, VA 24592, USA.

OVERMAN, A. J. Effect of system design on efficacy of sodium N-methyldithiocarbamate applied via irrigation.

Two rates of SMDC (sodium N-methyldithiocarbamate)(Vapam), 267 and 534 kg/ha, were injected into three drip irrigation tubes buried at 5 or 10 cm beneath the center and 30 cm off-center of a raised bed of EauGallie fine sand 105 cm wide. Irrigation supplied at a 5 cm depth in the bed resulted in a higher populations of Belonolaimus longicaudatus on Manatee Yellow Iceberg chrysanthemum than irrigation supplied 10 cm deep. Both rates of SMDC, regardless of the tube depth, controlled the nematodes. Polyethylene film full-bed mulch increased flower yield. Best production was obtained with shallow placement of the irrgation tubes applied under mulch and the high rate of SMDC. Agr. Res.& Educ. Ctr., University of Florida, 5007 60th St., East, Bradenton, FL 33508.

Paper Withdrawn

Paper Withdrawn

PLATZER, E. G., S. N. THOMPSON, and R. W. K. LEE. In vivo ^{31}P NMR spectrum of Steinernema feltiae.

The ^{31}P NMR spectrum of the dauer larvae of Steinernema feltiae was composed of seven major peaks. The phosphorus components included sugar phosphates, phosphorylcholine, inorganic phosphate, glycerophosphoryl choline, nucleotide mono-, and triphosphates, NAD and UDPG. Energy storage compounds such as creatine phosphate or arginine phosphate were not observed. These findings are similar to those reported by others for Ascaris. Under the static conditions used, the ATP concentrations did not decline significantly for 5 h, however, an upfield shift of the inorganic phosphate peak indicated cytoplasmic acidification in the nematodes. Sugar phosphates declined precipitously during the first h and remained stable thereafter. ^{31}P NMR spectroscopy has provided a rapid and non-invasive method for measurement of phosphorus metabolites and related energy metabolism in nematodes. Departments of Nematology, Entomology, and Chemistry, University of California, Riverside, CA 92521.

Paper Withdrawn

Paper Withdrawn

ROBBINS, R. T. Microplot study on soybean cyst nematode race 3 damage to susceptible soybean.

In 1985 an experiment was designed to test for interaction between soybean cyst nematode (SCN) race 3 and threecornered alfalfa hopper (TCAH) on Asgrow 5618 soybean grown in fine sand microplots. On 5/17/85, 20 microplots (28 X 39 cm glazed clay flue tiles, 62 cm deep) were inoculated with 0, 1, or 20 SCN race 3 J2 or eggs/cm^3 soil (top 20 cm) and planted linearly with 12 seeds. Rabbits ate these plants as they emerged. On 5/30/85 all remaining plants were pulled and the plots were replanted as before. On 6/10/85 the plants were thinned to 9 plants/plot for later TCAH inoculation at 5 rates. Soon after thinning the TCAH died, leaving only the 3 levels of SCN in the test. The plots were sampled and harvested 11/24/85. ANOVA and Duncan's multiple range tests were performed on; SCN J2/cm^3 soil, SCN cysts/cm^3 soil, dry weight of plant shoots, and seed weight. The 3 inoculum levels resulted in the following differences in means at harvest: number of SCN J2/cm^3 = 1.2 A, 42.7 C, 24.7 B ($P \leq 0.01$); number of SCN cysts/cm^3 = .01 A, 71.5 B, 78.8 B ($P \leq 0.01$); gms dry top weight = 310 A, 234 B, 217 B ($P \leq 0.05$); and gms seed weight = 61 A, 35 B, 37 B ($P \leq 0.01$), respectively. Different letters signify separation by DMRT. Department of Plant Pathology, University of Arkansas, Fayetteville, AR 72701.

ROBBINS, R. T. Observed race changes of Heterodera glycines in successive plantings of SCN resistant and susceptible soybeans in Arkansas.

Maturation of soybean cyst nematode (SCN) on Lee, standard SCN race differentials or Bedford was tested with populations from SCN race 4 infested plots successively (80-86) planted to Bedford (race 3 and 4 resistant) or an all-race susceptible variety. Mature female indices (MFI) on Bedford and Pickett were calculated in 5/81, 5/82, 9/82, 5/83, 10/83, 11/84, 5/85, 11/85 and 11/86 from successive Bedford (SB) and susceptible (SS) soybean plots. MFI were computed by dividing the number of white or yellow females on the differential X 100 by the number on Lee. Plots of SB had MFI on Bedford (BI) of 2, 8, 17, 12, 35, 30, 22, 38 and 40 while plots of SS had BI of 6, 3, 6, 7, 8, 5, 5, 9 and 2 respectively. The mean BI on SB increased from 2 to 40 while the mean BI on SS was always below 10. The MFI on Pickett remained > 30 for both SB and SS. Standard SCN race determinations were made in 9/82, 5/83, 10/83, 5/85, 11/85, and 11/86. On SB races 6, 2, 2, 6, 6 and 6 were found predominantly, while races 4, 2, 2, 6, 6 and 6 were found predominantly on SS, respectively. SCN race 6 produces a positive reaction on Pickett only. SCN on SB and SS have evolved to race 6 about the same rate. Department of Plant Pathology, University of Arkansas, Fayetteville, AR 72701.

