

# 25th Annual Meeting

## Society of Nematologists

### ABSTRACTS

BARNES, J.M. and J. F. FULKERSON. The impacts of formula funding on the science of nematology.

As the land-grant system developed and matured through provision of public lands and long-term, stable funding, so also has the Science of Nematology developed and benefitted. Changes in the scope of nematology research and in amount of formula funding of nematology research since 1961 are described. It is suggested that long-term formula funding has played significant roles in the expansion of nematology faculty positions in state institutions and in the development of graduates in the profession employed in state, federal and industrial organizations. As a result of this funding method, cores of excellence in the fundamental and applied aspects of the science of nematology exist at universities across the U.S. The mandate for adequate support for nematology research in the U.S. is clear; nematode damage occurs in a wide variety of crops including woody species, and their roles in many other problems remain to be clarified. Cooperative States Research Service, U.S. Department of Agriculture, West Auditors Building, Washington, DC 20251.

BOLLA, R. I. Nematodes as models for nutritional research.

The development of defined media for the in vitro cultivation of several species of free-living and parasitic nematodes makes it possible to design experiments to investigate nutritional requirements for vitamins, minerals, fatty acids and other substrates; and to follow the metabolic role for these components. These same studies may be possible by addition and subtraction of nutrients from less well defined media. Experiments using parasitic nematodes, cultivated in vitro can be designed to investigate host parasite nutritional relationships. It may also be possible to select auxotrophic mutants of nematodes which can be used to investigate the metabolic reactions and developmental events for which a particular nutritional substrate is required. Department of Biology, University of Missouri-St. Louis, St. Louis, MO 63121.

BURROWS, PETER M. Interaction concepts for analysis of responses to mixtures of nematode populations.

The usual statistical definition of interaction effects is inappropriate for inferences about associative effects of two or more nematode populations in designed experiments containing combinations (mixtures) of population dosages. Alternative formulations based on the product model of Fisher (1923) are suggested. Conceptual and analytical properties of bivariate dose-response surface formulations, with specified marginal responses, are developed. Experimental Statistics Unit, Clemson University, Clemson, SC 29634-0367.

DICKSON, D. W. and JULIA A. MEREDITH. Perspective of nematology teaching.

Nematology has reached a crucial point in its development. The number of students enrolled in graduate programs in the United States is lower than previous years in spite of a greater world-wide demand for specialized training in nematology. Few educational centers offer complete programs in the discipline, and most nematology teaching functions as part of other allied subjects. Universities themselves must provide the principal funding for teaching; few other sources are available. Although there has been an increase in didactic materials, they are not necessarily well adapted to specific needs of individual courses. Greater emphasis must be placed on adequate background preparation of students. In addition, proper recruitment and the establishment of comprehensive programs of excellence will determine nematology's future potential to prepare totally trained professionals. University of Florida, Department of Entomology & Nematology, Gainesville, FL 32611, U.S.A.

DUNN, R. A. Perspective on Extension Nematology.

In the broadest sense, every nematologist who has helped any laymen to recognize, better understand, or manage nematode problems has done extension work. Because there are relatively few nematologists and our subject matter is less widely understood than many other sciences, probably more research nematologists are in direct contact with those with nematological problems than are those in most disciplines. However, there is a more formal concept of "extension" to consider. The Cooperative Extension Service was created in 1914 as one of the three strong legs of the Land Grant College System "to aid in diffusing among the people of the United States useful and practical information on subjects relating to agriculture and home economics, and to encourage the application of the same." Many land-grant colleges have included formal assignment of a small percentage of time of one or more nematologists to formal extension work. Fewer than a dozen states have had personnel whose titles included "Extension Nematologist" with a commensurately major fraction of their time assigned to extension work. The steadily increasing complexities of the problems with which agriculture is faced and of the legal, economic, and social environments within which the problems arise and in which the remedies must be applied are creating an environment in which nematologists formally dedicated to extension programs will be increasingly in demand. Dept. of Entomology & Nematology, University of Florida, Gainesville, FL 32611.

ENDO, B.Y. Morphology and Ultrastructure of Host Cells Modified for Nematode Feeding. Root morphology is modified during nematode infections in ways that disrupt the vascular flow of

water and nutrients and cause severe stunting of crop plants. In infections caused by certain endoparasitic nematodes, multinucleate cells, termed syncytia or giant cells, play an integral role in host susceptibility and resistance. The ultrastructural changes observed in the host resulting from penetration and feeding by nematodes have revealed: 1) unique feeding site alterations of the outer wall of syncytia and giant cells; 2) cell wall dissolution and proliferations; 3) secretory products in host cells; and 4) organelle and nuclear changes within the host cells. The concepts of immunochemistry and the utilization of video-enhanced light microscopy supported with electron microscopy should provide ways to better understand host-parasite infections and to develop novel approaches for nematode control strategies. USDA, ARS, Plant Protection Institute, Beltsville Agricultural Research Center, Beltsville, MD 20705.

ESSER, R. P. and G. R. BUCKINGHAM. Genera and species of nematodes occupying freshwater habitats in North America.

A comprehensive list of freshwater nematodes from North America is presented, including the types of water habitats from which they originate. Detailed methods of sample collection, and laboratory processing strategies are included. Division of Plant Industry, Bureau of Nematology, Agric. Res. Service USDA, respectively, P.O. Box 1269, Gainesville, FL 32602.

EVANS, A.A.F. Diapause as a survival strategy.

An obligate diapause has been clearly demonstrated in several populations of Heterodera avenae, Meloidogyne naasi, and strongly implicated in Ditylenchus dipsaci. A winter dormancy has been shown in several temperate Heterodera species and a Scottish population of Globodera rostochiensis shows a facultative diapause. Delayed maturation and hatch of eggs of several other Meloidogyne species shows different features not necessarily associated with overwintering. The literature shows that the study of diapause in nematodes is still in its descriptive phase. Analysis of its ecological implications can be attempted but more information is needed on environmental factors in facultative diapause and heritability in obligate diapause before approaches can be made towards the underlying physiology. Imperial College at Silwood Park, Ashurst Lodge, Sunninghill, Ascot, Berkshire, SL5 7DE, England.

FERRIS, H. EXTRACTION EFFICIENCIES AND POPULATION ESTIMATION.

Standardization of data is important in studies of nematode population biology and crop damage. Extraction efficiency has two components: "catch" efficiency, the proportion of the population accessible to the methodology used; and "separation" efficiency of the technique used to separate nematodes from the surrounding medium. Intrinsic determinants of catch efficiency include population age structure, aggregation, and food distribution. Extrinsic determinants include the sample unit selected and the tools used. Intrinsic determinants of separation efficiency include population age structure and activity levels, life history strategy, and ornamentation. Extrinsic factors include soil characteristics, sieve apertures, temperature, and environmental suppressiveness. Most of the factors affecting efficiencies are ascertainable from knowledge of the biology of the organism and the impact of environmental conditions, and by comparing techniques against standards. Techniques vary in reliability, consistency and efficiency; they should be evaluated to test their appropriateness and to allow correction of population estimates to absolute terms. Advancements in biotechnology will provide improvements in diagnostic techniques and population assessments for nematodes. Division of Nematology, University of California, Davis 95616.

GERBER, K., and G. C. SMART, JR. Nematodes as parasites of aquatic plants.

Although many nematode species have been reported to be associated with aquatic plants, pathogenicity has been proven for only a few. Those include mainly species in the genera Aphelenchoides, Dolichodorus, Hirschmanniella, and Meloidogyne. A comprehensive list of phytoparasitic nematodes associated with aquatic plants will be presented. Some of these nematodes play a possible role as biocontrol agents of aquatic weeds. University of Florida, Institute of Food and Agricultural Sciences, Department of Entomology and Nematology, Nematology Laboratory, Building 78, Gainesville, FL 32611.

HEALD, C. M. Classical Nematode Management Practices

Nematode management is a practice whereby nematode populations are maintained at levels that do not inflict economic losses to the host crop. Classically there are two broad headings for such practices; chemical and cultural control. Chemical management involves delivery of a nematicide to the site of the nematode in concentrations which are lethal to the parasite but not to the plant. Basically there are two types of chemicals, soil fumigants and contact nematicides. Cultural practices reduce the nematode population by depriving the nematode of an adequate host for feeding and reproduction. Classical cultural nematode management practices include crop rotation, fallowing, use of resistant crops when available and soil heating. Plant Health and Stress Physiology Research Laboratory, P.O. Box 267, Weslaco, Tx 78596.

HUSSEY, R.S. Secretions of esophageal glands of Tylenchida nematodes.

Tylenchid plant-parasitic nematodes possess three complex esophageal glands that synthesize membrane-bound secretory granules. The contents of the granules may have a role(s) in egg hatching, penetration of host tissue, induction and maintenance of very specialized feeding sites, production of feeding plugs or tubes, and extra- and intra-corporeal digestion. Of particular interest are secretions of sedentary endoparasites which function in transforming host cells into elaborate nutritive feeding sites. However, secretory granules have not been purified from these nematodes so that their contents can be characterized and their role in these very specialized host-parasite relationships elucidated. The study of secretions of esophageal glands should be given high priority as their identification may lead to an understanding of the regulatory mechanisms involved in parasitism of hosts by sedentary endoparasites. Department of Plant Pathology, University of Georgia, Athens, GA 30602.

LEWIS, S. A. Host compatibility in plants.

A compatible host plant provides a suitable ecological niche for the nematode parasite and provides adequate nutrients for nematode growth and development including products that the parasite cannot itself synthesize. In addition to food, a compatible host may provide protection, feeding stimuli, and other physical needs of the parasite. Nematode development requires a series of changes in host plants in response to nematode secretions. During development, compatible hosts do not establish barriers that parasites cannot overcome. Dept. of Plant Pathology and Physiology, Clemson University, Clemson, S. C. 29631.

MAGGENTI, A.R. Adaptive steps from free-living nematodes to plant-parasitic sedentary endoparasites.

The earliest fossils of terrestrial vascular plants date from the Cambrian some  $600 \times 10^6$  years ago. Angiosperms do not appear in the record until the lower Cretaceous, an elapse of  $450 \times 10^6$  years. Nematodes are presumed to have been evolving the plant-parasitic habit throughout these time periods. Among Adenophorea, the primary adaptation is described as a shift from predators with cylindrical movable mouthparts to herbivores feeding on algae. Secernentean nematodes most likely made a transition from fungus-feeding forms. The morphological and physiological steps from migratory ectoparasitism to sedentary endoparasitism are discussed. Possible steps linking insect and plant parasitism are proposed. Division of Nematology, University of California, Davis, CA 95616.

MAI, W. F., and R. A. MOTSINGER. History of the Society of Nematologists.

The first officers of the Society of Nematologists (SON) were elected in 1961, meetings of the Executive Committee were held in late December, 1961, the constitution was ratified on March 14, 1962, and the first meetings of the Society were held August 26-29, 1962 on the campus of Oregon State University. Prior to the founding of SON there were many important events involving many people which were essential to the founding of this society. The need for SON was recognized only after the development of the Science of Nematology by pioneering plant nematologists and the recognition of the importance of plant-parasitic nematodes in agriculture production. The annual meetings of SON and related activities such as publication of the Nematology Newsletter and the Journal of Nematology, and the recognition and encouragement of excellence in nematology by presenting awards to outstanding members have played a major role in the rapid advancement of the Society of Nematologists. Department of Plant Pathology, Cornell University, Ithaca, NY 14853; and Extension Plant Pathology, University of Georgia, Athens, GA 30602.

MORTON, H.V. Perspectives on the Role of Industry in Nematology.

The commercial introduction of D-D® Soil Fumigant in 1944 by Shell Chemical Corporation marked the beginning of Industry's role in nematology. This event was soon followed by the introduction of other fumigants. The high dosages, special equipment, and long waiting periods due to the phytotoxic properties of fumigants led to the large scale screening of non-volatile compounds. Nematicides had a major impact on control of nematodes during the period 1950 to mid-1970's. Since then the EPA Regulatory Affairs, and lack of new discoveries has seen the contribution of the nematicide industry not keeping pace with that of other pesticide industries. CIBA-GEIGY Corporation, P. O. Box 18300, Greensboro, NC 27419.

NOLING, J.W. Partitioning crop losses among pest groups.

Accurate measurement of crop loss induced by a single nematode species is frequently complicated by the influences of other production factors and concomitant pests. For predictive purposes, multiple pest crop loss models require the capacity to combine and integrate component pest effects. Simple additivity of individual pest effects have generally resulted in over-estimation of crop loss. The stage of plant development at stress initiation is an important variable influencing temporal changes in plant health and final yield response. New approaches to the partitioning of multiple pest crop loss effects require descriptions of plant growth as a product of the plants environment and time. The element of time is an integral factor forming a standardization framework for summing stress effects applied to the plant during the course of development. Defining plant damage in relation to nematode or injury equivalents provides a promising avenue for quantifying multiple pest effects. University of Florida, IFAS, Citrus Research and Education Center, 700 Experiment Station Road, Lake Alfred, FL 33850.

O'BANNON, J.H., and R.P. ESSER. Regulatory perspectives in Nematology.

When a pest is deemed of sufficient economic risk to make it of quarantine importance, methods must be developed to regulate entry and/or prevent establishment. In the United States, as well as most other countries internationally, categories of pests have been established dependent upon various risk factors. Governmental agencies recognize the value in preventing the introduction and control of unwanted pests which has led to international cooperation on reporting the existence of or new outbreaks of potential pests. Pest quarantines and certification play major roles in protecting geographical areas from either known or unsuspected pests. A history of quarantines involving phytoparasitic nematodes is presented including regulatory considerations when dealing with phytoparasitic nematodes subjected to quarantines. The basic needs and equipment essential to the establishment and maintenance of a regulatory laboratory are included. Division of Plant Industry, Bureau of Nematology, P.O. Box 1269, Gainesville, FL 32602.

PINOCHET, J. Management of plant parasitic nematodes in Central America: the Panama experience.

Nematode damage in field crops in Panama is lower than in horticultural and fruit tree crops. Control measures rely mainly on crop rotation. Sugarcane, bean and cowpea tend to suffer more from Meloidogyne and Pratylenchus. On potatoes the use of nematicides is widespread. Pest management strategies, developed for Globodera rostochiensis have been difficult to implement. Meloidogyne spp. is the most important nematode in horticultural crops. Damage level ranges from slight to total loss, a situation mainly due to continuous cropping sequences with other good hosts of this nematode and weeds. The most recommended control measures are crop rotation, aided by the use of tolerant and resistant varieties whenever available. Banana is the only fruit crop that has developed sound nematode control programs consisting in a combination of agronomic practices and chemical control. Other fruit tree species like plantain, papaya, citrus, pineapple and chirimoya, generally do not apply any control measures. The improvement of cultural practices at the nursery level is possible and the adequate step in establishing nematode free orchards. IPM Project, CATIE. Apartado 6-3786, El Dorado, Panama.

RIDDLE, D. L., J. W. GOLDEN, and P. S. ALBERT. The role of Dauer Larvae in Survival of Caenorhabditis elegans.

Caenorhabditis elegans is free-living soil nematode which feeds on bacteria. Formation of a developmentally arrested, non-feeding dispersal stage called the dauer larva is enhanced by limited food, increasing concentrations of a Caenorhabditis-specific, fatty acid-like pheromone, and growth temperatures above 22 C. Recovery from the dauer stage is enhanced by an increased food supply, reduced pheromone levels, and lower temperatures. Worms apparently integrate these cues to maximize their survival in the soil by developing to the adult only when sufficient food is available to support reproduction. Dauer larvae have a unique cuticle structure and their mouth is tightly closed, providing them with enhanced resistance to desiccation and harsh chemical treatments such as exposure to detergents. Dauer larvae have been referred to as "non-aging" forms because they are capable of surviving for several months, and then recover to form adults with a normal post-dauer life span. More than 20 genes have been defined which affect the nematode's response to these environmental parameters. One mutant, daf-22, is defective in pheromone production and does not form dauer larvae unless exogenous dauer-inducing pheromone is added to the growth medium. Dept. Biol. Sci., University of Missouri, Columbia, MO 65221.

ROBERTS, T.M. Nematode sperm as a model for research on cell motility

Unlike their flagellated counterparts among most metazoa, nematode sperm move by extending pseudopods. Recent studies of sperm locomotion in vitro have shown that these cells exhibit the same polarized morphology, pattern of substrate attachment, and motility-associated membrane dynamics expressed by other crawling metazoan cells such as fibroblasts, epithelial cells, neurons, and leucocytes. Yet, surprisingly, sperm lack the actin-myosin contractile system generally associated with this type of locomotion. Efforts to identify the mechanism that propels sperm movement are focussed on the 2-3 nm filaments located in the pseudopod. Sperm from several different species contain these filaments ranging in organization from a loose network of fibers in sperm of C. elegans to long, well-ordered bundles of filaments in Ascaris sperm. Immunolabelling studies have tentatively identified an abundant, sperm-specific 15,000 dalton protein as the filament polypeptide. The filaments have been polymerized in vitro from cell-free extracts of Ascaris sperm allowing us to begin to analyze their molecular anatomy and function. Department of Biological Science, Florida State University, Tallahassee, FL 32306.

R. RODRIGUEZ-KABANA and G. MORGAN-JONES. Biological control for the management of nematodes.

An account is given of the principal antagonistic soil microorganisms known to cause diseases in nematodes and thereby exercise a biocontrol influence. Aspects of their interrelationship with phytonematodes including detrimental modes of action leading to disorders are reviewed. Emphasis is placed on the role of fungi in controlling nematode population dynamics. These include specialized obligate endoparasites, nematode-trapping predaceous forms, and opportunistic colonizers of cysts and eggs of cyst and root-knot nematodes. Recent developments in knowledge of the occurrence and activities of the latter group are discussed including their role in induction of suppressiveness in agricultural soils. Types of antagonistic fungal activity are broached, particularly mechanical disruption and enzymatic breakdown of nematode structures such as eggs shells and larval cuticles. Consideration is also given to the likely effects of the biosynthesis of diffusible toxic metabolites on the part of the fungi. Interpretations are offered of the potential role and value of fungi in the management of nematode populations. Department of Plant Pathology, College of Agriculture, Auburn University, Alabama 36849.

SAMOILOFF, MARTIN R. Free-living Nematodes as Systems for Monitoring Toxic Effects in Air and Water.

The survival, growth, and maturation of synchronous populations of free-living nematodes, such as Panagrellus redivivus, can be used as indicators of a range of toxic effects produced by contaminants in natural waters, industrial process sump waters, and in indoor air. These results can be used as a "yardstick" for prioritizing the risk potential at a series of tested locations. This review will present the test methods, sampling protocols, and methods of analysis. Bioquest International, Inc., 204-2989 Pembina Highway, Winnipeg, Manitoba, Canada R3T 2H5.

SASSER, J. N. and D. W. FRECKMAN. A World Perspective on Nematology: The Role of the Society.

A world perspective on nematology and the role of professional societies is presented. Information obtained from a questionnaire sent to all nematologists throughout the world was used to gain the perspective. The questionnaire was designed so as to provide information on the following three general questions: 1) How important are plant-parasitic nematodes in world agriculture and which genera are of greatest economic concern in each of nine regions of the world; 2) How well equipped is our profession in terms of available knowledge, personnel and financial resources to cope with the problems; and 3) What is the desired role of professional societies in helping the individual nematologist and in advancing the science of nematology as a whole. The perspective emphasizes plant nematology, although many questions on the questionnaire pertained to nematology as a science. The task was too great to assess the state of the art with reference to all groups of nematodes. Department of Plant Pathology, N.C. State University, Raleigh, NC 27695 and Department of Nematology, University of California, Riverside, CA 92521.

VAN GUNDY, S. D. Perspectives on Nematology Research.

Historically, a rapid expansion in the field of nematology took place in the 1950's. The success of that era of nematology relied heavily on the use of excellent inexpensive chemical pesticides and a cadre of conventionally trained plant pathologists and entomologists. As those scientists retire during the late 1980's and early 1990's, this era of nematology will come to a close. We are now on the threshold of a new era in nematology research. The driving force will be biotechnology. The loss of our chemical pesticides and society's greater concern about pesticides in the environment has insured an even greater need for continued nematology research. Are nematology research and training centers prepared to impliment and use these new technologies that have arisen from the biological and physical sciences to address the biology and control of nematodes so important to food production? Department of Nematology, University of California, Riverside, CA 92521.

WEBSTER, J.M. and G.B. DUNPHY. Host compatibility of insects to nematodes.

Compatibility of nematodes with their insect hosts represents a summation of continuously changing events in the host-parasite interaction. As such it may range from incompatibility (e.g. nematode death), through moderate compatibility (e.g. nematode survival and host debility) to complete compatibility (e.g. both insect host and nematode parasite thrive). These degrees of compatibility differ with species and age of both insect and nematode and with site and duration of the association. They are manifest in terms of the response of the host's haemolymph and non-haemolymph tissues to the parasite and, in less specialized interactions within the parasitosphere, in the eco-physiological and behavioural responses. The physico-chemical and nutritional requirements of some mermithids, tylenchids, filarial worms, steinernematids and heterorhabditids will be considered in terms of their biochemical, physiological and homeostatic influences on their insect vectors/hosts. Centre for Pest Management, Department of Biological Sciences, Simon Fraser University, Burnaby, Vancouver, Canada, V5A 1S6.

WILLIAMS, J. F. and D. W. TWOHY. Adaptations to parasitism of animals.

Nematodes parasitizing vertebrate animals show a remarkable diversity of structural and physiological adaptations to life in a wide range of host tissues and organ systems. Complex penetrating and migratory capabilities are often coupled with an extraordinary ability to persist and multiply in the face of highly responsive nonspecific and specific defense mechanisms. In this review we identify and outline contemporary understanding of: characteristics that facilitate invasion and preferred site locations; physiological and metabolic peculiarities that permit survival, growth and reproduction in the extremes of the internal environments provided by animal hosts; and active evasive measures undertaken by nematodes that counteract host defenses. Selective examples will be chosen to explore in detail concepts of mechanisms of nematode adaptation to parasitism that are the focus of current research efforts in medical and veterinary parasitology. Department of Microbiology and Public Health, Michigan State University, East Lansing, MI 48824.

