RESUMENES DE LA XXXI REUNION ANUAL DE ONTA
ABSTRACTS OF THE XXXI ANNUAL MEETING OF ONTA
16-20 APRIL (ABRIL) 2000, AUBURN, ALABAMA, U.S.A.

EVALUACIÓN DE LA TOLERANCIA DE PORTAINJERTOS DE VID AL NEMATODO DE LOS CÍTRICOS, *TYLENCHULUS SEMIPENETRANS*, EN CHILE [TOLERANCE EVALUATION OF GRAPE ROOSTOCKS TO CITRUS NEMATODE, *TYLENCHULUS SEMIPENETRANS*, IN CHILE]. E. Aballay y A. Navarro, Facultad de Ciencias Agronómicas, Departamento de Sanidad Vegetal, Universidad de Chile, Casilla 1004, Santiago, Chile.—El nematodo de los cítricos, *Tylenchulus semipenetrans* es una especie que se encuentra distribuida en una amplia zona de la superficie cultivada con vides (*Vitis vinifera* L.), tanto para producción de uva de mesa como para elaboración de vinos. La vid en Chile se cultiva principalmente sobre su propio pie, sin embargo ante la presencia de nematodos fitoparásitos, se han desarrollado programas de evaluación de resistencia de portainjertos a *Xiphinema* spp. y *Meloidogyne* spp pricipalmente, con poca atención a otras especies. La investigación se desarrolló en un predio que presentaba una infestación natural con *T. semipenetrans*, estableciendo los portainjertos Harmony, O 39-16, K 5BB, 420 A, 110 R, C 1613, Ramsey, SO4 y Cabernet Sauvignon, esta última como testigo. Las plantas se establecieron en 1994, en un sector de replante de vides y la evaluación del desarrollo de las poblaciones de nematodos se realizó durante 1998/1999, observándose diferencias importantes en las tasas de reproducción entre los diferentes tratamientos.

THE USE OF *HETERORHABDITIS* SPP. FOR WHITE GRUB CONTROL [USO DE *HETERORHABDITIS* SPP. PARA EL CONTROL DE GALLINA CIEGA]. R. Alatorre-Rosas, and M. A. Hernández-García, Instituto de Fitosanidad, Colegio de Postgraduados, Mexico, Montecillo, Edo Mexico, 56230.—The Scarabaeidae commonly known as white grubs constitute a serious problem for diverse crops of economic importance in Mexico. Two experiments were carried out to evaluate the effectiveness of *Heterorhabditis bacteriophora* and *H. indicus* under greenhouse conditions on larvae (1.0 to 1.5 g) of *Cyclocephala* sp. and *Phyllophaga vetula*. The tests were carried out in small pots with 88 g of soil (30% sand, 25% silt, 45% clay), two seeds of corn and a white grub larva. Each experimental unit was inoculated with 10 000 or 30 000 infective juveniles (IJ). There were 20 experimental units, four replicates per insect and nematode species, and pots were arranged in a randomized complete block design. *Cyclocephala* sp. at 10 000 IJ showed high susceptibility to *H. bacteriophora* (88.8%) and *H. indica* (93.1%); however, in the case of *P. vetula* the mortality was low (26.6%). With 30 000 IJ of *H. indica*, the mortality of *P. vetula* increased (76.0%). In both species of white grubs, the nematodes were unable to reproduce. Soil type and the insect species play an important role in the establishment of nematodes in the white grub environment.

TM-425 (METHYL IODIDE): DEVELOPMENT AND REGULATORY STATUS AS A METHYL BROMIDE REPLACEMENT IN STRAWBERRIES AND TOMATOES [TM-425 (IODURO DE METILO): DESARROLLO Y REGULACIÓN COMO SUBSTITUTO DE BROMURO DE METILO EN FRESAS Y TOMATES]. M. A. Allan, and C. T. Schiller, Tomen Agro Inc., 100 First St., Suite 1700, San Francisco, CA 94105, U.S.A.—TM-425 (active ingredient: methyl iodide) is a broad-spectrum fumigant applied to soil for control of various fungal, nematode and weed species in strawberry and fresh market tomato production acreage. Pre-plant applications are made with tractor mounted injection equipment on flat ground or into prepared plant beds. Early field efficacy studies conducted in California and Florida support use rates of 120-235 lbs of product per treated acre dependent upon target pest organism(s). Regulatory meetings with Federal EPA and California Department of Pesticide Regulations (CDPR) indicate TM-425 as a drop-in replacement for methyl bromide will be given top priority with an accelerated review process pending all toxicological and residue data outcome. Tomen Agro's target for submission is 1st quarter 2002 with potential Section 3 registration by 1st quarter 2003.

BIOLOGICAL AND MOLECULAR VARIATION IN POTATO CYST NEMATODE (*GLOBODERA PALLIDA*) [VARIATIÓN MOLECULAR Y BIOLÓGICA DEL NEMATODO ENQUISTADO DE LA PAPA (*GLOBODERA PALLIDA*)]. M. R. Armstrong, V. C. Blok, M. S. Phillips, and D. L. Trudgill, Scot-

tish Crop Research Institute, Invergowrie, Dundee, DD2 5DA, UK.—The white potato cyst nematode (wPCN; *Globodera pallida*), introduced into the UK from the Andes, now occurs in the majority of ware potato fields. Different "pathotypes" were described in the 1970's based on virulence differences on potato clones with partial (quantitative) resistance. We postulated in the 1980's that these virulence differences derived from initial founder effects and/or from genetic drift associated with subsequent spread within the UK. However, virulence tests and RAPD analyses of fragmented (inbred, single cyst lines) and unfragmented populations, and studies on the ITS region of ribosomal DNA, all suggested that UK populations are heterogeneous, possibly due to mixing of the introduced gene pools. To identify possible distinct introductions, the mitochondrial DNA (mtDNA) of populations from Europe and South America was analysed. The mtDNA of wPCN was shown to be uniquely organised. Instead of all the mtDNA genes being grouped on a single, circular molecule of >13 000 bases, they are distributed amongst several small (c. 6000 to 10 000 bases) molecules. Considerable variation in mtDNA was observed, particularly in South America where pathotype P5A was very different. The majority of UK populations of wPCN appear to derive from a single introduction that became widely spread and fragmented. However, two UK populations that had distinct patterns of virulence were also distinguished by their mtDNA.

BIOLOGICAL AND MOLECULAR CHARACTERIZATION OF THE NORTH AMERICAN ISOLATE OF *PASTEURIA* PARASITIC ON *HETERODERA GLYCINES* [CARACTERIZACIÓN BIOLÓGICA Y MOLECULAR DE UN AISLAMIENTO NORTEAMERICANO DE *PASTEURIA* QUE PARASITA *HETERODERA GLYCINES*] N. Atibalentja, and G. R. Noel, Department of Crop Sciences, University of Illinois, and USDA, ARS, Urbana, IL 61801, U.S.A.—The life cycle and ultrastructure of a *Pasteuria* isolate that parasitizes *Heterodera glycines* in Illinois was investigated with light and transmission electron microscopy of juveniles, adults, and cysts extracted from soybean roots and rhizosphere. To determine the phylogeny of the Illinois *Pasteuria*, a 1.5-kb region of the 16S rDNA obtained from endospores was PCR-amplified, sequenced, and compared to homologous sequences of 32 other bacterial species, including the *Daphnia* endosymbiont, *P. ramosa*, and *P. penetrans*, parasite of *Meloidogyne* spp. Endospores that adhered to the cuticle of second-stage juveniles (J2) of *H. glycines* did not germinate until the J2 invaded the roots. Then, germ tubes differentiated from the endospores and penetrated into the body of the J2. The life cycle is completed only in females. Ultrastructure revealed similarities and differences between the Illinois isolate of *Pasteuria* and *P. nishizawae*, the only other *Pasteuria* known to attack *H. glycines*. Mature endospores were similar, but those of the *Pasteuria* from Illinois were larger. Also, the laminated mesosome-like bodies observed in earlier stages of the endosporogenesis of the Illinois isolate differed in nature and function from the vesicular mesosomes involved in the forespore septum formation in *P. nishizawae*. Phylogenetic analyses placed the *Pasteuria* at the base of a clade that contained *Alicyclobacillus* spp., and further showed that *P. ramosa* diverged before the speciation of nematode- infecting *Pasteuria*.

BIOFUMIGACIÓN Y CULTIVOS EXTENSIVOS [BIOFUMIGATION AND VARIOUS CROPS]. A. Bello,[1] M. Arias,[1] J. A. López-Pérez,[1] L. Díaz-Viruliche,[1] R. Sanz,[1] J. C. Ferrandiz,[2] M. A. Leal[3] y A. Martínez,[3] Dpto Agroecología, Centro de Ciencias Medioambientales, CSIC. Serrano 115 dpdo, 28006 Madrid,[1] Cooperativa Agrícola Villena, Ctra del Puerto s/n, 03440 Villena (Alicante)[2] y Horfres S. L, camino del Arahal, Villena (Alicante), España.[3]—Se analiza el uso de la materia orgánica en el control de los organismos patógenos de los vegetales, destacando el interés de la biofumigación, que se define como la acción de los gases producidos por la materia orgánica como fumigantes, que en algunos casos se ha considerado como una solarización con materia orgánica. Se ha diseñado un experimento de biofumigación con residuos de brasicas, estiércol de oveja y residuos de champiñón en un cultivo extensivo de zanahoria bajo las condiciones ambientales de los climas mediterráneos continentales, donde la aplicación de los plásticos utilizados en la solarización no son viables económicamente por la gran extensión del cultivo, y no siempre pueden alcanzarse temperaturas altas, comparándolo con

un tratamiento químico con carbofurano. Los resultados obtenidos demuestran que la biofumigación es posible en cultivos extensivos, sin aplicar plástico y sin necesidad de temperaturas altas, que la diferencia claramente de la solarización. Se confirma que esta técnica de biofumigación, sin utilización de plástico ni temperaturas altas, puede aplicarse bajo determinadas condiciones agronómicas en cultivos intensivos.

NEMATODES AND SOIL QUALITY AS FOUNDATIONS OF SUSTAINABLE DEVELOPMENT [NEMATODOS Y CALIDAD EDÁFICA COMO BASE PARA DESARROLLO SUSTENTABLE]. G. W. Bird, M. F. Berney, and R. R. Harwood, Dept. of Entomology and Dept. of Crop & Soil Science, Michigan State University, East Lansing, MI 48824, U.S.A.—Taxa of the phylum Nematoda will be reviewed in relation to their ecosystem functions as bacterivores, fungivores, carnivores, algivores, omnivores and herbivores. This will be followed by an overview of the concept of soil quality: *ability to accept, hold and release nutrients and other chemical constituents; accept, hold and release water to plants, streams and groundwater; promote and sustain root growth; maintain suitable soil biotic habitat; respond to management and resist degradation.* Literature on the impacts of soil quality attributes (organic matter, water-holding capacity, water infiltration rate, texture, microbial biomass, nutrient mineralization, structure-bulk density, nutrient availability and release, pH, and balanced biotic diversity) on nematode function and dynamics will be discussed. A conceptual model of the role of nemtodes in soil organic matter dynamics will be presented in relation to the utility of nematodes as indicators of soil quality. The presentation will conclude with a discussion of mechanistic and ecological world views as they relate to sustainable development, soil quality and the phylum Nematoda.

IMMUNOCYTOCHEMICAL LOCALIZATION OF ADHESINS IN *PASTEURIA* SPP. [LOCALIZACIÓN INMUNOCITOQUÍMICA DE ADHESINAS EN *PASTEURIA* SPP.]. J. A. Brito,[1] J. F. Preston,[2] D. W. Dickson,[1] R. M. Giblin-Davis,[1] D. S. Williams,[2] C. Aldrich,[2] and V. P. Campos,[3] Department of Entomology and Nematology, University of Florida,[1] Department of Microbiology and Cell Biology, University of Florida, Gainesville, FL 32611, U.S.A.,[2] and Universidade Federal de Lavras, 37200 Lavras, MG, Brazil.[3]—An IgM monoclonal antibody that was selected on the basis of its ability to block the attachment of *Pasteuria penetrans* (P20 isolate), and to recognize an epitope shared on several polypeptides separated by SDS-PAGE was able to follow the appearance of adhesins during sporogenesis and to follow their distribution during the development of P-20 in previous studies. This IgM was used to detect and to localize the adhesins in two species of *Pasteuria* (soybean cyst *Pasteuria* and sting *Pasteuria* [S-1]), three undescribed species of *Pasteuria* (lance *Pasteuria* [L-1 and LS-1]), ring *Pasteuria* (C-1), and one *P. penetrans* isolate (P-1). TEM was used to exam thin sections of *Pasteria* infected nematodes. Nematodes were fixed, dehydrated, and embedded in LR White resin. Sections were labeled with anti-P-20 IgM and anti-mouse IgM conjugated with colloidal gold, and post stained with uranyl acetate and lead citrate. Antigens bearing the epitope were uniformly distributed in the sporangium, and exosporium, but not in the parasporal fibers. This suggests that the epitope that was recognized by the IgM in P-20 isolate is shared among other species of *Pasteuria.* Based on these studies and previous studies this epitope is unique to species of *Pasteuria.*

RESISTANCE IN POTATO TO MULTIPLE RACES OF POTATO CYST NEMATODES [RESISTENCIA DE LA PAPA A MULTIPLES RAZAS DEL NEMATODO ENQUISTADO DE LA PAPA]. B. B. Brodie, and R. L. Plaisted, USDA, ARS and Department of Plant Breeding, Cornell University, Ithaca, NY 14853, U.S.A.—Potato cyst nematodes (PCN) are composed of two species consisting of several races each. Although only race R_1A (Ro1) of *Globodera rostochiensis* was known to occur in the United States, a program was initiated to breed for resistance to exotic races of PCN to guard against the introduction or emergence of new races. Seeds from crosses of *Solanum tuberosum* ssp. *andigena, S. tuberosum* spp. *tuberosum* and *S. vernei* segregating for resistance to *G. pallida* races P_4A and P_5A were obtained from the International Potato Center. The progeny of this population was crossed with neotuberosum

x *S. tuberosum* hybrids and resultant selections were backcrossed to two commercial cultivars with resistance to *G. rostochiensis* race R_1A. Selections from these crosses were either intercrossed or crossed to a neotuberosum clone that possessed resistance to potato viruses (PVY) and late blight. The resultant progeny was evaluated in New York for resistance to *G. rostochiensis* races R_1A and R_2A (Ro2) and in Bolivia for resistance to *G. pallida* races P_4A (Pa2), P_5A (Pa3), and P_6A. Of the five clones selected from these crosses, three were resistant to *G. rostochiensis* races R_1A and R_2A, one was resistant to *G. rostochiensis* R_1A and R_2A and *G. pallida* races P_4A and P_5A, and one was resistant to the two races of *G. rostochiensis,* races P_4A, P_5A and P_6A of *G. pallida,* late blight, and PVY. The latter clone with multiple resistance is now being considered for cultivar release.

CAN WE CONTROL SOYBEAN CYST NEMATODE BY CONTROLLING HATCHING? [PODEMOS CONTROLAR EL NEMATODO ENQUISTADO DE LA SOYA CONTROLANDO LA ECLOSIÓN?]. B. Burgwyn, E. Kay, G. Brown, and R. I. Bolla, Department of Biology, Saint Louis University, St. Louis, MO 63103-2010, U.S.A.—The largest percentage of annual loss of soybean crop yield can be directly attributed to soybean cyst nematode. As the availability of effective nematicides decreases, the methods of management decrease. One of the most effective methods is crop rotation and planting of resistant varieties; however, this method is not highly efficient. Recent information suggests that a significant proportion of soybean cyst nematode eggs may remain in time mediated dormancy for more than five years. In this way nematode populations efficiently survive the planting of non-host cover crops. We proposed that one approach to management would be to understand the molecular genetics of embryogenesis and hatching of soybean cyst nematode so that we could promote either premature hatching or hold eggs in a permanent state of dormancy. This requires that we know the genes involved in the hatching response. Using $ZnCl_2$ as a hatching stimulator, we identified a series of genes unique to hatching. One gene is homologous to *hch-1* from *Caenorhabditis elegans.* This gene has several proposed roles in embryogenesis and hatching. We have affirmed the presence of this gene in SCN and several other cyst nematode species and have determined the timing of transcription of one of its domains during embryogenesis.

THE EFFECT OF ALTERNATIVE TREATMENTS AS ME.BR. SUBSTITUTES FOR NEMATODE CONTROL IN DIFFERENT CROPS: 1998-1999 [EFECTO DE LOS TRATAMIENTOS ALTERNATIVOS AL BR.ME COMO SUBSTITUTOS PARA EL CONTROL DE NEMATODOS EN DIFERENTES CULTIVOS]. L. Calderón, F. Solís, E. Trabanino, E. Barillas, and E. García, ICTA, UNIDO, CONAMA, CONCYT, IPM CRSP, Guatemala.—In accordance to the Montreal protocol trials were performed to evaluate alternatives to the use of methyl bromide to protect the Ozone layer. Seed beds were used for tomato, cabbage and broccoli. Physical treatments for soil used were water vapor, solarization, floating trays, and organic composting. Chemical treatments were metham sodium, Basmid and MeBr. In addition, solarization was combined with other options. The best treatment for reduction of nematode populations and reduction in root damage were floating trays, biofumigation, steam, Basamid and the combination of solarization with the chemical products. Under the study conditions, it is possible to substitute other methods for the use of MeBr for nematode control.

REGRESSION ANALYSIS OF PEST CONTROL FUNCTIONS FOR ECONOMIC EVALUATION [ANÁLISIS DE REGRESIÓN DE FUNCIONES DE CONTROL DE PLAGAS PARA EVALUACIONES ECONÓMICAS]. G. A. Carlson, Department of Agricultural and Resource Economics, North Carolina State University, Raleigh, NC 27695, U.S.A.—Economic evaluation of management practices in crop production systems involves modeling and estimating various biological and economic relationships. The first example illustrates the data collection and estimation procedures for cyst nematode damage equations for soybeans. This single pest, single pesticide model can directly provide coefficients for computing an economic threshold for use of the pesticide. Control of a major insect pest and root-knot nematode in tobacco with nematicides, and insecticides demonstrates the

power of regression analysis relative to analysis of variance since the latter leads to the "wrong" management decision even with 432 observations. Like the tobacco example, the third case with apples emphasizes the importance of product quality. However, this case is more complex with both current yield and tree stock to protect from diseases, insects and other pests. Regression equations were estimated for six components, as well as, an overall net return equation. Farm management, tree stock, insects, insect predators, disease level and current fruit yield are the components modeled and estimated using information from 44 orchards monitored over three years.