ROBERTS, P. A., and W. C. MATTHEWS. Metham-sodium applied through drip-irrigation for root-knot nematode and pathogen control on tomato.

In replicated field experiments metham-sodium (sodium methyl dithiocarbamate) dosages of 94 to 700 L/ha (32.7% a.i.) were applied preplant through temporary drip-irrigation lines positioned on planting beds in infested loam soils. Metham-sodium was continuously injected and mixed into irrigation water during the application before release into soil. Treatments were compared with standard 1,3-D fumigation and nontreated checks. Metham-sodium at 187 L/ha or more consistently significantly ($P = 0.05$) reduced Meloidogyne incognita soil populations, midseason and final root gall ratings, the Pythium sp. and Fusarium sp. soil populations and root infections. Tomato yield was correspondingly increased ($P = 0.05$) by metham-sodium, similar to or greater than yield following 1,3-D fumigation. Responses to 94 L/ha metham-sodium were variable. Department of Nematology, University of California, Riverside, CA 92521.

ROBINSON, A. F., C. M. HEALD, and S. L. FLANAGAN. Relationships between soil texture and the distributions of Rotylenchulus reniformis, Meloidogyne incognita, and Tylenchulus semipenetrans in the lower Rio Grande valley.

A survey was conducted during a 22-year period to evaluate the influence of soil texture and land use on the distributions of Rotylenchulus reniformis, Meloidogyne incognita, and Tylenchulus semipenetrans in the lower Rio Grande valley. By plotting the locations of soil samples from more than 1,500 crop fields and orchards onto soil classification maps it was observed that the distributions of R. reniformis and M. incognita were relatable to soil texture, whereas T. semipenetrans occurred wherever host plants were present. The incidence of M. incognita was greatest in elevated sandy loams and in moderately well-drained silts of modern flood terraces of the Rio Grande river. Rotylenchulus reniformis occurred predominantly in the clay silts and clays of ancient flood terraces. Clay loams and sandy clay loams of the central, irrigated portion of the lower Rio Grande valley appeared favorable for both species. Differences between their distributions could not be attributed to the distribution of host crops. Subtropical Agricultural Research Laboratory, USDA, ARS, P. O. Box 267, Weslaco, TX 78596.

RODRIGUEZ-KABANA, R., and G. MORGAN-JONES. Potential for nematode control by mycofloras endemic in the tropics.

Results of mycological surveys of root-knot and cyst nematodes from tropical regions indicate that most fungal species associated with females or cysts of species of Globodera, Heterodera and Meloidogyne are those found with nematodes from temperate areas. Some fungal species, however, were found in higher frequency in tropical regions than in temperate countries, e.g., Cylindrocladium destructans, and Ulocladium atrum were the most common species associated with G. pallida and G. rostochiensis cysts in Peru. These fungi

are not so frequent in nematodes from temperate areas. Fungi associated with diseased nematodes in the tropics vary greatly in nutritional requirements and include thermophilic species, as well as cold-tolerant fungi. Multi-cropping systems possible in most tropical regions may be designed to increase the frequency of occurrence of microbial species antagonistic to phytonematodes. Department of Plant Pathology, Ala. Agric. Exp. Stn., Auburn University, AL 36849.

RODRIGUEZ-KABANA, R., D. G. ROBERTSON, P. S. KING, and C. F. WEAVER. Evaluation of nematicides for control of root-knot and cyst nematodes in a nematode-tolerant soybean cultivar.

A 3-year field study (1984-1986) was conducted with Kirby soybean to assess the efficacy of at-plant applications of aldicarb, phenamiphos, and 1,3-D, for control of Heterodera glycines and Meloidogyne incognita. Aldicarb and phenamiphos were applied at rates of 0, 1.1, 2.2, and 3.3 Kgs a.i./ha; 1,3-D was injected into the soil at rates of 18.7 and 37.4 L/ha. All nematicide treatments increased yields. Applications of aldicarb and phenamiphos at the 1.1 and 2.2 Kgs rates resulted in profitable yield increases but yield response to the 3.3 Kgs rate was not economical. The only profitable application with 1,3-D was the 37.4-L rate. Nematicide treatments had no effect on juvenile populations of H. glycines in soil; juvenile populations of M. incognita in soil were reduced by the treatments in 2 of the 3 years of the study. Department of Plant Pathology, Ala. Agric. Exp. Stn., Auburn University, AL 36849.

RUSSELL, C. C. A space saving root incubation system.