WOMERSLEY, C. Nematode anhydrobiotes: levels of adaptation to dehydration stress.

Many nematodes are able to survive anhydrobiotically to varying degrees. Recently, we have begun to understand the complexity of adaptation required for this specialized strategy. Successful induction into anhydrobiosis is favored by slow drying, but since different habitats dry at different rates selections for a variety of adaptations have been made that allow for some nematode anhydrobiotes to effectively control the rate of evaporative water loss. However, this does not ensure survival. Only those nematodes able to adapt metabolically appear able to maintain viability during long periods of anhydrobiosis. Due to variability among the nematodes studied, inferences drawn from the limited research have caused some confusion as to the specific metabolic adaptations necessary for a nematode to survive essentially total dehydration. Present research now indicates that preferential accumulation of specific carbohydrates and modification of membrane phospholipids play a critical role in preventing irreversible structural damage and preserving functional integrity during anhydrobiosis. Department of Zoology, University of Hawaii at Manoa, Honolulu, HI 96822.

WYSS, U. Nurse cell systems of dorylaimid and tylenchid nematodes

All root parasitic nematodes appear to establish modified feeding sites to satisfy their nutritional demands. The main strategies are the creation of a large volume of cytoplasm and its modification for the efficient withdrawal of nutrients. Among epidermal feeders trichodorid nematodes trigger the most drastic cytoplasmic and nuclear responses. The impact by tylenchid epidermal feeders is less pronounced. The nurse cell systems of the ectoparasitic longidorid nematodes are most complex in Xiphinema spp. that feed on root tips. The highest degree in nurse cell structure and function is associated with those tylenchid endoparasites that establish their nurse cell systems within the vascular cylinder. Little is yet known about how these systems are induced and maintained. However, with the advance in high resolution video-enhanced contrast microscopy an insight into the living state can now be obtained. This will be illustrated by a research film that, together with associated cell responses, shows characteristic phases in the feeding behavior of Heterodera schachtii during the initial stages of nurse cell development. Institut für Phytopathologie, Universität Kiel, D-2300 Kiel 1, W.Germany

ZUCKERMAN, B. M. Nematodes as models to study biological aging.

Three subjects related to the use of nematodes as models to study biological aging are discussed. First, an overview of the rationale for utilizing nematodes to study aging is given. Questions considered are what types of answers can be expected and has the nematode been useful as a predictive model for specific age-related occurrences in mammals? Second, the impact on results obtained from the monoxenic as compared to the axenic culture systems used in Caenorhabditis aging studies is examined. It is emphasized that nematode development and aging under these two cultural regimes is radically different, so much so that the results from one cultural regime cannot be compared with those from the other. Finally, certain morphologic changes observed from very old nematodes examined close to the end-points of their lives are described, and interpretations given as to how these events may directly precede the death of the nematode. Department of Plant Pathology, University of Massachusetts, Amherst, MA, 01003.

# CONTRIBUTED PAPERS

Paper Withdrawn

ANAND, S. C., and S. R. KOENNING. Temporal deployment of resistance genes for management of *Heterodera glycines* and associated soybean yield suppression.

The effects of various soybean rotations on soybean yield and *Heterodera glycines* (SCN) populations were evaluated. Soybean cvs Essex (susceptible), Forrest (race 1 and 3 resistant) and Bedford (race 3 and 4 resistant) were grown continuously, in continuous soybean cv rotation or in soybean cv rotation with cotton since 1982. The SCN population levels were determined at planting and harvesting. The indices of parasitism (IPs) (% of cysts on Lee) of the SCN populations on Pickett 71, Peking, PI 90763 and PI 88788 were determined. IPs on Peking, Pickett 71 and 90763 were unaffected by any rotation. The IP on PI 88788 was greater ( $P = 0.05$ ) in plots planted to Bedford. Plots which were planted in Bedford in 1983 and Essex in 1984 also had a greater IP on PI 88788. The SCN population densities were greatest ( $P = 0.01$ ) when cotton was followed by either Essex or Forrest. SCN reproduction was greater ( $P = 0.05$ ) with continuous Forrest or Essex than continuous Bedford. Rotations with or without cotton tended to stabilize soybean yield when compared to continuous cultivation of soybean cvs. Department of Agronomy, University of Missouri, Columbia, Delta Center, P. O. Box 160, Portageville, MO 63873.

BALDWIN, J. G. and A. A. OTHMAN. SEM of lip patterns for use in phylogenetic analysis of Heteroderidae. SEM of lip patterns of second stage juveniles, males, and females of Heteroderidae are considered for phylogenetic analysis, not as single characters, but as a complex of several characters which each seem to be inherited independently. Many genera and species including *Atalodera ucrici*, *Sherodera lonicerae*, *Sarisodera hydrophila*, and *Sarisodera sequoiae* as well as certain *Heterodera* and *Globodera* spp. are polymorphic so that large numbers of individuals must be examined to interpret variability of patterns. Widely divergent lip patterns within certain genera, including *Meloidodera*, have subsequently been elucidated as extremes of a transformation series by discovery of new species with intermediate patterns. In other cases, divergent patterns weaken previous hypotheses of monophyly of certain genera including *Sarisodera sensu lato*. Insight into variation as well as convergent evolution is required for effective use of lip patterns in phylogenetic analysis of Heteroderidae. Department of Nematology, University of California, Riverside, CA 92521; Department of Plant Protection, University of Garyounis, El Beida, Libya.

BERNARD, E.C. and D.E. CARLING. Distribution of plant-parasitic nematodes in Alaska.

Nematodes were extracted from 550 samples collected July-August, 1985, from diverse regions of Alaska. Specimens from an additional 150 samples collected in previous years also were examined. Twenty-seven genera and about 79 species were recognized. Species of Scutylenchus, Trichodorus, Paratylenchus, and Criconemella were most frequent. Three Meloidogyne spp. were collected only in a small area of central Alaska; all three apparently are undescribed. A species of Sphaeronema was found to be common in boreal birch forests. The maritime fauna was characterized by Anguina radicicola, a circumglobal holarctic species, and Thecavermiculatus crassicrustata, a cystoid species distributed along the Aleutian Island-Gulf of Alaska rim. Many Alaskan nematodes seem to be endemic to the region. Department of Entomology and Plant Pathology, University of Tennessee, Knoxville, TN, 37901-1071; and Alaska Agriculture and Forestry Experiment Station, Palmer, AK, 99645.

BIRD, G.W. and L.S.O. GRANEY. Distribution of *Heterodera avenae* in Michigan.

Heterodera avenae was first detected in Michigan on 14 September 1983, in a routine extension sample analyzed for H. schachtii. The initial find was from a dry bean field (Phagelolus vulgaris) in Section (Sec.) 16 of Gilford Township (Twp.) in Tuscola County (Co.). A H. avenae survey of 102 soil samples from 42 small grain fields in Gilford Twp. was conducted from 15-22 November 1983. H. avenae was widely distributed on three farms in Sec. 16, and detected in one field in Sec. 3. A 1984 statewide survey of 349 small grain fields in 34 Michigan Co. resulted in the detection of three additional H. avenae infestations. All of these finds were in Gilford Twp. of Tuscola Co.! Two were from Sec. 11 and one from Sec. 10. A 1985 survey of 91 small grain fields was used to evaluate the border Sec. of Gilford Twp. and adjacent Sec. of Fairgrove, Denmark, Juniata, and Wisner Twps. of Tuscola Co.; Merritt Twp. of Bay Co. and Blumfield Twp. of Saginaw Co. H. avenae was detected in one field in Sec. 2 and 3 of Gilford Twp. and one field in Sec. 6 of Fairgrove Twp. The owners of 5 of the 10 farms currently known to be infested with H. avenae are close relatives. Department of Entomology, and Department of Botany & Plant Pathology, Michigan State University, East Lansing, MI 48824.

BOEHM, N.M. The development of controlled release granular nematicide formulations for use in annual and perennial cropping systems.

The insecticide 'suSCon' Blue (140g chlorpyrifos/kg) produced as a thermoplastic matrix granule is now registered in Australia for control of white grub in sugar cane for up to three years. The manufacturers, Incitec Ltd., have initiated a research program to investigate and develop nematicidal formulations based on similar granule matrices. Six currently used nematicides and one experimental compound have been successfully formulated in these thermoplastic granules, releasing active ingredient when placed in soil over periods ranging from several months to over three years. Nematicidal activity of the formulations has been demonstrated in glasshouse bioassay tests and field trials. INCITEC LTD., PO Box 140, MORNINGSIDE, Brisbane, QLD, AUSTRALIA. 4170.

R.I. BOLLA, P. KOSLOWSKI, C. WEAVER, K. FITZSIMMONS and R.E.K.

WINTER A nonpathogenic isolate of *Bursaphelenchus xylophilus*

produces ethanol as a metabolic end product.

During serial passage of the Missouri Scots pine isolate of *B. xylophilus* (pathotype MPSy-1) on fungal cultures, a population (MPSy-2av) was recovered which no longer infected Scots pine. Fifteen days after inoculation of 1-2 yr. old Scots pine seedlings with either 25,000 or 60,000 MPSy-2av, only 3 + 2 dying females could be recovered. The seedlings did not develop wilt symptoms. MPSy2-av did not infect Austrian, white, or loblolly pine seedlings. This isolate retains morphological characteristics of its parental pathotype, MPSy-1 and readily mates with this pathotype. Analysis of metabolic end products of glucose and  $\text{NaHCO}_3$  metabolism by MPSy-1 and MPSy-2av indicates the production of fumarate and/or succinate and glycerol by MPSy-1 and of ethanol by MPSy-2av. Differences between the alcohol dehydrogenase gene between MPSy-1 and MPSy-2av were observed by restriction endonuclease analysis and hybridization techniques. Depts. Biology and Chemistry, Univ. Missouri-St. Louis, St. Louis, MO 63121.

BRODIE, B. B. Effects of cyst ontogeny and cuticle integrity on hatching of *Globodera rostochiensis*.

*Globodera rostochiensis* females in different developmental stages were picked from potato roots (cv Katahdin) and their cuticles were either punctured with an acupuncture needle or left intact. Developmental stages studied were determined by cuticle color; white, golden, or brown. Mature cysts that had been stored three months (21C) were used as controls. Cysts or young females were immediately placed in hatching chambers to which 5 ml of water or potato root diffusate (PRD) were added. Emerged juveniles were counted weekly for 8 weeks. Increased hatch in both water and PRD was negatively correlated with cyst age and cuticle integrity. Greatest hatch occurred in white females whose cuticles had been punctured and least hatch occurred in brown cysts that were not punctured. USDA, ARS, Department of Plant Pathology, Cornell University, Ithaca, NY 14853.

CABANILLAS, E. and K. R. BARKER, Histological Examination of the Effects of the Fungus *Paecilomyces lilacinus* on Root Gallings

Caused by *Meloidogyne incognita* on Excised Tomato Roots Grown in a Synthetic Medium.

The histopathology of the interactions of the fungus *Paecilomyces lilacinus* on root gallings caused by *Meloidogyne incognita* race 1 on excised tomato roots growing in a synthetic medium was examined. There was no root galling or giant-cell formation in tomato roots inoculated with nematode eggs infested with *P. lilacinus*. No or few galls and no giant-cell formation were found in roots dipped in a spore suspension of *P. lilacinus* in the presence of *M. incognita* eggs. Increased numbers and size of galls and giant-cell formation were observed in roots inoculated with *M. incognita* alone. Root sections revealed that *P. lilacinus* colonized the surface of epidermal cells as an epiphyte, as well as the internal portions of epidermis and cortex as an endophyte. These examinations indicated that biological protection of plant-root surfaces can be another possible approach to biocontrol with *P. lilacinus* and other antagonists against *M. incognita* and other plant pathogens. Department of Plant Pathology, N.C. State University, Raleigh, NC 27695-7616.

CABANILLAS, E. and K. R. BARKER, The Effects of Fungal Inoculum Density and Time of Application of *Paecilomyces lilacinus* in Controlling *Meloidogyne incognita* on tomato.

Microplot experiments were conducted to evaluate the effects of the fungus *Paecilomyces lilacinus* (PL) at different rates of inoculum and times of application on the control of *Meloidogyne incognita* (MI) on tomato. The best control of MI was attained with 20 and 10 gm fungus-colonized wheat medium (fcwm) per plot. These treatments resulted in a 4X to 3X increase in tomato yields compared to plots infested with MI alone. There were significant differences in the suppression of gall development between 20 gm (36% gall inhibition) and 10 gm fcwm (20% gall inhibition). The greatest control was achieved when PL was added to the soil twice, one application at 10 days before planting and again at planting time which resulted in about a 2X increase in yield and 56% gall suppression compared to plots treated only with MI. Bioassays showed a greater percentage of PL-infected egg masses in plots treated at midseason only, or at midseason plus an early application than plots treated with the fungus 10 days prior and/or at planting time. Department of Plant Pathology, N.C. State University, Raleigh, NC 27695-7616.

CANTO-SAENZ, M. and I. CARO. Reaction of 15 Tomato Cultivars to *Meloidogyne incognita*.

Tomato cultivars Easy red, Peto 95, CIRT-8, N-291, N-22, Cx8101, Cx8203, Cx8303 E-6203, Cx8201, Cx8012, Peto 9889, CIRT-1, 65-27, CIRT-7 and Rutgers were grown in *M. incognita* infested fields. Root galling index was recorded 90 d after planting on a scale of 0 to 5. Roots of cultivars Peto 9889, CIRT-1, GS-27 and CIRT-7 had a galling index of 0 - 1 and were selected for further study. Three months after planting, root galling index and number of eggs/plant were evaluated and the soil was bioassayed. Also, fruit weights/plant, number of fruit per plant and root weights were recorded. Yield was determined at harvest. Some quality parameters such as hardness of fruit, weight of juice, fruit weight, pedicel retention, soluble solids content, earliness and harvest uniformity. The cultivars Peto 9889, CIRT-1, GS-27 and CIRT-7, were non efficient hosts of *M. incognita*. Combining this characteristic with yield, they were considered resistant to this nematode. In quality parameters Peto 9889 and CIRT-7 were the best. National Agrarian University, La Molina, Apartado 456, Lima, Peru. International Potato Center, Apartado 5969, Lima, Peru.

CARPENTER, A.S., and S.A. LEWIS. Reproduction and virulence of four *Meloidogyne arenaria* isolates on six soybean selections.

Virulence and reproduction of four *Meloidogyne arenaria* isolates were evaluated in two field tests consisting of 120 and 40 microplots. Three race 2 isolates were collected from South Carolina and one race 1 from Florida. Soybean selections having differential tolerance to *M. arenaria* were arranged in a split-split plot design with nematode isolates nested within soybean selections. In both the 40 and 120 microplot tests, the Govan isolate had significantly higher reproduction and virulence than the Pelion isolate while the Florida isolate had significantly lower reproduction and virulence than the three S.C. Race 2 isolates. Previous studies conducted in their native habitats have repeatedly shown greater virulence of the Pelion isolate compared to the Govan isolate. These microplot tests indicate that environmental effects are of major importance in determining soybean tolerance to *M. arenaria*. Department of Plant Pathology and Physiology, Clemson University, Clemson, SC 29634-0377.

CASWELL, E.P., and D.O. CHELLEMI. A geostatistical analysis of spatial pattern of *Rotylenchulus reniformis* in a Hawaiian pineapple field.

A Hawaiian pineapple field was intensively sampled after plant knock-down. An area 40 m x 116 m was sampled along transects at 3 m intervals. The variance to mean (V/m) ratio was 699.8, implying an aggregated spatial pattern of *Rotylenchulus reniformis* in the field. Taylor's Power Law was used to describe the relation between V and m, as  $\log V = 1.93 \log m + 0.57$  ( $r=0.95$ ). The b value of 1.93 indicates an aggregated spatial pattern. Using geostatistical techniques, semi-variograms were constructed for 0, 90, and 135 degrees and 90 degrees all directions. All analyses, except that for 0 degrees, appeared to be adequately described by the spherical model with "nugget effect"; suggesting a completely random spatial pattern of nematodes within the field. The analysis for 0 degrees appears to fit the exponential model, and shows a range of spatial dependence of approximately 10 m. The possible influence of cultivation on spatial pattern will be discussed. Department of Plant Pathology, University of Hawaii, Honolulu, HI 96822.

CASWELL, E.P., and I.J. THOMASON. A physiological-time based model for egg production by *Heterodera schachtii*.

Egg production by *Heterodera schachtii* infecting *Beta vulgaris* was compared at constant temperatures of 13, 18, 24, and 30 C. The relationship between cumulative degree days (DD) (base 8 C) and egg production was examined. Egg production was observed to commence between 190 and 270 DD after hatch, and reached a maximum between 390 and 480 DD. The rate of egg production ranged from 1.03 to 1.25 eggs/DD per female. Cumulative egg production (Y) is a linear function of cumulative DD (X), and can be described by the linear model:  $Y = 1.15X - 226.1$  ( $r=0.92$ ) ( $p=0.05$ ) at 24 C. There were no significant ( $p=0.05$ ) differences between regression parameters for those regressions with significant ( $p=0.05$ ) fit to this linear model. Department of Plant Pathology, University of Hawaii, Honolulu, HI 96822; and Department of Nematology, University of California, Riverside, CA 92521.

CID DEL PRADO V. I. Morphological Study of *Nacobbus* spp. including four populations from Mexico using SEM.

*N. dorsalis* females and males have a hemispherical head, with three cephalic annuli, labial disc circular, but in the males divided in six major sections. Oral opening surrounded by six sensorial papillae; two ovoidal lobes present in the subdorsal and subventral position while on dorsal and ventral sides there are bridge-like connections between the labial disc and the first annule. Lateral field with four incisures with irregular aeration. Vulval opening with irregular lips, anterior narrow and posterior wider and ornamented with small tubercles. Males with caudal alae well developed. *N. aberrans* populations basically have the same cephalic features; cephalic disc circular or oval in shape; oral opening oval in shape with three sensorial pits in each lateral side, the rounded lobes and the cuticular bridges also present. In the Nebraska populations the cephalic framework is weak; in the Actopan Hgo. population it is conspicuous with thick bars projecting posteriorly and in the other three populations it is moderately sclerotized and lightly curved. The bursa in males develop differently. Colegio de Postgraduados. Fitopatologia. Montecillos 56230 Mexico State. Mex.

CRAWFORD, J. L., R. E. MOTSINGER AND W. M. POWELL. Cotton yields affected by nematicides, application methods and rates in root-knot and lance nematode infested fields.

Replicated on-farm tests were conducted in both root-knot (*M. incognita*) and lance (*H. columbus*) nematode infested fields to evaluate efficacy of nematicides and application methods as measured by yield increase and reduction in nematode numbers. Field populations were moderate for lance and high for root-knot nematodes. Telone II (1,3-D) at 3 or 5 gals/A., injected 12" deep under the row at planting consistently gave the highest yields with almost imperceptible phytotoxicity, but only the 3 gal. rate plus Temik 15G (aldicarb) at 3.5 lbs/A row basis, in-furrow gave a significantly better yield than any other treatment. However, Temik 15G (aldicarb), Nemacur 15G (fenamiphos), Furadan 15G (carbofuran) and UC 70667 10G increased cotton yield significantly higher than controls. Different application methods for non-fumigants did not give significant yield differences. Division of Plant Pathology, University of Georgia, Athens, Ga 30602.

CRAWFORD, J. L., R. E. MOTSINGER AND W. M. POWELL. Cotton yields affected by varieties and levels of control in root-knot nematode infested field.

Replicated on-farm tests of 4 levels of nematicide treatment (High - 1,3-D at 5 gals/A. injected 12" deep under row at planting; Medium - fenamiphos at 14 lbs/A. in 6-inch bands over row; Low - 3.5 lb/A aldicarb in-furrow at planting; and none) were conducted in combination with 3 levels of varietal tolerance to the root-knot-Fusarium-wilt complex (High - McNair 235; moderate - Coker 315 and low - Stoneville 825) in an irrigated field. Root-knot nematode populations were low to moderate and *F. oxysporium* f. sp. *vasinfectum* incidence was low. The 3 highest yields were obtained with 1,3-D on the 3 varieties with essentially no phytotoxicity observed. Average yields were correlated with levels of nematode control treatments, but not with accepted varietal tolerance grouping. Stoneville 825, the "least tolerant" variety gave the highest yield at each level of nematode control. Division of Plant Pathology, University of Georgia, Athens, GA 30602.

CULBREATH, A. K., R. RODRIGUEZ-KABANA, and G. MORGAN-JONES. Chitin and Paecilomyces lilacinus for control of Meloidogyne arenaria.

Soil infested with *Meloidogyne arenaria* was amended with chitin at rates of 0, 0.1, 0.2, 0.4, 0.8, and 1.0% (w/w). Rice colonized with *Paecilomyces lilacinus* was also added to the soil at rates of 0, 1, 2, and 5 gm/Kg soil to have all possible combinations of rates for the 2 materials. The treated soils were kept moist for 2 wks and were then planted with squash seed. The plants were allowed to develop for 6 wks. when they were removed and the soils were replanted with 4-wk-old tomato seedlings. The tomatoes grew for an additional 8 wks. before the experiment was terminated. The number of galls/gm of root (GR) in squash was not affected by the *P. lilacinus* treatments; however, GR values increased for soils treated with 0.1-0.8% chitin. *P. lilacinus* and chitin amendments reduced GR values and the number of juveniles/gm tomato roots. Results indicate that chitin enhances the activity of *P. lilacinus* amendments against *M. arenaria*. Department of Plant Pathology, Auburn Univ., Auburn, Alabama 36849.

DAVIS, E. L., J. R. RICH, and G. R. GWYNN. Resistance to Meloidogyne spp. in the genus Nicotiana.