RESISTENCIA DE SELECCIONES DE GUAYABO (*PSIDIUM GUAJAVA* L.) AL NEMATODO AGALLADOR *MELOIDOGYNE INCOGNITA* EN EL ESTADO ZULIA, VENEZUELA [RESISTANCE OF GUAVA (*PSIDIUM GUAJAVA* L.) SELECTIONS TO ROOT-KNOT NEMATODE *MELOIDOGYNE INCOGNITA* IN ZULIA STATE, VENEZUELA]. Ana María Casassa-Padrón, Vivian Bravo, José Matheus, César González y Merylin Marín, Instituto de Investigaciones Agronómicas, Facultad de Agronomía, Universidad del Zulia, Apto. 15205, Maracaibo, (e-mail: casassae@cantv.net), Centro Hortifrutícola del Zulia-Corpozulia, municipio Mara, estado Zulia, Departamento de Botánica, Facultad de Agronomía, Universidad del Zulia, Maracaibo, Venezuela.—Se evaluó la reacción de 30 selecciones de guayabo (*Psidium guajava* L.) a *Meloidogyne incognita* raza 1 para determinar si algunos de estos materiales podrían ser usados como portainjertos resistentes al nematodo. La investigación se realizó en el vivero del Centro Hortifrutícola del Zulia-Corpozulia, ubicado en el municipio Mara del estado Zulia, Venezuela. Las plantas creciendo en bolsas plásticas con 2500 cc de suelo, fueron inoculadas con una población inicial (Pi) de 4 huevos + juveniles del segundo estado por cc de suelo. Las selecciones `LUZ-Frutícola´ 13, 14, 18 y 21 se comportaron como hospederos resistentes a la infección por *M. incognita* (Pf/Pi < 1); siendo los valores de reproducción del nematodo 0.7, 0.5, 0.9, 0.8, respectivamente; destacándose en este grupo la selección `LUZ-Frutícola´ 14 con el valor más bajo en índice de agallamiento (IA = 2.8) y la población final (Pf = 4892 nematodos/planta). Las plantas de las selecciones `LUZ-Frutícola´ 12, 15, 16, 17, 19, 20, 22, 23 y 24 se comportaron como hospederos susceptibles al nematodo. Las selecciones restantes murieron a los 60 días de la inoculación, considerándose hospederos extremadamente susceptibles.

EVALUATION OF RESISTANCE TO ROOT-KNOT NEMATODES IN SELECTED SWEETPOTATO CULTIVARS [EVALUACIÓN DE LA RESISTENCIA A NEMATODOS AGALLADORES EN CULTIVARES DE CAMOTE]. J. C. Cervantes, E. L. Davis, and G. C. Yencho, Department of Horticulture, North Carolina State University, NC 27695, U.S.A.—Five sweetpotato (*Ipomoea batatas* (L.) Lam) cultivars (Beauregard, Excel, Jewel, Hernandez, and Porto Rico) were evaluated for resistance to three root-knot nematode (*Meloidogyne*) species: *M. arenaria* (race 2), *M. incognita* (race 3) and *M. javanica*, using two different pot types in the screening process. Sweetpotato cuttings were planted in both 10-cm-size, square pots and 4-cm-diameter, cone pots containing a 3:1 sand-soil mixture. The experiment was arranged in a split plot design with pot type as the main treatment and nematode species as the subplot treatment. Cultivars were replicated five times in each subplot. Tests were conducted in three seasons: fall 1998, summer 1999 and fall 1999. Resistance response was determined based on gall index, necrosis index and number of nematode eggs per gram of root tissue. Means of the assessed indices were not significantly ($P > 0.05$) different between pot types. Necrosis and gall indices were not correlated. The resistance of the cultivars differed depending on the nematode species. 'Beauregard' was the most susceptible to *Meloidogyne*. 'Hernandez' and 'Excel' were found to be the most resistant to *Meloidogyne*. Statistically significant effects were due to cultivars and nematode species for all variables analyzed.

EVALUATION OF FOSTHIAZATE (NEMATHORIN® 10G) FOR THE CONTROL OF NEMATODES ON BANANAS IN MARTINIQUE [EVALUACIÓN DE FOSTHIAZATE (NEMATHORIN® 10G) PARA EL CONTROL DE NEMATODOS EN BANANO DE MARTINICA]. Christian Chabrier

and Jules Hubervic, CIRAD-FLHOR, BP 153, 97202 Fort-de-France, Martinique.—The efficiency of fosthiazate (Nemathorin® 10G) was evaluated against plant- parasitic nematodes on bananas in 4 field trials in Martinique. In the first trial, two doses of fosthiazate (2.0 and 3.0 g a.i./mat) were compared with aldicarb (Temik® 10G), applied at 2.0 g a.i./mat. In the other studies, fosthiazate at 1.5 and 2.0 g a.i./mat were compared with alternate applications of 3 reference nematicides: cadusafos (3.0 g a.i./mat), aldicarb (2.0 g a.i./mat) and fenamifos (3.0 g a.i./mat). The burrowing nematode, *Radopholus similis*, was the dominant species in these 3 experiments, followed by the spiral nematode *Helicotylenchus multicinctus*, while root-knot nematodes, *Meloidogyne* spp. dominated the nematofauna of the fourth trial and were present in all sites. The lance nematode *Hoplolaimus seinhorstii* was only present at one site. Results showed that fosthiazate was as effective as the reference nematicides in two trials and significantly more efficient in the two others in the control of the burrowing nematode, *R. similis*. No difference was observed in the control of *H. multicinctus* while both doses of fosthiazate induced a significantly higher reduction of infestation by *Meloidogyne* spp. and *H. seinhorstii* when present. Thanks to better prevention of fall-over, fosthiazate has increased yield up to 35% compared to reference plots.

ERADICATION OF *RADOPHOLUS SIMILIS* IN BANANA PLANTATIONS USING IMPROVED FALLOWING PRACTICES IN MARTINIQUE [ERRADICACIÓN DE *RADOPHOLUS SIMILIS* EN PLANTACIONES DE BANANO MEDIANTE PRACTICAS MEJORADAS DE BARBECHO EN MARTINICA]. Christian Chabrier,[1] Stephan De Bock,[2] Serge Marie-Luce[2] and Patrick Quénéhervé,[2] CIRAD-FLHOR, BP 153, 97202 Fort-de-France[1] and Nematology IRD, BP 8006, 97259 Fort-de-France Cedex, Martinique.[2]—Worldwide on bananas control of the burrowing nematode, *Radopholus similis*, is mainly based on nematicide applications. During the past decade in the French West Indies, alternative methods have been developed and based on i) the destruction of the infested plantations, ii) the sanitation of soils by fallow and, iii) the re-plantation with nematode-free micropropagated plants. The limit of this cropping system is in the quality of the fallow. In the past, the former banana plantations were destroyed mechanically with a rom-plow or a tractor-drawn rotary spade. These machines cut the banana rhizomes into pieces which may afterwards develop ratoons and infested roots. After banana destruction, the developing flora comprised mainly the weed families Poaceae, Euphorbiaceae, Capparidaceae and Solanaceae which are known as potential reservoirs for *R. similis*. In order to improve and speed up the destruction of infested banana plants, we evaluated a chemical method of banana destruction using a stem injection of a 90 g/l solution of glyfosate. At harvest, nine months after re-plantation with nematode-free micropropagated plants, the previous chemical destruction treatment reduced drastically and significantly the rate of *R. similis* infested plants (from 12.2% on no-tillage destruction to 29.3% when followed by a tractor-drawn rotary spade tiller) compared to the 76% of infested plants on the tilled plots. This method reduced *R. similis* population density on banana roots by 93.5% (compared with standard mechanical destruction) and yields were increased by 14% during the first year of production without application of any nematicide.

EVALUATION OF SUSTAINABLE AGRICULTURAL PRACTICES FOR THE PRODUCTION OF PINEAPPLE (*ANANAS COMOSUS* L.) IN THE CARIBBEAN [EVALUACIÓN DE PRÁCTICAS DE AGRICULTURA SUSTENTABLE PARA LA PRODUCCIÓN DE PIÑA (*ANANAS COMOSUS* L) EN EL CARIBE]. J. A. Chavarría- Carvajal,[1] W. Gandía,[2] E. Rosa,[1] L. Silva-Negrón,[1] and J. L. Troche,[3] Department of Crop Protection,[1] and Department of Agricultural Economics,[3] Puerto Rico Agricultural Experiment Station, University of Puerto Rico, P. O. Box 9030, Mayagüez, Puerto Rico 00681-9030 and Puerto Rico Land Authority, Vega Baja, Puerto Rico.[2] E-mail: j_chavarria@rumac.upr.clu.edu.—The use of broad-spectrum synthetic pesticides with high toxicity and persistence has traditionally played a major role in the commercial production of pineapple in the Caribbean. However, pesticides may have several drawbacks such as the contamination of water resources and deleterious effects on non-target organisms and the environment. Local consumers and government groups are concerned

about health effects of chemicals in food and they are interested in more acceptable alternatives that are economically attractive and environmentally safe. Reducing the amount of pesticides used in pineapple production has become an important goal in Puerto Rico and elsewhere in the Caribbean. Several experiments were designed to determine the effectiveness of sustainable agricultural practices for the production of pineapple (*Ananas comosus* L., cvs. 'Cayenna lisa' and 'Española roja'). Some of these practices included the use of organic amendments, cover crops and biologically-based products. The use of poultry litter (30 tons/ha) was very effective in increasing the number of fruits when compared with the conventional chemical-based treatment. *Mucuna deeringiana*, effectively increased fruit weight and reduced soil populations of *Rotylenchulus reniformis. Crotalaria juncea* and *Tagetes* spp., significantly increased the percentage of vitamin C in the fruit. Some treatments not only increased fruit quality, but the pineapple yield was very close or superior to that obtained with the standard chemical treatment. Results from this research show promise and may serve as a basis to find new alternatives for the commercial production of pineapple in the Caribbean.

USE OF POULTRY LITTER AND SEWAGE SLUDGE COMPOST FOR THE MANAGEMENT OF PLANT-PARASITIC NEMATODES ON PLANTAIN [USO EMIENDAS DE DESECHOS DE GRANJAS POLLERAS Y LODO DE DRENAJE PARA EL MANEJO DE NEMATODOS PARÁSITOS DEL PLÁTANO]. J. A. Chavarría-Carvajal, L. F. Osorio, L. Silva-Negrón, and E. Rosa, Department of Crop Protection, Puerto Rico Agricultural Experiment Station, University of Puerto Rico, P. O. Box 9030, Mayagüez, Puerto Rico 00681-9030. E-mail: j_chavarria@rumac.upr.clu.edu — Accumulation of solid wastes from human activities and agro-industries is a serious problem in Puerto Rico that represents an environment hazard and leads to significant pollution of soils, waterways, and lakes. The proper use and disposal of these materials in agricultural soils, to obtain biological control of phytonematodes, could be a useful solution to this problem. The effects of poultry litter and sewage sludge compost were evaluated in separate experiments for the management of plant-parasitic nematodes on plantain (*Musa acuminata* × *M. balbisiana*) cv. 'Maricongo'. The amendments were applied to nematode-infested soils at rates of 0, 10, 20, 40 and 80 g/kg soil. A treatment with phenamiphos at 1.5 g a.i/plant was also included. Pots were maintained moist in a greenhouse (25-30°C) for two weeks before planting. The experiments were continued for 20 weeks and harvested 22 weeks after treatment. Post-harvest soil and root samples were analyzed, and the number of plant-parasitic nematodes associated with the soil and root tissue were determined. The use of poultry litter at rates of 80, 40 and 20 g/kg soil, respectively, was very effective in reducing root populations of plant-parasitic nematodes (*Radopholus similis, Pratylenchus coffeae, Meloidogyne incognita, Rotylenchulus reniformis,* and *Helicotylenchus* spp.) when compared with the rates of 0 and 10 g/kg soil and phenamiphos. Sewage sludge was not as effective as poultry litter for the management of phytonematodes; however, this amendment at the higher rate (80 g/kg soil) significantly reduced populations of *R. similis* and *P. coffeae* in root tissue.

ULTRASTRUCTURE OF ENDOSPORE ATTACHMENT OF *PASTEURIA PENETRANS* TO *MELOIDOGYNE* SPP. [ULTRAESTRUCTURA DE LA ADHESIÓN DE LA ENDOSPORA DE *PAUSTERIA PENETRANS* A *MELOIDOGYNE* SPP.]. Z. X. Chen, and D. W. Dickson, Entomology and Nematology Department, P. O. Box 110620, University of Florida, Gainesville, FL 32611-0620, U.S.A. Current Address of the First Author: Pest Pros Inc., P. O. Box 188, 10086 1st Street, Plainfield, WI 54966, U.S.A.— *Pasteuria penetrans* is an endospore-forming bacterium that has shown great promise in biological control of root-knot nematodes. The attachment of endospores to the cuticle of second-stage juveniles of *Meloidogyne* spp. is a prerequisite of establishing the host-parasite relationship. The objective of this study is to investigate the ultrastructure of the endospore attachment using transmission electron microscopy. Morphological changes of the endospore and nematode cuticle were observed during the attachment. The hollow cup at the base of the endospore was flattened slightly and filled with the raised nematode cuticle. To quantify this phenomenon, is defined as the angle between the horizontal line passing the endospore center and the line connecting the tip of the parasporium

to the endospore center. It is 25-30° when endospores are not attached, and 20-24° when they are attached to the nematode cuticle. The nematode cuticle is raised approximately 0.3 µm, filling up the basal cup of the endospore. Endospores attached to nematodes can partially attach to another endospore. This, however, further reduces the angle α to 13°. A new attachment mechanism is subsequently proposed, which involves the physical flexibility of both the endospore parasporium and the nematode cuticle. The unusual morphology of the endospore is a perfect design for attachment, fixture, proper orientation, and parasitism.

DIAGNOSTIC MORPHOLOGICAL CHARACTERISTICS OF *MELOIDODERA* SPECIES FROM MEXICO [CARACTERÍSTICAS MORFOLÓGICAS DE DIAGNÓSTICO DE ESPECIES DE *MELOIDODERA* DE MÉXICO]. I. Cid del Prado Vera, Department of Plant Pathology, Colegio de Postgraduados, 56230, Mexico State, Mexico.—Most of *Meloidodera* species in the world have been found in tree hosts in Mexico during the last ten years. Three species, *M. zacanensis*, *M. mexicana* and *Meloidodera* sp., one from *Crataegus mexicana* tree and the last two from *Capsicum annuuum* and *Solanum rostratum,* have been detected. These species have distinct morphological characters in males and second stage juveniles (J2); males have cuticular blocks in the lip region in regular or irregular disposition; lateral field with four incisures and completely aerolated. J2 vary in head annuli from 2 to 4; phasmids are lens or pore-like in shape; tails are varied in shape, being conical with round to acute terminus. Mature females are spherical to pyriform in shape with or without capsule formed by the old cuticle, fungi and collapsed host tissue. The three species induce in their host a uninucleate giant cell.

ÁREA BAJO LA CURVA DEL PROGRESO DE LA ENFERMEDAD DEL AGALLAMIENTO RADICAL EN TOMATE (*LYCOPERSICON ESCULENTUM* MILL.) OCASIONADA POR *NACOBBUS ABERRANS* [AREA UNDER THE PROGRESS CURVE OF ROOT-KNOT DISEASE IN TOMATO (*LYCOPERSICON ESCULENTUM* MILL.) CAUSED BY *NACOBBUS ABERRANS*]. J. Cristóbal-Alejo,[1] I. Cid del Prado-Vera,[1] R. H. Manzanilla-López,[1] N. Marbán-Méndoza,[2] G. Mora-Aguilera[1] y P. Sánchez-García,[1] Colegio de Postgraduados, Km 36.5 Carretera México-Texcoco, Montecillo, México, 56230[1] and Departamento de Parasitología Agrícola, Universidad Autónoma Chapingo, Km 38.5 Carretera México-Texcoco, México, 56100.[2]—Como parte de un programa de Manejo Integrado de *N. aberrans* (MIT) en tomate *cv.* Río Grande, se calculó el balance óptimo nutricional del cultivo y se evaluó conjuntamente el efecto de los siguientes tratamientos: 1. Siete kg de EtoprofosÒ al 68% al momento del transplante y la incorporación de pollinaza (10 ton/ha) a los 30 días del transplante. 2. Testigo regional (TR), manejado con las prácticas locales. 3. Testigo absoluto (TA). Las variables respuestas evaluadas fueron: Altura de planta, peso y volumen radical, número de agallas y número de estadios del nematodo (suelo y raíz). Los tratamientos se establecieron bajo un diseño de bloques al azar durante el ciclo primavera-verano de 1999 y las evaluaciones se realizaron cada diez días por un período de 80 días. Con las variables número de agallas y hembras/g de raíz se elaboraron modelos epidemiológicos utilizando el Area Bajo la Curva del Progreso de Enfermedad. De acuerdo a ésta, existieron altas diferencias significativas (P = 0.001) en la variable del número de agallas, la cual fue menor en el MIT. Los TA y TR fueron iguales después de los 80 días posteriores al transplante. En cuanto al número de hembras por gramo de raíz, el mayor número se encontró en el TA, seguido del TR y MIT.

PROFITABILITY OF CROPPING AND NEMATICIDE SYSTEMS IN NORTHEASTERN FLORIDA [RENTABILIDAD DE SISTEMAS DE CULTIVO Y NEMATICIDAS EN EL NORESTE DE FLORIDA]. W. T. Crow,[1] D. P. Weingartner,[2] and D. W. Dickson,[3] Texas A&M University-Dallas, Dallas TX 75252,[1] Research and Education Center, Hastings FL 32145,[2] and Entomology and Nematology Department, Gainesville, FL 32611, U.S.A.[3]—Management of plant-parasitic nematodes is critical to the economic production of both potato (*Solanum tuberosum*) and cotton (*Gossypium hirsutum*) in northeastern Florida. An experiment was conducted for 2 years to identify cropping and nematicide appli-

cation systems that would maximize potential profit to growers. Cropping systems were: winter potato followed by summer sorghum-sudangrass, winter potato followed by summer velvetbean, cotton in monoculture, potato and sorghum-sudangrass rotated with cotton, and winter potato double-cropped with summer cotton. Nematicide treatments were aldicarb, 1,3-dichloropropene (1,3-D), and untreated. Yield data were used to calculate the gross profit/ha for each treatment. Fumigation with 1,3-D increased profit of potato followed by sorghum-sudangrass from $3 604/ha to $8 200/ha. Highest profit ($12 241/ha) was attained with double-cropping when 1,3-D was applied to potato and aldicarb to cotton. Lowest profit ($412/ha) was attained with double-cropping when both crops were untreated. Neither potato followed by velvetbean, cotton in monoculture, or rotation of potato and cotton increased profit over potato followed by sorghum-sudangrass.

USO DE ENMIENDAS ORGÁNICAS Y EXTRACTOS ACUOSOS PARA EL CONTROL DE *MELOIDOGYNE INCOGNITA* EN VENEZUELA [USE OF ORGANIC AMENDMENTS AND PLANT EXTRACT FOR CONTROL OF *MELOIDOGYNE INCOGNITA* IN VENEZUELA]. R. Crozzoli y K. González, Universidad Central de Venezuela, Facultad de Agronomía, Instituto de Zoología Agrícola, Apdo. 4579, Maracay 2101-A, Venezuela.—Se evaluó, en umbráculo, el efecto nematicida del corocillo (*Cyperus rotundus*), algodón de seda (*Calotropis procera*) y leucaena (*Leucaena leucocephala*) sobre diferentes poblaciones iniciales [0, 0.5, 4, 16 y 64 huevos (hv) + juveniles de segundo estadio (J2)/cm^3 de suelo] del nematodo agallador *M. incognita* en plantas de tomate (*Lycopersicon esculentum*) var Rutgers. A tal efecto plantas de tomate de 30 días se trasplantaron a macetas de arcilla conteniendo 650 cm^3 de suelo franco arenoso esterilizado y previamente inoculado con raicillas y tratado con el follaje de cada planta. Éste fue aplicado al terreno como extracto acuoso o como abono verde (15 Ton/ha) para cada nivel de inóculo. Adicionalmente se incluyó un tratamiento con carbofuran 10G (3 g a.i./ha). Cada tratamiento fue repetido 8 veces y las plantas distribuidas de forma aleatoria sobre mesas. Treinta días después de los tratamientos, se pudo comprobar que la forma de aplicación (extracto acuoso o abono verde) no afecta significativamente al control del nematodo. Los mayores porcentajes de control se consiguieron en las plantas tratadas con carbofuran (hasta 88,2%) y leucaena aplicada como extracto acuoso (hasta 88,4%). El nivel de inóculo no afectó significativamente el control del nematodo por parte de los productos aplicados.