Centrifuge tubes (100 ml) are placed into holes countersunk on 5 cm centers in a wooden baseboard. Roots are placed in the tubes, water added, and aerated. Air is supplied to each tube by a 1.2 mm ID PVC tube tapped into a manifold (1.25 cm OD PVC pipe) suspended above the tubes. Air flow is regulated by a single aquarium air control valve on the manifold intake. After the desired incubation period, the supernatant from each tube is poured through a 34 mesh screen fitted to the tube and onto an extraction tub. The tub consists of a non-vented 350 ml flower pot filled with sufficient water to saturate a wire mesh supported double facial tissue (4 layers) on top. As the supernatant is poured onto the tissue, excess water is withdrawn, through the tissue, by a vacuum tube inserted between the tissues and the tub rim. After an overnight waiting period, the extracted nematodes are concentrated to counting dish volume by serial decanting. Multiple incubation units can be mounted in banks on otherwise unusable space (e.g. low clearance walls) rather than occupying valuable bench space. Department of Plant Pathology, Oklahoma State University, Stillwater, OK 74078.

RUTHERFORD, T. A. and J. M. WEBSTER. Distribution of pine species with respect to pine wilt disease and climate.

Bursaphelenchus xylophilus and its insect vectors are found throughout North America, have been reported from Siberia and France and the nematode is considered an introduced pathogen in Japan. Where this nematode and suitable vectors occur, pine wilt disease is expressed in susceptible pines, but apparently only in regions where the mean air temperature exceeds 20 C for protracted periods. In the northern hemisphere, the July 20 C mean air temperature isotherm corresponds approximately to the southern distribution limits of susceptible pines. Pines resistant to pine wilt disease occur in regions warmer than the July 20 C isotherm. We hypothesize that the distribution of B. xylophilus throughout the continental northern hemisphere has influenced the distribution of some pine species. Susceptible pines that are transplanted from cool to warm regions are at risk to the disease. Centre for Pest Management, Simon Fraser University, Burnaby, Vancouver, British Columbia, Canada, V5A 1S6.

SAYRE, R. M. and A. M. GOLDEN. Morphological differences of endospores among members of the Pasteuria penetrans group parasitizing nematodes.

Diameters of sporangia and internal endospores of Pasteuria penetrans group varied with their host nematodes. Averages for the sporangia and endospores of Pratylenchus brachyurus were respectively 3.1 ± 0.2 (diameter ± standard deviation) and 1.8 ± 0.1. Similarly, measurements were as follows: Tylenchorhynchus maximus (4.2 ± 0.5, 1.8 ± 0.2); Meloidogyne incognita (4.4 ± 0.6, 1.8 ± 0.1); Xiphinema americanum (4.7 ± 0.3, 1.4 ± 0.3); and Hoplolaimus galeatus (7.0 ± 0.3, 3.2 ± 0.3). When surface areas of endospore attachment were calculated for each member of the group differences were even more apparent. Another morphological variable can be expressed by the ratio of the sporangial diameter divided by the diameter of the endospore. The ratio of 3.5 for the bacterium parasitizing X. americanum clearly separated it from the other group members that had ratios of approximately two. From the examination of these few group members criteria emerge for new bacterial species and help provide a more rational process for selecting biocontrol agents of nematodes based on host specificity. Nematology Laboratory, USDA, ARS, Beltsville, MD 20705.

SAYRE, R. M., W. P. WERGIN, B. Y. ENDO, and M. P. STARR. Ultrastructural comparison of Pasteuria penetrans, a bacterial parasite of Meloidogyne incognita, and a related parasite of Pratylenchus brachyurus.

The bacterial isolate from Pratylenchus brachyurus differed from Pasteuria penetrans in that the sporangium of the former was near rhombic in cross-section having a width of 2.46 ± 0.24 and height of 2.15 ± 0.19 um. The endospore was circular with a diameter 1.08 ± 0.12 um with a basal pore 0.13 ± 0.01 um in diameter. An irregular electron dense wall layer occurred sublaterally. In P. penetrans the sporangia were less rhombic measuring 3.31 ± 0.21 um in width and 1.42 ± 0.12 in height. Its central spore was elliptic in cross section having measurements of 1.10 ± 0.11 X 2.58 ± 0.23. The basal

pore is formed of outer spore wall and measured 0.28 ± 0.11. The irregular electron dense spore wall surrounded the endospore laterally. These differences in fine structure suggest characteristics to describe a new species of Pasteuria. USDA, ARS, Nematology Laboratory, Beltsville Agricultural Research Center, Beltsville, MD 20705.

SCHENCK, S. and W. APT. Application of avermectin B_1 through drip irrigation for control of Rotylenchulus reniformis on pineapple.