Three groups of tobacco (Nicotiana spp.) germplasm were tested for resistance to M. arenaria (MA) and M. javanica (MJ) in greenhouse experiments. The most promising accessions were then subjected to field evaluation against MJ and MA in microplots. Several species of tobacco including accessions of N. glauca, N. knightiana, N. longiflora, N. nudicaulis, N. plumbaginifolia, N. repanda, N. sanderae, and N. velutina exhibited resistance to MA or MJ in greenhouse tests. Nicotiana repanda '46-G' was strongly resistant to MA and MJ in both greenhouse and microplot tests. Some Nicotiana spp. accessions with growth characteristics similar to commercial tobacco displayed moderate resistance to MA or MJ, but resistance within these accessions was often quite variable. Accessions which had been backcrossed with N. tabacum showed little resistance to MA or MJ, but some produced relatively high tobacco yields in the presence of root-knot nematode infection. Nematology Department, University of Florida, Gainesville, FL 32611; IFAS, AREC, Live Oak, FL 32060; USDA, ARS, Tobacco Research Laboratory, Oxford, NC 27565.

DIEZ, J.A., B.A. CHAMPION, S.K. LAL, and D.B. DUSENBERY.

Bacteria that attract and repel root-knot nematodes.

A simple migration on agar method was designed to test responses of infective juveniles of Meloidogyne incognita to attractant or repellent stimuli. During testing of responses to root exudates, bacteria were discovered that influence migration of the nematodes. The nematodes were attracted to some bacterial cultures, avoided others, and did not respond to most. Attracting and repelling bacteria appear to have differing ratios of attractant and repellent stimuli. Heat stable repellent is found in sterile filtrates of aqueous suspensions of both kinds of bacteria, but more repellent activity is obtained from the repelling bacteria. Attraction of the nematodes to bacteria requires live bacteria; this stimulus is probably volatile or unstable. Both the attracting and repelling bacteria are Gram negative, oxidase positive rods.

School of Applied Biology, Georgia Institute of Technology, Atlanta, GA 30332.

DIEZ, J.A. and D.B. DUSENBERY. Root exudate fractions repellent to root-knot nematodes.

A simple migration on agar method has been used to test responses of infective juveniles of Meloidogyne incognita to samples of root exudate. The method is equally effective for repellents and attractants. The nematodes avoid most preparations of tomato root exudate, indicating that under the conditions used repellents predominate over attractants. The repellent activity is stable to heating, lyophilization, and evaporation under air. Extraction with organic solvents and ion exchange fractionation indicate that the molecules responsible for the bulk of the activity are ionic. Most of the repellent activity passes through anion exchange resin but is retained by and can be eluted from cation exchange resin. Conversely, attractant activity has been obtained in effluent from cation exchange columns and acid-eluant from anion exchange columns. Sephadex chromatography yields 2 peaks of repellent with apparent molecular sizes of about 500 and 1000 daltons.

School of Applied Biology, Georgia Institute of Technology, Atlanta, GA 30332.

DI VITO, M., N. GRECO, and G. ZACCHEO. The biology of *Meloidogyne artiellia*.

The development of *Meloidogyne artiellia* on chickpea was studied in pots at 10, 15, 20, 25 or 30 C and in microplots from plant emergence to harvest. In pots at 10 C no nematode invasion of the roots had occurred at 10 days after sowing and 56 days later only fourth stage juveniles were present. Females were found 34, 27, 20, or 41 days after sowing at 15, 20, 25, and 30 C, respectively and they produced egg masses by 48, 41, 27, and 41 days after sowing, respectively. In microplots second and third stage juveniles were present within chickpea roots in mid February, fourth stage juveniles at the beginning of March, adults by 25 March, and egg masses by 9 April. Egg masses were collected at weekly intervals and incubated at 20 C; no diapause was evident and hatching occurred within one to three weeks. After harvest of the microplots some were irrigated and others were not. In the irrigated microplots the nematode population consisted of second stage juveniles only, but in the non irrigated microplots it consisted of 57% eggs until July and 100% juveniles after the rain occurred in August. In all microplots the nematode population had declined by 85% at the end of November compared with the population size at harvest. C.N.R. Istituto di Nematologia Agraria, Via Amendola 165/A, 70126 Bari, Italy.

DUNCAN, L.W. and J.W. NOLING. Resistance of mature, healthy citrus to infestation by *Tylenchulus semipenetrans*.

A monthly survey of citrus fibrous root abundance and *Tylenchulus semipenetrans* population density under 100 trees was conducted in a bedded grove of Valencia oranges on sour orange rootstock. Data were collected to assess citrus growth and yield responses to *T. semipenetrans* parasitism and to describe nematode population dynamics. The natural logarithm of fibrous root abundance was directly proportional ( $p < 0.01$ ) to visual estimates (0-4 log<sub>2</sub> scale) of tree size and vigor. Infestation of *T. semipenetrans* juveniles per gram of fibrous roots was inversely related ( $p < 0.01$ ) to fibrous root abundance and to tree vigor ratings. Female *T. semipenetrans*/g root did not vary with tree vigor. Fibrous root growth as a proportion of total fibrous root abundance was described by a sigmoid shaped decay function. The data suggest that mature vigorous citrus trees are more resistant to *T. semipenetrans* infestations than growing or non-vigorous trees because young fibrous roots that support high female fecundity represent a smaller proportion of the entire root system. University of Florida, IFAS, Citrus Research and Education Center, 700 E. Station Rd., Lake Alfred, FL 33850.

ELLIOTT, A.P., J.A. GRIESBACH, and D.R. VIGLIERCHIO. Evaluation of Neem oil extracts in the development of *Meloidogyne*

*incognita*, *M. hapla* and *M. javanica*.

Normal development of *Meloidogyne incognita*, *M. hapla* and *M. javanica* were significantly inhibited by varying concentrations of Neem oil extract. All three species had significantly lower egg hatch at 10,000 ppm Neem oil extract compared to Triton-X solvent and water controls at 14 days. Lower egg hatch was observed for *M. hapla* at 4,000 ppm Neem oil and 2,000 and 4,000 ppm for *M. incognita*. Larvae of *M. hapla* and *M. incognita* were immobilized at the two higher concentrations, whereas *M. javanica* was immobilized only at 10,000 ppm. Glasshouse soil drenches of 2,000 ppm Neem oil extract significantly reduced the number of egg masses produced and the number of eggs per egg mass compared to controls for *M. javanica*. Division of Nematology, University of California, Davis, CA 95616.

ESBENSHADE, P. R., and A. C. TRIANTAPHYLLOU.

Biochemical relationships of Meloidogyne species.

Thirty populations of Meloidogyne of diverse geographic origin representing 10 species were studied with regard to 27 enzymes. The 184 isozyme bands resolved in this study were considered as independent characters. Pair-wise comparisons of populations were performed in all possible combinations to calculate the enzymatic distances and coefficients of similarity (S). A phylogenetic tree was constructed. The apomictic species M. arenaria, M. microcephala, M. javanica, and M. incognita shared a common lineage. M. arenaria was highly polytypic, whereas conspecific populations of M. javanica and M. incognita were largely monomorphic. The mitotic and meiotic forms of M. hapla were very similar ( $S = 0.93$ ), suggesting that the apomictic race (B) evolved from the meiotic race (A) recently. The five remaining species, i.e. M. chitwoodi, M. graminicola, M. graminis, M. microtyla, and M. naasi, were not closely related to each other or to the apomictic species. Department of Genetics, North Carolina State University, Raleigh, NC 27695-7614.

ESTANOL, E., C. SOSA-MOSS and R. FERRERA-CERRATO. Interaction

between Rhizobium phaseoli, Gigaspora calaspora, and Glomus L. S. Rhizobium phaseoli, of two endomycorrhizal fungi (Gigaspora calaspora and Glomus sp.) were inoculated with Meloidogyne incognita race 1 on bean cultivar Black Valentine. The nematode alone reduced the yield considerably. In contrast, Rhizobium phaseoli increased the number and weight of pods, even when the nematode was present. Where both organisms were inoculated simultaneously, the bacterium nodules were reduced by 50%. When Gigaspora and Meloidogyne were together, root galls were reduced and the number of eggs produced were decreased 80%. Glomus sp. had no effect on the bean or the nematode. Centro de Fitopatologia, Colegio de Postgraduados, 56230 Chapingo-Montecillos, Mex.

D. A. FLORINI and R. LORIA. Changes in population densities of

Pratylenchus penetrans and P. crenatus on winter cover crops. The effect of eight winter cover crops and fallow on population densities of Pratylenchus penetrans and P. crenatus was assessed in separate potato fields on Long Island, NY. Nematodes were extracted from mixed root and soil samples (10 bulked soil cores/replication, 10 replications) for 7-10 days on Baermann pie pans. Initial population densities of P. penetrans and P. crenatus were 2531 and 1652 nematodes/100 cm<sup>3</sup> soil, respectively, when cover crops were planted in September and October. Final population densities were measured in March. P. penetrans densities were reduced 68% on rye, 42% on wheat, and 32% on oats. P. crenatus densities decreased 22% on rye and wheat but increased 56% on oats. The contrast of winter grains (rye and wheat) versus spring grains (oats) was significant at  $P=0.015$  and  $P=0.0001$  for P. penetrans and P. crenatus, respectively. Wheat differed from rye at  $P=0.011$  for P. penetrans only. No significant differences were found between fallow and crops, between ryegrass and grains, or between cultivars of the crops tested. Plant Pathology Department, Cornell University, Long Island Horticultural Research Lab, 39 Sound Avenue, Riverhead, NY 11901.

FORTNUM, B. A., M. J. KASPERBAUER AND P. G. HUNT. Development of *Meloidogyne incognita* on tomato plants that received red or far-red light at the end of the photosynthetic period.

The role of phytochrome (red/far-red reversible reaction) on the growth and fecundity of *M. incognita* infesting tomato was examined in a controlled environment. Tomato seedlings were inoculated with 2000 eggs of *M. incognita* and placed in a chamber at 25C with 12-h days of cool-white fluorescent light at  $450\mu\text{Em}^{-2}\text{s}^{-1}$  between 400 and 700 nm. At the end of the daily light period, the plants received 5 min of red ( $360\mu\text{w}/\text{cm}^2$  in the 600 to 700 nm waveband) or 5 min of far-red ( $360\mu\text{w}/\text{cm}^2$  in the 700 to 770 nm waveband) and then were placed in the dark. Plants receiving the far-red light and inoculated with *M. incognita* had larger galls but fewer eggs and egg masses than plants receiving red light at the end of the photosynthetic period. Far-red light treated plants had larger shoots and roots. These results suggest phytochrome influences nematode-host interactions. Clemson University, Pee Dee Research and Education Center, P. O. Box 271, Florence, S. C. 29503 and USDA-ARS, Coastal Plains Soil and Water Conservation Research Center, P. O. Box 3039, Florence, S. C. 29502.

FORTNUM, B. A., J. P. KRAUSZ and R. E. CURRIN, III. Varietal reaction of grain sorghum to *Meloidogyne* spp.

Grain sorghum cultivars 'Funk G-499GBR', 'Funk G-611', 'Funk G-522A', 'Funk G-522DR', 'Coker 7723', 'Coker 7675', 'Coker 7623', 'Pioneer B815', 'Pioneer 8222' and 'Pioneer 8272' were evaluated in the greenhouse for resistance to *M. incognita* race 3, *M. arenaria* race 1, *M. arenaria* race 2 and *M. javanica*. All *Meloidogyne* spp. populations were collected in South Carolina except *M. arenaria* race 1 which was collected in Georgia. Pots containing 1000  $\text{cm}^3$  of heat-sterilized soil were seeded with the sorghum varieties or Tomato 'Rutgers' and inoculated with one of the four populations of *Meloidogyne* spp. All sorghum varieties tested were poor or non-hosts of *Meloidogyne* spp. Roots of inoculated tomato seedlings were heavily galled and contained large numbers of egg masses. In a field study, sorghum (Coker 7723) was planted into a field containing concomitant populations of *M. arenaria* race 2 and *M. incognita* race 3. Gallings and egg masses were observed on the susceptible crop tobacco 'PD4' but not on the sorghum variety. Clemson University, Pee Dee Research and Education Center, P. O. Box 271, Florence, S. C. 29503.

FRANCL, L. J., L. V. MADDEN, R. C. ROWE, and R. M. RIEDEL.

Modeling yield loss due to potato early dying disease.

Reduced yield of Solanum tuberosum attributable to simultaneous infection by Verticillium dahliae and Pratylenchus penetrans, pathogens involved in potato early dying disease, varies with yearly weather patterns. Significant environmental effects were found when weather station and experimental microplot data from two locations for 5-6 yr were analyzed. Microplot data consisted of controlled pathogen inoculum levels in fumigated soil and resulting yields of potato cv. Superior. Reduced yields were correlated with late-season degree days (DD, base 7 C) as average daily DD increased from 11 to 17. Increasing average daily DD over the range of 7 to 15 in the 10-20 days after planting was associated with higher yield. Mid- to late-season precipitation was negatively correlated with yield but one outlying observation was influential. Multiple regression models were developed using inoculum and environmental data from one location and were validated on data from the second location. Twelve provisional models will be tested on data from future experiments. Dept. of Plant Pathology, The Ohio State Univ., Ohio Agric. Res. and Dev. Center, Wooster, 44691 and Columbus, 43210.

FRECKMAN, D. W.<sup>1</sup>, W. G. WHITFORD<sup>2</sup>, R. A. VIRGINIA<sup>3</sup>,

M. B. JENKINS<sup>1</sup>, J. A. MENGE<sup>1</sup>, and W. M. JARRELL<sup>4</sup>. Deep soil

microbiota in deserts.

Although roots may penetrate to >50 m depths in deserts, the nature of the deep soil biotic community has not been characterized. We examined the hypothesis that root symbiotic associations are important in low nutrient, deep soil environments. Biotic communities in systems dominated by the symbiotic shrub Prosopis glandulosa were compared with those associated with non-symbiotic Larrea tridentata. Undisturbed cores were collected to 13 m in the Chihuahuan Desert, New Mexico. Nematodes, microarthropods, rhizobia, and mycorrhizal fungi were isolated from 1 m depth increments throughout the core. In New Mexico, population numbers decreased with depth in all cases, with representatives of all biota recovered from depths greater than 10 m. Nematode trophic groups, rhizobia growth rates, and microarthropod apparent trophic groups were determined. Species of plant parasites included Xiphinema, Pratylenchus, Paratylenchus, Tylenchorhynchus, Helicotylenchus and an undescribed heteroderid. Soil biota distributions will be related to water and nutrient availability. U. CA, Riverside, 92521; San Diego State U., CA 92182; NM State U., Las Cruces 88003, Dry Lands Res. Inst., U. CA, Riverside 92521.

GEORGI, L., O. C. YODER, and S. VANWERT. Comparison of restriction endonuclease fragments of ribosomal DNA from

Meloidogyne javanica and M. incognita.

DNA extracted from eggs of Meloidogyne javanica or M. incognita was digested with restriction endonucleases and subjected to agarose gel electrophoresis. Ribosomal gene fragments were identified by Southern hybridization using the cloned genes from Caenorhabditis elegans, supplied in plasmid pCe7 by Michael Krause (University of Colorado). This plasmid harbors the 7kb repeat containing the 18S, 5.8S and 26S rRNA sequences. No major differences in hybridizing fragments were found between the two Meloidogyne species in digests with BamHI, EcoRI, or HindIII. BamHI failed to cut within the gene in either nematode species. EcoRI released major fragments of about 3.6 and 1.7 kb; HindIII, 2.0 and 1.7 kb. EcoRI digests showed minor-band differences (possibly reflecting changes in flanking DNA or divergent gene copies) between single egg-mass cultures taken from the same population of M. javanica. Department of Plant Pathology, Cornell University, Ithaca, NY 14853.

GOODELL, P.B. AND H. FERRIS. Development of an overwinter simulation model for *Meloidogyne incognita* on cotton in the San Joaquin Valley of California.

An explanatory model was developed to simulate the overwinter survival of egg and second stage soil juvenile (J2) populations of *Meloidogyne incognita* on cotton (*Gossypium hirsutum* cv. Acala SJ2) fields at 0-30 cm depth in a Hesperia sandy loam. The elements of the model were based on biological knowledge of the nematode and its environment in a modified time-varying life-table structure based on physiological time (degree days 10 C). Development and hatch were regulated by temperature- and moisture-based functions. Hatch was distributed across several egg age substages by incorporating cumulative probability functions. Parallel life-stage arrays were included to allow differential aging of unhatched J2 when environmental conditions precluded hatch. The model was parameterized with data developed in controlled environment experiments using field-cultured nematodes collected in autumn. Simulation runs with the model were driven using real time and/or historical soil temperatures, rainfall, and management activities. U.C. Cooperative Extension, Bakersfield, CA 93303 and Division of Nematology, University of California, Davis, 95616.

GOODELL, P.B. AND H. FERRIS. Validation of an overwintering simulation for *Meloidogyne incognita* in cotton fields in the San Joaquin Valley of California.

A computer simulation model developed for the overwintering population dynamics of eggs and soil juveniles (J2) of *Meloidogyne incognita* in cotton (*Gossypium hirsutum* cv Acala SJ2) fields was validated with independently collected field data sets. The data sets were collected on 21 sample dates between Sept. 1981 and April 1982 (5 replications) and on 16 sample dates between Sept. 1982 and April 1983 (12 replications). The model adequately simulated J2 population dynamics and predicted spring populations densities. However, the simulation of egg population dynamics was poor as the model allowed for synchronous hatch of eggs when the developmental state of the population and soil conditions were conducive for eclosion. U.C. Cooperative Extension, Bakersfield, CA, 93303 and Division of Nematology, University of California, Davis, CA, 95616.

GRANEY, L.S.O. Description of the female of *Cactodera cacti* with additional observations of second-stage juveniles.

Isolates of *Cactodera cacti* were obtained from greenhouse cultures located in East Lansing, Michigan (MI), Gainesville, Florida (FL), and Lottum, Netherlands (LO). Description of the female of the MI isolate is as follows: L including neck = 532-765  $\mu\text{m}$  (mean 646  $\mu\text{m}$ , standard deviation  $\pm 56$ ); W = 323-574  $\mu\text{m}$  (450  $\mu\text{m} \pm 62$ ); stylet = 30.2 - 35.6  $\mu\text{m}$  (33.2  $\mu\text{m} \pm 1.2$ ); DEGO = 5.4 - 9.8  $\mu\text{m}$  (6.9  $\mu\text{m} \pm 1.2$ ); vulval slit = 9.5 - 15.1  $\mu\text{m}$  (12.6  $\mu\text{m} \pm 1.4$ ); distance between vulval slit and anus = 34.5 - 50.0  $\mu\text{m}$  (40.6  $\mu\text{m} \pm 4.2$ ). The average stylet length of second-stage juveniles (J2) measured in water of the MI, FL, and LO isolates is 25.1  $\mu\text{m}$ , 25.7  $\mu\text{m}$ , 25.0  $\mu\text{m}$ , respectively. The shape of the J2 dorsal stylet knob in lateral view ranges from sloping posteriorly to distinctively concave anterior. SEM enface views of J2 of the MI isolate reveals a dorso-ventrally elongated labial disc surrounded by six lips. Fusion of the lips with each other and the oral disc is common. Department of Entomology, Michigan State University, East Lansing, MI 48824.

GRECO, N., A. BRANDONISIO, and F. ELIA - Nematicide activity of SIP 5569 and polyethylene mulching.

The effect of 0.5-40.5 ppm of SIP 5569 on egg hatch and juvenile movement of Meloidogyne incognita was investigated in vitro. The efficacy of single (10 kg a.i./ha) and split (5+5 kg a.i./ha) applications of SIP 5569 and 4, 6, and 8 week periods of polyethylene mulching in controlling Heterodera carotae on carrot and Ditylenchus dipsaci on onion, under field conditions, was compared with that of equal rates of aldicarb and 300 l/ha of DD. Egg hatch and juvenile movement were significantly suppressed at  $\geq 5$  ppm SIP 5569, juvenile movement only at  $\geq 1.5$  ppm and there was no effect at  $\leq 0.5$  ppm. Carrot yield was doubled in the plots treated with DD 300 l/ha. Significant yield increases were also obtained with single application of SIP 5569 or 4-8 week mulching. Split applications of SIP 5569 and aldicarb were not satisfactory. All treatments, except aldicarb, reduced H. carotae infestations in carrot roots. D. dipsaci infestations were reduced and onion yields increased. C.N.R., Istituto di Nematologia Agraria, Via G. Amendola 165/A, 70126 Bari, Italy.

GRIFFIN, G.D., and E.E. SCHWEIZER. Effect of different cropping systems on soil populations of plant parasitic nematodes.

A four year crop rotation, weed control study on barley, bean, corn, and sugarbeet resulted in differences in the population dynamics of five nematode species. Heterodera schachtii populations declined under barley, bean, and corn, and increased under sugarbeet. Sugarbeet was a poor host, and barley, bean, and corn were fair to good hosts for Helicotylenchus crenacauda, Merlinius brevidens, Pratylenchus neglectus, and Xiphinema americanum. Herbicides had no effect on nematode populations except for possible destruction of weed hosts. X. americanum and M. brevidens populations showed significant yearly increases over a 6 year period, while a P. neglectus population stabilized after one year, in a minimum till wheat planting. USDA-ARS Forage and Range Research, Logan, UT 84322; USDA-ARS Crops Research Laboratory, Ft. Collins, CO 80523.

HACKNEY, R.W. Range of variability in the perineal patterns of Meloidogyne chitwoodi.