***LONGIDORUS EDMUNDSI*, FIRST RECORD OF A LONGIDORUS SPECIES IN SOUTH AMERICA [*LONGIDORUS EDMUNDSI*, PRIMER REPORTE DE UNA ESPECIE DE *LONGIDORUS* EN AMÉRICA DEL SUR]. R. Crozzoli, F. Lamberti, S. Molinari, A. Agostinelli, M. Moens, and N. Greco, Laboratorio de Nematología Agrícola, Instituto de Zoología Agrícola, Universidad Central de Venezuela, Maracay, Venezuela, Istituto di Nematologia Agraria, C.N.R., Bari, Italy and Department of Crop Protection, Agricultural Research Centre, Merelbeke, Belgium. —** Soil samples collected in December 1988 and November 1999 from the rhizosphere of coconut palms and *Coccolaba uvifera* shrubs on the beach of Cuyagua, on the Caribbean sea in northern Venezuela contained specimens of *Longidorus edmundsi* Hunt and Siddiqi. *L. edmundsi* is a bisexual species, characterized by ca. 5 mm body length, 100 µm odontostyle length, 50% V and 0.8 c'. Males possess 10 to 15 supplements and there are four juvenile development stages. Isoelectrofocusing of SOD isoforms showed five bounds. The highest SOD activity had a pI of 6.9 as in *L. elongatus* from which *L. edmundsi* differs in the position of secondary bounds. The PCR products of ITS region of *L. edmundsi* is about 1.2 kb and was digestible by ten restriction enzymes with the exception of MvaI. The occurrence of *L. edmundsi* on a beach of the Caribbean sea is not surprising since it was originally described from similar habitats in Santa Lucia and Dominica. However, this is the first record of a Longidorus species from South America.

EFFICACY OF COTTON ROOT DESTRUCTION AND WINTER COVER CROPS FOR SUPPRESSION OF *HOPLOLAIMUS COLUMBUS* [EFICACIA DE LA DESTRUCCION DE RAICES DE ALGODÓN Y COBERTURAS DE INVIERNO PARA SUPRIMIR A *HOPLOLAIMUS COLUMBUS*]. R. F.

Davis, Department of Plant Pathology, University of Georgia, Athens, GA 30602, U.S.A.—The efficacy of rye (*Secale cereale*) and wheat (*Triticum aestivum*) winter cover crops and cotton stalk and root destruction for Columbia lance nematode (*Hoplolaimus columbus*) management in cotton were evaluated in field tests during two growing seasons. The effect of removing debris following root destruction was also evaluated. Wheat and rye produced similar amounts of biomass, and both wheat and rye produced more biomass following cotton root destruction. Cover crops did not suppress *H. columbus* population levels or increase subsequent cotton yields. Cotton root destruction did not affect subsequent cotton stand or plant height. Cotton root destruction reduced ($P \leq 0.05$) *H. columbus* population levels at planting in 1996 but not in 1997; cotton yield was not increased by root destruction in either year. Removing debris following root destruction did not significantly ($P \leq 0.05$) reduce *H. columbus* levels compared to leaving debris on the soil surface. This study suggests that the potential recommendations of a rye or wheat cover crop or of cotton root destruction following harvest are ineffective for *Hoplolaimus columbus* management in cotton.

CONTROL DE *MELOIDOGYNE* EN CULTIVOS HORTÍCOLAS PROTEGIDOS [CONTROL OF *MELOIDOGYNE* IN PROTECTED VEGETABLES CROPS]. L. de León, A. Rodríguez, M. Arias and A. Bello, Dpto Agroecología, Centro de Ciencias Medioambientales, CSIC. Serrano 115 dpdo, 28006 Madrid, España.—Se plantea el trabajo ante los problemas de reducción de producción debidos a los nematodos formadores de nódulos del género *Meloidogyne* que se ven incrementados por el monocultivo, las características ambientales de los cultivos protegidos y el uso intensivo de pesticidas, entre ellos el bromuro de metilo. Se señala que el objetivo fundamental del trabajo es la selección de estrategias no químicas de control de nematodos, que sean alternativas al empleo de esterilizantes químicos del suelo, integrando aquellos factores ambientales, características de la planta y técnicas de cultivo que regulen las poblaciones de nematodos fitoparásitos, determinando su efecto sobre el suelo y la producción del cultivo. El trabajo se ha realizado en un cultivo de acelga en Tacuarembó (Uruguay) y en una rotación pepino-acelga en Villa del Prado, Madrid (España), que presentaban problemas de *M. arenaria y M. incognita* respectivamente. Previa determinación de las poblaciones de nematodos mediante su extracción por centrifugación, en Uruguay se aplicaron los cuatro tratamientos siguientes: 1. incorporación de abono verde y cubierta vegetal, utilizando *Crotalaria spectabilis*, 2. biofumigación con estiércol de vacuno, 3. tratamiento químico con dazomet y 4. testigo, cultivando acelga durante 10 meses; en España las alternativas fueron 1. compost de champiñón, 2. metan sodio, 3. bromuro de metilo y 4. testigo. Se concluye de los resultados obtenidos que es posible utilizar alternativas no químicas en el control de nematodos del género *Meloidogyne* con una eficacia similar y, en algunos casos, superior a los tratamientos químicos. La biofumigación con la incorporación de diferentes enmiendas orgánicas, y la utilización de *C. spectabilis* como abono verde abren nuevas posibilidades para el desarrollo de alternativas en el control de patógenos, con disminución de costos y mejoramiento de las características del suelo, siendo posible su aplicación en sistemas de producción integrada y ecológica.

USO DE *VERTICILLIUM CHLAMYDOSPORIUM* GODDARD EN EL CONTROL BIOLÓGICO DE NEMATODOS AGALLADORES EN ORGANOPÓNICOS [USE OF *VERTICILLIUM CHLAMYDOSPORIUM* GODDARD FOR BIOLOGICAL CONTROL OF ROOT-KNOT NEMATODE IN ORGANOPONICS]. L. Hidalgo Diaz,[1] M. A. Hernández,[1] E. del Pozo,[2] B. Kerry,[3] and Lourdes Sanchez,[1] Centro Nacional de Sanidad Agropecuarial (CENSA), Apdo 10, San José de las Lajas, Habana, Cuba,[1] Facultad de Agronomía, UNAH, San José de las Lajas, La Habana, Cuba[2] and Nematology and Entomology Dept., IACR- Rothamsted, Harpenden, Herts AL5 2JQ, UK.[3]—Diferentes medios naturales fueron evaluados para la reproducción masiva de *Verticillium chlamydosporium var. catenulatum* (Cvc-108) mediante fermentación sólida. El hongo alcanzó la mayor producción de clamidosporas sobre arroz partido (10^7 clamidosporas/g de arroz), desarrollándose un sistema de bajos insumos para su producción masiva. El producto obtenido se aplicó a razón de 10 g m^2 sobre canteros con un alto

índice de infestación por *Meloidogyne* spp., evaluando el efecto del hongo sobre las poblaciones de nematodos en una sucesión de cultivos que comprendió habichuela-acelga-tomate. A los seis meses de aplicado el hongo, se observó una reducción significativa ($p \leq 0.05$) del índice de agallamiento en el tomate y un aumento en los rendimientos comparado con el testigo. Un 69% de los huevos de *M. incognita* expuestos en la rizosfera fueron parasitados por el hongo, valor que difirió significativamente del 5% de parasitismo natural detectado en el tratamiento testigo, donde estaban presentes los géneros *Fusarium* spp. y *Paecilomyces* spp. *V. chlamydosporium* puede ser una alternativa eficiente para el manejo de *Meloidogyne* spp. en sistemas de producción intensiva de hortalizas, en las condiciones de Cuba, si se utiliza dentro de una sucesión de cultivos seleccionados atendiendo a su grado de susceptibilidad al nematodo.

ACCIÓN BIOFUMIGANTE Y MEJORANTE DE LA *MUCUNA* [EFFICACY OF BIOFUMIGATION WITH *MUCUNA*]. L. Díaz-Viruliche, J. A. López-Pérez y S. C. Arcos, Dpto. Agroecología, Centro de Ciencias Medioambientales, CSIC. Serrano 115 dpdo, 28006 Madrid, España.—Se estudia el efecto biofumigante del abono verde de mucuna (*M. deeringiana*) solo o en combinación con residuos de caña de azúcar, maíz, plátano y sorgo, así como su efecto biomejorador. Se encuentra que la mayoría de las dosis presentan una eficacia de mortandad de *Meloidogyne incognita* superior al 90%, incrementando las poblaciones de nematodos saprófagos y la nutrición de las plantas. Paralelamente, se ha estudiado, bajo microscopía electrónica de barrido, la composición de los biominerales de los abonos verdes utilizados, señalando su interés en los ciclos biogeoquímicos que tienen lugar en los agrosistemas.

BIOMINERALES Y EFECTO BIOFUMIGANTE DE LOS ABONOS VERDES, [BIOMINERAL AND BIOFUMIGANT EFFECT OF GREEN MANURES]. L. Díaz-Viruliche, A. Pinilla, J. A. López-Pérez y A. Bello, Dpto Agroecología, Centro de Ciencias Medioambientales, CSIC, Serrano 115 dpdo, 28006 Madrid, España.—Se analiza la eficacia biofumigante de diferentes abonos verdes en el control de nematodos parásitos de plantas y su acción como biomejoradores de suelos, mediante el estudio de los biominerales presentes en plantas representativas de crucíferas, cucurbitáceas, gramíneas y leguminosas. Se encuentra que la mayoría de los biofumigantes estudiados tienen una eficacia superior al 90% en el control de *Meloidogyne incognita*, incrementando las poblaciones de nematodos saprófagos, mejorando la fertilidad de los suelos y la nutrición de las plantas. Los biominerales encontrados en las plantas estudiadas se encuentran en forma de fitolitos de sílice, oxalato cálcico y carbonato cálcico, compuestos que tienen gran interés en los ciclos biogeoquímicos de los agrosistemas, confirmándose la acción biomejorante de la biofumigación.

REPRODUCTIVE VARIATION IN ISOLATES OF *ROTYLENCHULUS RENIFORMIS* [VARIACIÓN REPRODUCTIVA EN AISLADOS DE *ROTYLENCHULUS RENIFORMIS*] H. E. Domínguez, E. C. McGawley, and C. Overstreet, Department of Plant Pathology and Crop Physiology, Louisiana State University, LA 70803, U.S.A.—Populations of reniform nematode (2 from LA, 1 from AR, 1 from MS, 2 from HI, 1 from TX, and 1 from GA) from the U.S.A. were studied in greenhouse tests to evaluate reproductive variation. In the first test, two trials [86 days (trial 1) and 110 days (trial 2)] employed the NCSU host differentials used for separation of species and races of root-knot nematode. A second test (95 days) employed 5 cultivars of cotton (Deltapine 5415, Stoneville 474 and 887, Suregrow 125 and 747). Significant variation ($P \leq 0.05$) in reproduction was found among reniform populations in both tests. In trial 1, reproduction (R, where R = Pf/Pi) values on cotton ranged from a high of 125.8 for the MS population to a low of 28.2 for a LA population. R-values on tobacco ranged from 63.7 (HI) to 10.7 (LA), and from 150.0 (MS) to 35.8 (LA) on tomato. No population reproduced on peanut, pepper, or watermelon. The second trial also indicated variation in R on cotton and tomato, and values ranged from 60.8 (GA) to 13.2 (LA), and from 86.0 (MS) to 28.8 (LA), respectively. Results for tobacco in this test were opposite of those of test 1, but were the same for peanut, pepper or water-

melon. In the cotton cultivar test, R-values on STN-887 ranged from 174.8 (TX) to 38.8 (MS); on STN-474 from 205.0 (HI) to 28.2 (AR); on SG-747 from 184.7 (HI) to 29.2 (LA); on SG-125 from 144.1 (TX) to 45.3 (MS); and from 321.7 (TX) to 38.0 (MS) on DPL-4515. The HI and TX populations had R-values exceeding 100 on all cultivars (321.7-133.0). Across all 5 populations, DPL-4515 was the most suitable (321.7-TX; 260.9-HI) and the STN-474 was the least suitable (28.2-ARK) host.

COMPARISON OF *STEINERNEMA RIOBRAVE* AND AN UNDESCRIBED *STEINERNEMA* SP. FOR MANAGEMENT OF THE ROOT WEEVIL *DIAPREPES ABBREVIATUS* [COMPARACIÓN DE *STEINERNEMA RIOBRAVE* Y UN *STEINERNEMA* SP. NO DESCRITO PARA EL MANEJO DE *DIAPREPES ABBREVIATUS*]. L. W. Duncan, and Khuong Nguyen, University of Florida, Citrus Research and Education Center, 700 Experiment Station Rd., Lake Alfred, FL 33850, and Department of Entomology and Nematology, Bldg 970, PO Box 110620, Gainesville, FL 32611-0620, U.S.A.—An undescribed *Steinernema* sp. was discovered parasitizing >50% of caged, buried *Diaprepes abbreviatus* larvae in experimental plots in a citrus orchard that were established to evaluate management tactics against the weevil. The nematode is related to *S. feltiae*, *S. glaseri*, and *S. oregonense*, but differs from these species based on morphology, cross hybridization, and composition of the internal transcribed spacer regions (ITS1 and ITS2) of rDNA. The efficacy of the new nematode against *D. abbreviatus* was compared in the laboratory to *Steinernema riobrave*, which is commercially available to manage these insects. In moist sand in Petri dishes, *S. riobrave* killed *D. abbreviatus* at a faster rate than *Steinernema* sp., but cumulative mortality for both species exceeded 90% over a period of 30 days. *Steinernema* sp. exited the insect cadaver (recycled) sooner than *S. riobrave*, but it is a larger nematode and produced 35% fewer offspring than *S. riobrave*. *Steinernema* sp. moved 20 cm through sand columns in 4 days to kill 70% of buried larvae of *D. abbreviatus* compared to 15% for *S. riobrave*. *D. abbreviatus* cadavers infected by either nematode were maintained in moist sand in Petri dishes at 22-25°C to evaluate the relative persistence in soil of the two species. Live insect larvae were periodically added to the dishes. Both species killed >90% of the newly introduced insects for up to 90 days, but *Steinernema* sp. recycled in the freshly killed insects at a significantly higher rate. *Steinernema* sp. killed 100% of newly introduced insects after 210 days in the dishes, compared to 60% for *S. ribrave*. Recyling of *S. riobrave* and *Steinernema* sp. after 210 days in sand was 10% and 90%, respectively. Trials have been initiated to compare the effective persistence of the two nematodes in the field.

TURF NEMATODE MANAGEMENT EFFECTS OF THREE PRODUCTS [EFECTO DE TRES PRODUCTOS EN EL MANEJO DE NEMATODOS DEL CESPED] R. A. Dunn, Entomology and Nematology Department, University of Florida, Gainesville, FL 32611, U.S.A.—Field trials conducted near Gainesville in 1999 assessed effects of experimental materials on turf performance and nematodes associated with turf injury. All trials had four or five replications of plots 1 meter× 1 meter in a randomized complete block design. Three products tested were: Nature Safe,® a turf fertilizer based on animal processing by-products (NS in this discussion); a botanical product (CN); and Agri-50,® whose active ingredient is sodium lauryl sulfate (A-50). NS applied at recommended fertilizer rates clearly was beneficial to turf performance. Much of the observed response could have been nutritional, but repeat application of NS seemed to suppress lance (*Hoplolaimus galeatus*) and ring (*Criconemella* spp.) nematodes in one of three trials. CN showed some evidence of suppressing lance, ring, turf root-knot (*Meloidogyne graminis*), and stubby-root (*Paratrichodorus* spp.) nematodes 1 month after treatment, and three genera appeared suppressed 3 months after treatment. Minor phytotoxicity dissipated 2 weeks after treatment; high rate plots clearly surpassed control plots 3 months after treatment. Core cultivation to improve physical penetration of product into the root zone was not beneficial. A-50 applied at 1% gave mixed results in three field trials conducted May-August. A 2% solution of product reduced numbers of stubby-root and ring nematodes but did not affect turf root-knot and lance nematodes. Visual ratings were initially lower for turf receiving the highest rate of A-50, but were higher than for other plots 2 months after treatment.

DEVELOPMENT OF TELONE C-17 AND TELONE C-35 AS METHYL BROMIDE ALTERNATIVES IN FLORIDA CROPS [DESARROLLO DE TELONE C-17 Y TELONE C-35 COMO ALTERNATIVAS PARA EL BROMURO DE METILO EN CULTIVOS DE FLORIDA]. J. E. Eger, Dow AgroSciences, 4880 Bay Heron Place, #213, Tampa, FL 33616, U.S.A.—Over 100 trials have been conducted in conjunction with the University of Florida and Florida growers, since 1993 to evaluate Telone products as methyl bromide alternatives in horticultural crops. Extensive testing has been conducted with Telone C-17 (78.3% 1, 3-dichloropropene + 16.5% chloropicrin). A second formulation, Telone C-35 (61.8% 1, 3-dichloropropene + 35% chloropicrin) was developed to provide improved disease control where needed. Testing was focused primarily on tomatoes, peppers and strawberries with lesser emphasis on cucumbers, squash, melons, caladiums and other bulb crops. The primary nematode in tests to date was root-knot nematode (*Meloidogyne* spp.), although sting (*Belonolaimus* spp.) and other species were evaluated when present. The primary diseases occurring in our trials were Fusarium wilt (*Fusarium oxysporum* f.sp. *lycopersici*), Fusarium crown and root rot (*Fusarium oxysporum* f.sp. *radicis-lycopersici*) and southern blight (*Sclerotium rolfsii*). Although Telone products provide some levels of weed control, control of nutsedge (*Cyperus* spp.) with these products alone has not been equivalent to that of methyl bromide + chloropicrin. For this reason, herbicide partners are necessary where weed control is needed. Trials to date indicate that 35 gallons per treated acre of either formulation applied in the bed provides nematode and disease control equivalent to methyl bromide/chloropicrin combinations. Based on these studies, Telone products form a foundation for pest management programs which will provide suitable alternatives to methyl bromide/chloropicrin programs currently in place. Ongoing studies are focused on identification of additional herbicide partners and optimizing their use, optimizing application parameters for Telone products, and combining Telone products with other management practices such as solarization or the use of different mulch films.