Avermectin B_1 (MK-936 0.15EC, Merck, Sharp & Dohme) was tested for control of Rotylenchulus reniformis on pineapple. Avermectin was applied through drip irrigation to 9.3 m^2 field plots planted with pineapple and heavily infested with R. reniformis. Rates were 1: 0.504 kg a.i./ha applied six times at biweekly intervals and b) 0.186 kg a.i./ha applied eleven times at weekly intervals. These were compared to 1,3-dichloropropene fumigant (309.7 l a.i./ha) and to untreated plots. R. reniformis numbers in avermectin plots remained slightly lower than untreated plots for three months following planting, but control was not comparable to fumigation and did not prevent plant stunting. Studies at higher rates (0.504 to 504.0 kg a.i./ha) were carried out in pots with single soil drench applications. The highest rate eliminated R. reniformis for the four month test period, but also inhibited root development. Lower rates failed to completely control the nematodes but still caused some phytotoxic stunting. Dole Pineapple Co., Wahiawa, HI 96786 and Department of Plant Pathology, University of Hawaii, Honolulu, HI 96822.

SCHMITT, D. P., and K. R. BARKER. Incidence of plant-parasitic nematodes in the Coastal Plain of North Carolina.

A survey of the coastal plain of North Carolina included a systematic sampling of 800 fields. Corn and soybeans were the predominant crops. Nematode genera occurring in approximately 50% or more of the fields were Criconemella, Helicotylenchus, Meloidogyne, Pratylenchus, and Tylenchorhynchus. Meloidogyne spp. were recovered from 402 fields. Of these populations, 30% reproduced on NC-95 tobacco (M. arenaria, M. javanica, races 2 and 4 of M. incognita and M. hapla), 12% on peanut (M. arenaria and M. hapla) and 15% on cotton (races 3 and 4 of M. incognita). Heterodera glycines was present in 25% of the fields sampled (33% of the soybean fields, 16% of fields with nonhosts). Sixty percent of the infested fields contained H. glycines races which could not be managed with available resistant cultivars. The specific geographical spatial patterns of nematodes were associated with cropping patterns. Department of Plant Pathology, North Carolina State University, Raleigh, NC 27695-7616.

SCHMITT, D. P., and R. D. RIGGS. Hatch response of Heterodera glycines eggs to host and nonhost plant species.

Hatch response of eggs of Heterodera glycines race 3 to soybean ('Bedford', 'Coker 156', 'Essex', 'Forrest' and 'Lee'), alfalfa 'Cody', clover 'Kenland', hairy vetch, cabbage ('Flat Dutch early' and 'Flat Dutch late'), corn 'Funks 4740', cotton, sorghum, sweet corn, tobacco 'NC95' and wheat 'Coker 747' was determined in the laboratory and greenhouse. Seedlings of each were transplanted into soil (300 cm^3) infested with 5000 eggs. Treatments were replicated 6 times in a randomized complete block design. Five hundred eggs were exposed in hatching chambers to leachates of selected plants. nonlegumes gave little or no stimulation of hatch of the soybean cyst nematode when compared to fallow soil or water. All legumes stimulated hatch with the greatest stimulation achieved by soybeans. The resistant cultivars Forrest and Bedford stimulated more hatch than the susceptible Essex. Departments of Plant Pathology, North Carolina State University, Box 7616, Raleigh, NC 27695-7616, and University of Arkansas, Fayetteville, AR 72701.

SHAMS-EL-DIN, M. M. and E. G. PLATZER. A simple technique for the study of mermithid cuticle by scanning electron microscopy.

Adult Romanomermis culicivorax were killed in hot water (70 C) and fixed in 3% glutaraldehyde buffered with 0.1 M sodium cacodylate for 3 hours. Specimens were washed 3 times with 0.1 M buffer and left overnight in the refrigerator (7 C). They were dehydrated gradually in a graded ethanol series. Specimens were left for ca 25 minutes in each of the following ethanol concentrations: 10, 20, 40, 60, 70, 80, 95, and 100%. They were subsequently treated three times with 100% ethanol for 25 minutes each and critical point dried using carbon dioxide with a Balzers Union CPD-020 critical point drier. Dried specimens were fractured with an eye knife, fixed with double sticky tape on aluminum stubs and the fractured surfaces oriented face up. They were then coated with gold/palladium alloy inside an EMscope sputter coater 500A. This procedure results in quick and simple preparations of the internal cuticular structure of adult mermithids. Department of Nematology, University of California, Riverside, CA 92521.

SHAMS-EL-DIN, M. M. and E. G. PLATZER. Comparative body wall structure of three mermithid species.

The adults of Romanomermis culicivorax, Pheromermis pachysoma and Mermis nigrescens were prepared for scanning electron microscopy by critical point drying. Dried specimens were fractured with an eye knife, coated with gold/palladium alloy, and examined by SEM. The cuticle of each species had five main layers with differing numbers of sublayers. The highest ratio between cuticle thickness and body width was obtained with the terrestrial mermithid Mermis nigrescens, with Pheromermis pachysoma in an intermediate position, and the lowest ratio was found in the aquatic mermithid, Romanomermis culicivorax. Department of Nematology, University of California, Riverside, CA 92521.