An identification profile of the perineal pattern was constructed for Meloidogyne chitwoodi. Forty-nine perineal patterns representing 27 paratypes and 22 specimens from populations with known host reactions were examined. The range of variability for perineal patterns of M. chitwoodi has five common elements which are used as a standard for comparison against unknown specimens: (1) dorsal inner striae arched, coarse, and rope-like - (a) low relatively circular arch, (b) highly arched, (c) wing present on either lateral side, and (d) "shoulders" on both lateral sides; (2) fine, relatively circular striae surrounding the inner coarse striae; (3) cross striations around the lateral field - (a) knuckling effect at top focus, (b) suturing effect at low focus, (c) specimens with wings may appear to lack lateral fields; (4) suken vulva in a smooth central field, i.e., no striae; and (5) illusion that there are two superimposed perineal areas. California Department of Food and Agriculture, 1220 N Street, Sacramento, California 95814, U.S.A.

HAFEZ, S. L., AND K. HARA. The Effect of Vapam Injection on Meloidogyne chitwoodi in Potatoes.

Vapam (sodium methyl dithiocarbamate) is very commonly used as a preplant application through the sprinkler system for nematode and disease control on potatoes. Since furrow irrigation is the common irrigation method in south-western Idaho potato fields, Vapam cannot be used in southwest Idaho. In this study different rates of Vapam (61.7, 123.5, 185.2, 247 g/ha) were mixed with water 1:1, and injected 12" deep during bedding using two shanks for each bed. Results of this study suggest that Vapam can be injected in the soil and before planting significantly increases potato yields and reduces the percentage of nematode infected potatoes. University of Idaho, Department of Plant, Soil and Entomological Sciences, SW Idaho Research and Extension Center, Parma, Idaho.

HAFEZ, S. L. AND D. MILLER. Optimum inoculum levels and conditions for screening alfalfa for resistance to Ditylenchus dipsaci and Meloidogyne hapla.

This study was conducted to determine the optimum inoculum levels and other conditions for more efficient and rapid screening of alfalfa entries for resistance to stem and root-knot nematodes. Plants were inoculated at the unifoliate stage with 10 and 15 stem and root-knot nematodes per plant respectively. Stem nematode inoculation was accomplished by using an aqueous suspension of nematode with corn starch as a sticking agent to insure plant contact and nematode penetration. Following inoculation plants were covered with moist cheesecloth for 48 hours, then misted lightly four times daily for seven days. For root-knot nematode inoculation, an aqueous suspension of 2nd stage juveniles was applied to unsaturated soil around the root zone. Excessive watering was avoided for two weeks after inoculation. Greenhouse air temperatures were kept in the range of 65-70°F and a 12-16 hour photoperiod was used. Plants were evaluated for visual symptoms of stem and root-knot nematode 60 and 100 days respectively after inoculation. University of Idaho, Department of Plant, Soil and Entomological Sciences, SW Idaho Research and Extension Center, Parma, Idaho.

HARRIS, J. M. FMC 67825, Nematicide for tobacco root-knot nematode control.

FMC 67825, a new organophosphate nematicide from FMC Corporation has been evaluated on tobacco for root-knot nematode control in seventeen trials during the 1983, 84, and 85 season. No visible tobacco injury has been noted with rates up to 12.0 lb ai/A. Excellent root-knot nematode control based on root-knot gall ratings has been obtained with rates of 4.0-6.0 lb ai/A. Yield increases over the untreated check averaged 320 to 437 pounds of cured tobacco per acre as compared with 439 lb/A with the standard Nemacur. FMC Corporation 6065 Roswell Road NE, Suite 700, Atlanta, GA 30328.

**HENN, A. and R. A. DUNN. Monthly population fluctuations of *Hoplolaimus galeatus* associated with St. Augustinegrass.**

Two St. Augustinegrass lawns, one with high and the other with a low population density of *H. galeatus*, were sampled monthly. A 2.2 cm diam t-tube was used to sample at 0-7.6, 7.6-15, and 15-23 cm depths with a known degree of precision. Lance nematodes in soil and roots were counted in four life-stage groups: J2, J3/J4, males, and females. A small proportion of the total lance nematode population, predominantly the J3/J4 group, was recovered from roots. Many fewer were associated with roots during the cool season than in warmer months. There were poor correlations between total populations or levels of any life stage groups and dry root weights or root lengths. Population fluctuations exhibited sharp peaks and valleys in which levels of juvenile stages closely corresponded to levels of adults. Large fluctuations were associated with periods of heavy rainfall.

**HUETTEL, R. N. Analysis of Phosphoglucose Isomerase from Single Female Soybean Cyst Nematodes, Races 1, 3, 4 and 5 by Isoelectric**

**Focusing.**

Approximately 200 single *Heterodera glycines* virgin females, race 1, 3, 4 and 5, from three to five different cultivars of soybean (cv. Kent, Essex, Williams, Bedford, and Forrest) were analysed by isoelectric focusing and stained for the isozyme, phosphoglucose isomerase (PGI). The gels were then scored to generate gene frequency data. Three-banded dimeric phenotypes were observed at this locus for all races, but race 1, which was always observed to be monomorphic. No mobility differences in electromorphs were observed between the races or hosts; however, some races had greater frequency of certain phenotypes than others. Some populations were not in Hardy-Weinberg equilibrium that indicates genetic instability occurs in some races/hosts. The observed phenotypes in this study indicates populations may be identified by data. This type of data may be useful in comparing race shifts as they occur under field conditions. USDA ARS, Nematology Laboratory, Beltsville Agricultural Research Center, Beltsville, MD 20705.

Paper Withdrawn

**IBRAHIM, I.K.A., M.A. REZK, and A.A.M. IBRAHIM.**  
Occurrence of the cyst nematodes *Heterodera avenae*,  
*H. daverti* and *H. rosii* in northern Egypt.

Information concerning the occurrence and distribution of the cyst nematodes (*Heterodera* spp.) in Egypt is very important. Survey studies revealed the widespread occurrence of the cyst nematodes in the Nile Delta and other localities of northern Egypt. *Heterodera avenae* was found on barley and wheat, *H. daverti* on Egyptian clover (*Trifolium alexandrinum*) and *H. rosii* on annual yellow sweet clover (*Melilotus indica*) in Rashied Co., Behera Governorate. Generally, the morphometrics of *H. avenae* and *H. rosii* in Egypt correspond well with previous descriptions. This is the first record of *H. avenae* and *H. rosii* in Egypt. In addition, it is also a new host plant record for *H. rosii*. Previous studies showed the occurrence of *H. glycines* on cowpea and Egyptian clover, *H. cajani* on cowpea, *H. trifolii* and *H. daverti* on Egyptian clover and *H. zeae* on corn in Egypt. Department of Plant Pathology, College of Agriculture, Alexandria University, Alexandria, Egypt.

INSERRA, R.N., J.H. O'BANNON, N. VOVLAS, R.P. ESSER, and K.R.

LANGDON. Noncultivated hosts of *Tylenchulus semipenetrans* grass  
race.

The grass race of *Tylenchulus semipenetrans* Cobb is presently known only in Florida from a grass *Schizachyrium rhizomatum*. Preliminary observations on the host-range of this race in noncultivated lands of Florida have indicated that it is able to reproduce on both dicotyledons and monocotyledons. Among the dicotyledons *Baccharis halimifolia* and *Fraxinus caroliniana* were found infected with mature females. Among the monocotyledons *Andropogon virginicus* was infected with mature females. The adult females of the *A. virginicus* population have shorter necks, conoid awl-shaped tail tips and a greater distance between the excretory pore and vulva compared to *T. semipenetrans* females from citrus. Females from *F. caroliniana* have wider tails and tail cavities than females from citrus. Histological observations of nematode-infected *B. halimifolia* and *F. caroliniana* roots indicated the grass race induces the formation of a cluster of 'nurse' cells in the cortex as reported for other races of *T. semipenetrans*. Division of Plant Industry, P.O. Box 1269, Gainesville, FL 32602; and Istituto Nematologia Agraria, CNR, 70126 Bari, Italy.

JAFFEE, B.A. Infection of *Xiphinema* spp. by zoosporic fungi  
during Baermann funnel extraction. Orchard soil containing a mixture of *X. americanum* and *X. rivesi* (6:1) was processed by elutriation followed by Baermann funnel. Immediately after elutriated material was added to funnels, poppy seeds infested or uninfested with zoosporic fungi (*Catenaria anguillulae* [ATCC 58382], *Lagenidium caudatum* [ATCC 58383], *Leptoglenia* sp. [ATCC 58384], and *Aphanomyces* sp. [ATCC 58381]) were added to each funnel. The funnels were tapped after 2 days, and the nematodes counted and examined for parasitism. The number of nematodes recovered was similar in all treatments. However, the percent infected nematodes from funnels containing 2 seeds infested with *C. anguillulae*, *L. caudatum* or uninfested seeds was 17%, 17% or 3% (background infection), respectively. In a second experiment, the addition of 10 seeds infested with *C. anguillulae* (ATCC 22437) or uninfested seeds resulted in 36% or 1% infection, respectively; the number of *Xiphinema* spp. recovered was not significantly affected. Although the fungi were active, they did not prevent the nematodes from passing through the funnels. Consequently, this extraction technique can be used to evaluate parasitism occurring in soil. Penn State Univ, Fruit Research Lab, Biglerville, PA 17307.

## Paper Withdrawn

P. JATALA, M. IWANAGA and H. MENDOZA. Development of a New Race of *Meloidogyne incognita* by the Successive Monoculture of an Aggressive Population on Resistant Potato Clones.

After several years of breeding and screening potatoes for resistance to *Meloidogyne incognita*, several potato clones with improved gene base and a high degree of resistance were developed. In a further genetic study, seedlings of six different crosses consisting of 4x X 4x (SXS), 4x X 2x (SXS), 4x X 2x (SXR), 2x X 2x (SXR), and 2x X 2x (RXR) were tested to determine the segregation of the resistant progenies. All the progenies were found to be susceptible. This contradicts the expected genetic segregation for resistance to nematodes. In reviewing the background of the screening process, it was noted that throughout the past five years the source of inoculum was the nematodes saved in the screening program and maintained solely on potatoes. Theoretically, the nematodes had completed over 30 generations over this period. As a result, those which were successful in attacking the resistant plants (even at low levels) had the opportunity to multiply and increase in number by successive propagation on potatoes. Therefore, a new race of resistant-breaking *M. incognita* had evolved. Hence the discrepancies in the expected segregation of resistant progenies. Results indicate that extreme precautions must be taken in the screening programs to avoid the reuse of the inoculum which may subsequently lead to the development of a new nematode race.

P. JATALA, H. MENDOZA and M. IWANAGA. A Strategy for Development of Potato Cultivars Resistant to *Meloidogyne*.

Screening wild tuber bearing *Solanum* species for resistance to *Meloidogyne incognita* resulted in selection of some genotypes of *S. sparsipilum*, *S. chacoense*, *S. microdontum*, *S. phureja* and *S. stenotomum*. To improve the resistant gene base, a population breeding strategy was developed and recurrent selection practiced in a population composed of crosses among and between these species. The selection was carried out for up to five generations. 4x2x crosses of cultivated tetraploid clones and selected diploids with resistance to 4 races of *M. incognita*, 2 races of *M. arenaria*, *M. javanica* and *M. hapla* were made to develop tetraploid clones with desirable traits. Segregation of resistant genotypes from the families consisting of at least one resistant parent were significantly higher than susceptible check. A relatively high percentage of the progenies from the crosses with a resistant diploid parent exhibited a root system with galling index of 1 or 2 (scale of 1-5), indicating that the resistant of wild diploid species can be transmitted to cultivated tetraploid genetic material and that highly resistant genotypes can be readily selected.

JENNINGS, P.L. and E.C. BERNARD. Cover crop effects on *Heterodera glycines*.

Use of a graminaceous winter cover crop may suppress *Heterodera glycines*, but the mechanism is not known. Seedlings of tall fescue, annual ryegrass, alfalfa, barley, wheat, white clover, and Essex soybean were planted in soil infested with *H. glycines*. After 15 days, roots were harvested and stained. Soybean, clover, and alfalfa were extensively invaded, but none of the grasses was invaded, thus they probably do not act as trap crops. In another experiment, soybean roots were invaded by *H. glycines* more readily when soil was infested with eggs at the time wheat was planted, rather than after wheat crowns were removed. The reason for this phenomenon is unknown. Department of Entomology and Plant Pathology, University of Tennessee, Knoxville, TN, 37901-1071.

JOHNSON, A.W. Irrigation Simulator - A Research Tool for Nematogation.

Advances in irrigation system design, the availability of improved injection equipment and widespread development and use of agricultural chemicals have led to expanding irrigation technology and commercialization. Since 1978, a small plot irrigation simulator has been used to apply nematicides with irrigation water (nematogation). The simulator is equipped with injection pumps to inject nematicides as water moves through the system. The dosage of nematicides, size of water droplets and volume of water can be calibrated by varying the types of orifices and nozzles and speed. Nematicides have been applied alone and with other pesticides without loss of efficacy. Nematogation compares favorably with conventional methods of nematicide application. Yields of many crops have been increased significantly by managing nematode populations with nematogation. As new information is developed from small research plots, it is pilot tested on small center-pivot irrigation systems before being released to Cooperative Extension Specialists for use by growers. USDA,ARS, Coastal Plain Experiment Station, P. O. Box 748, Tifton, GA 31793.

KO, M. P., J. S. HUANG, and K. R. BARKER. *Bradyrhizobium* colonization and infection of soybean roots as affected by *Heterodera glycines*.

The effects of soybean cyst nematode (SCN), *Heterodera glycines* on the initial events of nodulation were examined. Soybean seedlings (Lee 68) in the greenhouse were inoculated with *Bradyrhizobium japonicum* strain 1110 ARS (azide, rifampicin, streptomycin resistant) in the presence or absence of 5000 SCN eggs, race 1. *Bradyrhizobia* around the rhizoplane and rhizosphere of seedlings from either treatment were enumerated at various times by the dilution-plate method and the most-probable number technique. The number of *bradyrhizobia* on or around the SCN-infected roots and their fraction with ability to nodulate were not different from those of control plants for the first 2 weeks after inoculation. Nor was the number of deformed or infected root hairs in the nodulating root segments of the former treatment different from the latter. Nodule number, however, was severely limited in the SCN-infected plants at 25 days after inoculation. Thus, the presence of SCN did not initially affect *bradyrhizobia* colonization and infection but did disrupt subsequent development into emergent nodules. Department of Plant Pathology, Cornell Univ., Ithaca, NY 14853; Department of Plant Pathology, NC State Univ., Raleigh, NC 27695.

KOENNING, S. R., and S. C. ANAND. Effects of a wheat/soybean double cropping system on the population dynamics of *Heterodera glycines*.

Field plots were established to compare the effects of full season versus short season (double cropping) soybean production systems on the population dynamics of *Heterodera glycines* (SCN). Selected plots were planted with winter wheat at three plant population densities or left fallow. Fallow plots were planted with soybean on 7 May 85, 27 May 85 and 21 June 85. Wheat was harvested and plots planted with soybean on 21 June 85. Soil samples were taken at wheat planting and at monthly intervals beginning with soybean planting. Wheat had little influence on the survival of SCN. Delayed planting, associated with short season production systems, resulted in a significant decline in the number of SCN cysts and eggs in May and June. Early soybean planting resulted in higher ( $P = 0.01$ ) SCN population densities at mid season, but there was no significant effect of planting date on final population densities. A late May planting gave the greatest ( $P = 0.01$ ) soybean yield. Department of Agronomy, University of Missouri, Columbia, Delta Center, P. O. Box 160, Portageville, MO 63873.

LAMONDIA, J. A. and B. B. BRODIE. Stimulation of *Globodera rostochiensis* juvenile emergence by exudates of potato roots infected by three nematode genera.

Katahdin potatoes were planted in vermiculite in 625 cm<sup>3</sup> plastic trays. Two trays each were inoculated with 43,000 infective *Globodera rostochiensis* (Gr), *Pratylenchus penetrans* (Pp), *Meloidogyne chitwoodi* (Mc) or left uninoculated. At weekly intervals for 3 weeks, trays were misted with water to field capacity and two hours later 400 ml of potato root diffusate (PRD) was leached from each tray. PRD (5 ml) was added to chambers containing 20 Gr cysts and emerged juveniles were counted weekly for 3 weeks. More juveniles emerged in PRD from roots infected with Gr and Mc than from those infected with Pp or uninoculated. Halves of split-root systems of potatoes were inoculated with 50,000 Gr. More juveniles emerged in PRD from the infected roots than in PRD from uninfected roots. Gr-induced changes in potato roots that cause increased PRD activity do not appear to be translocated to uninfected roots. Department of Plant Pathology, Cornell University and USDA ARS, Ithaca, NY 14853.

LAWRENCE, G.W., and C.A. CLARK. Identification, race determination, and pathogenicity of root knot nematodes to resistant and susceptible sweet potatoes.

Thirty root-knot nematode populations common to Louisiana soil were identified to species and race. Twenty-nine populations were *Meloidogyne incognita* (MI) and one population was *M. javanica*. Sixteen populations of *M. incognita* were Race 1 (55%), eleven were Race 3 (38%), and two populations were identified as Race 4 (7%). The *M. incognita* population used in the Louisiana Sweet Potato Breeding Program (MIS) to screen for resistance was compared to the other populations for virulence on the sweet potato cultivars Centennial (MI susceptible), Jasper (MI intermediate to resistant), Jewel (MI resistant), and the breeding line L4-73 (MI resistant). The populations varied in their virulence on sweet potato; some were more virulent than the MIS population whereas others were less virulent. Trends in virulence on sweet potato were not correlated with the identified races. Several populations appeared capable of overcoming the resistance exhibited by the sweet potato cultivars used in this study. Department of Plant Pathology and Weed Science, Mississippi State University, Starkville, MS 39762 and Department of Plant Pathology and Crop Physiology, Louisiana State University, Baton Rouge, LA 70803.

LEACH, L., D.L. TRUDGILL,\* and P.B. GAHAN. Immunocytochemical localisation of neurosecretory amines and peptides in *Goodeyus ulmi*.

The localisation of neuroamines and peptides in the free-living nematode, *Goodeyus ulmi* was determined with mammalian antibodies to a number of neurotransmitters and hormones. Serotonin (5-HT) was localised in nerve fibres and six associated cell bodies in the ventral nerve cord as well as in four cell bodies in the lateral and ventral ganglia of the nerve ring in nematodes at all developmental stages. In addition four more cell bodies and associated fibres were immunoreactive (5-HT) in the vulva of adult females, whilst in male adults serotonin-immunoreactive nerve fibres were seen in the spicular region. Immunoreactivity to adrenocorticotrophic hormone (ACTH) was visualised in the ventral nerve cord in both adults and juveniles of the third and fourth stage. No reactivity was found in first and second stage juveniles. Coexistence of ACTH and 5-HT immunoreactivity was seen in the foregut and tail regions of the ventral nerve cord. Antibodies raised against the molluscan neuropeptide-FMRF amide evoked a response in a few nerve fibres within the nerve ring of both adult and juvenile *G. ulmi*. Thus, this indicates the presence of 5-HT, ACTH, FMRF amide-like molecules in *G. ulmi* and that the antibodies to these molecules are not species specific implying a similarity of immunogenic sequences of 5-HT, ACTH and FMRF amide in mammals, molluscs and nematode (*G. ulmi*). Biology Department, King's College London, UK. \*Scottish Crop Research Institute, Invergowrie, Dundee, Scotland

LEHMAN, P. S. Contamination by adherence of nematodes to new plastic containers.

Nematodes were observed adhering to new polystyrene petri dishes, polypropylene beakers, and polycarbonate centrifuge tubes, after routine rinsing with deionized water from a wash bottle. After one rinse, 85% of *Meloidogyne incognita* juveniles, 64% of *Tylenchulus semipenetrans* juveniles, and 18% of *Radopholus similis* juveniles and adults adhered to the surface of 60x15 mm polystyrene petri dishes. After 5 successive rinses, 30, 28, and 6% of *M. incognita*, *T. semipenetrans*, and *R. similis* remained, respectively. In additional tests with *R. similis*, after 4 rinses 261 and 46 of 2000 nematodes adhered to the surface of 250 ml polypropylene beakers and polycarbonate conical centrifuge tubes, respectively. Some nematodes adhered to the surface of these plastic containers even after spraying with moderate water pressure at a laboratory sink. In all tests, no nematodes adhered to the surface after one rinse, when glass containers were used. These findings indicate that contamination or errors may occur in regulatory and research laboratories if plastic containers are used. Florida Dept. of Agric. & Consumer Services, Division of Plant Industr, Gainesville, FL 32602.

LUEDDERS, V.D. Races and the Genetic Complement of Soybean Cyst Nematodes.

Populations of *Heterodera glycines* (SCN) are classified as races based on their abilities to form cysts on the soybean differentials Pickett, Peking, PI 90763, and PI 88788. The qualitative + and - do not accurately reflect the continuum of cyst numbers. Numbers of cysts/plant is the phenotype of the association of SCN-soybeans and determined by interactions of corresponding genes for avirulence-resistance. Sexual reproduction is conducive to maintaining genetic heterogeneity: frequencies of genes for avirulence must be considered. Nematodes were inbred so that one inbred could not form cysts on PI 88287. The effect was due to one recessive gene for resistance, presumably interacting with one gene for avirulence with frequency near 1.0. The differentials have many genes for resistance, therefore the few cysts phenotype can be due to many different interactions which depend on the SCN gene frequencies. Thus, race classification really gives very little information on the genetic composition of populations. Farmers want to know which cultivars will not be damaged by the SCN in their field; only Pickett was developed for reasonably good agronomic characters. Department of Agronomy, University of Missouri, Columbia, MO 65211.

MALEK, R. B., and E. B. HIMELICK. Interrelationship of *Bursaphelenchus xylophilus* and *Ceratocystis ips* in the pine wilt complex.