COMPUTER MODELLING OF THE INTEGRATED MANAGEMENT OF *GLOBODERA PALLIDA*: A NEMATODE OUT OF CONTROL IN THE UK? [MODELO COMPUTARIZADO DEL MANEJO INTEGRAL DE *GLOBODERA PALLIDA*: UN NEMATODO FUERA DE CONTROL EN INGLATERRA?]. M. J. Elliott,[1] K. Evans,[2] M. S. Phillips,[1] J. W. McNicol,[1] S. Minnis,[3] P. Haydock,[3] and D. L.Trudgill,[1] Scottish Crop Research Institute, Invergowrie, Dundee, Scotland DD2 5DA,[1] IACR-Rothamsted, Harpenden, Herts., UK AL5 2JQ[2] and Harper Adams University College, Newport, Shropshire, UK TF1 08NB.[3] — Prior to the introduction of resistant cultivars in the 1960's, *Globodera rostochiensis* was much more widespread in England and Wales than *G. pallida*. In 1992, c. 42% of potato land was estimated to be infested with potato cyst nematodes. In 1999, a structured survey showed this had increased to 64%, of which only 8% were pure *G. rostochiensis*. To help manage this rapid increase in *G. pallida*, a computer model was developed based on data from field trials with plots containing a range of pre-planting population densities (*Pi*). Yields and multiplication were well described by density dependent equations, which incorporated functions for consistent site and cultivar differences in damage tolerance and in yield potential. The effects of differences in resistance, nematicide effectiveness, and decline rates between potato crops can also be modelled. The results show that in integrated management, nematicides are more effective when applied at a *Pi* below the tolerance threshold and that even low levels (<70%) of partial resistance can be effective when combined with a nematicide. It also shows that rates of *G. pallida* decline between potato crops greatly affect the effectiveness of rotation as a component of integrated control.

***HETERODERA CRUCIFERAE* Y *H. SCHACHTII* EN HORTALÍZAS EN ESPAÑA [*HETERODERA CRUCIFERAE* AND *H. SCHACHTII* IN VEGETABLES CROPS IN SPAIN]. M. Escuer,[1] M. Guerrero,[2] A. Cano,[2] A. Lacasa[2] y A. Bello,[1] Dpto. de Agroecología, Centro de Ciencias Medioambientales, CSIC. Serrano 115 dpdo, E-28006 Madrid[1] y Consejería de Agricultura, Agua y Medio Ambiente, C/ Mayor s/n 30.150. La Alberca (Murcia).[2]—**Se señala que el género *Heterodera* por su especificidad no produce problemas graves en los cultivos hortícolas, aunque donde los sistemas de rotación no son

adecuados y el uso del suelo es intensivo se han detectado problemas de baja rentabilidad en coles, coliflor y bróculi, causados por *H. cruciferae* en diferentes localidades de Alicante, La Rioja, Murcia y Valencia. Mientras que en acelga, la rentabilidad es reducida por *H. schachtii* en Madrid, Murcia y Navarra. Se estudia la etiología producida en bróculi por *H. cruciferae*, se señalan las diferencian morfológicas entre *H. cruciferae* y *H. schachtii* y su distribución en cultivos hortícolas en España, así como aspectos relacionados con su biología y ecología, que son de gran interés para el manejo agronómico de estos patógenos.

APPROACHES TO MEASURING MICROBIAL CONTRIBUTIONS TO SOIL SUPPRESSIVENESS BY MEASURING SOIL ENZYMES [MÉTODOS PARA EVALUAR LA ACTIVIDAD MICROBIANA Y SU CONTRIBUCIÓN EN LA SUPRESIVIDAD DEL SUELO A TRAVÉS DE ENZIMAS]. C. Fernández,[1,2] R. Rodríguez-Kábana,[1] and J. W. Kloepper,[1] Plant Pathology Department, 209 Life Sciences Building, Auburn University, AL 36849-5409, U.S.A.[1], and Current address: R + D Department, Agromillora Catalana, el Rebato s/nº, 08739 TM Subirats, Barcelona, Spain.[2]— A wide range of different studies has been conducted during the last years related to soil enzymes. Different authors have proposed soil enzymes as an index of soil fertility, an indirect method to measure microbial biomass, population levels or microbial activities, and even as pollution indicators. The effect of agronomic practices like tillage, crop rotations or organic amendment on activity of soil enzymes and the effect of pesticides on their activities have been reported extensively. More recently, different soil enzyme activities have been correlated with plant pathogen suppression. Hydrolysis of fluorescein diacetate in sphagnum peat container media has been used for predicting suppressiveness to damping off caused by *Pythium ultimum* and *P. graminicola*. This enzyme hydrolysis has been also correlated with a decrease in disease severity caused by *Phytophthora cinnamomi* in an advocado plantation. Soil urease and chitobiase activities after squash were inversely correlated with the number of galls induced by the nematode *Meloidogyne arenaria* in greenhouse conditions. Functional changes in the microbial community induced by applying a biorational nematicide in the soil have been investigated. Application of the compound increased bacterial populations and several enzyme activities (urease, protease, chitobiase, catalase and FDA hydrolysis) and also enhanced parasitism of *Meloidogyne incognita* eggs in non-autoclaved soil, indicating a role for native soil microorganisms. Different approaches can be used to investigate roles of soil or rhizosphere microorganisms in the suppression of plant pathogens. Shifts in specific functional groups of microorganisms in soil can be detected by measuring antagonistic potential of the soil to a certain pathogen, quantification of specific groups of bacteria, studying changes in microbial physiology, or determining soil enzyme activities. There is not a unique method recommended to use as an indicator of disease suppression, hence it is important to use many of them to have a better view of the mechanisms.

COMPORTAMIENTO DE PLÁNTULAS DE BANANO MICORIZAAS ANTE *MELOIDOGYNE INCOGNITA* EN CUBA [BEHAVIOUR OF MICORRHIZAL BANANA PLANTLETS TOWARD *MELOIDOGYNE INCOGNITA* IN CUBA]. E. Fernández, J. González, R. Herrera, M. Escobar y H. Gandarilla, Inst. Inv. Sanidad Vegetal, Gaveta Postal 634CP, Miramar, Playa, INIVIT, Villa Clara, IES-Ciudad Habana, Cuba.—Plántulas de banano var. Grand Naine, procedentes de cultivo de tejidos fueron inoculadas al inicio de la fase de endurecimiento, con dos aislados de hongos formadores de micorrizas arbusculares, *Glomus mosseae* y *G. manihotis*, para valorar su comportamiento ante *Meloidogyne incognita*, en condiciones de umbráculo. La etapa de micorrización duró 45 días, posteriormente las plántulas se transplantaron a recipientes plásticos con suelo ferralítico rojo (pH 6,5 y 15 ppm de fósforo), donde se inocularon con 2500 juveniles de *M. incognita*. Después de tres meses, las plantas micorrizadas desarrollaron mejor que las no micorrizadas con o sin nematodos. El tratamiento con *M. incognita*, mostró un menor peso verde fresco y altura así como un grado máximo de infestación en las raíces (grado 5), mientras que en presencia de micorrizas el grado fue 2. Ambos aislados incrementaron la tolerancia de la planta a los nematodos y puede constituir otra alternativa biológica con-

tra estos parásitos. Actualmente se buscan otras cepas nativas de micorrizas para su caracterización y evaluación ante las especies de nematodos del banano.

Este trabajo fue financiado por el proyecto ERB IC18 CT97-0208 de la Unión Europea.

ALTERNATIVAS DE CONTROL DE NEMATODOS EN CUBA: SITUACIÓN ACTUAL Y PERSPECTIVAS [ALTERNATIVES FOR CONTROL OF NEMATODES IN CUBA: ACTUAL SITUATION AND PERSPECTIVES]. E. Fernández,[1] L. Sánchez,[2] J. Mena,[3] L. Hidaldo[2] y M. Montes,[4] Instituto de Investigaciones de Sanidad Vegetal, Ciudad Habana 11600, Cuba,[1] Centro Nacional de Sanidad Agropecuaria, San José de las Lajas, La Habana, Cuba,[2] Centro de Ingeniería Genética y Biotecnología, Camagüey 70100, Cuba[3] y Instituto de Investigaciones de Cítricos y Frutales, Ciudad Habana 11600, Cuba.[4]—Son abordados las especies de nematodos asociadas a cultivos temporales y perennes en Cuba. Entre ellas sobresalen por su amplia incidencia en importantes cultivos *Meloidogyne* spp., *Radopholus similis* y *Pratylenchus coffeae*. Se brinda una panorámica de la situación actual y perspectivas de las alternativas de control de nematodos en el país para cada cultivo considerando los aspectos legales, culturales, genéticos, físicos, químicos y manejo integrado. Igualmente, se señala el estado de aplicación de cada una de esas alternativas con énfasis en las medidas biológicas, reflejando el estado actual del desarrollo de los agentes biocontroles como es el caso de los hongos *Verticillium chlamydosporium*, *Trichoderma* spp., *Arthrobotrys* spp. y *Paecylomices lilacinus*; así como los notables éxitos en el empleo de las bacterias *Corynebacterium paurometabolum*, *Pasteuria penetrans* y *Bacillus thuringiensis*. También se plantean las estrategias de integración de los biocontroles y las estrategias para el desarrollo de los métodos de lucha no química en el nuevo milenio.

NEMATODE EVALUATIONS IN MELON CROPS IN THE NORTHEASTERN REGION OF GUATEMALA [EVALUACIONES DE NEMATODOS EN MELONERAS DE LA REGIÓN NORORIENTAL DE GUATEMALA]. H. Figueroa, (CONCYT / CONMA), Guatemala.—Three studies performed in four melon plantations revealed the presence of *Rotylenchulus* sp. at all sites. Nematode densities in roots did not differ among sites and differences in population densities in soil were not correlated with crop yield. In a second study, treatment of plots with methyl bromide reduced the numbers of *Rotylenchulus* sp. and increased fruit quality, but not brix. We detected 120 species of nematodes in river water in the region, which indicates the need for further study of the impact of rivers on spread of nematodes.

CONTRIBUCIÓN AL CONOCIMIENTO DE LAS ESPECIES DEL GÉNERO *GLOBODERA* PRESENTES EN MÉXICO [A CONTRIBUTION TO THE KNOWLEDGE OF THE SPECIES OF *GLOBODERA* IN MEXICO]. N. F. Franco,[1] I. V. Cid del Prado[2] y R. Lamothe-Argumedo,[3] IFIT, Colegio de Posgraduados, C. P. 56230, México[1,2] y Instituto de Biología, U.N.A.M., C. P. 04510, México.[3]— Una especie del género *Globodera* procedente de "La Cañada de Contreras", México, D. F. fue encontrada asociada a raíces de *Jaltomata procumbens* (Cav.) J. L. Gentry. La descripción de la especie se hizo con base en el estudio de los diferentes estadios en fresco y deshidratados. También se llevaron a cabo estudios histopatológicos para lo cual se observaron cortes de fragmentos de raíces de *J. procumbens* embebidos en parafina y teñidos utilizando la técnica de safranina-verde rápido. La especie de *Globodera* encontrda en Contreras es semejante a las subespecies del complejo *Globodera tabacum*. Aunque presenta ciertas similitudes, en particular con *G. t. tabacum*, difiere con las tres subespecies en: el patrón de estrías entre el ano y la fenestra, el radio de Granek, el número de anillos de la región labial de los machos, el patrón de los pseudolabios de machos y larvas del segundo estadio y la longitud de la región hialina de la cola de los juveniles del segundo estadio. En los tejidos de la raíz del hospedante se observó la presencia de un sincicio en la región vascular conteniendo núcleos grandes, de elípticos a ameboides, con nucleolos evidentes. Las paredes adyacentes al xilema presentan sobrecrecimientos internos positivos al verde rápido y dentro del sincicio se observan paredes celulares fragmentadas además de que el citoplasma suele ser denso, oscuro y granular.

QUANTITATIVE RESISTANCE TO ALL LOCALLY IMPORTANT PARASITES OF BEANS IN THE MIXTECA REGION OF MEXICO [RESISTENCIA CUANTITATIVA DE TODOS LOS PARÁSITOS IMPORTANTES DEL FRIJOL EN LA REGIÓN MIXTECA DE MÉXICO]. R. García-E., A. Aguilar-P., R. A. Robinson, P. Ramírez V., F. Castillo G., and F. Romero-R, Colegio de Postgraduados, Texcoco, Mex. 56230, México.—Recurrent mass selection is a breeding technique used for the improvement of quantitative traits that has very rarely been used in beans with the purpose of developing disease resistance. Using this technique, this interdisciplinary program began in 1998 and started with seven highly susceptible parents selected from a wide collection from the local land races of the Mixteca Region. One breeding cycle includes a season for selection, one for crosses, and one or more for generation advancement, thus, it might take from 2 to 4 years to complete. So far, five breeding cycles have been completed and the advanced genotypes more than double the yields of the original progenitors, and yield up to seven times more than the local varieties, or commercial varieties, when cultivated under strong selection pressure, particularly from soil borne diseases (taken as a complex including several species of fungi and nematodes). The original parents show only 47% to 86% plants survival due mainly to the impact of the soil pathosystem, whereas the best advanced materials go from 83 to 98% of survival, partly explaining their higher yields. The higher levels of resistance of the advanced materials to the bean common mosaic virus and perhaps also to common blight, induced by the bacterium *Xanthomonas campestris pv phaseoli*, also contribute to their higher yields.

RENIFORM NEMATODE (*ROTYLENCHULUS RENIFORMIS*)- A SERIOUS THREAT TO COTTON PRODUCTION IN ALABAMA [EL NEMATODO RENIFORME (*ROTYLENCHULUS RENIFORMIS*) UNA SERIA AMENAZA PARA LA PRODUCCIÓN DE ALGODÓN EN ALABAMA]. W. S. Gazaway, Department of Entomology and Plant Pathology, Auburn University, AL 36849, U.S.A.—First reported in a single cotton field in 1959, reniform nematode (*Rotylenchulus reniformis)* is now considered a major threat to cotton production in Alabama. According to a 1998-1999 survey conducted in northern and central Alabama counties, the six northern counties (85 750 hectares) and the six central Alabama counties (15 410 hectares) had reniform nematodes in 41% and 42% of their fields, respectively. This represents a sharp increase in the northern Alabama counties in which only 4% of fields contained reniform nematodes in 1990. It is estimated that reniform nematodes now account for approximately $6.6 million in production losses annually in Alabama. If reniform nematodes continue to spread at the present rate, it is expected that production losses to this nematode will exceed $10 million within the next five years.

IDENTIFICACIÓN Y CARACTERIZACIÓN DE DOS CEPAS DE *ARTHROBOTRYS OLIGOSPORA* [IDENTIFICATION AND CHARACTERIZATION OF TWO *ARTHROBOTRYS OLIGOSPORA* STRAINS]. Lucila Gómez, G. Baró y Lourdes Sánchez, Div. Protección de Plantas, Centro Nacional de Sanidad Agropecuaria, Apdo. 10, San José de las Lajas, La Habana, Cuba. —El estudio y selección de antagonistas autóctonos constituye la piedra angular para el desarrollo del control biológico como táctica dentro del manejo integrado de nematodos. El objetivo del presente trabajo es la identificación y caracterización de dos cepas de *Arthrobotrys* spp., provenientes del cepario de organismos biorreguladores de nematodos que se ha creado en el CENSA. El estudio morfológico y morfométrico dió como resultado que las cepas A-31 y A-37 corresponden a la misma especie, nombrada *Arthrobotrys oligospora*. Tanto el crecimiento miceliar como la esporulación se afectaron por la temperatura, resultando la óptima para el A-31 de 25°C y para la cepa A-37 28°C. La primera cepa fue más patogénica con un menor porcentaje de larvas vivas de *M. incognita*, mientras que la cepa A-37 colonizó más rápido la cascarilla de café y produjo mayor número de esporas en condiciones *in vitro*. En macetas, esta cepa tuvo mayor persistencia en ausencia de nematodos y menor colonización de la rizosfera del tomate. En cambio en similares condiciones la cepa A-31 mostró dependencia del nematodo con mayor frecuencia y persistencia en suelo cuando *M. incognita* estuvo presente. En sentido general el comportamiento de esta cepa la señala con mayores potencialidades como agente de control biológico.

PROSPECTS FOR EXPLOITING RESISTANCE AND TOLERANCE TO *RADOPHOLUS SIMILIS* AND *PRATYLENCHUS COFFEAE* IN BANANA CULTIVARS [PERSPECTIVAS PARA LA EXPLOTACIÓN DE CULTIVARES DE BANANA RESISTENTES Y TOLERANTES A *RADOPHOLUS SIMILIS* Y *PRATYLENCHUS COFFEAE*]. S. R. Gowen, Department of Agriculture, The University of Reading, Reading, RG6 6AT, UK.—Breeding bananas for disease resistance was first started in Jamaica in 1921. Initially, the objective was to develop new dessert cultivars for the international trade. The breeders sought progeny with all the attributes of the popular dessert bananas, Gros Michel and Cavendish, but including resistance to Fusarium wilt and, more recently, the leaf spot diseases and nematodes. Genetic improvement of the many other types of cooking and dessert bananas with local or regional importance has only been attempted in the last two decades. Nematode resistance in *Musa* is not common: subtle differences in susceptibility occur between clones but no resistance as such occurs in the more widely grown cultivars. The most well known source of resistance to *Radopholus similis* was first described from diploid cultivars in the collection of the United Fruit Company in Honduras (now FHIA). One accession, Pisang jari buaya was subsequently used by breeders and is a parent of a breeding line SH 3142 which is still used by banana breeders in Honduras and elsewhere. This source of resistance to *R. similis* is not effective for *Pratylenchus coffeae*. Resistance to both species is found in a triploid cultivar Yangambi km 5 that was found in the Congo, unfortunately this clone is not universally acceptable for culinary and agronomic reasons and more important, it cannot be used in breeding programmes. Recently, resistance has been reported in cultivars from southern India and these are currently under evaluation as parent breeding lines. The biochemical basis for resistance is not yet fully understood but may be related to levels of condensed tannins and other phenolic compounds. There is no evidence to suggest that resistance can be easily manipulated by banana breeders. The development of new varieties that tolerate nematode attack may depend on the use of parents with good root vigour and relatively low susceptibility to nematodes. The use of transformation technologies is also a real possibility.

EVALUATION OF TRAP CROPS IN WHEAT AND PEA-OAT ROTATIONS FOR *HETERODERA SCHACHTII* CONTROL [EVALUACIÓN DE CULTIVOS TRAMPA EN ROTACIONES DE TRIGO Y CHICHARO-AVENA PARA EL CONTROL DE *HETERODERA SCHACHTII*]. F. A. Gray, D. W. Koch, J. M. Krall, and J. W. Flake, Department of Plant Sciences, University of Wyoming, Laramie, WY 82071-3354, U.S.A.—Radish (cv. Adagio) and mustard (cv. Metex), bred specifically to reduce soil populations of the sugar beet nematode (SBN), *Heterodera schachtii*, were grown full season and as a second crop following harvest of spring wheat and pea-oat mixture at two field sites in southeastern Wyoming. Soil samples were taken in the spring prior to seeding and again in the fall after crop harvest. Treatments and percent reduction of *H. schachtii* in soil over the two locations were; full season radish (27%), full season mustard (28%), pea-oat mixture followed by radish (38%), pea-oat mixture followed by mustard (36%), wheat followed by fallow (24%), wheat followed by radish (49%) and wheat followed by mustard (54%). Average growing degree days base 10°C at the 5 and 15 cm soil depths were 1829 and 1146, respectively. Radish and mustard trap crops planted after wheat harvest resulted in a greater reduction in soil populations of *H. schachtii* than did trap crops grown over the entire season.