SIPES, B. S. and D. P. SCHMITT. Post-infection development of Heterodera glycines on resistant and susceptible soybean as affected by the interaction of fenamiphos and alachlor.

Developmental rates of Heterodera glycines (HG) race 1 were studied on susceptible and resistant soybean cultivars. Freshly hatched second-stage juveniles (J2) were allowed 60 hours at 28 C for host-parasite establishment prior to pesticide application. On the susceptible cultivar Deltapine 105, adults developed by 7, 10 and 14 days after pesticide application in the untreated control, alachlor (1.0 ug/g soil), and alachlor-fenamiphos (1.5 ug/g soil) combination, respectively. Fenamiphos at 0.09 and 0.19 ug had no affect on development. Rates of 0.38 and 0.75 ug retarded adult development by 1 and 6 days. Alachlor of 0.5 ug/g soil and lower did not change the rate of nematode development. On the HG races 1 and 3 resistant cultivar Centennial, HG development was slow with 1.0 ug fenamiphos/g soil with only a few nematodes reaching adulthood. Development of HG was completed in 18 days in the alachlor and combination treatments. Department of Plant Pathology, North Carolina State University, Raleigh, NC 27695-7616.

STANTON, M. A., R. A. DUNN, and K. J. BOOTE. Physiological response of soybean to infection by root-knot nematode.

The effects of Meloidogyne spp. on soybean [Glycine max (L.) Merr.] carbon exchange rate and water relations were measured to develop parameters for inclusion of the nematode in computer models of soybean growth. 'Cobb' soybeans were planted in Arredondo sand (92% sand, 5% silt, 3% clay) in a split plot design with four field replications: main plot treatments were rainfed/irrigated; split plot treatments were nematode infested/non-infested. Leaf carbon exchange, transpiration, and water potential were measured weekly; canopy carbon exchange, evapotranspiration, and light interception were measured bi-weekly. Leaf carbon exchange rate was significantly diminished by nematodes only during the period of decline associated with pod-fill. Reductions in canopy carbon exchange rate were related to reductions in light interception. Consistent significant effects on leaf transpiration, leaf water potential, and evapotranspiration were not noted. Department of Agronomy, University of Arkansas, Fayetteville, AR 72701.

STANTON, M. A., R. D. RIGGS, and J. M. STEWART. Resistance of Asiatic cottons to the root-knot nematode, Meloidogyne incognita.

Responses of 69 lines of Gossypium arboreum and 27 lines of G. herbaceum to infection by Meloidogyne incognita (Kofoid & White) Chitwood were determined utilizing the IMP rating system. These diploid cotton lines are part of the US Asiatic Cotton Germplasm Collection currently being evaluated for resistance to a number of biotic factors. Three G. hirsutum cultivars, Stoneville 213 (susceptible), Auburn 634 (highly resistant) and M-8 (a highly susceptible doubled-haploid), were included as checks. Ten seedlings of each

line were planted individually in 10-cm-d pots containing pasteurized sand and inoculated with 15,000 eggs. After 42 days, plants were rated for galling, egg mass production, and total eggs per root system. Comparative analyses will be presented. Resistant Asiatic lines will be entered into an introgression program to transfer the resistances into upland cotton. Department of Agronomy, University of Arkansas, Fayetteville, AR 72701.

THOMAS, S. H. and L. MURRAY. Yield reductions in grain sorghum associated with injury by Meloidogyne incognita race 3.

Grain sorghum (Sorghum bicolor [L.] Moench) yields were reduced 45% by preplant M. incognita race 3 populations of 490 juveniles/500 cm^3 soil. The study was conducted under drip irrigation in 90-cm diameter microplots containing sandy loam soil (66% sand, 21% silt ad 13% clay; pH 9.0 and 0.5% OM). Five replications of the following treatments were arranged in a completely randomized design: uninoculated control (UC), uninoculated control + foliar insecticide (UC+I), inoculated control (IC), and inoculated plots treated with 56 L/ha 1,3-D (1,3D), 1.12 kg/ha aldicarb (ALD) or 1.12 kg/ha carbofuran (CBF). No significant differences in recovery of J2 from soil occurred among chemical treatments at 30, 60 or 90 days after treatment. Plant heights were 33% greater in uninoculated plots 45 days after emergence. Numbers of M. incognita eggs recovered from sorghum roots/500 cm^3 soil 120 days after planting ranged from 15,180 to 20,660 among inoculated treatments. Department of Entomology, Plant Pathology and Weed Science, Box 3BE, New Mexico State University, Las Cruces, New Mexico 88003.

TODD, T. C. Population dynamics, vertical distribution, and damage potential of a species of Belonolaimus on corn.