The bluestain fungus, *Ceratocystis ips*, is an almost constant associate of the pinewood nematode, *Bursaphelenchus xylophilus*, in wilt-afflicted pines in Illinois. Four-yr-old Scotch pines (*Pinus sylvestris*) were inoculated with 1500 propagative *B. xylophilus* and/or 100,000 spores of *C. ips* or propagules of the nematode culture fungus, *Botrytis cinerea*, in June during rapid spring tree growth and in September after growth had ceased. There was no evidence of an interaction between *B. xylophilus* and *C. ips* as the cause of tree death during 6 mo of incubation in a greenhouse. With or without the fungus, the nematode killed 60% of June-inoculated trees, 2-7 wk after inoculation, and only 15% of September-inoculated trees, 8-12 wk after inoculation. All controls and trees inoculated with *C. ips* alone remained healthy. *C. ips* caused localized bluestaining of stem wood and was re-isolated from trees only when co-inoculated with *B. xylophilus*. Foliar symptom development in nematode-inoculated trees was nearly identical to that in older established pines under natural conditions. Department of Plant Pathology, University of Illinois, and Sec. of Botany and Plant Pathology, Ill. Natural History Survey, Urbana 61801.

MAQBOOL, M.A. and HASHMI, S. Effect of granular nematicides on nematode population and sugarcane yield.

Aldicarb (Temik 10G) and carbofuran (Furadan 3G) were applied @ 1kg ai and 2kg ai/ha in two years sugarcane ratoon crop field, to determine their effects on nematode populations in the soil and on yield of sugarcane. Frequency of the most commonly occurring genera of parasitic nematodes depicted as percent of total samples yielding each parasitic form was *Helicotylenchus digonicus* 30%, *H. indicus* 10%; *Hoplolaimus indicus* 10%; *Paratrichodorus mirzai* 10%; *Pratylenchus zaei* 6%; *Tylenchorhynchus annulatus* 20%; *Xiphinema index* 8% and others 6%. Maximum reduction of 90% was obtained with 2kg ai/ha of aldicarb at which a significantly higher yield was also recorded. Carbofuran @ 2kg ai/ha reduced the nematode population by 85%. The reduction in the nematode count and increase in yield differed significantly between the nematicides, between rates and between treated and control plots.

MAQBOOL, M. A. and F. SHAHINA. Observation on the morphology and systematics of three new species of the subfamily Merliniinae

Siddiqi, 1970 from Northern areas of Pakistan.

In a recent survey of nematodes carried out in the Northern areas of Pakistan, three undescribed species belonging to the subfamily Merliniinae were found from soil around the roots of herbaceous plants and grasses from the slopes of hills near the lake Saifulmuluk during September, 1985. New species of *Nagelus* differs from all the species of the genus by having more than a hundred tail annules. New species of *Scutylenchus* is close to *S. mamillatus* (Tobar-Jimenez, 1966) *Jairapuri*, 1971 and *S. siddiqi* (Mulk, 1978) Andrzej, 1984, but differs from both species by having shorter body length, fewer longitudinal lines and absence of males and spermatheca. New species of *Merlinius* comes close to *M. loofi* Siddiqi, 1979 and *M. processus* Siddiqi, 1979, but differs from *M. loofi* by having longer stylet, wider body, lower c' value, more posterior vulva, fewer tail annules, and absence of terminal mucro; and from *M. processus* by having smaller stylet, greater body width, less c' value, simple rounded spermatheca longer tail and fewer tail annules. National Nematological Research Centre, University of Karachi, Karachi-32, Pakistan.

MCGAWLEY, E.C. Influence of Crop Rotation on Nematode Community Structure.

The influence of a continuous soybean (cvs. Centennial and Davis [resistant and susceptible respectively to race 3 of *Heterodera glycines*]) treatment versus 7 other rotation schemes was monitored from 1982 thru 1985. Under continuous soybean, cyst populations increased to damaging levels in 2 years on Davis and race 4 was detected on Centennial after only 1 year. A ryegrass winter cover crop enhanced survival of non-cyst genera. Rotations involving soybean and wheat or grain sorghum in alternate years reduced cyst levels but favored reproduction of *Tylenchorhynchus claytoni*. This nematode may cause significant root injury to soybean and grain sorghum at levels of 2,000 individuals/500cc soil ( $\pm 20\%$ ). Department of Plant Pathology and Crop Physiology, Louisiana Agricultural Experiment Station, Louisiana State University Agricultural Center, Baton Rouge, Louisiana 70803.

MCKENRY, M. V. AND J. KRETSCH. Attempts to eradicate nematodes.

For two years nematode populations were monitored at three experimental sites following various soil treatment strategies. The sites had supported tree, vine or alfalfa plantings for the previous 10 to 20 years and were replanted after treatment. Pin nematode, *Paratylenchus hamatus* and stubby root nematode, *Paratrichodorus minor* were the first plant parasites to re-colonize. *Pratylenchus vulnus*, *Meloidogyne* spp., *Tylenchorhynchus* spp. and *Xiphinema americanum* were controlled at better than 99.7% of the untreated with 560 kg/ha Telone II. Methyl bromide treatments of 224 kg/ha with "high barrier" tarp provide equivalent nematode control. Treatments of 168 kg/ha Telone II followed by 1.12 kg/ha of fenamiphos or oxamyl at monthly intervals through a dripper system provided 99.5% control to a 60 cm<sup>2</sup> zone of soil profile for 25 months. Populations of pin nematode were 97% controlled 19 months after treatment with 11 kg/ha aldicarb, whereas stubby root nematode populations increased. Drying of soil improves control, but no treatment strategy provided 100% control for every sampling of every replication. University of California, Riverside, located at Kearney Agricultural Center, 9240 So. Riverbend Avenue, Parlier, CA 93648.

MELAKEBERHAN, H\*, R. C. BROOKE, and J. M. WEBSTER. Meloidogyne incognita induced changes in nutrient concentration of bean plants

The concentration of K, Ca, Mn, Fe, Cu and Zn in the shoots and roots of bean plants that received normal strength Hoagland solution was determined at intervals from 1 to 28 d after inoculation with 0, 2000, 4000 & 8000 *Meloidogyne incognita* larvae. One week after inoculation, the concentration of the elements changed followed by leaf chlorosis and abscission. Thereafter, Mn, Fe and Cu had no clear trend with duration of the experiment and level of infection while K and Zn had a decreasing and Ca an increasing trend. Supplementary KNO<sub>3</sub> (2-4X) resulted in an increase in the concentration of leaf K, an increase in the photosynthetic rate and yield of nematode-infected plants compared with those receiving normal or no supplementary KNO<sub>3</sub>. The relationship between changes in nutrient concentration due to nematode infection or their reversal by nutrient supplement and some of the physiological processes that affect crop yield will be discussed. Department of Biological Sciences, Simon Fraser University, Burnaby, Vancouver, British Columbia, Canada, V5A 1S6. \* Present Address: Dept. of Nematology, University of California, Davis, CA 95616.

MINTON, N.A. and A.S. CSINOS. Effects of methyl bromide on nematodes and southern stem rot of peanut and nematodes of soybean.

Nematode and southern stem rot control on peanut and nematode control on soybean with Terr-0-Cide II (GLC 682 active ingredient = methyl bromide) injected 25 cm and 50 cm deep without tarping was investigated. Yields of Florunner peanut planted on Ocilla loamy sand infested with Meloidogyne arenaria and Sclerotium rolfsii were significantly increased at rates of 67 kg ai/ha, 101 kg ai/ha, and 168 kg ai/ha. The greatest increase of 2129 kg/ha or 66% occurred at 101 kg ai/ha. Root-knot indices were reduced by the above rates but the incidence of southern stem rot caused by S. rolfsii was not affected. Yields of Coker 237 soybean planted on Tifton sandy loam infested with M. arenaria and Belonolaimus longicaudatus were significantly increased at rates of 67 kg ai/ha and 101 kg ai/ha. The greatest increase of 1448 kg/ha or 96% occurred at 101 kg ai/ha. Root-knot indices were reduced by 34 kg ai/ha, 67 kg ai/ha and 101 kg ai/ha. USDA, ARS and Department of Plant Pathology, Univ. of Georgia, Coastal Plain Experiment Station, Tifton, GA 31793.

MOJTAHEDI, H., J. N. PINKERTON, and G. S. SANTO. Differential response of alfalfa roots to infection by Meloidogyne hapla and two races of M. chitwoodi.

Second stage juveniles (J2) of M. hapla and race 1 (non-alfalfa) and race 2 (alfalfa) of M. chitwoodi readily penetrated roots of alfalfa and tomato seedlings. However, only a few individuals of race 1 were able to establish successful feeding sites and complete their life cycle. Histopathological studies indicate that J2 of race 1 either failed to initiate feeding sites, or caused cell enlargement without typical cell wall thickening. The protoplasm of these cells coagulated and did not support the development of race 1 beyond the swollen J2 stage. Further studies were conducted to determine if the failure of race 1 to establish feeding sites was due to egression from the roots. Results show that race 1 egressed from alfalfa roots in higher ( $P=0.05$ ) numbers than race 2 or M. hapla. However, similar results were also obtained with tomato roots, which is a suitable host. I.A.R.E.C., Washington State University, Prosser, WA 99350.

MOJTAHEDI, H., J. N. PINKERTON, G. S. SANTO, and J. H. O'BANNON. Vertical migration of Meloidogyne chitwoodi and M. hapla under controlled temperatures.

The migratory ability of second-stage juveniles (J2) of two Meloidogyne chitwoodi isolates, race 1 and race 2, and a M. hapla isolate were compared in soil filled columns at 12, 18 and 24 C. J2 of all isolates migrated best at 18 C and least at 12 C. Nematode recovery was significantly reduced ( $P=0.05$ ) at 24 C. M. chitwoodi J2 migrated further and in greater numbers than M. hapla J2 at all temperatures. A comparison with and without a host plant demonstrated no preferential migration toward the plant. Water percolation through the migration columns did stimulate vertical migration. I.A.R.E.C., Washington State University, Prosser, WA 99350.

MUELLER, J., M. SULLIVAN, AND S. TURNIPSEED. Control of *Hoplostaimus columbus* using granular nematicides and tolerant cultivars.

The effects of granular formulations of aldicarb, carbofuran, and fenamiphos on *H. columbus* (Hc) were studied on three soybean cultivars in a naturally infested field near Blackville, SC. The cultivars Braxton (highly susceptible), Centennial and Foster (both highly tolerant) were planted on May 21, 1984 and May 28, 1985 in fields with initial populations of 134 and 81 Hc/100 cm of soil respectively. The nematicides were applied as 20 cm bands in front of the press wheel at 0.56 and 1.68 kg (a.i.)/ha. Nematodes were extracted from the soil at planting and from soil and roots at 6 weeks after planting. Yields of non-treated cultivars were; Braxton 1251 kg/ha (84) and 1997 (85), Centennial 2010 (84) and 2367 (85), and Foster 2179 (84) and 2394 (85). All chemicals and rates increased yields of Braxton both years, however, yields of Centennial and Foster were increased only in 1985. Greatest yield increases were Braxton in 1985 in which fenamiphos at 1.68 kg (a.i.)/ha increased yield 1009 kg/ha. Correlations between Hc/g root freshweight at 6 weeks and yields were not significant. Clemson University, Edisto Research and Education Center, Blackville, SC 29817.

MULLIN, BARBARA A. and B. B. BRODIE. Syncytia associated with *Globodera rostochiensis* (RIA) females developing in resistant potatoes.

Root segments bearing white *Globodera rostochiensis* females excised from susceptible (cv Katahdin) and resistant (ex *andigena*) potato plants were fixed, embedded in plastic and sectioned at 5-25  $\mu$ m. Syncytia in Katahdin roots were large, located in the stele, contained dense, granular cytoplasm and resulted from extensive cell wall breakdown (CWB). There were 3 types of syncytia associated with ex *andigena* plants. Most syncytia (90%) were relatively small and delimited by necrosis. The second type (one specimen) had little CWB, but was large, extended into both cortex and stele, and the cytoplasm was unusually dark but not granular. A third type (one specimen) was identical to the susceptible response. Syncytia associated with "successful" *G. rostochiensis* females in resistant potatoes have not been previously characterized. Department of Plant Pathology, Cornell University, and USDA, ARS, Ithaca, NY 14853.

MULLIN, BARBARA A. and B. B. BRODIE. The reproductive potential of *Globodera rostochiensis* (RIA) in resistant potatoes.

The reproductive potential of *Globodera rostochiensis* encysted juveniles from females that developed in resistant (ex *andigena*) potato was assessed. Cysts were collected from resistant (R) or susceptible (S) plants and reinoculated to S plants. Cysts obtained from the second generation were reinoculated to either S or R plants. The resulting 4 treatments were: SSS, SSR, RSS, and RSR with letters R and S representing the host status in generations 1, 2, or 3, respectively. Viable eggs per cysts, VEC, (+ S.E.) after generation 3 were 82.6 (14.6) for SSS; 32.4 (16.4) for SSR; 34.8 (17.4) for RSS; and 6.7 (4.0) for RSR. After three generations, VEC were reduced even when only the first generation was produced on R plants. The reproductive potential of this nematode on resistant potatoes appears severely limited. Department of Plant Pathology, Cornell University, and USDA, ARS, Ithaca, NY 14853.

NICKLE, W. R. and D. P. JOUVENAZ. A new species of Tetradonema parasitic on the red imported fire ant from Brazil.

Explorations in Brazil to find parasites of the imported fire ant, Solenopsis invicta Buren have uncovered a new species of the mermithid nematode genus, Tetradonema. It was found to be fatal to about 25% of the colony. The female nematodes are large and sausage-shaped and the males are small and insignificant, which is typical of the genus. It appears that ingestion of the eggs may be the normal route to parasitism. Systematic Botany, Mycology, and Nematology Laboratory, USDA, ARS, Beltsville, MD 20705; Insects Affecting Man and Animals Research Laboratory, USDA, ARS, Gainesville, FL 32604.

NICOLAS, Z. and M. CANTO-SAENZ. Reaction of 15 Selected Potato Clones to *Pratylenchus flakkensis*.

Potato clones resistant to *Globodera pallida*, *Meloidogyne incognita*, *Nacobbus aberrans* and *Pseudomonas solanacearum* and the susceptible potato cultivar 'Revolucion' were inoculated with *Pratylenchus flakkensis* to measure their host efficiency as well as the damage caused by this nematode. Each clone or cultivar was inoculated with 5000 nematodes/pot. Non inoculated plants did not receive any nematode. All treatments were replicated five times. The differences in yield parameters of some clones were statistically significant. Non efficient hosts of *P. flakkensis* were the clones, 702535, 702698, 280189.1, 280208.4, 279038.5, 278024.8, 280284.11 and 280230.13 of *S. tuberosum* subsp. *andigena*, the clones 760147.7, 760917.1 of *S. sparsipilum* and the hybrid TD 29.1 (*S. plureja* x *S. sparsipilum*). The number of nematodes per gram of roots was a better criterion in rating host efficiency than the Pf/Pi ratio. Considering the host efficiency and the damage caused by the nematode, the clones B-17, B-25 and 280284.8, 280284.11 and 280230.13 were resistant. International Potato Center, Apartado 5969, Lima, Peru.

NIGH, E. L. Populations Dynamics of *Xiphinema americanum* in Irrigated Non-Dormant Alfalfa.

Non-dormant alfalfa is grown in the irrigated desert valleys of Arizona where mild winter temperatures permit year-long harvest. *X. americanum* find the perennial crop a favorable host. A total of 87% of all fields in these areas are infested with this nematode. Adults and juveniles can be recovered each month of the year. Peak adult populations were recovered from mid-May to July. Total populations of 242-327 dagger nematodes/Lt of soil were found in late September. While alfalfa appears to sustain this pest without serious damage, the nematode may be of importance to rotational crops which are more susceptible to its attack. Univ. of Arizona, Dept. of Plant Pathology, Yuma, AZ 85364.

NIGH, E.L. The Biology and Distribution of *Ditylenchus dipsaci* in Arizona Alfalfa.

*D. dipsaci* is a chronic nematode pest in irrigated non-dormant alfalfa in the desert valleys of Arizona. It has not been recovered in the higher elevations of the state where cooler weather dictates the use of dormant cultivars. The greatest infested acreage is in the Salt River Valley of central Arizona with isolated infestations in one eastern and one western county. The extreme weather conditions of the lower valleys restrict population development. Inactive pre-adults survive periods of inclement weather imbedded in the crown. Feeding usually begins in mid-October followed soon by reproduction that can continue until maximum temperatures exceed 34° in late spring. Few of the nematodes can be recovered from the soil although they are dispersed in irrigation water from the contaminated hay that is lost during harvest. Stand decline from this nematode may exceed 75% in Arizona. Univ. of Arizona, Dept. of Plant Pathology Yuma, AZ 85364.

NOE, J. P. and J. L. IMBRIANI. Yield-loss relationships and population dynamics of *Hoplolaimus columbus* on cotton, as modified by edaphic parameters.

Nematode-host relationships were determined with respect to edaphic parameters in 192 four-row by 6-m plots established in contiguous grids of 64 plots in three different cotton fields located in Scotland County, NC. The best model for explaining variation in seed-cotton weights, as selected by stepwise-multiple regression, included log-preplant densities of *Hoplolaimus columbus* and *Helicotylenchus dihystrera* and soil pH and base saturation ( $R^2=0.42$ ,  $p>F=0.0001$ ). Parameter estimates indicated a negative log-linear relationship between *H. columbus* preplant counts and cotton yields with maximum damage estimated at 19% of seed-cotton weight. The best model for explaining variation in at-harvest counts of *H. columbus* included preplant *H. columbus* counts, soil phosphorus and potassium levels and soil bulk densities ( $R^2=0.60$ ,  $p>F=0.0001$ ). Parameter estimates indicated a positive log-linear relationship between harvest and preplant nematode counts, with maximum rates of increase occurring at preplant densities of between 20-200 nematodes per 500 cm<sup>3</sup> soil. Department of Plant Pathology, NC State University, Box 7616, Raleigh, NC 27695-7616; Agro-nomic Division, NC Department of Agriculture, Raleigh, NC 27611.

NYCZEPIR, A. P., C. C. REILLY, and R. E. MOTSINGER. Parasitic, biochemical, and morphological differences between *Criconemella xenoplax* and *C. ornata* on peach.

Two ring nematode species previously detected in peach tree short life orchards in GA and SC included *C. xenoplax* (Cx) and *C. ornata* (Co). Host response and susceptibility of Nemaguard peach and common bermudagrass to these two nematodes was investigated in the greenhouse over a six month period. Nematode population density increase, dry root and shoot weight, and height increase were used to determine host susceptibility. Peach was a good host for Cx and a poor one for Co, whereas the opposite was true regarding common bermudagrass. Root and shoot growth of peach was reduced in the presence of Cx but not Co. Both nematodes could enzymatically degrade prunasin, the cyanogenic glucoside found in peach, however only Cx had B-cyanoalanine synthase, the enzyme associated with detoxification of CN. This may explain, in part, the inability of Co to parasitize peach. Distinguishing characteristics between Cx and Co include stylet length and shape of the anterior head region and vagina. USDA, ARS, S.E. Fruit & Tree Nut Res. Lab., Byron, GA 31008, and Extension Plant Pathology, University of Georgia, Athens, GA 30602.

OSBORNE, W.W. Parasitism of *Nicotiana tabacum*,  
*Lycopersicon esculentum*, and *Solanum melongena*  
by *Globodera solanacearum*.

The Osborne's cyst nematode (OCN) *Globodera solanacearum* occurs in twelve Virginia counties where high populations severely curtail tobacco yield and quality. Relative growth of various flue-cured tobacco varieties was determined on chemically treated and untreated OCN infested soil. During the 1985 growing season, the OCN was found associated with crop failure of tomato and eggplant in Halifax County, Virginia. International Agricultural Institute, Inc., 1319 Main Street, South Boston, VA 24592, USA.

OVERMAN, A. J., and J. P. JONES. Efficacy of soil solarization  
in full-bed mulch culture of tomato.

Eau Gallie fine sand was treated with combinations of solarization x soil fumigation for fall Sunny tomato production. Main blocks were either solarized for 8 weeks during July/August 1985 or seeded to *Sesbania macrocarpa*. Prior to planting Sunny tomato in October, subplots received either no fumigation, MENCS 17% + 1,3D 34% + C 15% (Vorlex 201) 327 l/ha, or methyl bromide 98%/C 2% (Terro-O-Gas 98) 336 kg/ha. Solarization reduced incidence of *Paratrichodorus christiei*, *Meloidogyne incognita*, and wilt caused by *Verticillium albo-atrum*, but did not affect the incidence of wilt caused by *Fusarium oxysporum* f. *lycopersici*. Tomato yield was increased 25% by solarization. Fumigation suppressed *Verticillium* and *Fusarium* wilt, *P. christiei* and *M. incognita*, but improved yield only in nonsolarized plots: 40% following Vorlex 201 and 58% following Terro-O-Gas 98. Solarization alone produced a tomato yield equivalent to that harvested from non-solarized plots treated with Terro-O-Gas 98. IFAS, University of Florida, Gulf Coast Research & Education Center, 5007 60th Street East, Bradenton, FL 34203.

OVERSTREET, C. and E. C. MCGAWLEY. The influence of *Calonectria crotalariae* on population development of *Heterodera glycines*.

Seedlings of soybean cultivars susceptible (Lee) and resistant (Centennial) to *Heterodera glycines* (Hg) were inoculated with Hg, the red crown rot fungus *Calonectria crotalariae* (Cc), or combinations of both. Cc affected the penetration but not maturation of juveniles of Hg in both cultivars. The combination of both pathogens resulted in 2 and 3-fold increases in cyst and juvenile counts, respectively within Lee roots at 18 d. The difference in cyst but not juvenile counts remained approximately 2-fold at 30 d in the cv Lee. Juvenile levels in the cv Centennial were 6, 3, and 6-fold higher at 15, 21, and 27 d, respectively in the presence than in the absence of the fungus. There was no corresponding increase in cyst levels on Centennial during this time due to the failure of most juveniles to mature. Department of Plant Pathology and Crop Physiology, Louisiana State University, Baton Rouge, Louisiana 70803.

PABLEO, E. C. and A. C. TRIANTAPHYLLOU. DNA complexity and relationship of the genomes of *Meloidogyne* species.