OCCURRENCE OF THE PINE WOOD NEMATODE (*BURSAPHELENCHUS* FUCHS, 1937) IN MEXICO [PRESENCIA DEL NEMATODO BARRENADOR DEL PINO (*BURSAPHELENCHUS* FUCHS, 1937) EN MÉXICO]. J. J. Guerra-Santos, I. Cid del Prado Vera, D. Alvarado Rosales, Instituto de Fitosanidad, Colegio de Postgraduados, México.—The distribution of the pine wood nematode in Mexico has not been studied and there is only one report of its presence in northern México. Six forest areas in the states of Hidalgo, México, Tlaxcala, and the Distrito Federal of the central part of Mexico were visited to collect wood samples. By using some modifications of the incubation, sieving extraction and centrifuge methods, the wood samples were processed in order to improve nematode

extraction. The genus *Bursaphelenchus* was found in Zacualtipan Hidalgo, associated with dead wood of *Pinus rudis*. This area is inhabited by two species of *Monochamus* and the nematode-infected samples were taken from logs containing galleries of the insect. Nematodes were detected only in dead wood. Some morphological features of the nematodes indicate that they are *B. xylophilus*, but this needs to be confirmed. This is the first report of the Pine Wood nematode in the central part of Mexico.

EFFECT OF *CROTALARIA LONGIROSTRATA*-TOMATO INTERCROPPING ON PLANT PARASITIC NEMATODES [EFECTO DE LA ASOCIACIÓN DE *CROTALARIA LONGISTRATA*-TOMATE SOBRE NEMATODOS FITOPARÁSITOS]. A. Gutiérrez E.,[1] P. Ponce D.,[1] J. L. Zuart M.,[1] R. R. Quiroga M.,[1] and I. Cid del Prado V.,[2] Facultad de Ciencias Agronómicas, Campus V de la Universidad Autónoma de Chiapas, Villaflores, Chiapas, Mexico, 30470[1] and Colegio de Postgraduados, Montecillo, México, 56230.[2]—Two planting dates (23 days before and simultaneous with tomato) and three plant densities of *Crotalaria longirostrata* (0, 1 and 5 plants/m^2) were tested in a microplot experiment. Three replications per treatment were arranged in a split plot design. Root galling by *Meloidogyne incognita* in tomato roots and numbers of *Meloidogyne, Pratylenchus, Hoplolaimus, Tylenchorhynchus, Helicotylenchus and Xiphinema* in *C. longirostrata* roots, were evaluated. Numbers of plant parasitic nematodes in soil (except *Meloidogyne*) were also estimated. In tomato, root galling (7%) and number of females (250/5 g of roots) were significantly lower when tomato was associated with *C. longirostrata* at rate of 5 plants/m^2, as compared to 1 (25% and 430 females/5 g of roots) and 0 plants (50% and 550 females/5 g of roots). The best protection of tomato roots (lowest root galling) was obtained when planting of *C. longirostrata* and tomato was simultaneous. *C. longirostrata* roots contained *Pratylenchus, Hoplolaimus,* and juveniles, males and small and malformed females of *M. incognita*. These females did not produce egg masses, while in tomato roots they did. In plots with *C. longirostrata*, the soil populations of *Pratylenchus, Tylenchorhynchus* and *Helicotylenchus* decreased, but that of *Hoplolaimus* increased. Numbers of *Xiphinema* was not affected by the presence of *C. longirostrata*.

EVALUATION OF MOCAP FOR MANAGEMENT OF *MELOIDOGYNE CHITWOODI* IN IDAHO POTATOES [EVALUACIÓN DE MOCAP PARA EL MANEJO DE *MELOIDOGYNE CHITWOODI* EN PAPA DE IDAHO]. Saad L. Hafez, and P. Sundararaj, Parma Research and Extension Center, 29603, U of I Ln, Parma, Idaho 83660, U.S.A.—Studies were conducted to compare the efficacy of nematicides on the management of *Meloidogyne chitwoodi* on potato and the resulting yield increase under field conditions. An experiment was conducted in 1999 at Parma, Idaho to determine if fall and spring applications of a combination of Mocap and Vapam on potatoes are effective in controlling nematode infection. Pretreatment nematode numbers indicated the uniformity in population in all treatments. Yield data indicated that fall or spring application of Mocap (2.0 or 1.5 gal) along with Vapam (40 gal) significantly reduced the nematode infested potatoes compared to untreated controls. Percent of nematode infestation declined to 0.2% and 2.7% as a result of fall or spring application, respectively. Significant increases in clean yield and market yield were also observed with fall or spring applications. Another experiment was conducted to study the efficacy of Mocap formulations (Mocap 10G and Mocap 15G) on the control of Columbia root knot nematode in a potato field. Yield data indicated that there is a significant increase in clean yield and a tendency of increase in total yield and marketable yield due to mocap application as compared to controls. Numbers of nematode infected tubers were reduced by both formulations as compared to controls.

NEMATODE MANAGEMENT RESEARCH IN IDAHO AND IT'S IMPACT ON THE GROWERS ECONOMY [INVESTIGACIONES SOBRE EL MANEJO DE NEMATODOS EN IDAHO Y SU IMPACTO EN LA ECONOMÍA DE LOS PRODUCTORES]. Saad L. Hafez, and P. Sundararaj, Parma Research and Extension Center, 29603, U of I Ln, Parma, Idaho 83660, U.S.A.—In Idaho more than 50% of the sugarbeet acreage is infested with sugarbeet cyst nematode, causing yield losses of up to 60% in the endemic regions where the growers use nematicides at a cost of $100 to $300/acre. Al-

though nematodes are causing immense loss of production of sugar beet, potato and alfalfa, growers are saving millions of dollars by adopting environmentally friendly nematode management strategies developed by University of Idaho at Parma. Cultivars of oil radish and white mustard stimulate egg hatch, while preventing completion of life cycles, thereby controlling nematode populations in sugar beet and potato without risk to the environment. Early planting of oil radish or mustard cultivars prior to sugarbeet, reduced nematodes in soil (62-92%) and increased yield (24.7%). A promising method for the control of nematodes in potato in Idaho is the use of green manure crops. Columbia root-knot nematode numbers decrease after green manure incorporation and before planting potatoes, with oil radish performing more effectively than rapeseed or fallow. The University of Idaho Nematology Lab at Parma is also involved in developing and evaluating alfalfa germplasm for resistance to nematodes. The development of alfalfa varieties that exhibit resistance to nematodes and commercially suitable agronomic characteristics provides alfalfa growers with additional options for nematode management.

EFFICACY OF TANNINS FOR CONTROL OF ROOT-KNOT NEMATODES [EFICIENCIA DE TANINOS PARA EL CONTROL DE NEMATODOS AGALLADORES]. T. E. Hewlett and D. W. Dickson. Entomology and Nematology Department, University of Florida, Gainesville, FL 32611, U.S.A. — Several tannins have been identified as attractants or repellants of root-knot nematodes. The efficacy of tannic acid, wattle, and querbracho tannins was tested for control of *Meloidogyne arenaria* and *M. javanica* on tomato (cv. Agriset 761) in two microplot studies. These tannins, either in powder and pellet formulations, were applied and mixed into the soil. Fenamifos 15G was used as a standard in both tests and treatments were replicated eight times. In test one, fenamifos, and tannic acid applied preplant as pellets produced higher yields, 2.1 kg and 1.9 kg, respectively, compared with the untreated control, l.1 kg ($P < 0.1$). Fenamifos, and tannic acid applied either preplant or at-plant resulted in a lower percentage of root galling (63, 64, and 63%, respectively) than the untreated control (97%, $P < 0.1$). In the second test, wattle pellets applied broadcast preplant produced greater yield (623 g) than the untreated control (391 g, $P < 0.1$) and querbracho tannin applied at-plant produced fewer galls (50.4%) than the untreated control (90%, $P < 0.05$). Management of root-knot nematodes with tannins may be possible with further research on formulation and application timing.

1,3-DICHLOROPROPENE AND CHLOROPICRIN IN THE AMERICAS: CURRENT REGULATORY STATUS [1,3-DICLOROPROPENO Y CLOROPICRINA EN LAS AMÉRICAS: ESTADO ACTUAL REGULATORIO]. Bruce Houtman, and John Busacca. Dow AgroSciences, 9330 Zionsville Rd., Indianapolis, IN 46268, U.S.A.—The impending exit of methyl bromide from agricultural uses require that new soil fumigation alternatives or combinations must be identified and tested during the period leading up to 2005. In combination, 1,3-dichloropropene and chloropicrin have demonstrated a unique ability to control nematodes, diseases and weeds and have become a primary alternative for methyl bromide. 1,3 dichloropropene and chloropicrin are presently registered in the principal agricultural countries in the Americas. 1,3-dichloropropene has recently completed the USEPA reregistration process and has been dropped from "Special Review" in the United States. Traditional, subsoil injection formulations of 1,3-D (Telone II) and 1,3-D/chloropicrin combinations (Telone C-17 and Telone C-35) continue to be the principal soil fumigation options for growers for nematode and disease control in agriculture. To optimize the utility and practicality of 1,3-D/chloropicrin formulations, research is ongoing to update the regulatory conditions of product use in existing and new product use patterns. Regulatory research is presently being conducted in the areas of emission reduction, buffer zone refinement and personal protective equipment refinement. In addition, to provide more application flexibility in diverse cropping practices, Dow AgroSciences is presently pursuing global registrations for drip irrigation formulations of Telone II (Telone EC) and of Telone C-35 (InLine).

A NEW SPECIES OF *PRATYLENCHUS* FROM CITRUS IN BRAZIL [UNA NUEVA ESPECIE DE *PRATYLENCHUS* EN CÍTRICOS DE BRASIL]. R. N. Inserra,[1] L. W. Duncan,[2] A. Troccoli,[3] J. Maia dos Santos,[4] and N. Vovlas,[3] Florida Department of Agriculture & Consumer Services, DPI, Gainesville, FL 32614-7100, U.S.A.,[1] University of Florida, CREC, 700 Experiment Station Road, Lake Alfred, FL 33850, U.S.A.,[2] Istituto Nematologia Agraria, CNR, via Amendola 165/A, 70126 Bari, Italy[3] and UNESP/Fac. Ciencias Agrarias e Veterenarias, Dep. Entomologia e Nematologia, Rod. C. Tonanni 05, 14870.000 Jaboticabal SP, Brazil.[4]—A recent molecular and morphological study of lesion nematodes similar to *Pratylenchus coffeae* detected no differences between a topotype population of *P. coffeae* from coffee in Java and *P. coffeae* populations from aglaonema and citrus in Florida, banana in Honduras, cocoyam in Brazil, and yam in the Caribbean islands and Brazil. A phylogenetic analysis of ribosomal DNA (D2/D3) sequences revealed that these *P. coffeae* populations differed from a population of putative *P. coffeae* collected from citrus in Brazil. Morphological comparisons between this undescribed species from Brazil and the *P. coffeae* populations indicated that the population from Brazil shares similar head morphology with *P. coffeae,* having a plain and smooth face, with all labial sectors fused together and at least partially with the oral disc. The undescribed lesion nematode from Brazil differs from those of *P. coffeae* by only a few morphological characters of the females. The stylet length mean values are <15.5 m compared to ≥15.5 m in *P. coffeae,* and the vulva position mean values are <79% compared to ≥79% in *P. coffeae*. The tail is subhemispherical with smooth terminus in the *Pratylenchus* from Brazil whereas it is commonly truncated and indented in *P. coffeae*. The morphological separation of this new lesion nematode from *P. coffeae,* requires the examination of several specimens (>10) because overlap occurs among the high ranges of morphometric values of the Brazilian population with the low ranges of the morphometric values of *P. coffeae*. The great variability of *P. coffeae* tail morphology complicates the morphological separation of the two lesion nematodes when only a few specimens are available for the diagnosis.

ACCIÓN NEMATICIDA *IN VITRO* DE EXTRACTOS DE VARIAS PLANTAS EN *XIPHINEMA INDEX* Y *X. AMERICANUM SENSU LATO* [*IN VITRO* NEMATICIDE ACTION OF SEVERAL PLANT EXTRACTS ON *XIPHINEMA INDEX* AND *X. AMERICANUM SENSU LATO*]. V. Insunza,[1] E. Aballay,[2] D. Contreras[2] y J. Macaya,[2] Swedish University of Agricultural Sciences, Dept. Ecology and Crop Production Science, Box 7043, SE-750 07 Uppsala, Sweden[1] y Facultad de Ciencias Agronómicas, U. de Chile, Casilla 1004, Santiago, Chile.[2]—En Chile, *Xiphinema index* y *X. americanum s.l.* son uno de los principales problemas nematológicos en la vid, tanto como patógenos radicales o como vectores de virus, p.e. GFLV. El control de *Xiphinema* se basa en agroquímicos, con todas sus desventajas. En la búsqueda de alternativas de control ecocompatibles, se evaluó el efecto nematicida de 38 plantas de la flora chilena en *X. index* y *X. americanum s.l.*, siendo los testigos, agua destilada y Fenamiphos (200 ppm). Se prepararon extractos acuosos de partes aéreas de las plantas al 1:4 P/V (frescas) o 1:10 (secadas al aire), como soluciones standard (S); y diluciones al 10% y 1% de los tratamientos significativamente ($P < 0.05$) efectivos como S. Los nematodos se observaron después de 24–48 horas de inmersión en los extractos y resuspendidos por 24 horas en agua destilada para su eventual recuperación. Según la movilidad de los nematodos, el efecto se registró como: nematóxico (irreversible), nemostático (reversible), o acción nula. La acción nematicida de las plantas decreció con las diluciones, siendo la mayoría efectivas en S; todas fueron inefectivas al 1% de S. Las plantas con mayor efecto nematicida (S y 10% de S) fueron *Marrubium vulgare, Oxalis articulata, Plantago hispidula* var *tumida., Senna stipulacea, Sisyrinchium striatum* en *X. americanum s.l.*; y *Podanthus mitique* y *S. stipulacea* en *X. index.*

COMPORTAMIENTO EN LA INCUBACIÓN DEL NEMATODO QUISTE DE LA PAPA, *GLOBODERA ROSTOCHIENSIS*, EN VENEZUELA [BEHAVIOR IN INCUBATION OF POTATO CYST NEMATODE, *GLOBODERA ROSTOCHIENSIS*, IN VENEZUELA]. N. Jiménez P.,[1] R. Crozzoli[2] y N. Greco,[3] UCLA, Post grado de Fitopatología, Apdo. 400, Barquisimeto, Venezuela,[1] UCV, Fac. Agronomía, Inst. Zoología Agrícola, Apdo. 4579, Maracay, Venezuela[2] y CNR, Istituto di Nematologia

Agraria applicata ai Vegetali,70126 Bari, Italia.[3]—Quistes de *G. rostochiensis* (Ro_2) provenientes de la localidad de Cubiro (1200 msnm), estado Lara, fueron colectados sobre raíces de papa (*Solanum tuberosum*) tan pronto maduraron y almacenados en una bandeja en condiciones de campo. Durante un año, a intervalos de 15 días, se colocaron a incubar 400 quistes en una solución de Metavanadato de Sodio 0,6 mM a 20°C. Se observó una alta respuesta a la incubación durante todo el año. Los juveniles de segundo estadio emergieron rápidamente y no se detectó periodicidad. La emergencia máxima se alcanzó entre la tercera y quinta semana después de iniciada la incubación y osciló entre 35 y 58%. La emergencia total se alcanzó a la octava semana de iniciada la prueba y se ubicó entre 80 y 90% en la mayoría de los períodos; excepcionalmente fue menor a 70%. Los resultados sugieren la ausencia de latencia en esta población.

MANAGEMENT OF ROOT-KNOT AND RENIFORM NEMATODES WITH 1,3-D IN NARROW-ROW COTTON [MANEJO DE NEMATODOS AGALLADORES Y RENIFORMES CON 1,3-D EN SURCADO ANGOSTO DE ALGODONERO]. R. A. Kinloch and J. R. Rich, West Florida Research and Education Center, University of Florida, Jay, FL 32565, U.S.A.—Two field sites, one infested with *Meloidogyne incognita* and the other with *Rotylenchulus reniformis,* were fumigated with replicated treatments of 0, 16, 32, 48, 80, and 96 kg 1,3-D/ha. The fumigant was applied through chisels set 0.4 m apart to a soil depth of 0.3 m. Non-treated plots were chiseled. Three days following treatment at the *R. reniformis* site and ten days following treatment at the *M. incognita* site, Delta Pine 655 BRR cotton was planted in rows 0.25 m apart. Lint yields (Y in kg / ha) at the *M. incognita* site were positively related to rates of 1,3-D (X) by $Y = 661.5 + 4X$, $r = 0.6$, $df = 34$, $P < 0.01$, and at the *R. reniformis* site by $Y = 922.4 + 4.2X$, $r = 0.6$, $df = 34$, $P < 0.01$. The latter equation was effective for 1,3-D rates 0 - 80 kg / ha. Data from the 96 kg / ha treatment indicated phytotoxic effects probably due to the short delay between treatment and planting at this site. Post-harvest soil densities of *M. incognita* J2 / 100 cm^3 soil (Y) were negatively related to 1,3-D rates (X) by $Y = 125 - 1.5X$, $r = 0.7$, $df = 34$, $P < 0.01$. However, there was no relationship between post-harvest soil densities of *R. reniformis* and treatment rates.

ROLES OF PLANT-ASSOCIATED BACTERIA IN NEMATODE BIOCONTROL: SELECTIVE MANIPULATION OF INDIGENOUS BACTERIA AND INTRODUCTION OF SPECIFIC STRAINS [ROL DE LAS BACTERIAS ASOCIADAS A PLANTAS EN EL BIOCONTROL DE NEMATODOS: MANIPULACIÓN SELECTIVA DE BACTERIAS SILVESTRES E INTRODUCCIÓN DE CEPAS ESPECÍFICAS]. J. W. Kloepper, R. Rodríguez-Kábana, N. Martínez-Ochoa and C. Fernández, Department of Plant Pathology and Biological Control Institute, Auburn University, Auburn, AL 36849, U.S.A.—Rhizobacteria (root-colonizing bacteria) and endophytic bacteria (Bacteria inside plant tissues) are considered to be important contributors to plant health and general soil suppressiveness. Efforts to use bacteria for control of diseases involve either application of specific introduced bacterial strains as biological control agents or various cultural practices to induce suppressiveness via alterations in the indigenous soil microbial community. Plant Growth-Promoting Rhizobacteria (PGPR) are beneficial rhizobacteria, and there are many reports on their use for biocontrol of soilborne target pathogens. More recently, endophytic bacteria have also been examined as biological control agents. Compared to work on biocontrol of fungi, much less has been done with plant-associated bacteria for biocontrol of nematodes. We have found that some PGPR strains, applied to tomato seedlings prior to transplanting in the field, lead to significant reductions in damage by root-knot nematodes. An alternative or supplemental approach to introducing specific bacteria as biological control agents is to manipulate the indigenous bacterial communities of the rhizosphere or endorhiza (inside roots) to enhance suppressiveness. Soil suppressiveness may be induced through shifts in microbial community structure and function using several nematode control practices, including the use of organic amendments, antagonistic plants in cropping systems, and applications of biorational nematicides. Soil amendment with 1% chitin led to alterations in the taxonomic structure of the bacterial communities of the soil, rhizosphere and endorhiza. Several bacterial species were found in chitin-amended soils

and cotton rhizospheres but not but not in non-amended soils and rhizosphere, and surprisingly, amendment of soil with chitin selectively influenced the community structure of endophytic bacteria within cotton roots. Nematodes can also be controlled by use of velvetbean (*Mucuna deeringiana*) as a rotational crop, and this control has recently been found to be associated with shifts in the microbial community and changes in microbial activity of soils, in addition to direct toxicity. Similarly, work with several biorational nematicides, including botanical aromatics and DiTera®, suggests that in addition to direct toxicity to nematodes, soil suppressiveness was induced via activity of antagonistic microflora.