A species of Belonolaimus (close to B. nortoni) is frequently associated with severely stunted corn in the sandy soils of southwestern Kansas. The relationship of the damage potential and population dynamics of this nematode was studied in 25 X 75 cm PVC microplots. Naturally-infested sand was mixed uniformly with methyl bromide-fumigated sand to create initial population densities ranging from 0 to 7,000 nematodes/plot. Vertical distribution was monitored at 3-week intervals from soil cores collected in 15-cm increments. Highest numbers of nematodes were recovered from the 16-30 cm depth 3 weeks after planting and the 46-60 cm depth thereafter. Changes in distribution of nematode densities appeared to be due to differential production of second-stage juveniles and migration of adult females. Linear regression analyses indicated negative relationships between initial nematode densities and early season plant heights (R^2=0.61, $P<0.0001$), and corn yields (R^2=0.26, $P=0.02$). Department of Plant Pathology, Kansas State University, Manhattan, KS 66506.

TSAI, B. Y. and S. D. VAN GUNDY. Comparison of anhydrobiotic ability of citrus nematode with other plant parasitic nematodes.

Second-stage larvae of Tylenchulus semipenetrans were treated at 50, 70, 90, and 100% RH for 24 hr and % survival determined after rehydration. The same treatment was made on other plant parasitic nematodes for comparison. Anhydrobiotic ability of the nematodes was ranked in descending order as follows: Anguina > Ditylenchus > Hirschmanniella > Aphelenchus > Heterodera > Pratylenchus > Meloidogyne > Tylenchulus. The anhydrobiotic ability seems to correlate to the habitat of the nematodes. The citrus nematode was the weakest anhydrobite among all nematodes. However, it was capable of surviving the permanent wilting point (-15 bars at 98.9% RH). Approximately 79% of the citrus nematode larvae survived 48 days at -15 bars. The intestine of the larvae in the control (D.W.) became empty while those at -15 bars for 48 days were still full, indicating a reduction of metabolism during anhydrobiosis. All the plant parasitic nematodes listed above are capable of surviving the permanent wilting point as they are stronger anhydrobiotes than the citrus nematodes. Department of Nematology, University of California, Riverside, CA 92521.

VERDEJO, S., B. A. JAFFEE, and R. MANKAU. The use of Agrobacterium rhizogenes transformed root cultures for the reproduction of Meloidogyne javanica and Pasteuria penetrans.

Agrobacterium rhizogenes transformed roots (generously provided by Genetics Institute, Cambidge, MA 02140) were cultured in vitro on modified Murashige and Skoog medium. One-hundred and twenty Meloidogyne javanica second-stage juveniles were added to cultures of Lycopersicon esculentum cv Tropic, L. esculentum cv Rutgers, Solanum tuberosum, and Convolvulus sepium. Cultures yielded 4212, 2705, 7991, and 3034 eggs/g root, respectively, after 50 days at 23 C. Solanum tuberosum root cultures inoculated with 150 M. javanica juveniles encumbered with Pasteuria penetrans spores produced healthy and P. penetrans infected females at 25 C, and spores from infected females obtained in vitro adhered to M. javanica juveniles. Transformed roots offer excellent opportunities to culture and study nematodes and their parasites since they grow rapidly, tolerate stress and subculture easily by root transfer. Division of Nematology, University of California, Davis, CA 95616.

WADSWORTH, W. G., and D. L. RIDDLE. Energy metabolism during larval development of Caenorhabditis elegans.

In the life cycle of the free-living soil nematode, Caenorhabditis elegans, overcrowding and starvation leads to the formation of the dauer stage. The dauer larva is a dispersal form that does not feed, and can survive harsh conditions for several months. If favorable conditions are encountered, dauer larvae will recover to resume development. Energy metabolism in C. elegans is developmentally regulated. ^{31}P NMR spectra and assays for isocitrate lyase and isocitrate dehydrogenase activities from synchronously developing larvae indicate high activity of the glyoxylate pathway only during the L1 stage, whereas respiration during the L2, L3, and L4 stages occurs preferentially by

the TCA cycle. During dauer larva development, both enzyme activities, and levels of high energy phosphates, decrease. PO_4 is virtually the only detectable phosphate in dauer larvae. The higher energy state is rapidly restored as dauer larvae recover. We also used ^{31}P NMR techniques to show that intracellular pH becomes more acidic during recovery. We did not detect any phosphocreatine or phosphoarginine, but we have discovered a modified nucleotide that appears to be important in phosphorus energy metabolism. We have isolated this compound and we are currently analyzing its structure. Division of Biological Sciences, University of Missouri-Columbia, Columbia, MO 65211.

Paper Withdrawn

WEAVER, C. F. and R. RODRIGUEZ-KABANA. Nematicide seed treatments for control of soybean nematodes.