Cot curves derived from renaturation kinetics of sheared, denatured DNA indicated that the genome of *Meloidogyne* species is composed of 19.5% repetitive and 80.5% unique sequences. The complexities of the repetitive sequences, unique sequences, and total genome are approximately  $0.15 \times 10^8$ ,  $0.62 \times 10^8$  and  $0.78 \times 10^8$  nucleotide base pairs, respectively. The relationship of the genomes of 12 populations representing the four common *Meloidogyne* species was determined by DNA-DNA hybridization and thermal elution tests, using radioactively-labeled  $^{32}\text{P}$ -DNAs from *M. arenaria* and *M. incognita* as probes. Results suggested that *M. incognita*, *M. javanica*, and *M. arenaria* are closely related, with 80 to 100% DNA homology to both probes, while *M. hapla* showed a wide divergence with 23 to 35% DNA homology. One half of the populations showed higher percentage of DNA homology with the unique sequences of both probes, while the other half with the repetitive fraction. The thermal stabilities and elution profiles of the DNA duplexes revealed similar relationships among the species and indicated differences of 1 to 2.5% in nucleotide base pairs between the populations and the probes. Department of Plant Pathology and Department of Genetics, N. C. State University, Raleigh, NC 27695-7614.

PARACER, S. M. and A. C. TARJAN. Root-Knot nematode suppression by some Florida marine algae.

Freeze-dried powders of 10 marine algae collected from the Florida waters were tested against *Meloidogyne* spp. on tomato plants in greenhouse studies. *Spatoglossum schroederi*, *Botryocladia occidentalis* and *Bryothamnion triquestrum* when used as soil amendments at 1% concentration by weight produced significant reduction of root gall development in tomato plants infected with *M. incognita*. Soil amendment of *S. schroederi* at concentrations of 0.5 and 1.0 percent significantly reduced root galling of tomato plants infected with *M. incognita*, *M. arenaria*, and *M. javanica*. Tomatoes grown for 9 weeks in *S. schroederi* soil mixture produced significantly heavier shoots and roots than plants raised in autoclaved soil. The chemical nature of the active ingredient in *S. schroederi* is unknown. Department of Entomology and Nematology, University of Florida, Gainesville, FL 32611.

PINKERTON, J. N., H. MOJTAHEDI, and G. S. SANTO. Reproductive efficiency of Pacific Northwest isolates of *Meloidogyne chitwoodi* on alfalfa.

Thirty-two geographic isolates of *Meloidogyne chitwoodi* were evaluated for the ability to reproduce on 'Thor' alfalfa. Host reaction to these isolates ranged from nonhost to a suitable host based on egg mass index (EI) and reproduction factor (R). Thirteen isolates that had  $\text{EI} > 2$  and  $\text{R} > 1$  were classified as the alfalfa host race (race 2). *M. chitwoodi* race 2 was found in major potato production areas in the Pacific Northwest. Therefore, alfalfa rotation can no longer be generally recommended to reduce *M. chitwoodi* population densities. I.A.R.E.C., Washington State University, Prosser, WA 99350.

PINKERTON, J. N., G. S. SANTO, and H. MOJTAHEDI. Population dynamic of *Meloidogyne chitwoodi* in relation to Russet Burbank potato tuber penetration.

Severity of Russet Burbank potato tuber damage caused by *Meloidogyne chitwoodi* is dictated by the initial population density and the generation time during the season. A two-year study in eastern Washington State followed *M. chitwoodi* population dynamics on potato in microplots and a commercial field. Soil population density of second-stage juvenile (J2) peaked in mid-fall, declined through the winter and was lowest in early July. Eggs produced on roots by the first generation hatched in mid-July at 1000-1100 degree days (DD) base 5 C after planting (May 3). The second and third generations were completed in 1600-1700 DD and by harvest in early October, respectively. Tuber penetration corresponded to the appearance of second and third generation J2 in the soil. J2 were massed in lenticle tissue and tissue galling was initiated when nematode penetrated the tubers. As tubers matured, many J2 became encased in dense tissue similar in appearance to tissues surrounding egg masses. I.A.R.E.C., Washington State University, Prosser, WA 99350.

POWERS, T.O., E.G. PLATZER, and B.C. HYMAN. *Meloidogyne* mitochondrial DNA.

Our work with *Meloidogyne* mitochondrial DNA (mtDNA) focuses on two different, but related questions. Do mitochondrial molecules from *Meloidogyne* species and populations diverge genetically, and can this divergence be used to diagnose host-races? We have isolated and cloned the mtDNA genome from *M. arenaria*, *M. hapla*, *M. javanica*, and *M. incognita* race 4. Restriction fragment length polymorphisms readily separate species and are diagnostic for some field populations of *M. incognita*. DNA hybridization indicates both highly conserved and variant regions of nucleotides among species. Some variant regions, cloned as a Mbol library in PBR322 appear promising as diagnostic hybridization probes. We are constructing fine structure restriction maps of the mtDNA from these species. Department of Plant Pathology, University of Nebraska, Lincoln, NE 68583 and Departments of Nematology and Biology, University of California, Riverside, CA 92521.

PREMACHANDRAN, D., N. VON MENDE, M.A. MCCLURE and R.S.

HUSSEY. Stains for nematode secretions. Attempts to stain products from the dorsal esophageal gland, led to the discovery that amphidial secretions of *Meloidogyne incognita* stained dark blue when the preparasitic, second stage juveniles (J2) were placed in a solution of Coomassie Blue (CB) in methanol, acetic acid, water (4:1:5). CB in either water, methanol or acetic acid also stained secretions from the amphids, excretory pore and phasmids. Up to 4.1 X 10<sup>4</sup> µm<sup>3</sup> of stained products from the excretory pore were measured after 24 hours in CB. Aqueous CB penetrated the egg shell of *M. incognita* and stained secretions of the J2 within the egg. Solutions of 68 histological stains were applied to a number of plant parasitic nematodes. At least 25 show promise as dyes for differentiation of morphological features. Departments of Plant Pathology, University of Arizona, Tucson, AZ 85721 and University of Georgia, Athens, GA 30602.

RADICE, A. D., T. O. POWERS and R. D. RIGGS. Characterization of mitochondrial DNA from selected populations of *Heterodera glycines*.

Mitochondrial DNA (mtDNA) has been isolated from several single cyst populations of the soybean cyst nematode, *H. glycines*, by buoyant separation in cesium chloride. Cleavage of mtDNA by the restriction endonucleases Bgl II, Cla I, and Hind III followed by fractionation by agarose gel electrophoresis produced identical fragment patterns. The enzyme Hind III recognized four cleavage sites producing four fragments 7.9, 6.2, 5.8 and 4.1 kilobases. The size of the mitochondrial genome was estimated by an average of multiple digests to be 24 kilobases. To rapidly assess population heterogeneity, <sup>32</sup>P labeled mtDNA fragments were used as hybridization probes against restriction enzyme digested genomic DNA from single cysts which had been fixed to nitrocellulose. Cloned hybridization probes derived from mtDNA from numerous *H. glycines* populations are being evaluated for population and host race specificity. Dept. Plant Pathology, University of Arkansas, Fayetteville, AR 72701; Dept. of Plant Pathology, University of Nebraska, Lincoln, NE 68583; Dept. Plant Pathology, University of Arkansas 72701.

RAMMAH, A., and H. HIRSCHMANN. Morphological comparison of excised nematode copulatory structures by SEM.

Spicules of nine *Meloidogyne*, two *Heterodera* and three *Globodera* species, as well as twelve species of other plant-parasitic, insect-parasitic and free-living nematodes were excised from males and viewed with scanning electron microscopy (SEM). Gubernacula of some of these species were also examined. Structural details of inner and outer aspects of spicule base, shaft, blade, and location of cytoplasmic core opening, as well as morphology of gubernacula were clarified. Basic differences in spicule structure were observed between secernentean and adenophorean nematodes. Genera differed in spicule morphology, but species within *Meloidogyne*, *Heterodera* and *Globodera* were similar. The two spicules of individual males were morphologically identical. Departement de Phytopathologie, Institut Agronomique et Veterinaire Hassan II, Rabat, Morocco; and Department of Plant Pathology, N. C. State University, Raleigh, NC 27695-7616.

RAYMUNDO, S.A. and J. ALCAZAR. Increasing Efficiency of Soil Solarization in Controlling Root-knot Nematodes by Using Two Layers of Plastic Mulch.

A major mechanism for the lethal effect of solarization is direct physical killing by high temperature on solarized plots. It follows then that any method that will raise plot temperature would increase solarization efficiency. To do this, 2-layer plastic mulch was compared with 1-layer plastic mulch. Temperature of nursery beds were recorded for 3 weeks along with temperature of bare or non-solarized beds. The second plastic sheet was supported by a concave-shaped plastic molding and placed over the bed with 1 layer of plastic. The highest point of the roof of the second layer of plastic was approximately 50 cm from the first plastic. Results from 1985 trials in La Molina, Peru showed that the 2-layer plastic bed had 12.5° C higher temperature compared with the 1-layer plastic bed (60.0° C vs 47.5° C). 2-layer plastic bed had almost twice as high temperature compared with temperature of bare beds (60° C vs 32.2° C). Temperatures were recorded at 10 cm soil depth. International Potato Center (CIP), P. O. Box 5969, Lima, Peru.

RAYMUNDO, S.A., J. ALCAZAR and R. SALAS. A Technique for Testing the Efficiency of Soil Solarization in Controlling Root-Knot Nematodes at Varying Soil Depths.

A method was developed to compare solarization efficiency at varying soil depths. Root knot nematode inoculum consisting of a pre-determined amount of soil with known level of infestation (number of larvae/100 g soil) is wrapped in gauze bags then placed at the bottom of previously dug pit. Pit is covered with soil and slightly compacted before the experiment is solarized by spreading over it a transparent plastic sheet. As close a contact as possible should be insured between the plastic sheet and the plot surface. Edges of the sheet are held secure by burying them in a trench around the plot. After the desired period of solarization, inocula are sampled to determine larvae count. Bio-assay studies are then conducted to determine severity of infection on susceptible host (root galling index), number of females per 5 g roots and other desired parameters. From results of studies in La Molina, Peru in summer of 1985, it was found that nematode population and infection were significantly reduced at a maximum depth of 20 cm after one month solarization. International Potato Center (CIP), P.O. Box 5969, Lima, Peru.

REDDIGARI, S.R., R.S. HUSSEY, P.L. JANSMA, and P. DEVIDAS. Cuticular Collagenous Proteins of Second-Stage Juveniles and Adult Females of *Meloidogyne incognita*

Cuticles from second-stage juveniles (J2) and adult females of *Meloidogyne incognita* were purified by treatment with 1% sodium dodecyl sulfate (SDS). The J2 cuticle was composed of three zones differing in their solubility in  $\beta$ -mercaptoethanol (BME). Proteins in cortical and median zones were partially soluble in BME, whereas the basal zone was the least soluble. The BME-soluble proteins from J2 cuticles were separated into 12 bands by SDS-polyacrylamide gel electrophoresis and characterized as collagenous proteins based on their sensitivity to collagenase and amino acid composition. The adult cuticle consisted of two zones which were dissolved extensively by BME. The basal zone was completely solubilized leaving behind a fibrous network corresponding to the cortical zone. The BME-soluble proteins from the adult cuticles were separated by electrophoresis into nine bands one of which constituted >55% of the total BME-soluble proteins. This major collagenous protein, localized in the adult female cuticle with immunogold labelling, was distributed throughout the cortical and basal zones. Dept. of Plant Pathology, Univ. of Georgia, Athens, GA 30602.

REISE, R. W., R. N. SAYRE and R. N. HUETTEL. Use of Carrot Callus for Maintenance of Migratory Plant Parasitic Nematodes in

Sterile Culture.

Carrot callus tissue can be excised from surface sterilized carrot discs and maintained on Gamborg's B5 agar medium containing 0.1 mg/L 2,4-dichlorophenoxy acetic acid. Sufficient amounts of callus can be generated and successively subdivided into rapidly dividing lines within 10-30 days. Parent plates of callus can be maintained for several months and subdivided as needed for new callus. This eliminates having to restart callus each time as required for alfalfa callus. Carrot callus cultures when inoculated with 100 surface sterilized nematodes of *Pratylenchus brachyurus*, *P. scribneri*, *P. agilis*, *Radopholus similis*, and *R. citrophilus* supported a greater than 10-fold increase within 60 days. Nematode infested carrot callus can be subdivided without loss of nematode viability. USDA ARS, Nematology Laboratory, Beltsville Agricultural Research Center, Beltsville, MD 20705.

ROBINSON, A.F., and C.M. HEALD. Factors influencing the control of *Rotylenchulus reniformis* by soil solarization.

Field and laboratory experiments were conducted to evaluate the potential of soil solarization for controlling *Rotylenchulus reniformis* in the lower Rio Grande Valley of Texas. In four field experiments during 3 years, fallow seedbeds were tarped with polyethylene film (optically clear, 102  $\mu$ m thick) for 4, 6, and 8 weeks and soil temperatures were monitored continuously at depths of 7.5, 15, 22.5, and 30 cm. Tarping always reduced nematode densities 15 cm deep and usually increased yields. Lethal time-temperature surfaces were derived under controlled conditions for eggs and for vermiform stages in water and in soil. These surfaces were in general agreement with time-temperatures observed to be required for population density reductions at four soil depths in the field. Discrepancies between laboratory data and field data were explainable in terms of cumulatively lethal effects, measured under laboratory conditions, that result from repeated daily exposures to marginally sub-lethal time-temperatures. Recovery of normal motility and embryonation rates after single exposures to sub-lethal time-temperatures required 1-10 days. Subtropical Agricultural Research Laboratory, USDA, ARS, P.O. Box 267, Weslaco, TX 78596.

RUTHERFORD, T. A. and J. M. WEBSTER. Commercial use of entomophilic nematodes in Canada.

Nematodes of the genera *Steinernema* and *Heterorhabditis* kill a wide range of pest insects and have long been considered as potential biological control agents. These nematodes are free from pesticide registration requirements in both Canada and the United States and this has made them attractive to companies wishing to produce biological control agents commercially. The relatively high production cost of nematodes vs chemicals restrict their present use to high value crops or the crops where chemicals are unable to provide adequate insect control. *Heterorhabditis heliothidis* is now being marketed in Canada to control housefly maggots in the manure of caged layer poultry barns and root weevils in nursery and household ornamentals. Both of these treatments provide better and less expensive insect control than pesticides currently registered for these applications in Canada. Centre for Pest Management, Simon Fraser University, Burnaby, British Columbia, Canada, V5A 1S6.

SANTO, G. S., H. MOJTAHEDI, and J. H. WILSON. Reproduction and pathogenicity of *Meloidogyne chitwoodi* races on carrot cultivars.

The reproductive factor (R) [R = final egg production at 55 days/5000 Pi] of *Meloidogyne chitwoodi* race 1 (non-alfalfa) on nine carrot cultivars was determined. The R value ranged from 2 to 18 indicating that all cultivars were suitable hosts for race 1. The pathogenicity of *M. chitwoodi* race 1 and race 2 (alfalfa) was determined on three cultivars; A Plus, Chancellor and Six Pack. The soil was infested with 10,000 eggs, planted with pre-germinated seeds, and grown for 55 days. Race 2 reduced (P=0.05) plant dry weight of all three cultivars and R values were less than 1. Race 1 only reduced (P=0.05) plant weight of Six Pack and R values were greater than 1 on all three cultivars. In general, race 2 was more pathogenic than race 1, and A Plus was more severely damaged by nematode infection. I.A.R.E.C., Washington State University, Prosser, WA 99350.

SANTO, G. S. and C. B. SKOTLAND. Interaction of *Pratylenchus penetrans* and *Verticillium dahliae* on Scotch spearmint in microplots.

A field microplot experiment was conducted in 15 liter buckets to study the relationship between *Pratylenchus penetrans* and *Verticillium dahliae* on Scotch spearmint. Treatments included two levels of nematode (100 and 500/250 cm<sup>3</sup> soil) and fungus (75 and 150 microsclerotia/gm of soil) alone and in all combinations. *P. penetrans* increased ( $P=0.05$ ) the incidence and severity of *Verticillium* wilt at the low fungus inoculum level. A factorial analysis of the data showed that there was a positive ( $P=0.05$ ) interaction between *P. penetrans* and *V. dahliae*. Most of the fungus alone and combination treatments reduced plant top growth compared to the control and the nematode-only treatments. The nematode alone did not have a detrimental effect on plant top growth. I.A.R.E.C., Washington State University, Prosser, WA 99350.

SCHMITT, D. P. and L. A. NELSON. Chemical control of plant-parasitic nematodes in soybeans double-cropped with wheat in no-till and conventional till systems.

Efficacy of nematicides to control selected nematodes, with emphasis on *Heterodera glycines*, was determined in no-till and conventional till planted soybeans over a 3-year period (1981-83). Greatest numbers of *H. glycines* eggs were recovered in conventionally tilled plots. The highest occurrence of *Tylenchorhynchus claytoni* was in no-till, nonsubsoiled treatments. The lowest numbers of this nematode occurred in the in-row subsoiled, no-till treatments. Nematicide effects were not consistent across years as measured by population densities of nematodes. Yields were greatest in the in-row subsoiled, no-till plots treated with ethylene dibromide. Department of Plant Pathology, Box 7616, North Carolina State University, Raleigh, NC 27695-7616.

SELF, L. H. and E. C. BERNARD. Association of dogwood canker and nematodes.

Dogwood canker is a serious production problem of unknown cause. Dr. Frank Santamour, Jr. (U.S. National Arboretum) has hypothesized that nematodes are the causal agents of dogwood canker based on field samplings (unpublished). In Tennessee from May through November, 1985, cankers from 250 flowering dogwood trees in fifteen separate nurseries were sampled for nematodes. Seventy-five percent of the cankers (187 samples) were found to contain nematodes. Four *Aphelenchoides* spp., one *Paraphelenchus* sp. and one *Panagrolaimus* sp. have been recognized. Presently, stylet-bearing nematodes from thirteen samples are being reared on antibiotic media with *Glomerella cingulata* as a food source, and microbivorous nematodes are being reared on water agar with bacteria as a food source. Nematodes will be inoculated into healthy dogwood stems to determine if they can induce canker formation. Department of Entomology and Plant Pathology, University of Tennessee, Knoxville, TN 37901-1071.

SHAMS-EL-DIN, M. M. and E. G. PLATZER. Romanomermis culicivora:  
penetration of larval mosquitoes.

In the presence of second larval instars of three mosquito species the preparasites of Romanomermis culicivora swam near the water surface in an orthokinetic manner. When the preparasites were ca 1 mm from the host, they stopped and swam klinotactically toward the host. At that point the nematodes secreted a small amount of a putative adhesive material from the anterior portion of the body and host contact was completed. The adhesive appeared to aid in attachment of the nematode to the host and initiation of the search boring phase. The preparasites glided over the host body until a suitable penetration site was found. The penetration phase was initiated by probing with the odontostyle and injection of esophageal secretions which caused partial paralysis, decreased intestinal peristaltic movement and temporary cardiac arrest. SEM observations showed that the abdominal walls were the most frequent site for penetration. As the nematode entered through the penetration hole, surrounding microorganisms were retained by the adhesive secreted during the initial attack phase. The microbial contamination of the host was avoided by both mechanical and biochemical cleansing mechanisms. Penetration was usually completed in less than 10 minutes. Dept. of Nematology, University of California, Riverside, CA 92521.

SHREFLER, J. W., E. C. MCGAWLEY, W. J. BLACKMON, & B. D. REYNOLDS  
Effects of Hot-water Treatments on Root Knot Nematodes in Tubers

of Apios americana.

Apios americana Medikus, a nitrogen-fixing, viny legume, which produces seeds and tubers, is being evaluated as a food crop. The underground stems (rhizomes), which give rise to tubers, and tubers were found to be infested with the root knot nematode Meloidogyne incognita. Hot-water treatments are being evaluated as a method to free seed tubers of nematodes. Tubers were treated at 45, 50, and 55 C for periods of 0, 5, 10, 20 and 30 minutes. Tubers tolerated up to 50 C for 30 minutes with no greater than 10% decrease in sprouting; whereas, 55 C for 5 minutes reduced sprouting by 60% with longer intervals at 55 C being lethal. Nematode survival was assayed by mixing diced, treated tubers with soil into which Rutgers tomato seedlings were transplanted. After one month, galling of tomato roots were apparent for untreated tubers and those treated at 45 C. No galling was observed for tubers treated at 50 C for 10 minutes or longer. Department of Plant Pathology and Crop Physiology, Louisiana Agricultural Experiment Station, Louisiana State University Agricultural Center, Baton Rouge, Louisiana 70803.

SIKORA, E. J., and R. B. MALEK. Influence of temperature on pine wilt development in Scotch pine.

The influence of temperature on pine wilt development in Scotch pine (Pinus sylvestris) was examined in three tests. Four- to 6-yr-old potted pines inoculated with 1500 propagative Bursaphelenchus xylophilus were incubated at constant temperatures in growth chambers for 8 wk, then at a mean temperature of 22 C in a greenhouse for 10-20 wk. Nematode infection success was greater, tree mortality was higher, and disease incubation was shorter in 32 and 30 C treatments than in 25, 23, 18, 16 and 11 C treatments. Foliar symptom development generally was more rapid and uniform with increasing temperature. Ninety-five percent of mortalities at 32 and 30 C and 88 percent of mortalities at 25 and 23 C occurred within the period of exposure to constant temperatures. No mortalities occurred in 18, 16 and 11 C treatments until trees were transferred to the greenhouse. Results indicate that pine wilt incidence is directly related and disease incubation period is inversely related to temperature and that high-temperature stress predisposes Scotch pine to lethal infection by B. xylophilus. Department of Plant Pathology, University of Illinois, Urbana, IL 61801.

SIPES, B. S. and D. P. SCHMITT. Post-infection development of *Heterodera glycines* on fenamiphos treated soybeans.