INVOLVEMENT OF ROOT COLONIZING BACTERIA IN THE NATURAL SUPPRESSION OF PEACH TREE SHORT LIFE AND THE RING NEMATODE, *MESOCRICONEMA XENOPLAX* [PARTICIPACIÓN DE BACTERIAS RIZOSFÉRICAS EN LA SUPRESIÓN NATURAL DE DURAZNO DE CORTA VIDA Y EL NEMATODO ANILLADO, *MESOCRICONEMA XENOPLAX*]. D. A. Kluepfel,[1] J. Lawrence,[1] A. Nyczepir,[2] T. M. McInnis,[1] P. Wechter,[1] and E. I. Zehr,[1] College of Agriculture Forestry and Life Sciences, Clemson University, Clemson, SC, 29634[1] and Southeastern Fruit and Tree Nut Research Laboratory, USDA, Byron, GA 31008, U.S.A.[2]—The ectoparasitic migratory ring nematode, *Mesocriconema (Criconemella) xenoplax* has been shown to play an important role in the induction of the disease syndrome, Peach Tree Short Life (PTSL) in the southeastern United States. Field sites suppressive to PTSL, and the ring nematode, have been identified in South Carolina. During a three-year monitoring period, ring populations in these sites remain at or below detection limits while populations rose to greater than 1 400 ring nematodes/100cc soil in adjacent sites in the same orchard. In green house testing, steam treatment of these soils eliminated suppressiveness, whereas small amounts of non-steamed suppressive soil added to steamed soil inhibited *M. xenoplax* multiplication. Seven fluorescent pseudomonad strains from the suppressive field soil were found to inhibit ring nematode multiplication. Cells and cell-free culture filtrate of one of these isolates, *P. synxantha* BG33 kills the ring nematode eggs when applied to the eggs within 5 days of deposition. Application of BG33 to trees in newly established orchards planted into solarized soil significantly reduced nematode reproduction. Up to 18 months post-solarization and BG33 inoculation, ring nematode populations remained significantly below populations in non solarized/non-BG33 inoculated control field sites. This level of nematode control is equivalent to that observed with methyl bromide fumigation. Using Tn5 mutagenesis, we have identified 5 genetic loci in BG33 that are involved in egg-kill factor production. The Tn5 insertion sites in these mutants have been cloned and sequenced and gene sequence homologies have been determined. Egg-killing activity appears to be associated with salicylic acid production by BG33.

***TYLENCHULUS SEMIPENETRANS* SUPPRESSES INFECTION OF CITRUS FIBROUS ROOTS BY THE FUNGUS, *PHYTOPHTHORA NICOTIANAE* (= *PARASITICA*) [*TYLENCHULUS SEMIPENETRANS* REPRIME LA INFECCIÓN DE RAÍCES DE CÍTRICOS CAUSADA POR EL HONGO *PHYTOPHTHORA NICOTIANAE* (= *PARASITICA*)]. F. E. Kora, L. W. Duncan, and J. H. Graham, University of Florida, Citrus Research and Education Center, Lake Alfred, FL 33850, U.S.A.—**The most commonly encountered association between nematodes and fungi in citrus worldwide occurs between the citrus nematode *Tylenchulus semipenetrans* and the root rot fungus *Phytophthora nicotianae (= parasitica)*. Both organisms parasitize the cortex of the fibrous root system. The interaction between *T. semipenetrans* and *P. nicotianae* in citrus roots was evaluated in the laboratory. Forty five-day-old *Citrus aurantium* (sour orange) seedlings growing in soil in glass test tubes were infested with 2 inoculum levels (8 000 and 80 000) of a mixture of *T. semipenetrans* eggs and second stage juveniles. After nematode infection was well established, two levels of fungal zoospores (6 300 and 63 000) were added either alone or in combination with the nematode. Both inoculum levels of the fungus alone reduced the growth of citrus seedlings compared to the nematode alone or in combination with the fungus. Fungal protein in roots infected by both organisms was 57% lower ($P = 0.001$) than when infected by only the fungus. Compared to plants infected only by *P. nicotianae*, shoot weights were 44% ($P = 0.001$) greater and

root weights were 17% greater ($P = 0.05$) in plants infected by both parasites. Results of this and other experiments reveal an antagonistic relationship between *T. semipenetrans* and *P. nicotianae*.

FIELD RESPONSE OF SELECTED MID-SOUTH SOYBEAN VARIETIES TO THE RENIFORM NEMATODE [RESPUESTA DE VARIEDADES SELECTAS DE SOYA DEL MEDIANO-SUR A EL NEMATODO RENIFORME EN CAMPO]. G. W. Lawrence,[1] K. S. McLean,[2] and S. M. Baird,[1] Department of Entomology and Plant Pathology, Mississippi State University, Mississippi State, MS 39762 ;[1] and Department of Entomology and Plant Pathology, Auburn University, Auburn, AL 36849, U.S.A.[2] —Twenty-seven mid-south soybean varieties in maturity groups (MG) IV through VI were evaluated for their yield response to the reniform nematode (*Rotylenchulus reniformis*). Included in the study were eleven MG IV, thirteen MG V and three MG VI varieties. The test was conducted in a field located at Inverness, Mississippi that was naturally infested with the reniform nematode. Each variety was planted with and without the nematicide Temik 15G at 5.0 lbs formulated material per acre. Soybean yields in MG IV ranged from 39.3 to 52.3 bu/acre with Asgrow 4601 and Delta and Pine Land (DP) 4909. In MG V yields ranged from 41.2 to 52.8 bu/acre with Terral-Norris TV 5666 RR and Pioneer Brand 95B33. Maturity group VI yields were 38.7, 43.2 and 51.5 bu/acre for Hornbeck 6600, Pioneer Brand 96B01 and Aagrow 6101, respectively. The addition of Temik 15G improved soybean yields ranging from 2.9 to 12.2 bu/acre in MG IV, 0.6 to 8.0 bu/acre in MG V and 3.9 to 6.3 bu/acre in MG VI.

LONGIDÓRIDOS Y TRICODÓRIDOS DE SUDAMÉRICA: FILOGENIA E INTERÉS BIOGEOGRÁFICO [LONGIDORIDS AND TRICODORIDS OF SOUTH AMERICA: PHYLOGENY AND BIOGEOGRAPHIC ASPECTS]. J. A. López-Pérez, Dpto de Agroecología, Centro de Ciencias Medioambientales, CSIC. Serrano 115 dpdo, 28006 Madrid, Spain.—Se lleva a cabo un análisis de los diferentes estudios realizados sobre la evolución y filogenia de las familias Longidoridae y Trichodoridae, ya que ambas difieren filogenéticamente de los restantes nematodos fitoparásitos y son las únicas que comprenden especies vectoras de virus, aunque sus líneas evolutivas también son diferentes. Asimismo se analiza su distribución actual, estudiando la presencia o ausencia de los distintos géneros en los diferentes continentes, morfología de las especies según el ambiente. Se considera que Sur America es un área donde se han originado líneas evolutivas diferentes para ambas familias, por ser la única zona en el mundo donde se han encontrado hasta ahora los géneros *Xiphidorus* y *Paraxiphidorus* en los longidóridos y *Allotrichodorus* y *Monotrichodorus* en los tricodóridos. Por todo ello se considera de gran interés los estudios biogeográficos de los nematodos en esta región por que nos puede facilitar un mejor conocimiento de su filogenia y comportamiento ecológico, que son de gran interés en el manejo agronómico de estos patógenos.

TEMPERATURA DEL SUELO Y BIOGEOGRAFÍA DE LOS NEMATODOS DEL GÉNERO *MELOIDOGYNE* [SOIL TEMPERATURE AND BIOGEOGRAPHY OF *MELOIDOGYNE* SPP]. J.A. López-Pérez, M. Escuer y A. Bello, Dpto Agroecología, Centro de Ciencias Medioambientales, CSIC. Serrano 115 dpdo, 28006 Madrid, España.—Se ha tomado como referencia la distribución geográfica de los nematodos ectoparásitos de las familias Criconematidae, Longidoridae y Trichodoridae, que nos han permitido diferenciar un grupo de especies de ambientes frios y templados de otro de ambientes cálidos y subtropicales. Estos planteamientos biogeográficos también los encontramos en los nematodos endoparásitos del género *Meloidogyne*, aunque aparecen numerosas excepciones, llegando a considerar la existencia de ecotipos diferentes, estableciendo el término termotipo para las poblaciones de una misma especie que presentaban distribuciones geográficas diferentes en relación con la temperatura. Todo ello nos ha llevado a estudiar bajo condiciones de laboratorio el comportamiento de diferentes poblaciones de *M. incognita* y *M. hapla* frente a la temperatura, encontrando que no aparecen termotipos, únicamente presentan una duración del ciclo diferente.

CONTROL DE *MELOIDOGYNE HAPLA* EN VIDES VAR. FLAME Y PERLETTE EN EL VALLE DE COPIAPÓ, III REGIÓN DE CHILE, CON EXTRACTO DE *QUILLAJA SAPONARIA* MOL. [CONTROL OF *MELOIDOGYNE HAPLA* IN FLAME AND PERLETTE GRAPE CULTIVARS IN COPIAPÓ VALLEY, CHILE, USING EXTRACT OF *QUILLAJA SAPONARIA* MOL.]. J. C. Magunacelaya y R. San Martín, Dpto. Sanidad Vegetal, Fac. Ciencias Agronómicas, Universidad de Chile, y Facultad de Ingeniería, Universidad Católica de Chile, Santa Rosa 11315, Santiago, Chile.—Entre septiembre de 1998 y diciembre de 1999 se realizó un ensayo para evaluar la acción del extracto de *Quillaja saponaria* Mol. como alternativa para contrarrestar la acción depresora que sobre las plantas de vid para uva de mesa ejercen niveles poblacionales altos de *Meloidogyne hapla*, en el valle de Copiapó, zona norte de Chile. Se trabajó con uva de mesa. vid var. Flame, dos sectores, y vid var. Perlette, tres sectores. Los tratamientos fueron, extracto de *Quillaja saponaria* 11 litros por hectárea, extracto de *Q. saponaria* 20 litros por hectárea, Enzone 60 litros por hectárea, y Ethoprophos 10 litros por hectárea. Los muestreos se realizaron antes de la aplicación de los productos, 35 días después y a inicios de la temporada agrícola siguiente. Las aplicaciones de extracto de *Q. saponaria* así como la aplicación de productos en los tratamientos testigos químicos, fueron efectivos en evitar el incremento de las poblaciones de nemátodos fitoparásitos. La producción en los sectores tratados fue siempre mayor a la producción de las plantas testigo, y en algunos casos con significación estadística. Las plantas de sectores tratados tuvieron mayor calibre o diámetro de uva y mejor calidad de racimos.

EXTRACTO DE *QUILLAJA SAPONARIA* MOL. EN EL CONTROL DE *TYLENCHULUS SEMIPENETRANS* EN LIMONEROS DE LA ZONA CENTRAL DE CHILE [EXTRACT OF *QUILLAJA SAPONARIA* MOL. AS A CONTROL FOR *TYLENCHULUS SEMIPENETRANS* IN LEMON ORCHARDS OF THE CENTRAL REGION OF CHILE]. J. C. Magunacelaya y R. San Martín, Dpto. Sanidad Vegetal, Fac. Ciencias Agronómicas, Universidad de Chile y Facultad de Ingeniería, Universidad Católica de Chile, Santa Rosa 11315, Santiago, Chile.—A partir de Octubre de 1998 se realizan aplicaciones periódicas de extracto de quillay (*Quillaja saponaria*) cada tres o cuatro meses en limones para evaluar la acción nematicida sobre *Tylenchulus semipenetrans*. Los ensayos se realizan en Hijuelas y Limache (Quinta Región, zona central de Chile) 150 Km al norte de la ciudad de Santiago. Los cítricos utilizados en Hijuelas son plantas de un huerto altamente tecnificado y comercial, mientras que los de Limache tienen menos características técnicas. Ambos presentan niveles altos de infestación de *T. semipenetrans*. Algunos árboles presentaron síntomas de decaimiento. Transcurridos 14 meses de estudio, se observó una reducción significativa de las poblaciones del nemátodo, pero no se apreció recuperación de las plantas que ameritara la realización de evaluaciones de producción.

TOLERANCIA A LA DESHIDRATACIÓN E INFECTIVIDAD DE JUVENILES Y MASAS DE HUEVOS DE *NACOBBUS ABERRANS* (NEMATODA: PRATYLENCHIDAE) [DEHYDRATION TOLERANCE AND INFECTIVITY OF JUVENILES AND EGG MASSES OF *NACOBBUS ABERRANS* (NEMATODA: PRATYLENCHIDAE)]. R. H. Manzanilla- López,[1] M. Pluma-Contreras[2] and E. López-Martínez,[2] Instituto de Fitosanidad, Colegio de Postgraduados, Km 36.5 Carretera México-Texcoco, Edo. 56230[1] y Instituto Tecnológico Agropecuario No. 29, Xocoyucan (Tlax.), México.[2] — La tolerancia e infectividad de las masas de huevos (MH) y los juveniles de tercer (J3) y cuarto estadio (J4) de *Nacobbus aberrans*, fueron evaluadas después de una deshidratación gradual por periodos de cinco y quince días. Los J3 y J4 se deshidrataron en condiciones de humedad relativa (HR) del 20%, 40%, 60%, 98.8% y 100% mantenidas con soluciones de agua-glicerina. Los juveniles fueron rehidratados (24h), inoculados en plantas de jitomate (*Lycopersicon esculentum* Mill. cv. Río Grande) y evaluados 35 días después. El experimento constó de cinco tratamientos y tres repeticiones por periodo; cien J3 y J4 formaron cada unidad experimental. Las MH se deshidrataron en suelo contenido en columnas de vidrio de 2.5cm de diámetro, de diferente altura y porcentaje de humedad que constituyeron los tratamientos: 11.25cm (100%), 18.75cm (96%), 22.5cm (86%), 26.25cm (75.5%), con cuatro repeticiones por periodo; la unidad experimental estuvo constituida por el suelo de cada columna y diez

MH. El experimento se repitió en tres hospedantes (chile, jitomate y remolacha) y fue evaluado a los 35 días. El diseño en ambos experimentos fue completamente al azar. Los J3 y J4 fueron infectivos en jitomate, con el mayor número de agallas en el tratamiento del 20% de HR en ambos periodos. Las MH indujeron agallas en chile, jitomate y remolacha, en general con un mayor número en el periodo de cinco días. El análisis de varianza no mostró diferencias significativas en el número de agallas entre los tratamientos, sin embargo su presencia confirmó la infectividad de estos estadios y su tolerancia a la deshidratación.

EVALUATION OF NEW AND ESTABLISHED COMPOUNDS FOR REPLACEMENT OF METHYL BROMIDE AS A SOIL FUMIGANT FOR NEMATODE MANAGEMENT IN LOUISIANA [EVALUACIÓN DE NUEVOS Y TRADICIONALES COMPUESTOS PARA LA SUBSTITUCIÓN DE BROMURO DE METILO COMO FUMIGANTE DE SUELO EN EL MANEJO DE NEMATODOS EN LOUSIANA] E. C. McGawley,[1] C. Overstreet,[2] M. J. Pontif,[1] J. P. Bond,[3] and H. E. Dominguez,[1] Department of Plant Pathology and Crop Physiology,[1] Louisiana Cooperative Extension Service,[2] Louisiana State University AgCenter, LA 70803, and Department of Plant, Soil, and General Agriculture, Southern Illinois University, Carbondale, IL 62901-4415, U.S.A.[3]—The efficacy of Agri 50 (Organic Solutions, LLC), a potential replacement for Methyl Bromide, against nematodes was evaluated full-season under microplot conditions. On sugarcane ('LCP 8289') concentrations of 7 500 and 10 000 ppm caused stepwise and significant ($P \leq 0.01$) reductions in populations of ring (*Mesocriconemella xenoplax*) and stunt (*Tylenchorhynchus annulatus*) nematodes. A significant reduction in populations of stubby-root (*Paratrichodorus minor*) nematode was observed on 'Pioneer 3223' corn at 7 500 ppm. At 10 000 ppm, the reduction in stubby-root population density was accompanied by a significant ($P \leq 0.05$) positive growth response. Data for studies with bell pepper ('Red Bell') were averaged over spring and fall plantings. Root-knot nematode (*Meloidogyne incognita*) populations on pepper were reduced significantly ($P \leq 0.01$) by treatment with a 10,000 ppm concentration of Agri 50. Pepper fruit yield was increased significantly ($P \leq 0.05$) at the 7 500 ppm level but decreased significantly (P œ 0.05) at the 10 000 ppm level. Results with 'Cypress' rice showed no efficacy against ring nematodes (*M. xenoplax*) at any concentration and plant growth data suggested some phytotoxicity. Telone II (4 and 8 GPA, in-furrow) and Agri 50 (10 GPA, in furrow) were employed in a full-season, field study with the cotton cultivar 'Stoneville LA887.' Relative to the non-treated control, all chemicals reduced populations of *Rotylenchulus reniformis* at harvest. Only the highest rate of Telone II produced a significant yield response.

POPULATION DIVERSITY OF PLANT-PARASITIC NEMATODES [DIVERSIDAD POBLACIONAL DE NEMATODOS FITOPARÁSITOS]. K. S. McLean,[1] and G. W. Lawrence,[2] Department of Entomology and Plant Pathology,[1] Auburn University, Auburn, AL 36849, and Mississippi State University, Mississippi State, MS 39762, U.S.A.[2]—A survey was conducted to determine the diversity and abundance of plant-parasitic nematodes associated with cotton. Five percent of the production area in four parishes was sampled. Nematodes were extracted by gravity screening and sucrose centrifugation. Eight genera of plant-parasitic nematodes were identified, *Criconemella* spp., *Helicotylenchus* spp., *Hoplolaimus* spp., *Meloidogyne incognita, Pratylenchus* spp., *Paratrichodorus* spp., *Rotylenchulus reniformis*, and *Tylenchorhynchus* spp. *Helicotylenchus* spp. were isolated most frequently consisting of 37% of the nematode population. *Rotylenchulus reniformis* comprised 33% followed by *M. incognita* at 13%. One genus of plant-parasitic nematode were found in 36% of the samples. Of samples containing a single genus, 66% contained only *R. reniformis* and 34% contained only *Helicotylenchus* spp. Multiple plant-parasitic nematode species were found in 64% of the samples. Sixty percent of the samples contained two genera, 29% contained three genera and 11% contained more than four genera.

NEMATODES AND SUSTAINABLE AGRICULTURE IN MEXICO [NEMATODOS Y AGRICULTURA SUSTENTABLE EN MÉXICO]. N. Marban-Mendoza, Departamento de Parasitología Agrícola,

Universidad Autónoma Chapingo, Chapingo Estado de México C. P. 56230, Mexico. —It is generally accepted that the IPM philosophy is one of the most efficient tools to develop sustainable agroecosystems. But the biggest challenge among IPM practitioners is to make IPM a reality in the field. This is particularly true in developing countries where basic elements (i.e. trained researchers, funds, IPM leaders, farming organizations, goverment policies) are lacking. The multiple problems affecting the development of nematode management in two major Mexican agroecosystems, coffee (*Coffea arabica*) and watermelon (*Cetrillus vulgaris*), will be discussed with special emphasis on the progress of nematology research, but also addressing conflicting questions about management decisions that are practical in Mexico.