Results from a greenhouse experiment on the efficacy of seed treatments with aldoxycarb, thiodicarb, and Gus 6015 for control of Meloidogyne incognita in soybean indicated that aldoxycarb was the most effective of the 3 nematicides. Data from a second greenhouse experiment indicated that aldoxycarb rates higher than 0.189 kgs a.i./100 kgs seed were required to suppress juvenile population development of the nematode. In a field experiment yields of 'Kirby' soybean were improved with aldoxycarb rates of 0.377 kgs a.i./100 kgs seed or higher; in a second field experiment 'Kirby' yields were improved by aldoxycarb rates of 0.126, 0.251 and 0.377 kgs a.i./100 kgs seed. Seed treatments had no effect on juvenile populations of H. glycines in soil in any of the 2 field experiments. The treatments suppressed juvenile populations of M. incognita early in the season in the first but not the second field experiment; the effect on M. incognita juveniles was short-lived and was not evident late in the season. Dept. of Plant Pathology, Ala. Agric. Exp. Stn., Auburn University, AL 36849.

WEINGARTNER, D. P. and J. R. SHUMAKER. Nematode and soil-borne disease control in northeast Florida potatoes.

Methyl bromide (MB), metam sodium (MS), chloropicrin (C), 1.3D, and 1,3D+17% C were tested alone and with aldicarb 15G (3.36 kg/ha)(A) for control of nematodes [Meloidogyne incognita (MI), Belonolaimus longicaudatus (BL), Pratylenchus sp. (PR), and trichodorids (TR)] and bacterial wilt (Pseudomonas solanacearum)(BW). MB and C were injected at 25 and 50 cm using a "rip-chisel" (RC). At harvest population densities (Pf) of MI, BL, and PR were significantly (P=.05) less in fumigant (F) and A plots than in controls. A significant F x A effect on Pf of MI + BL + PR occurred wherein Pf's were less following A treatments in F plots than in those treated solely with A. Potato yields (PY) were increased by F and A. PY of C and MB > MS, but not 1,3D, and 1,3D + C plots. A significant F x cultivar effect on yield was observed with nontreated (NT) 'Atlantic' (AT) producing < 'Sebago' (S). NT - RC plots outyielded non - RC plots. Least BW occurred in C plots. Incidence and severity of BW > in AT than S. IFAS, University of Florida, Agricultural Research and Education Center, P. O. Box 728, Hastings, FL 32045.

WEISCHER, B. Histological reactions in Muscadine grape to Meloidogyne incognita and Xiphinema index.

The muscadine grape Vitis rotundifolia is resistant to both the endoparasite Meloidogyne incognita and the ectoparasite Xiphinema index. Although juveniles of the root-knot nematode enter the roots they are not able to induce nurse cell formation. The only plant reaction observed is the dissolution of middle lamellae in some cells surrounding the nematode. Cells punctured by X. index necrotize and collapse readily. The fast degradation of the cytoplasm prevents nematode-transmitted virus particles from getting established. This process can successfully be transmitted to V. rotundifolia by mechanical techniques but not by nematodes. Westf. Museum fuer Naturkunde, Sentruperstr. 285, D-4400 Munster, Fed. Rep. Germany.

WIGGERS, R., J. L. STARR, and H. J. PRICE. DNA Content of Meloidogyne induced giant cell nuclei

DNA content of Meloidogyne-induced giant cell nuclei in several host species was measured microspectrophotometrically. Nuclei from mature giant cells in pea and tomato averaged over a 7-fold increase in DNA in comparison to nuclei from uninfected root tip cells. Nuclei from broad bean and lettuce showed a mean increase in DNA content of 4.2- and 3.3-fold, respectively, when compared to uninfected root tip nuclei. DNA content of giant cells was highly variable (coefficients of variation > 41%) while DNA content of root tip cells showed little variation (coefficients of variation < 8%). DNA content in giant cells from pea increased linearly from the time of inoculation until development of mature females three weeks after inoculation. In giant cells from lettuce, DNA content increased 3.3-fold during the first week after inoculation with no further increase. Effects of Meloidogyne spp. on nuclear DNA increase may differ with different host species. Dept. Plant Pathology and Microbiology, and Dept. Soil and Crop Sciences, Texas Agricultural Experiment Station, College Station, TX 77843.

WILSON, J. H. JR. New and proposed pesticide regulations.

Requirements for obeying pesticide regulations have become more complex. Many states have adopted chemigation regulations requiring check valves, vacuum - relief valves, automatic low-pressure drains and other safety devices to prevent back - flow of pesticides into water supplies. Aerial regulations limit the application of pesticides near schools, rights-of-ways, residences, water and registered bee apiaries. Storage regulations are being expanded to require contingency plans for minimizing hazards to human health from fires, spills and other unplanned emergencies. Burying and burning practices for pesticides and their containers are being outlawed except by licensed hazardous waste companies capable of incinerating pesticides at high temperatures. Right-to-Know regulations make it necessary to inform workers of all hazardous materials in their work environment. Re-entry and pre-harvest intervals will be enforced to greater degrees. Stricter regulations to control drift of pesticides and to protect groundwater and surface water are proposed in most states. Department of Horticultural Science, North Carolina State University, Raleigh, NC 27695-7609.