Development of *Heterodera glycines* (HG) race 1 after infection was determined in the greenhouse. Treatments, each replicated four times, were fenamiphos rates (0, 0.19, 0.38, 0.75 and 1.50 ug [a.i.]/g soil). HG eggs were placed in hatching chambers and maintained at 28C. Juveniles that hatched during the first 12 hours were discarded and those emerging during the next 36 hours were used for inoculum. Soybeans 'Deltapine 105', germinated on moist paper at 28C, with radicals 1-2 cm long were transplanted into sterile 65 mesh sand in wooden flats, inoculated with aliquants of 150 juveniles/seedling and maintained at 28C for 72 hours to allow for host-parasite establishment. Infected seedlings were washed with tap water to remove infested sand and then transplanted into 5 cm diameter clay pots filled with 65 mesh sterile sand. Fenamiphos treatments were then applied. Roots were harvested at 2 day intervals for 24 days and stained using a modified sodium hypochlorite-acid fuchsin technique. Development at 0.19 and 0.38 ug/g soil was similar to the untreated control, but was slower at 0.75 ug, and greatly inhibited at 1.5 ug. Department of Plant Pathology, Box 7631, N. C. State University, Raleigh, NC 27695-7631.

STANTON, M. A. and R. A. DUNN. Effect of a root-knot nematode on soybean growth and yield.

The effects of *Meloidogyne arenaria* Race 1 on soybean [*Glycine max* (L) Merr.] growth and yield were measured to enable inclusion of the nematode into mechanistic and carbon-balance computer models of soybean growth. 'Cobb' soybeans were planted in an Arredondo Fine Sand (92% sand, 5% silt, 3% clay) in a split plot design with four replications: main plot treatments were rain-fed/irrigated; split plot treatments were nematodes infested/non-infested. Aboveground plant growth, nematode populations, and root-length densities at depths of 0-15, 15-30, 30-45, and 45-60 cm were measured bi-weekly. Data on nematode population dynamics, root length density, leaf area index, dry weight accumulation, and yields will now permit inclusion of root-knot nematode into the soybean growth models. Root-length densities were unaffected by nematode infestation at any of the four depths, yet top growth was significantly reduced. Yields were reduced significantly by nematodes, mainly by reducing numbers of seeds produced. Nematode infestation did not affect seed weight; irrigation had a minor but significant effect on seed weight, and there was a significant interaction between nematodes and irrigation effects on seed weight. Departments of Agronomy and Entomology & Nematology, respectively, University of Florida, Gainesville, FL 32611.

A. C. TARJAN and RICK L. VINTON. A novice-oriented computer program for identifying the more common marine nematodes.

The student or novice taxonomist with basic training in nematode anatomy can identify to family and genus most of the more ubiquitous marine nematodes using an illustrated computer program written in Turbo Pascal. Only the morphology and anatomy of the nematodes being studied need be determined, biometrical data is unnecessary. The user can review and change previous answers to questions at will. Recognition is usually based on one to three characters, as the taxon being studied is identified from order to genus. An incorrect answer to one question does not necessarily result in misidentification. The program occupies 17 kilobytes of random access memory and the related data files use about 600 kilobytes of disk storage. Five utility programs totalling 84 kilobytes aid in manipulating or correcting the data files. A digitizer tablet prepared the drawings of genera included in the files. Though the program is based on one system of marine nematode classification, it easily can be modified to conform to other classification schemes using the utility programs previously mentioned. Department of Entomology and Nematology, University of Florida, Gainesville, FL 32611.

TEDFORD, E.C., and B.A. FORTNUM. Weed hosts of *Meloidogyne incognita* and *M. arenaria*.

Four-week-old seedlings were inoculated with 5000 eggs of *Meloidogyne incognita* race 3 or *M. arenaria* race 2. Root galls and egg masses were rated after 60 d. Egg mass production and galling differed ( $P < 0.05$ ) between the species. Lambsquarters, hairy vetch, curly dock and spotted spurge were good hosts of *M. arenaria*. Smooth pigweed, common ragweed, entireleaf morning-glory, prickly sida, red sorrel, palmer's amaranth and yellow foxtail were moderate hosts. Dandelion, ivyleaf morningglory, yellow nutsedge, bermudagrass, bahia grass, barnyardgrass, dallisgrass, goosegrass, carpet grass, johnsongrass, green foxtail, showy croton, sicklepod, purslane, jimsonweed and field sandbur were poor hosts. For *M. incognita* hairy vetch, smooth pigweed, lambsquarters, prickly sida, curly dock, spotted spurge, yellow foxtail, purslane, palmer's amaranth and entireleaf morningglory were moderate hosts. Common ragweed, dandelion, cocklebur, yellow nutsedge, bahia grass, ivyleaf morningglory, bermudagrass, goosegrass, carpet grass, johnsongrass, green foxtail, showy croton, sicklepod, jimsonweed, red sorrel, and field sandbur were poor hosts. Department of Plant Pathology and Physiology, Clemson University, Clemson, SC 29634-0377.

TSAI, B. Y. and S. D. VAN GUNDY. Coiling of plant parasitic nematodes in irrigated soil.

Coiled second stage larvae of *Tylenchulus semipenetrans* and *Meloidogyne incognita* were found in the root zones of their host plants between irrigation cycles. The percentage of coiled citrus nematodes peaked before irrigation and declined sharply after irrigation. Approximately 50% of the citrus nematodes were coiled on the day before irrigation. The highest percentage of coiled citrus nematodes was found at the depth of 10-20 cm in the root zone. There was a significant negative correlation between the percentage of coiled citrus nematodes and soil moisture. Forty nine percent of the root-knot nematodes were coiled in the vineyard (a sandy soil) with a soil moisture of 15.8%. SEM studies showed orderly packing of cuticles on the coiled nematodes. The inactivity of nematodes in irrigated soil is a new observation on the behavior of nematodes around their host plants. Coiled *Heterodera schachtii* larvae were found in fallowed sugarbeet field but not in sprinkler irrigated field. This was the first record on the coiling of cyst nematodes. Department of Nematology University of California, Riverside, CA 92521.

TSAI, B. Y. and S. D. VAN GUNDY. Tolerance of coiled, shallow-anhydrobiotic citrus nematodes to adverse conditions.

Coiled citrus nematodes sampled on the day before irrigation from a citrus orchard were tested for their tolerance to extreme drought (0% RH) and unfavorable temperatures (45, 40, 0, and -18 C). The coiled citrus nematodes were in different physiological states from the non-coiled ones because they were more tolerant to freezing temperature (0 and -18 C). However, they did not survive the 24 h exposure to 0% RH, therefore, they were not in the deep form of anhydrobiosis (cryptobiosis). The term "shallow anhydrobiosis" was coined for the coiled citrus nematodes naturally occurring in the citrus orchards. Air drying experiments showed that survival of citrus nematodes was favored by slow dehydration. Percentage of coiled nematodes was highest (75% coiled) in the driest soil but the nematodes were all dead, indicating that coiled morphology was not sufficient to protect the nematodes from severe drought. Physiological changes were more important for the survival of anhydrobiotic nematodes. Coiling is not necessarily related to physiological changes of anhydrobiosis. Department of Nematology, University of California, Riverside, CA 92521.

VERDEJO, S. and R. MANKAU. Culture of *Pasteuria penetrans* in *Meloidogyne incognita* on oligoxenic excised tomato root culture.

Although *Pasteuria penetrans* (Pp) has been proposed as a promising biological control agent against root-knot nematodes, many aspects of its biology remain unknown. Oligoxenic cultures can be useful to study this organism since infected nematodes can be easily observed and monitored without disturbing the system. Sterilized seeds were grown on modified 1% Tepfer & Tempe medium in petri dishes. Epicotyls were removed after a week and roots inoculated with both Pp and *M. incognita* (Mi). Pp infected females were surface sterilized in 0.01% mercuric chloride and 1% streptomycin sulfate for five min and rinsed twice in sterile distilled water. Mi egg masses were obtained from axenic cultures of the nematode. A Pp infected female was squashed on a small block of agar placed close to the roots to release the spores, then a single Mi egg mass was placed on the agar block. Six replicate plates were prepared and the roots examined after 58 days. The spores attached to hatching juveniles which invaded the roots and diseased females were found in all replicates. Although some parasitized females were able to produce a few eggs, more than 50% of the females were infected per plate in all cases and 100% were infected in two plates. Dept. of Nematology, University of California, Riverside, CA 92521.

C. WEAVER\* and R. I. BOLLA. Pathotypes of *Bursaphelenchus xylophilus* Show Genetic Differences.

Population of *B. xylophilus* from Scots pine in Missouri (MPSy-1) and white pine in Vermont (VPSt-1) were compared for ability to infect Scots, white, Austrian and loblolly pine. MPSy-1 infected and caused wilting of only Scots pine, and VPSt-1 infected and wilted only white pine both in greenhouse and field tests. Based on this observation, and several observations of host response, these isolates have been designated as pathotypes. To further ascertain that these isolates were different, restriction endonuclease cleavage of total genomic DNA and competitive hybridization was used. *B. mucronatus* was used as control, since genetic differences are expected between species. When restriction endonucleases that recognize 6 base pair sequences were used, major differences were seen between VPSt-1 AND MPSY-1. These differences were, however, not as great as those seen between the *B. xylophilus* isolates and *B. mucronatus*. These results support the contention that MPSy-1 and VPSt-1 are pathotypes of *B. xylophilus* and that these methods can be used to differentiate other possible pathotypes. Department of Biology, University of Missouri-St. Louis, St. Louis, MO 63121.

WEAVER, C.F., E.L. SNODDY, and R. RODRIGUEZ-KABANA. Population dynamics of root-knot nematode in Florunner peanut.

The development of *Meloidogyne arenaria* was studied in a peanut field near Headland, Alabama. The field had been in peanut for the preceeding 10 years. Soil samples for the study were collected from 20 different sites in the 7-ha.-size field. Each site consisted of a plot 2 rows wide and 20 M long. Soil samples were collected every 2-3 wks. through the peanut growing season (May-Sept.) and at monthly intervals after harvest. Samples were collected to a depth of 20-25 cms and consisted of 16-20 2.5-cm-diam. cores per site. The cores from each site were composited and a 100 cm<sup>3</sup> subsample was used to determine juvenile populations. Juvenile numbers were low (<50/100 cm<sup>3</sup> soil) during the first 90 days after planting but increased rapidly through the last month before harvest. The equation  $J = 0.6205 \cdot e^{0.049T}$  described ( $R^2 = 0.962$ ) the relation between numbers of juveniles in soil (J) and days (T) from planting to harvest. Juvenile populations declined sharply after harvest; the relation between numbers of juveniles and days after harvest (t) was described ( $R^2 = 0.87$ ) by  $J = 3.4453(0.9905)^t \cdot t^{-0.1808}$ . Department of Plant Pathology, Ala. Agric. Expt. Stn., Auburn University, AL 36849.

# POSTER PRESENTATIONS

CABALLERO, L.G., E.A. OSMANSKI, and P.M. TEFFT. Factors influencing plant-induced egg hatching in *Heterodera glycines*.

Diffusate from host-plants and certain divalent cations are known to stimulate hatching in eggs of the soybean cyst nematode, *Heterodera glycines*. This preliminary report suggests that there are varietal differences in activity of diffusate produced by host plants. More eggs were hatched in diffusate obtained from susceptible soybeans compared to resistant plants when plants were in the vegetative stage. In contrast, eggs hatching in diffusates from plants in the reproductive stage were similar. Diffusates from plants held in sunlight hatched significantly more eggs when compared to hatching in diffusates from plants held in room light or in the dark. The role of ions in plant-diffusate activity was tested by dithizone extraction and chelation with EDTA. Hatching in extracted and chelated diffusate were similar and higher than controls. Addition of zinc to diffusate decreased activity. Biology Department, St. Joseph's University, Philadelphia, PA 19131.

CHITAMBAR, J.J. and E.M. NOFFSINGER. Life cycle and morphology of a predaceous nematode, *Odontopharynx* sp. (Diplogasterida: Odontopharyngidae). A species of *Odontopharynx* found in soil samples from San Francisco, California, was cultured in the laboratory on *Acrobeloides* sp. (Rhabditida: Cephalobidae). The nematode was found to reproduce well at 25 C and completed its life cycle in approximately 15 days. Morphological and taxonomical studies of the different stages were done using light and scanning electron microscopes. A camera lucida was used for measurements and illustrations, and internal structures were studied from stained serial sections. The life cycle, morphology, and diagnostic characters of this species will be presented. Division of Nematology, University of California, Davis, CA 95616.

CHITWOOD, D. J., and W. R. LUSBY. Metabolism of sitosterol by *Panagrellus redivivus* and *Turbatrix aceti*.

*P. redivivus* and *T. aceti* were propagated axenically in a semidefined aqueous medium supplemented with sitosterol, and sterols were subsequently identified by gas-liquid chromatography (GLC) and GLC-mass spectrometry. The sterols of *P. redivivus* consisted of 61.7% cholesterol, 20.3% cholestanol, 6.7% sitosterol, 6.1% desmosterol, and 4.2% 4 $\alpha$ -methylcholestanol; the sterols of *T. aceti* included 42.9% 7-dehydrocholesterol, 18.8% cholesterol, 9.4% lathosterol, 4.5% sitosterol, 10.4% 4 $\alpha$ -methylcholest-8(14)-enol, 6.3% 4 $\alpha$ -methylcholestanol, and 2.4% 4 $\alpha$ -methylcholest-7-enol. Thus, each species was capable of removing the C-24 ethyl substituent of sitosterol and attaching a 4 $\alpha$ -methyl substituent to the sterol nucleus. However, other nuclear modifications varied, as only *T. aceti* introduced  $\Delta^7$ - and  $\Delta^8(14)$ -bonds. The lack of 7-dehydrocholesterol, production of stanols, and existence of C-24 dealkylation capability are three characteristics shared by many plant-parasitic nematodes and *P. redivivus*, which would appear to be a more useful model than *T. aceti* or *Caenorhabditis elegans* for investigating sterol metabolism in plant-parasitic nematodes. USDA, ARS, Insect and Nematode Hormone Laboratory, Plant Protection Institute, BARC-E, Beltsville, MD 20705.

EISENBACK, J. D. and NALINI GNANAPRAGRASAM. Additional notes on the external morphology of *Meloidogyne brevicauda*.

Females, males, and second-stage juveniles of *Meloidogyne brevicauda* from Sri Lanka were examined by scanning electron microscopy. The labial disc of the female is separated from the lips by a deep groove and the medial lips are divided into pairs. The lateral lips extend posteriorly to the first body annule and make discernment of the head region difficult or impossible. The head of the male is characterized by a distinct labial disc and apparent absence of a head region; the posterior edges of the lips are adjacent to the first body annule. The tail is marked by a crescent-shaped slit around the posterior half of the cuticle surrounding the cloacal opening. In the second-stage juvenile, the labial disc is nearly separated from the medial lips by a deep groove but remains connected by a narrow band of cuticle. The head region is apparently absent. The tail of the juvenile is marked by transverse grooves that radiate from the posterior and of the lateral field. The morphology of *M. brevicauda* is very different from the four most common species of root-knot nematodes. Dept of Plant Pathology, Physiology and Weed Science, Virginia Polytechnic Institute and State University, Blacksburg, VA 24061; Nematology Division, Tea Research Institute, St. Coombs, Talawakele, SRI LANKA

FLEMING, M.W. Ecdysteroids in adult male *Ascaris suum*, the swine intestinal roundworm.

Adult male *A. suum* were obtained from a local abattoir and dissected into 3 tissue components: cuticle/muscle, reproductive tract, and perienteric fluid. Each tissue type was extracted with methanol/water (70%) and partitioned with methanol/hexane. Extracts were fractionated on reverse phase HPLC (18% ACN/water) and the elutions were analyzed with radioimmunoassay for ecdysone and 20-hydroxyecdysone (20-HE). Cuticle/muscle tissue contained little (< 50pg) or undetectable levels of these ecdysteroids. The male reproductive tract contained  $320 \pm 169$  pg/g wet weight ( $X \pm SEM$ ) and  $208 \pm 87$  pg/g of ecdysone and 20-HE, respectively. Pooled perienteric fluid contained 997 pg/ml and 285 pg/ml, respectively (approximately, 199 pg and 57 pg/worm). These results are consistent with detection of ecdysteroids in adult male insects and suggest a role in gametogenesis. Helminthic Diseases Laboratory, Animal Parasitology Institute, A.R.S., U.S.D.A., Beltsville, MD 20705.

FORGE, T. A., and A. E. MACGUIDWIN. Autofluorescence in nematodes and its use as an assay of viability.

With the use of epifluorescence microscopy, autofluorescence has been observed in nematodes. A 50 watt mercury vapor lamp, 450-490 nm band pass filter, and barrier filter for 520 nm and below were used to view the nematodes. A representative species from each of ten genera of phytophagous nematodes and *Caenorhabditis elegans* were observed, and all exhibited autofluorescence. Variation in the color and intensity of the autofluorescence occurred between genera. The autofluorescence, most prevalent in the form of discrete globules in the intestine of live nematodes, was dispersed throughout the body of dead nematodes. The lip region and spicules were also observed to exhibit autofluorescence. The dispersed fluorescence proved to be a reliable assay of viability for *Pratylenchus penetrans*. The dispersed fluorescence method detected mortality due to freezing, whereas other assays using vital stains did not. Other possible uses of autofluorescence in nematology research will be discussed. Department of Plant Pathology, University of Wisconsin-Madison, Madison, WI 53706.

Giblin, R. M., and G. E. Eickwort. Aduncospiculum halicti; a nematode associate of halictid bees in Florida.

Adult halictid bees from Broward Co., Florida were dissected and examined for nematode associates. Bees were collected on Bidens bipinnata between November 1985 and May 1986. Dauer nematodes were recovered from the Dufour's glands of adult females of Halictus ligatus (16%), Augochlora pura mosieri (41%) Augochlorella sp. (80%). Dauer nematodes were recovered from the aedeagus of males of A. pura mosieri (33%). The dauer nematodes from each bee species were cultured to adults on 5% glycerol supplemented potato dextrose agar (GPDA) in xenic culture and identified as Aduncospiculum halicti (Diplogasteridae). These observations increase our knowledge about the phoretic host range of A. halicti and also its southern distribution in the United States of America. Department of Entomology and Nematology, University of Florida, IFAS, 3205 College Avenue, Ft. Lauderdale, FL 33314; and Department of Entomology, Cornell University, Ithaca, NY 14853.

INGHAM, R.E. and J.K. DETLING. Nematode population dynamics from different aged prairie dog colonies.

The effects of prolonged intense aboveground grazing on soil nematode populations in a native North American mixed grass prairie was studied on areas of a prairie dog town colonized for 0, 1, 4 and 14 years. This colony was also heavily grazed by bison, elk and pronghorn antelope. Total nematode populations and particularly root-feeding Tylenchida increased with increasing age of the colony except in the 14-year-old area where numbers had declined to levels less than in the uncolonized area. This area had succeeded to a community dominated by forbs and shrubs and contained few grasses. However, root-feeding nematodes expressed as numbers per gram of root biomass were as high in the 14-year-old colony as in the 4-year-old colony and much greater than in the 1-year-old or uncolonized areas. The nematode community was dominated by Tylenchida (45.3%) with 15 genera and Rhabditida (30.9%) which were not identified. Seventeen genera of Dorylaimida were identified which composed 20.5% of the community. Department of Botany and Plant Pathology, Oregon State University, Corvallis, OR 97331 and Natural Resource Ecology Laboratory, Colorado State University, Fort Collins, CO 80523.

KAPLAN, D. T., and J. L. KOEVENIG. Unusual galls on oak associated with Meloidogyne chritei.

Infection of roots of Quercus falcata by Meloidogyne chritei results in the formation of distinct galls with a nodule-like appearance. Each gall contains one female and numerous eggs. In cross section, eggs appear to be housed in elliptical cavities bounded by several layers of suberized cells within the gall. Feeding sites are comprised of giant cells with thickened walls containing well-defined pits. Giant cells often contain vacuolated cytoplasm and are multinucleate with nuclei and nucleoli being greatly enlarged. Nuclear envelopes are irregularly lobed with nuclei routinely forming oblong aggregates. USDA, ARS, USHRL, 2120 Camden Road, Orlando, FL 32803; Department of Biological Sciences, University of Central Florida, Orlando, FL 32816.

KING, P.S., AND R. RODRIGUEZ-KABANA. Application depth and efficacy of 1,3-D for control of root-knot nematodes in peanut.

1,3-D (Telone® II) was applied one week before planting of Florunner peanut in a field infested with *Meloidogyne arenaria*; 1,3-D rates were 13, 26, and 52 L/ha and each rate was injected to depths of 8, 15, 25, and 36 cms. Each rate-depth combination was represented by 8 replications (plots) within a randomized complete block design. Plots were 2 rows wide x 10 M long. The interaction between rates and application depth on the number of *M. arenaria* juveniles in soil, determined 6 wks before harvest, was not significant. Applications of 1,3-D at 26 or 52 L/ha reduced juvenile populations in soil; the 52 L rate resulted in the smallest populations. 1,3-D applications at depths of 15 cm or deeper resulted in lower numbers of juveniles than the 8 cm applications. The interaction between rate and depth of application on yield was not significant. Yield response (Y) to 1,3-D rates (L) fit ( $R^2=0.98$ ) the model  $Y=4500-e^{7.446-0.0139L}$ . The relation between yield and depth of application (D) followed ( $R^2=0.99$ ) the model  $Y=1928 \cdot (0.9857)^{D \cdot 0.2953}$ .  
Department of Plant Pathology, Alabama Agricultural Experiment Station, Auburn University, AL 36849.

Lawson, E. Clifford and Bruce C. Hemming. Effect of *Meloidogyne incognita* Infection on Soybean Root Colonization by Recombinant

Pseudomonads.