THE ECONOMICS OF ECONOMIC THRESHOLDS FOR NEMATODES [LA ECONOMÍA DE LOS UMBRALES ECONÓMICOS PARA NEMATODOS]. M. C. Marra, Department of Agricultural and Resource Economics, North Carolina State University, Raleigh, NC 27695-8109, U.S.A.—The basic economic principles of the economic threshold in both a static and a dynamic setting are developed. Then, data needs and sources for threshold calculation are outlined. An example root-knot nematode threshold, using previously developed pest-yield relationships for peanuts, is calculated for both the static and dynamic case. The impacts of risk aversion and additional sample information on the threshold are discussed. Finally, changes in economic conditions are demonstrated to have a significant impact on threshold calculations.

ELEMENTS OF SUSTAINABLE AGRICULTURE [ELEMENTOS DE AGRICULTURA SUSTENTABLE]. R. McSorley, Department of Entomology and Nematology, University of Florida, Gainesville, FL 32611-0620, U.S.A.—A nearly infinite number of elements or dimensions must be considered if productivity of an agroecosystem is to be sustained indefinitely. In many cases, the most limiting element may determine the future sustainability of the system and set the context in which management decisions, including those involving nematodes, must be made. Some examples of critical elements include human population size, water, fossil fuel energy, nitrogen, carbon dioxide, salinity, economics, and amount of cropland. The implications of these factors in future nematode management trends are discussed briefly. The multiple dimensions affecting the sustainability of an agroecosystem parallel the dimensions of the ecological niches of the organisms involved, but include a number of human-imposed dimensions (political, social, economic, and management practices) as well. A variety of complex questions, some with conflicting answers, must be addressed in the planning and design of agroecosystems sustainable for future generations.

PEANUT SUSCEPTIBILITY TO AN UNDESCRIBED ROOT-KNOT NEMATODE [SUSCEPTIBILIDAD DEL MANÍ A UN NEMATODO AGALLADOR NO DESCRITO]. C. B. Meador,[1] T. A. Lee,[1] C. E. Simpson,[2] and J. L. Starr,[3] Department Plant Pathology and Microbiology, Texas A&M University, Stephenville, TX,[1] Department of Soil & Crop Sciences (Plant Breeding), Texas A&M University, Stephenville, TX[2] and Department of Plant Pathology and Microbiology, Texas A&M University, College Station, Stephenville, TX 76401, U.S.A.[3]—Nematodes cause significant yield reductions in peanut. A survey was conducted in Collingsworth Co., TX to determine areas infested with an undescribed *Meloidogyne* spp. Soil samples were taken from fields at 1.6 km intervals in the areas of peanut production in the county. Nematodes were distributed uniformly over the sampling area. In addition to the survey, plots were established in one Collingsworth Co. field infested with the undescribed species and another in Comanche Co. TX infested with *M. javanica*. Yield response to Temik® of four *M. arenaria*-resistant genotypes (COAN, TP301-1-8, TP293-3-3, TP296- 4-4) and two susceptible cultivars (Florunner and Tamrun 96) were compared. Yield responses to Temik at the Collingsworth Co. site ranged from 3-42% with the susceptible cultivars having a greater response than the *M. arenaria*-resistant lines. Yield responses to Temik at the Comanche Co. site ranged from 1-79%, with the susceptible cultivars having a much greater response than the *M. arenaria*-resistant genotypes. At both

sites, the final nematode population densities were lower with the resistant genotypes than with the susceptible cultivars. These data indicate that the undescribed *Meloidogyne* spp. is less damaging than *M. javanica*. Additionally, resistance to *M. arenaria* also suppressed populations of the undescribed species.

PLANT PARASITIC NEMATODES IN DECIDUOUS FRUIT ORCHARDS AND VINEYARDS IN THE WESTERN CAPE PROVINCE OF SOUTH AFRICA [NEMATODOS FITOPARÁSITOS EN HUERTOS CADUCIFOLIOS Y VIÑEDOS EN LA PROVINCIA OCCIDENTAL DE AFRICA DEL SUR]. A. J. Meyer, Department of Entomology and Nematology, University of Stellenbosch, Republic of South Africa.—Between 120 000 and 150 000 hectares are planted to a variety of pome-fruits, stone-fruits and vines in the Western Cape Region of South Africa. This region has a mediterranean climate with winter rainfall, in contrast to the rest of the country which experiences summer rainfall. In addition to the insect pests and diseases affecting production in this region, growers and researchers recently have had to add the often overlooked damage caused by plant parasitic nematodes. Stone-fruits are damaged by *Meloidogyne* species, *Mesocriconema xenoplax,* and *Xiphinema* species. Apples are free of root-knot nematodes but may be affected by *Pratylenchus* species and *Xiphinema brevicolle*. Vines suffer from fanleaf transmitted by *Xiphinema index* and are further infected by very much the same parasites that damage peach and plum trees.

EFECTO DEL NEMATODO AGALLADOR *MELIDOGYNE INCOGNITA* SOBRE EL CRECIMIENTO DE PLANTAS DE *IMPATIENS BALSAMINA* [EFFECT OF *MELOIDOGYNE INCOGNITA* ON *IMPATIENS BALSAMINA* GROWTH]. J. Montilla, E. Briceño, N. Jiménez y J. Renaud, Universidad Centroccidental Lisandro Alvarado, Posgrado de Fitopatología, Apdo 400, Barquisimeto, Venezuela.—Se determinó la relación entre la densidad de población inicial del nematodo agallador *M. incognita* y el crecimiento de plantas de *I. balsamina* cultivar Dazzler Blush cultivadas en umbráculo en bolsas plásticas de 1 000cm^3 de capacidad. Las densidades poblacionales iniciales fueron 4, 8, 16 y 32 huevos/cc de suelo. Los resultados demostraron la susceptibilidad de las plantas a *M. incognita*. El peso seco de la parte aérea fue afectado significativamente al disminuir 60 y 71% con relación al testigo para las poblaciones iniciales de 16 y 32 huevos/cc de suelo respectivamente. De igual manera, la altura de las plantas presentó diferencias altamente significativas con respecto al testigo obteniéndose una reducción del 50% tanto para la población inicial de 16 huevos/cc de suelo como para 32 huevos/cc de suelo.

PLANT PARASITIC NEMATODE PROBLEMS IN PERNAMBUCO AND NEIGHBORING STATES: AN OVERVIEW IN 2000 [PROBLEMAS DE FITONEMATODOS EN PERNAMBUCO Y ESTADOS VECINOS: SITUACIÓN EN EL 2000]. R. M. Moura, and E. M. R. Pedrosa, UFRPE, Dept. Agronomia, Dois Irmãos, Recife, PE 52171-900, Brazil.—The Nematology Laboratory of the Federal Rural University of Pernambuco, located in Northeast of Brazil, has a permanent extension program for farmers, through diagnose and control measure recommendations. The Northeast has a diversified agriculture and plant nematology problems which cause high losses. The effects of these pathogens are reflected on yield reduction, market quality and premature microbiotic rotting of the agricultural products during storage. Sugarcane is severely affected by the root-knot nematodes, particularly *Meloidogyne incognita* and *M. javanica*, and the leason nematode *Pratylenchus zeae*. *Meloidogyne* spp., *Scutellonema bradys* and *P. coffeae* have been found associated with yams (*Dioscorea cayenensis*) always with severe effects. Banana cannot be cultivated without the continual use of nematicides. *Meloidogyne* spp., *Helicotylenchus multicinctus, Radopholus similis* and *P. coffeae* are the main causes of banana losses by nematodes. *Bursaphelenchus cocophilus* frequently attacks coconut, oil palm and imperial palm. The diseases sudden death of soursop (*Annona muricata*), dwarf of cilantro (*Coriandrum sativum*) and black spot of Irish potato (*Solanum tuberosum*) caused by *P. coffeae, R. reniformis* and *P. brachyurus*, respectively, are of economic value. Although there is a system of control for most crop-nematode combinations, the use of nematicides increases every year.

IN-LINE™ AS A METHYL BROMIDE ALTERNATIVE IN CALIFORNIA [IN-LINE™ COMO ALTERNATIVA AL BROMURO DE METILO EN CALIFORNIA]. J. P. Mueller, Ph.D., Dow AgroSciences LLC, 175 Mesquite Ct. Brentwood, CA 94513, U.S.A.—Soil injection and drip applications of 1,3-dichloropropene / chloropicrin combinations (1,3-D/pic) and straight pic have been tested extensively as alternatives to methyl bromide / chloropicrin (MeBr/pic). InLine is an emulsifiable formulation of 1,3-D/pic, for drip irrigation application. InLine was recently registered under an Experimental Use Permit by US-EPA. Early stage commercial use is now underway in several crops. Research in California strawberries is a prototype for other methyl bromide alternative projects. Several years of research have been conducted by a collaboration which includes the California Strawberry Commission, USDA-ARS, the University of California and industry researchers. This has involved a variety of small plot replicated studies and large-scale commercial validation trials in all major strawberry production areas. In these studies, no other chemical or non-chemical options have shown the consistency and reliability of these compounds in delivering results comparable to MeBr/pic. Strawberry yields have ranged from to 85% to 112% of yields from MeBr/pic. Drip-applied InLine was as effective as soil injected Telone C35 at comparable rates. Results indicate that these are primary methyl bromide alternatives. Continuing research is determining the effect of virtually impermeable plastic film, optimizing the amount of water applied with the treatments, and testing reduced rates. Extensive delivery systems research has identified several hardware configurations that will safely and conveniently deliver 1,3-D through commercial drip irrigation systems. A product delivery and application infrastructure already exists which will implement this innovative methyl bromide alternative.

MORPHOLOGICAL DIVERSITY OF THE CEPHALIC REGION IN SOME CEPHALOBIDAE FROM CALIFORNIA [DIVERSIDAD MORFOLÓGICA DE LA REGIÓN CEFÁLICA DE CEPHALOBIDAE EN CALIFORNIA]. M. Mundo-Ocampo,[1] J. G. Baldwin,[1] S. Nadler,[2] S. P. Stock,[2] I. De Ley,[3] and P. De Ley,[3] Department of Nematology, University of California, Riverside, CA 92521,[1] Department of Nematology, University of California, Davis, CA 95616-8668, U.S.A.[2] and Vakgroep Biologie, Universiteit Gent, Ledeganckstraat 35B-9000 Gent, Belgium.[3]—Cephalobidae members are characterized by a remarkable degree of morphological diversity. This is expressed by the dissimilar arrangement (organization) of the cephalic structures. Although the cephalic region is extremely variable in morphology, it provides many of the diagnostic characters for identification of genera and even species. Scanning Electron Microscopy (SEM) has been a helpful tool to resolve and understand the elaborate diversity and configuration of cephalic structures. Cephalobids recovered from soils of the California deserts including Death Valley, Mojave and Joshua Tree, were prepared by standard methods for SEM observations. Digital images of *Acrobeles, Acromoldavicus, Cephalobus, Cervidellus, Chiloplacus, Metacrobeles, Nothacrobeles, Paracrobeles, Stegellata, Zeldia*, and others are illustrated and discussed. Information on the morphology of the cephalic region in combination with molecular, ecological and developmental data will expand our knowledge of phylogenetic relationships among members of Cephalobidae.

PATOGENICIDAD DE *XIPHINEMA VUITTENEZI* SOBRE PATRONES DE CÍTRICOS EN CHILE [PATOGENECITY OF *XIPHINEMA VUITTENEZI* ON CITRUS ROOTSTOCKS IN CHILE]. L. Navarro y J. C. Magunacelaya, Departamento de Sanidad Vegetal, Facultad de Ciencias Agronómicas, Universidad de Chile, Santa Rosa 11315, Santiago, Chile.—El uso de portainjertos en cítricos es una práctica muy frecuente en Chile por la ventaja que presenta a problemas sanitarios de raíces. Hoy el agricultor pide que el patrón tenga resistencia a enfermedades y nemátodos ya que se favorece la productividad y permite mejor calidad de fruta. En Chile, en los dos últimos años hemos detectado poblaciones importantes de *Xiphinema vuittenezi* sobre cítricos, nemátodo que sólo había sido encontrado en la Región Metropolitana, sobre damasco, duraznero y membrilleros. Durante 7 meses

se realizó un ensayo que consistió en la inoculación de 100, 200, 400, 800, 1600 y 3200 ejemplares en tres patrones de cítricos de uso frecuente en el país. Se concluye que: - 400 individuos de *Xiphinema vuittenezi* inoculados por planta (20 ejemplares por 250 ml de suelo) es el nivel poblacional con mayor tasa de reproducción. - A pesar de que hubo diferencias de crecimiento entre plantas inoculadas con diferentes niveles poblacionales, el análisis estadístico no arrojó diferencias estadísticamente significativas entre los diferentes niveles de infestación de *Xiphinema vuittenezi*. - El patrón que presentó la mayor resistencia a la reproducción de *X. vuittenezi* fue Citrumelo Swingle, *Citrus macrophylla* tuvo resistencia intermedia y Citrange Carrizo la mayor susceptibilidad.

APPROACHES FOR ASSESSING CONTRIBUTIONS OF SOIL MICROBIAL COMMUNITIES TO SOIL SUPPRESSIVENESS [MÉTODOS PARA EVALUAR LA CONTRIBUCIÓN DE LAS COMUNIDADES MICROBIALES EDÁFICAS EN LA SUPRESIVIDAD DE SUELOS]. E. B. Nelson, Cornell University, Department of Plant Pathology, 334 Plant Science Bldg., Ithaca, NY 14853, U.S.A.—Plant-associated soil microorganisms play important roles in the suppressiveness of soils to plant pathogens and diseases. However, the organisms involved in suppressiveness and the mechanisms by which suppressiveness is expressed have been elusive. This has been due in part to the poor understanding of the pre-infection behavior of the target pathogens, to the lack of suitable methods for studying the diversity, distribution, and behavior of plant-associated microorganisms in soil habitats, and to the poor understanding of the mechanisms by which these microorganisms suppress pathogens and diseases. A common approach for the study of microbial communities related to disease suppressiveness has been to simply describe microbial communities present in both suppressive and non-suppressive soils. It is possible that this comparative approach may allow one to deduce which species may potentially play a role in suppressiveness. These descriptive analyses have most commonly relied on culturing techniques using a variety of culture media designed to maximize the recovery of diverse microbial populations. However, only a small fraction (<0.1%) of the soil or rhizosphere microbial community has been accessible with this approach, limiting the value of this approach for determining the role of specific populations in soil suppressiveness. In an attempt to overcome these problems, culture-independent methods have been developed to examine the composition of microbial communities. These include the analysis of phospholipid fatty acids, community-level physiological profiles, and molecular methods in which small subunit rRNA genes are amplified from soil-extracted nucleic acids, sequenced, and either compared with databases of similar sequences from previously-studied microorganisms or used to develop group—and taxon-specific oligonucleotide probes. New developments in genomics are also providing opportunities for examining complex soil microbial communities. Whereas this comparative approach can provide correlations between specific microorganisms and disease suppressiveness, it does not allow us to directly study the microbial interactions responsible for pathogen and disease suppressiveness. A more meaningful approach is to directly ask questions about specific microbial processes that may logically be involved in disease suppressiveness, taking into account the temporal aspects of pathogen responses and the specific microbial mechanisms that affect differential pathogen responses in both suppressive and non-suppressive soils. Studies that have been conducted over the years with microbial inoculants as well as studies of pathogenesis by soil pathogens have generated many of our important concepts in biological disease control, particularly those related to mechanisms of action and important ecological relationships between introduced microorganisms and pathogens, plants, and soil microbial communities. This approach may be best illustrated by applying insights gained from studies of biological seed treatments to control *Pythium* damping-off to studies focused on determinations of specific functional populations within spermosphere microbial communities that contribute to *Pythium* suppressive soils. The various pros and cons of both descriptive and functional approaches to the study of plant-associated microbial communities in suppressive soils will be discussed.

RESISTANCE OF WILD ANNUAL AND PERENNIAL SOYBEANS TO *HETERODERA GLYCINES* [RESISTENCIA DE LA SOYA ANUAL SILVESTRE Y PERENNE A *HETERODERA GLYCINES*]. G. R. Noel, T. Hymowitz, and S. Bauer, USDA, ARS and Department of Crop Sciences, University of Illinois, Urbana, IL 61801, U.S.A.—Approximately 30 wild annual soybean, *Glycine soja*, accessions and 170 accessions of the perennial species, *G. arenaria, G. argyrea, G. canescens, G. clandestina, G. curvata, G. cyrtoloba, G. falcata, G. latifolia, G. microphylla, G. pindanica, G. tabacina* and *G. tomentella* were evaluated for resistance to *Heterodera glycines* race 3. Most of the *G. soja* accessions evaluated were susceptible to *H. glycines*. A few accessions expressed a low to moderate level of resistance that is not adequate to use for resistance to *H. glycines*. All of the perennial soybeans had at least one accession that was immune to *H. glycines*. Differences in chromosome numbers between perennial soybean ($2n = 38, 40, 78$ or 80) and domestic soybean, *G. max* ($2n = 40$), require embryo rescue procedures to incorporate resistance in perennial soybean into *G. max*.

FACTORS INFLUENCING THE USE OF INTEGRATED METHODS OF NEMATODE MANAGEMENT IN FLORIDA [FACTORES INFLUYENTES DEL USO DE METODOS INTEGRADOS DE MANEJO DE NEMATODOS EN FLORIDA]. J. W. Noling, University of Florida, Institute of Food and Agricultural Sciences, Citrus Research and Education Center, 700 Experiment Station Rd, Lake Alfred, FL 33850, U.S.A.—Alternatives to methyl bromide that are currently under development will require management strategies in addition to those needed for methyl bromide alone. For example, recent studies with use of nematode resistant tomato and pepper cultivars have demonstrated that neither are stand alone replacements for methyl bromide soil fumigation, nor can the resistance be maintained if resistance management strategies are not implemented. Organic soil amendments were shown to improve plant growth, but they also favored population growth of root-knot nematodes, thereby increasing the rate at which resistance breaking biotypes are likely to develop. Other studies revealed that it was not possible to resolve nematode problems following infection of the root system, or to avoid significant crop losses with post plant nematicides such as oxamyl. The inconsistency of both nematode control and crop yield responses to alternative management tactics appears to be related to pest diversity and variable edaphic and environmental conditions, only some of which are manageable. Other nematode management tactics have similar shortcomings and require further research.

A REVIEW OF IR-4'S METHYL BROMIDE ALTERNATIVES PROGRAMS FOR MINOR CROPS [REVISIÓN DE LOS PROGRAMAS ALTERNATIVOS IR-4'S AL BROMURO DE METILO EN CULTIVOS MENORES]. J. A. Norton, IR-4 Project, Technology Centre of New Jersey, Rutgers, The State University of New Jersey, 681 U.S. Highway 1 South, North Brunswick, NJ 08902-3390, U.S.A.—R-4 has ongoing trials in California and in Florida where a number of possible methyl bromide alternatives are being evaluated in production strawberries. These trials were established during the fall of 1999. Trials were initiated by IR-4 in fresh market tomatoes in California and in Florida during the spring of 2000. Several treatments showing promise in the IR-4 program in strawberries are included in the tomato program plus several new entries have been included. IR-4 programs for methyl bromide alternative research in strawberry nurseries and in cut flowers are being planned for initiation during the fall of 2000. Treatments in the ongoing and planned methyl bromide alternatives programs will be discussed. These treatments include the use of products that could possible serve as "drop in" replacements for methyl bromide as well as products that will require other products used in various combinations for biological activity equivalent to methyl bromide.