Paper Withdrawn

WIXTED, D. J., R. LORIA and J. P. KOTCON. Efficacy of ethoprop on potato and the potential for groundwater contamination.

Ethoprop (4 kg a.i./ha) banded over the row at planting reduced midseason and harvest population densities of Pratylenchus penetrans and Meloidogyne hapla and increased yields of potato more than did a post-emergence application

during 1985. In 1986, banding ethoprop (3.4 kg a.i./ha) in the seed furrow reduced midseason population densities of P. penetrans more than banding it over the row prior to emergence. However, harvest population densities were lower, and yields generally higher, with the pre-emergence application in 1986. Ethoprop (4 kg a.i./ha), when banded over the row at planting in April 1985, reached a depth of 30-45 cm by 83 days after application (DAA). Ethoprop ws detected at up to 13 ppb in groundwater sampled from wells on the periphery of treated fields by 90 DAA. In April 1986, ethoprop (10 kg a.i./ha) was broadcast at planting. Movement of this nematicide in the soil profile was similar to that in 1985; however, it was not detected in groundwater as of 147 DAA. Dept. of Plant Pathology, Cornell Univ., Long Island Hort. Res. Lab., 39 Sound Ave., Riverhead, NY 11901.

Paper Withdrawn

ZERVOS, S. Sex and violence in insect nematodes.

Mature infrapopulations of thelastomatid (Oxyurida) nematodes in insects range from species with several males/many females/host through species with one male/many females/host to monogamous species. In cockroaches, infrapopulations are not regulated by host immune responses or by physical or exploitative worm competition. Rather, a density- and sex-dependent parasite mediated chemical interference competition reduces infection intensity. In monogamous and polygamous species, males are precocious and compete with each other (leaving one). Females probably compete with females until one/few remain. The nature of the parasite produced anthelmintic is unknown. Infection incidence is generally high so regulation results, unusually, in underdispersal. Egg production is inversely proportional to adult female intensity; thus elimination of rivals allows greater fecundity in survivors. Dept. Biological Sciences, Simon Fraser University, Burnaby, British Columbia, Canada, V5A 1S6.

SMITH, G. S., and D. T. KAPLAN. Influence of a mycorrhizal fungus and phosphorus on growth of rough lemon and burrowing nematode root-population densities.

In two greenhouse experiments, Citrus limon (L.) Burm. f. cv. rough lemon seedlings were grown in soil which was mycorrhizal infested or phosphorus amended (100 and 300 mg P/kg soil). Plants ewere inoculated with four inoculum densities (0, 50, 100, or 200 per pot) of the burrowing nematode, Radopholus citrophilus. Six months later, mycorrhizal plants and nonmycorrhizal high-P plants had larger shoot and root weights than low-P nonmycorrhizal plants. Burrowing nematode population densities were lower in roots of mycorrhizal or nonmycorrhizal high-P plants than in roots of nonmycorrhizal low-P plants. However, differences in plant growth between mycorrhizal and nonmycorrhizal plants were not significant with respect to initial nematode inoculum densities. Enhanced tolerance associated with root colonization by the mycorrhizal fungus on this plant-nematode system appears to result from improved P nutrition and not antagonism or competition between the mycorrhizal fungus and the nematode. Texas A&I Citrus Center, Weslaco, TX 78596.

STIRLING, G. R. Ecology and control of Paralongidorus australis on rice in northern Australia.

P. australis is endemic to the Burdekin region of north Queensland, occurrin gmost commonly in low-lying areas that are inundated periodically by floodwater. When such areas are cleared of natural vegetation and sown to rice, the rice paddies provide an ideal environment for the nematode and within 5-10 years nematode populations often reach levels sufficient to cause heavy crop losses. At present there are no practical means of controlling P. australis on rice. Crop rotation schemes are unsatisfactory because nematodes can survive for several years in fallow soil or under non-host crops such as maize, sorghum and soybean. Experiments carries out in pots have shown that root damage is reduced when permanent water is applied 3-5 weeks later than usual, but this delay is dentrimental to the performance of cultivars adapted to paddy conditions. Fenamiphos does not kill the nematode or reduce the severity of symptoms when used at rates as high as 20 kg a.i./ha. 1,3D (200 L/ha) gave excellent nematode control and increased yields by more than 40% in one field trial and carbofuran (8 kg a.i./ha) reduced nematode populations by 75% in another experiment, but neither nematicide is economic to use on rice at these application rates. A search for resistance or tolerance amongst fourteen cultivars and breeding lines was unsuccessful because all accessions were susceptible to P. australis. Department of Primary Industries, Plant Pathology Branch, Meiers Road, Indooroopilly, Queensland, 4068, Australia.