*Pseudomonas fluorescens* strain 1141L1 (ATCC 53176), genomically marked with the genes coding for the *E. coli* -galactosidase and lactose permease proteins, has been used to follow population levels and spatial distributions of this bacterium in the rhizoplane of soybean as influenced by increasing inocula of the root-knot nematode species, *Meloidogyne incognita*. Four weeks after inoculation, one replication set was washed for determination of the bacterial strain's rhizoplane population density on intact roots and another replication set was similarly washed for separate recovery from tap roots and lateral roots. The spatial distribution of the recoverable bacterial cells was influenced by nematode infections. Decreasing populations on tap roots and increasing populations of bacteria on lateral roots were observed with increasing nematode inocula as examined on a per root weight basis. The use of the non-antibiotic, selectable marker genes represents a suitable and reproducible model system for tracking root-colonizing fluorescent pseudomonads on plants subjected to pathogen or environmentally induced stress.  
Biological Sciences Department, Monsanto Co., St. Louis, MO 63198.

MUELLER, J. D., E. R. SHIPE and H. R. MUSEN. Evaluation of soybean cultivars for tolerance to *Hoplolaimus columbus*.

Three replications of 17 soybean cultivars from maturity groups V and VI and 19 cultivars from maturity groups VII and VIII were evaluated in separate tests in a field naturally infested with 80 *H. columbus* (Hc)/100 cm<sup>3</sup> of soil. Plots consisted of two row 6.4 m long, planted on May 28, 1985. Differences in Hc/g root at 6 weeks and yields were not significantly different at  $P=.05$ . Yields in the group V and VI test ranged from 1157 kg/ha (cultivar Narrow) to 2603 (Young). Yields of selected cultivars included Asgrow 6381 (2233 kg/ha), Coker 156 (2085), Davis (2051), Centennial (1769), Leflore (1567), and Coker 485 (1164). Mean number of Hc/g freshweight of roots for all cultivars at 6 weeks after planting was 300. Yields of the group VII and VIII tests ranged from Braxton (1426) to FFR 711 (2925). Other yields included Coker 627 (2751), Kirby (2623), Coker 458 (2482), Foster (2448), Coker 317 (2428), Gordon (2327), Gasoy 17 (1977), and Cobb (1816). Mean number of Hc/g freshweight of roots for all cultivars was 214 in groups VII and VIII. Clemson University Departments of Plant Pathology and Physiology, and Agronomy, Blacksville, SC 29817.

POTTER, J.W., L.I. WAINMAN, and J.L. TOWNSEND. Sex distinction and male juvenile development of *Meloidogyne microtyla*.

The development of *M. microtyla* was studied on tomato. Roots were fixed, stained, and nematodes photographed with interference contrast microscopy. Sex distinction of germinal primordia, body shape, and body width at the median bulb, was seen in J2's by day 8. The male germinal primordium grew as an elongated ellipse, while that of the female was deltoid to "boomerang" shaped; an "accessory cell" was often associated with the male primordium. In J3 males, the stylet disappeared, esophageal area degenerated, and rectal glands deteriorated; late J3 males showed intestinal reorganization, gonads sometimes joined to the rectum, and lateral chord development indicative of the future vermiform shape. J4's showed further growth of the reproductive system, while sex-related differences in body shape and width at the median bulb remained. Male rectal gland nuclei were still detected and the spicule pouch was evident. The stylet and spicules were visibly differentiated after the final molt, adult males being seen at about 30 days. Agriculture Canada Research Station, Vineland Station, Ontario, L0R 2E0.

ROBBINS, R. T. Observations of *Californidorus crallei* with two vaginas and an intersex of *Longidorus elongatus*.

Two vaginas and vaginas were found on an otherwise typical specimen of *Californidorus crallei*. The two vaginas are 24  $\mu$ m apart. The two vaginas were slightly smaller than normal and connected by uterine tissue. A single ventral pore is found 6  $\mu$ m posterior to the posterior vulva. Vaginal muscles obscured the reduced sclerotized vulval plates. The 170  $\mu$ m long anterior genital branch consisted of a reduced uterus, sphincter, and oviduct. The 436  $\mu$ m long posterior genital branch contained an egg 176  $\mu$ m long and 42  $\mu$ m wide, 10  $\mu$ m posterior to the posterior vulva. An intersex of *Longidorus elongatus* was compared to 4 females and 1 male of the same population. The intersex's vulva is located at 46.6% of it's 5670  $\mu$ m length, similar to the 46.9% and 5357  $\mu$ m female averages. The intersex ovaries averaged about 75  $\mu$ m less in length. The tail shape of the females and intersex are similar. The intersex spicules are misshapen with the anterior end much wider than normal, appearing almost 'T' shaped and the spicule length (29.5  $\mu$ m) is less than half that of the male (64  $\mu$ m). The adanal pair and 11 single supplements have obvious ducts, but lack or have very slight cones. Dept. of Plant Pathology, Univ. of Arkansas, Fayetteville, AR 72701.

RODRIGUEZ-KABANA, R., and G. MORGAN-JONES. Effectiveness of *Paecilomyces lilacinus* against root-knot nematode.

Rice colonized with *Paecilomyces lilacinus* (PL), uncolonized rice (R), and rice colonized with *P. lilacinus* and then sterilized (APL) were each added at rates of 0, 0.25, 0.5, 1.0, 2.0, 4.0, 6.0, 8.0, and 10.0% (w/w) to field soil infested with *Meloidogyne incognita*. The amended soils were kept moist in pots for 2 wks in a greenhouse when they were planted with squash (*Cucurbita pepo*) seed. The plants were allowed to develop for 6 wks and were then examined for root galling. The pots were replanted with 4-week-old Rutgers tomato seedlings which were allowed to grow for 8 weeks when they were removed, the roots examined for galls, and soil samples were collected for analyses. The number of galls per gm of squash root decreased with increasing amounts of the amendments; differences between amendments were not significant. The number of galls per gm of tomato root was lowest in unamended soil and in soils that received either PL or APL. PL-treated soils generally contained more fungi than soils treated with R or APL; most fungal isolates from PL soils were *P. lilacinus* but this was not the case for soils with the other amendments. Department of Plant Pathology, Ala. Agric. Exper. Stn., Auburn Univ., AL 36849.

RUSSELL, C. C. The feeding habits of a species of Mesodorylaimus.

The genus Mesodorylaimus is known to contain predaceous species. A Mesodorylaimus sp. (close to M. lissus) was collected from the rhizosphere of wheat. These nematodes exhibited an omnivorous feeding habit in vitro. They were observed to feed: predaceously on other nematodes and encysted amoebae; parasitically on fungal hyphae ( $>3 \mu\text{m}$  dia.), algae and wheat epidermal cells; and microphagously in colonies of bacteria, actinomycetes and globules of a human dietary preparation. Root hairs were the predominant feeding site on wheat roots, although the nematodes were also observed to feed on the epidermal cell proper. Mesodorylaimus sp. appeared to feed without preoral digestion as esophageal activity and ingestion were initiated immediately upon stylet insertion. In root hairs, however, cytoplasmic streaming ceased within 2 sec. of stylet insertion and the cell nucleus became distorted. In soil, they reduced wheat seedling root wt. by as much as 70%, top wt. by 46% and produced a significant reduction in seedling emergence rate. Dept. of Plant Pathology, Oklahoma State University, Stillwater, OK 74078-0285.

RUSSELL, C. C. An accurate, inexpensive, low pressure, ULV in-furrow nematicide applicator.

A difficulty encountered in achieving low pressure ULV (Ultra Low Volume) in-furrow application is avoiding emission of droplets which result in uneven application at higher ground speeds. The regulator and manifold of the applicator described here are fabricated primarily of commonly available PVC (Polyvinyl Chloride) water pipe fittings. Manifold outlets are PVC mist nozzle pipe saddles fitted with 3.2 mm brass compression fittings. Drip irrigation leader tubing (3.2 mm OD) used as drops are threaded into 2.3 mm ID clear plastic uterine infusion tubes. The infusion tube may be used as an orifice for high rate of flow (3.32 ml./sec at  $1.6 \text{ kg/cm}^2$ ) or fitted with a hypodermic needle (point inside tube) for ULV rates (No. 27 tuberculin needle - .038 ml/sec at  $.2 \text{ kg/cm}^2$ ). Components for the regulator and manifold for an eight drop unit (without 12 Volt DC pump) cost less than \$50 (U.S.). Component, source and price list is available on request. Dept. of Plant Pathology, Oklahoma State University, Stillwater, OK 74078-0285.

VALENZUELA, A. ADELINA. Chemical Control of Meloidogyne in Tobacco.

The effect of 3 kg a.i./ha of Carbofuran, Aldicarb and Fenaminphos, and 6.54 kg a.i./ha of Ethoprop was tested in tobacco cv. Kentucky growing in soil naturally infested with root-knot nematode in four localities of the Fith Region of Chile. Meloidogyne incognita, M. arenaria and M. javanica were present. Root-knot nematode infection was significantly less in three of the four localities. Yield improvement occurred in only two of the localities. The effect of chemical treatments varies in the presence of mixed Meloidogyne species populations. Depto. de Sanidad Vegetal. Facultad de Ciencias Agrarias y Forestales. Universidad de Chile. Casilla 1004, Santiago, Chile.

TEDFORD, E.C., B.A. FORTNUM, and W.C. BRIDGES. Effects of flue-cured tobacco varieties on *Meloidogyne* spp. population shifts in South Carolina.

Shifts in root-knot nematode populations from *Meloidogyne incognita* to *M. arenaria* occur in South Carolina tobacco producing areas. Investigations of tobacco varieties on these shifts were performed in microplots. Tobacco (*Nicotiana tabacum*) seedlings 'NC 95' (resistant) and 'PD 4' (susceptible to *M. incognita*) were inoculated with initial population ( $P_i$ ) levels of *M. arenaria* race 2 (0, 1875, 3750, 7500, 15000 and 30000 egg/plant) and *M. incognita* race 3 (0, 7500, 15000, 30000 eggs/plant) in all combinations. At harvest, larvae extracted from root tissue were measured for species identification. Population shifts varied ( $P < 0.05$ ) between tobacco varieties. *Meloidogyne incognita* increased in relation to *M. arenaria* on 'PD 4.' *Meloidogyne arenaria* increased ( $P < 0.05$ ) on 'NC 95' for all combinations of *M. incognita* with low  $P_i$  (1875, 3750) of *M. arenaria*; as the  $P_i$  of *M. arenaria* increased, populations shifted in favor of *M. incognita*. Tobacco 'PD 4' inhibited the development of *M. arenaria* populations and *M. arenaria* was capable of breaking resistance in 'NC 95' to *M. incognita*. Department of Plant Pathology and Physiology, Clemson University, Clemson, SC 29634-0377.

THOMAS, S.H., and J.L. SAUNDERS. Joint influences of cultivation, residue incorporation and pesticides on nematode populations under tropical maize monoculture.

Numbers of nematodes associated with maize monoculture in Costa Rica were monitored 45 and 75d after planting during the seventh and eighth consecutive corn crops. The experiment compared plowed with uncultivated plots receiving three levels of maize residue incorporation. Each plot also received a soil insecticide/nematicide (carbofuran), a foliar insecticide (carbaryl), or no early season insect protection. Numbers of *Helicotylenchus dihystrera* and *Pratylenchus zeae* recovered from soil were greatest in plots treated with carbofuran, but numbers of *P. zeae* from maize roots were lowest from these plots. Incorporation of crop residue influenced soil populations of *H. dihystrera* and *P. zeae* more than plowing, but recovery of *P. zeae* from roots was affected by both cultural practices, with greatest numbers occurring in plowed plots from which residue was removed and lowest numbers occurring in unplowed plots. Department of Entomology and Plant Pathology, Box 3-BE, New Mexico State University, Las Cruces, NM 88003; Centro Agronomico Tropical de Investigacion y Ensenanza, Turrialba, Costa Rica.

TODD, T.C. and N.A. TISSERAT. Relationships between nematode densities and damage to bentgrass golf greens in Kansas.

Nematode populations were altered in replicated plots on separate bentgrass greens during June, 1984 and 1985 by application of ethoprop (0.5 lb ai/1,000 ft<sup>2</sup>), fenamiphos (0.2 and 0.5 lb ai/1,000 ft<sup>2</sup>), or isophenphos (0.05 lb ai/1,000 ft<sup>2</sup>). Turf quality was monitored on the greens and plant growth was estimated by dry-weight accumulations of grass clippings collected from 10-cm-diameter plugs removed from each plot and placed in the greenhouse for 2 months. Mid-season nematode populations/100 cm<sup>3</sup> soil (treatment averages) ranged from 950-2,600 *Criconebella ornata* and 27-1,210 *Helicotylenchus pseudorobustus* in 1984 and 6,525-13,650 *C. ornata*, 0-207 *H. pseudorobustus*, and 168-798 *Hoplolaimus galeatus* in 1985. Grass clipping weights were negatively correlated ( $p < 0.05$ ) with *C. ornata* densities during both years and *H. galeatus* densities in 1985, while turf quality ratings were only correlated with populations of *H. galeatus*. Regression analysis predicted that unacceptable turf quality (10% of turf area affected) would occur at a midseason population density of 350 *H. galeatus*/100 cm<sup>3</sup> soil. Department of Plant Pathology, Kansas State University, Manhattan, KS 66506.

VRAIN, T.C., AND R.J. COPEMAN. Antagonistic and synergistic interactions of *Agrobacterium tumefaciens* and *Pratylenchus penetrans* in raspberry roots.

The crown gall disease on roots of red raspberries has recently become a concern in British Columbia, since new high yielding cultivars have been found quite susceptible and the frequent association in the fields of high densities of *Pratylenchus penetrans* with the galls of *Agrobacterium tumefaciens* suggests a possible role of the nematode in the bacteria infection process. Two raspberry cultivars Skeena and Willamette were infected with root lesion nematodes and crown gall bacteria in concomitant, serial or spatially separated inoculations. Plant height, foliage and root weight of Skeena were reduced by the bacteria. The number of galls increased with each level of nematode infection, and when the nematodes were inoculated 3 weeks before the bacteria. Nematode densities per g of roots or per root system were reduced when galls were numerous in the roots. However the split root experiment did not show significant effects of the bacteria and nematodes on each other. Agriculture Canada Research Station, Vancouver, B.C. V6T 1x2, and University of British Columbia, Vancouver, B.C. V6T 1X2.

WINDHAM, G. L., and K. R. BARKER. Spatial and temporal interactions of *Meloidogyne incognita* on soybean.

The spatial and temporal population dynamics of *Meloidogyne incognita* (MI), as related to 'Lee 68' soybean shoot and root growth, were determined over a growing season in microplots in a Fuquay sand. Initial nematode populations were 0, 1250, 5000, 10,000, and 20,000 eggs/500 cm<sup>3</sup> of soil. Plant growth and nematode reproduction were determined biweekly for 18 weeks and then at ca. 3-week intervals for the last two harvests. Soil cores 5.1 cm d were collected at 0, 10, and 20 cm from the row and split into 0-15, 15-30, and 30-45 cm for nematode assay and root extraction. Highest numbers of juveniles and eggs were recovered from mid to late-season and were associated with periods of high soil moisture. Greater numbers of juveniles and eggs were found in the upper 30 cm in the row and the upper 15 cm at 10 and 20 cm from row center. Maximum shoot-growth differences caused by MI occurred at or near the final harvest. Crop Science Research Laboratory, USDA, ARS, P. O. Box 5367, Mississippi State, MS 39762; Department of Plant Pathology, North Carolina State University, P. O. Box 7616, Raleigh, NC 27695-7616.

YOUNG, L.D., AND E.E. HARTWIG. Effects of Soybean Cropping Sequences on Race Development of the Soybean Cyst Nematode.

In 1976, a management study was initiated in a field in which high populations of soybean cyst nematode (SCN) developed on 'Tracy' a susceptible cultivar and very few nematodes developed on 'Centennial', a cultivar resistant to race 3. Tracy and Centennial were grown continuously, in a sequence of 2 years of Centennial and 1 year of Tracy, and in a blend of 80% Centennial and 20% Tracy for 10 years. A breeding line resistant to races 3 and 4 was also grown. In 1985, 'Lee', 'Pickett 71', 'Peking', PI 88788, and PI 90763 soybeans were grown in soil from each of these plots to determine the predominant SCN race present following each cropping sequence. Female indices (% of females compared to Lee) were calculated for these race differentials. SCN populations following the breeding line resistant to races 3 and 4 and continuous Tracy were SCN race 3. Populations following the other cropping sequences did not fit any of the five designated races; all had indices on Pickett 71 greater than 63. There were no significant differences between indices for continuous Centennial and the sequences of Centennial and Tracy. USDA, ARS, 605 Airways Blvd., Jackson, TN 38301; USDA, ARS, Box 196, Stoneville, Ms 38776.

# DISCUSSION TOPICS

DUNCAN, L.W. Intrinsic and extrinsic factors related to nematode overwinter survivorship.

Nematode overwinter survival rates declined with increasing preoverwinter population levels in reported field studies. Laboratory measurements indicate that nematode egg hatch rates and juvenile motility may be inversely related to parental population density with respect to food source. During an 8-month field survey, variation in survival rates of Tylenchulus semipenetrans were best explained when preoverwinter population levels were measured per unit soil volume. However, density dependent growth rates for T. semipenetrans were best described when populations were measured in terms of food availability as nematodes/g root. These trends suggest that the abundance of nematodes in the soil may be more important in overwinter survival than the quality of food source prior to overwintering and that rhizosphere antagonists may be key factors in nematode overwinter mortality. University of Florida, IFAS, Citrus Research and Education Center, 700 Experiment Station Road, Lake Alfred, FL 33850.

GOODELL, P.B. Correlative vs. explanatory models for overwinter survival of root-knot nematodes.

Overwinter survival models for root-knot nematodes have been analytical. In particular, correlative models have been developed which regress percent nematode survival against time. Such models are restricted in their application to the environmental conditions under which the models were developed. In contrast, explanatory models incorporate more of the nematode's biology and may be more appropriate for overwinter simulations. Explanatory models generally require more environmental inputs and therefore better reflect the influence of the broader environment. While explanatory models are more difficult to develop than analytical models, they can result in more general application to field situations. Cooperative Extension, Bakersfield, CA 93303

HEALD, C.M. Nematology as a component of IPM of vegetables

Nematode management can be a vital component of a vegetable IPM program. Crop rotation and the use of resistant varieties play an important role in nematode population management. The nematode species in question dictates the cropping sequence. Fallowing and weed control are additional useful tools in the control program. The use of nematicides can be reduced significantly and in some cases omitted from the cropping scheme in a well planned IPM program. When necessary, systemic pesticides may be used that reduce populations of certain insects and nematodes. Plant Health and Stress Physiology Research Laboratory, P. O. Box 267, Weslaco, TX 78596.

HENRY, HERBERT M., Ph.D. Opportunities for Employment as Private Agricultural Consultants and Researchers.

Agricultural trends indicate a continuing increase in the number of larger farms at the expense of the family farm. As farm size increases there is a growing need for innovative technology in these large agricultural production units. There is, consequently, an increased demand for highly trained and experienced independent crop consultants--agricultural consultants with a diverse background in total crop production. The ideal crop consultant's resume should include training and experience in weed science, agronomy, entomology, plant pathology, nematology, communication skills, business management, as well as the basic building blocks in chemistry, physics, and ecology. Generally, the broader one's background in academic training and experience, the more opportunities there are in the private agricultural sector. The specialist in nematology may find opportunities with private agricultural labs. Henry Agri-Scientific, 2180 Elder Rd., Bishop, GA 30621.

MacGUIDWIN, A.E. Overwinter mortality of *Pratylenchus* spp. - who, what, when, and where.

The increasing use of fall fumigation in Wisconsin has renewed interest in the overwinter survival of *Pratylenchus* spp. Census data were collected from indigenous *Pratylenchus* populations occurring in the sandy loam soils of central Wisconsin to assess nematode mortality from harvest until planting. All life stages of *Pratylenchus* were found during the winter months, but the age distribution differed between populations associated with potato or corn. Laboratory studies indicate that mortality at subzero temperature is due to ice crystallization. Nematodes associated with both potato and corn occurred primarily in the top 30 cm of soil, were evenly distributed between soil and root fragments, and did not migrate vertically prior to or after temperatures fell below 10C. Most mortality occurred before or at the onset of freezing temperatures. Department of Plant Pathology, University of Wisconsin-Madison, Madison, WI 53706.

ROBERTS, P.A. Chemical and nonchemical control of vegetable nematodes.

Selection of a control strategy is often determined by factors that make the selection inappropriate from a strictly nematological perspective. Nematode-crop problems are used to illustrate practical and economic constraints of control options for nematode management in vegetables.

- 1) *Meloidogyne incognita* in processing tomato, controlled with preplant soil fumigation (soil condition and cost constraints) or resistant cultivars (cultivar preference for processing contract constraint).
- 2) *Heterodera schachtii* in beets, cole crops and spinach, controlled with preplant soil fumigation (soil type, soil condition and cost constraints), nonfumigant nematocides (effective only on light to moderate population levels), and (or) rotation (economic constraints of alternate nonhost crops).
- 3) *Ditylenchus dipsaci* in garlic, controlled with seed-dip disinfection (practical constraint) in conjunction with rotation to nonhost crops. Department of Nematology, University of California, Riverside, CA 92521.

STARR, J. L., and M. J. JEGER. Egg viability and winter survival of *Meloidogyne* spp.

Eggs of *Meloidogyne* spp. constitute approximately 90% of the total population present in the soil at the time of harvest of annual crops. Numbers of eggs decline rapidly during the winter months due to hatch and normal mortality; however, some viable eggs may persist for five to six months. Egg hatch during the winter months increases the population of juveniles present and partially offsets the decline in numbers of juveniles due to juvenile mortality. Factors which appear to affect egg viability include a density dependent viability factor, time of egg production, and presence of egg parasites. Department of Plant Pathology and Microbiology, Texas Agricultural Experiment Station, College Station, TX 77843.