MANAGEMENT OPTIONS FOR RENIFORM NEMATODE IN COTTON PRODUCTION FOR LOUISIANA [OPCIONES PARA EL MANEJO DEL NEMATODO RENIFORME DEL ALGODONERO EN LOUISIANA]. C. Overstreet, and E. C. McGawley, LSU Agricultural Center, P.O. Box 25100, Raton Rouge, LA 70894, U.S.A.—Management options for the reniform nematode (*Rotylen-*

chulus reniformis) in cotton have been fairly limited until the last several years because of government policies and reluctance by producers to rotate to resistant or nonhosts crops. Nematicides have been the most widely used management option. Thirty-two nematicide trials have been conducted in fields infested with the reniform nematode since 1982 to evaluate the efficacy of aldicarb at 0.59 kg/ha (a.i.). Population levels of the reniform nematode varied across locations and ranged from 80 to 13 505 per 500 cm^3 at the time of planting. Yields in the non-treated controls averaged 2298 kg/ha, whereas those in the aldicarb treatment were significantly better ($P = 0.0001$), averaging 2584 kg/ha. Midseason levels of the reniform nematode were not significantly reduced by aldicarb. Eleven nematicide trials were conducted to determine if increased rates of aldicarb [0.84, and 1.18 kg/ha (a.i.)] could be more effective than the standard treatment of aldicarb (0.59 kg/ha (a.i.). No significant differences were observed among treatments, and yields were 2 261, 2 307, and 2 283 kg/ha for the 0.59, 0.84, and 1.18 kg/ha (a.i.) rates of aldicarb, respectively. Nematicide use in cotton has increased from essentially none 20 years ago to current levels of 75-80% across the state.

MANAGING BURROWING NEMATODES AND ENHANCED BIODEGRADTION ON BANANAS IN AUSTRALIA [MANEJO DEL NEMATODO BARRENADOR Y MEJORAMIENTO DE LA BIODEGRADACIÓN DEL BANANO EN AUSTRALIA]. A. B. Pattison,[1] J. M. Stanton,[2] J. Cobon,[2] and C. Versteeg,[1] Queensland Department of Primary Industries, P.O. Box 20 South Johnstone, Qld, 4859, Australia[1] and Queensland Department of Primary Industries, 80 Meiers Rd, Indooroopilly, Qld, 4068, Australia.[2]—Burrowing nematode (*Radopholus similis*) is controlled with the routine application of nematicides to banana growing soils in north Queensland. A field trial was established to determine the efficacy of the five currently registered nematicides; fenamiphos, ethoprofos, cadusafos, terbufos and oxamyl against an untreated control. Bioassays were conducted to determine the extent of enhanced biodegradation to each chemical prior to the application of treatments, after three and after five treatment applications over an 18 month period. The change in nematode damage and nematode populations were determined prior to each treatment application and three months after the fifth application of nematicide. The trial site was found to have enhanced biodegradation for fenamiphos before treatments were applied. After five consecutive applications of all nematicides, the efficacy was significantly improved in sterilized soil relative to unsterilized soil, suggesting microbial degradation. Nematicides were only able to maintain the level of nematode damage and nematode populations on roots. All nematicides significantly reduced the number of fallouts relative to the untreated control. All nematicides, except fenamiphos, increased yields one year after the first nematicide application.

POTENTIAL METHYL BROMIDE ALTERNATIVES TRIALS IN THE LATIN AMERICAN ARENA [POTENCIAL DE LOS ENSAYOS ALTERNATIVOS AL BROMURO DE METILO EN EL ÁMBITO LATINOÁMERICANO]. J. Pierce, Trical de Baja California, Hendrix and Dail Central America, Trical de Sudamerica, San José, Costa Rica.—Trical and Hendrix and Dail, soil fumigation industry leaders have advanced methyl bromide alternatives under evaluation in Mexico and Central America in all high value crops. Current trials include: Telone II, Telone C-17, Telone C-35, Chloropicrin 100%, and Basamid. Application methods are via tarped drip systems and traditional tarped knife injections. Preliminary research has been performed with 1, 3-dichloropropene post-plant applications in bananas with favorable results. Evaluations to date with all alternatives in traditional methyl bromide markets have been positive. Unique drip system applications have allowed flexible fumigation timing and weed pre-germination control, enabling improved herbicidal performance from 1, 3-dichloropropene + chloropicrin formulations.

COMBINATION OF SOIL HEATING AND AMENDING SOIL WITH BROCCOLI CONTROLS *MELOIDOGYNE INCOGNITA* INFESTATION OF MELON IN GREENHOUSE POT EXPERIMENTS [ENSAYOS EN INVERNADERO COMBINANDO SOLARIZACIÓN Y ENMIENDAS DE

BROCOLI EN EL CONTROL DE *MELOIDOGYNE INCOGNITA* EN MELÓN]. A. T. Ploeg, Department of Nematology, University of California, Riverside, CA 92521, U.S.A.—Soil solarization and "bio-fumigation" have been used to control weeds, soil-borne diseases and nematodes. However, managing the root-knot nematode *M. incognita* using these strategies appears difficult. It was recently shown that combining soil solarization with bio-fumigation may improve levels of root-knot nematode control dramatically. In a series of greenhouse experiments, we studied the effects of soil-heating alone, and in combination with adding broccoli leaf material to *M. incognita* infested soil on nematode infestation and growth of melon plants. Melon plants grown in non-treated nematode infested soil generally did not survive. Heating nematode-infested soil for 5-20 days at 40°C greatly reduced nematode infestation. Heating soil at temperatures between 25 and 40°C slightly reduced nematode infestation, but adding broccoli to the soil at these temperatures resulted in a strong reduction in root-galling and improved growth of the melon bio-assay plants comparable to those grown in nematode-free soil. At soil temperatures of 20°C and 25°C, the addition of broccoli to the soil did not reduce root galling of the melon plants. The results indicate that a combination of soil solarization and "bio-fumigation" may be useful for control of *M. incognita* in areas with suitable climates.

GREENHOUSE AND FIELD TESTS ON CONTROL OF *MELOIDOGYNE INCOGNITA* USING MARIGOLDS [ENSAYOS EN INVERNADERO Y CAMPO PARA EL CONTROL DE *MELOIDOGYNE INCOGNITA* CON CLAVELÓN]. A. T. Ploeg, and P. C. Maris, Department of Nematology, University of California, Riverside, CA 92521, U.S.A.—A range of marigold varieties representing four species were tested for their efficacy in controlling *M. incognita*, *M. javanica*, *M. arenaria* and *M. hapla*. Large differences occurred between different marigold varieties and between the four different root-knot nematode species. Two marigold varieties which were effective in controlling *M. incognita* in greenhouse tests were used as a cover crop grown for three months prior to susceptible tomato on two *M. incognita* infested field sites. Infection by *M. incognita* was dramatically reduced in tomato grown after marigolds compared to tomato grown after a fallow period and was similar to fumigated treatments. Tomato fruit yields following marigolds and following soil fumigation increased correspondingly. Melons grown on the marigold plots during the following season still yielded more fruits (kg), although nematode soil counts and root infection had started to increase. Greenhouse experiments showed that effects of marigolds on *M. incognita* levels were greatest at soil temperatures most favorable to nematode activity. Amending *M. incognita* infested soil with marigold plant refuse slightly lowered the root galling and infestation of tomato, but similar results were obtained when soil was amended with tomato plant refuse.

WEEDS AS POTENTIAL RESERVOIRS OF *RADOPHOLUS SIMILIS* IN BANANA FIELDS IN MARTINIQUE [MALEZAS COMO RESERVORIO POTENCIAL DE *RADOPHOLUS SIMILIS* EN HUERTOS DE BANANO EN MARTINICA]. P. Quénéhervé,[1] C. Chabrier,[2] A. Auwerkerken,[1] and S. Marie-Luce,[1] Nematology IRD, BP 8006, 97259 Fort-de-France Cedex[1] and CIRAD-FLHOR, BP 153, 97202 Fort-de-France, Martinique.[2]—During a survey of the nematodes associated with weeds in banana fields in Martinique, 37 weed species in 34 genera and 19 families were collected to extract nematodes from the roots. Result of this survey showed that at least 20 weed species were hosts of *Radopholus similis* with a few exceptions (e.g., *Phenax sonneratii*), most good *R. similis* reservoirs (e.g., *Euphorbia heterophylla*, *Echinochloa colonna*, *Eleusine indica*, *Paspalum fasciculatum*, *Solanum torvum*) were consistently found within 3 families, the Euphorbiaceae, Poaceae and Solanaceae. Nematode densities varied from 4 to a maximum of 1896 adults and juveniles per gram of dry root (e.g., *Echinochloa colonna*) with an overall mean density of 192 per gram of dry root when present. These results showed that weeds can be very significant reservoirs of *R. similis* in banana fields. This information is crucial to devise future appropriate nematode control measures such as rotation crops and fallow before re-planting with nematode free planting material.

ENZYME PHENOTYPES OF *MELOIDOGYNE* SPP. ASSOCIATED WITH BANANAS IN MARTINIQUE [FENOTIPOS ENZIMÁTICOS DE *MELOIDOGYNE* SPP. ASOCIADOS AL BANANO EN MARTINICA]. P. Quénéhervé,[1] S. de Bock,[1] C. Valette,[1] and C. Chabrier,[2] Nematology IRD, BP 8006, 97259 Fort-de-France Cedex,[1] and CIRAD-FLHOR, BP 153, 97202 Fort-de-France, Martinique.[2]— Root-knot nematodes (*Meloidogyne* spp.) are more and more frequently found associated with bananas in the Antilles, replacing *Radopholus similis* in the root system, especially on plants issued from micropropagated plants after fallow. Because of the severity of these root-knot infestations, it is important to determine what species are involved in order to develop appropriate nematode management methods. Root-knot populations from thirty-one banana plantations in Martinique (ten females per site) were dissected from the roots and characterized by their esterase and malate dehydrogenase patterns using an automated electrophoretic system (Phastsystem,® Pharmacia). Only 3 phenotype combinations (EST-MDH) were found, corresponding to: *M. incognita* (I2-N1 in 33.9%), *M. arenaria* type 1 (A2-N1 in 62.9%) and *M. arenaria* type 2 (A2-N3 in 3.2%). Twenty-one fields showed a monospecific infestation and it is interesting to notice that the highest infestation levels occurred with *M. arenaria* (> 100 000 J 2/ 100 g roots), 4 times higher than with *M. incognita* (> 20 000 J2/ 100 g roots).

EFFECTS OF CROPPING SYSTEM ON OVERWINTER DYNAMICS OF SOYBEAN CYST NEMATODE [EFECTOS DE SISTEMAS DE CULTIVO SOBRE LA DINÁMICA INVERNAL DEL NEMATODO ENQUISTADO DE LA SOYA]. R. D. Riggs, L. Rakes, and A. Mauromoustakos, Department of Plant Pathology and Agricultural Statistics Laboratory, University of Arkansas, Fayetteville, AR 72701, U.S.A.—Survival of the eggs of *Heterodera glycines* between crop maturity and spring planting may be a major factor in the damage to soybean that year and determining the measures necessary to prevent damage. The objective of this project was to determine the effect of different cropping systems on overwinter survival of *H. glycines* in Arkansas. In plots with nonhosts or resistant cultivars, designed to reduce *H. glycines* population levels during the growing season, soil samples collected at harvest and at planting were analyzed to determine the nematode survival rate. In 4-year rotations, mean nematode survival was lowest (34.9-51.7%) in plots where the most susceptible cultivars were grown, and highest (50.1-74.8%) where the most resistant cultivars or nonhosts were grown. Nematodes in plots that had winter wheat or a cover or green manure crop appeared to survive better (48.1-70.3%) than those from plots that had soybean only (34.9-55.6%). Nematodes from plots with continuous susceptible or resistant cultivars survived at about the same rate as the same cultivar in a rotation. These results indicate that double-cropping with wheat may result in higher nematode population levels when the soybean crop is planted.

EFFECT OF FRESH AND DRY ORGANIC AMENDMENTS ON *MELOIDOGYNE ARENARIA* IN GREENHOUSE EXPERIMENTS [EFECTO DE ENMIENDAS FRESCAS Y SECAS SOBRE *MELOIDOGYNE ARENARIA* EN EXPERIMENTOS DE INVERNADERO]. C. H. S. P. Ritzinger,[1] and R. McSorley,[2] Embrapa Mandioca e Fruticultura, Caixa postal 007, 44380-000, Cruz das Almas, Ba, Brasil[1] and Department of Entomology and Nematology, University of Florida, Gainesville, FL 32611, U.S.A.[2] — Organic amendments (OA) were evaluated in two greenhouse experiments for their effectiveness in suppressing *Meloidogyne arenaria* populations in naturally infested soil. Vegetative shoots from castor (*Ricinus communis*), collard (*Brassica oleracea*), sesame (*Sesamum indicum*), sorghum (*Sorghum bicolor*), velvetbean (*Mucuna deeringiana*), and zinnia (*Zinnia elegans*) were chopped into small pieces, and placed on the soil surface in plastic pots. Nematode numbers and growth of 'Clemson Spineless' okra (*Hibiscus esculentus*) planted into each pot were evaluated. In the spring experiment, 4 g of the fresh OA or 4 g of the dried OA were used as separate treatments. The main effect of fresh vs. dry OA on nematode population and its interaction with OA type were significant ($P \leq 0.05$), with greater efficacy from dried OA than fresh OA. Reduction of juveniles (J2) in the root system was obtained with dry OA from zinnia, castor, velvetbean, and collard treatments. The lowest egg mass indices were noted when castor was used. In the summer trial, 4 g of dry OA and the fresh weight of each OA correspond-

ing to 4 g dry weight did not differ in their ability to reduce J2 ($P \geq 0.05$). Castor and velvetbean gave best suppression of J2 in soil, while reduction of J2 in the root systems was greatest with velvetbean. For both seasons, the best growth responses of okra were obtained with OA of castor, velvetbean, collard, and zinnia, which had lower C/N ratios than sesame and sorghum. In general, castor and velvetbean were the most effective OA source, and sesame and sorghum the least effective, for plant growth and nematode suppression.

COMPARATIVE VERTICAL DISTRIBUTION OF *ROTYLENCHULUS RENIFORMIS* IN SOIL IN COTTON PRODUCTION IN ARKANSAS, LOUISIANA, AND TEXAS [DISTRIBUCIÓN VERTICAL COMPARATIVA DE *ROTYLENCHULUS RENIFORMES* EN SUELOS DE ALGODONERO DE ARKANZAS, LOUISIANA Y TEXAS]. A. F. Robinson,[1] A. C. Bridges,[1] C. G. Cook,[2] T. L. Kirkpatrick,[3] E. C. McGawley,[4] C. Overstreet,[5] and B. Padgett,[6] USDA, College Station, TX 77845,[1] Novartis Seeds, Inc., Santa Rosa, TX 78593,[2] Arkansas SW REC, Hope, AR 71801,[3] Louisiana State Univ., Baton Rouge, LA 70803,[4] Louisiana Coop. Ext. Svc., Baton Rouge, LA 70894[5] and Winnsboro, LA 71295, U.S.A.[6]—Yield responses of Upland cotton (*Gossypium hirsutum*) to nematicides often are unpredictable in fields infested with *R. reniformis*. In one field in 1998, we observed that *R. reniformis* was unique among nematodes in the soil profile by occurring in smallest numbers near the surface and in greatest numbers 1 m deep, where other nematodes were rare or absent. Deep occurrence meant that most nematodes would escape nematicide treatment and standard diagnostic samples (0-45 cm deep) could provide a completely misleading measure of the nematode pressure on the crop. We examined the vertical distribution of *R. reniformis* in cotton in relation to soil texture and moisture and other nematode species in 10 fields in Arkansas, Louisiana, and Texas. *R. reniformis* distributions in four fields were concentrated near the surface but in the remaining fields extended well below 1 meter. Greatest concentrations were between 40 and 120 cm or were in two peaks, one deep and one near the surface. Vertical distribution patterns appeared unrelated to soil texture or moisture patterns.

ESTUDIO AL MICROSCOPIO ELECTRÓNICO DE BARRIDO DE POBLACIONES DE *MELOIDOGYNE MAYAGUENSIS* [SCANNING-ELECTRON MICROSCOPY OF *MELOIDOGYNE MAYAGUENSIS* POPULATIONS]. M. G. Rodríguez,[1] L. Sánchez[1] and J. Rowe,[2] Laboratorio de Nematología, Centro Nacional de Sanidad Agropecuaria (CENSA), Apartado 10, San José de las Lajas, Habana, Cuba[1] y Nematology Laboratory, Rothamsted Experimental Station, Harpenden, Herts AL5 2JQ, UK.[2]—La utilización del Microscopio Electrónico de Barrido (MEB) en el estudio de los nematodos parásitos de plantas ha propiciado la observación de detalles en la morfología de estos organismos. En Cuba esta tecnología no ha sido explotada con estos fines, constituyendo el objetivo de este trabajo el estudio de la población cubana de *Meloidogyne mayaguensis* y su comparación con las de Puerto Rico (paratipo) y Costa de Marfil. Los nematodos fueron fijados con una mezcla de TAF-Glicerol 2% y posteriormente deshidratados empleando una serie de alcoholes y un equipo de Punto Crítico de Secado. Los especímenes fueron recubiertos con oro y observados en un microscopio Hitachi con 10 y 15 Kv. Se observaron diferencias marcadas en la morfología del patrón perineal de las hembras entre las tres poblaciones en estudio. La cubana exhibe un patrón con fasmídeas muy separadas y el área de la cola despejada y elíptica, mientras que las hembras de P. Rico y Costa de Marfil presentan esta área surcada por estrías. La forma y disposición de las estrías cuticulares, varían en el patrón perineal de acuerdo a la población. Los machos presentan 4 líneas laterales, con las externas areoladas, detalle que aparece también en las larvas.

NEMATICIDAL AND HERBICIDAL PROPERTIES OF POTASSION AZIDE [PROPIEDADES HERBICIDAS Y NEMATICIDAS DE LA ÁCIDA DE POTASIO]. R. Rodríguez-Kábana and D. G. Robertson, Department of Entomology and Plant Pathology, Auburn University, Auburn, AL 36849, U.S.A.—The nemtotoxic properties of potassion azide (KN_3) were studied in a greenhouse experiment with a soil from a cotton field infested with the reniform nematode (*Rotylenchulus reniformis*).

The compound was added to soil in an aqueous solution at rates of: 1, 2, 3, 4 and 5 mgs KN_3/kg soil. Soil samples for nematological analysis (salad bowl incubation technique) were collected one week after application of the material. Numbers of the reniform nematode declined exponentially in response to increasing KN_3 rates up to 4 mg/kg soil where almost 100% control of the nematode was observed; the 5 mg rate resulted also in 100% control. Numbers of microbivorous nematodes also declined in response to increasing KN_3 rates; however, the declined was linear and not as sharp as that observed for *R. reniformis*. Application of KN_3 at nematicidal rates to a soil infested with crab grass (*Digitaria sanguinalis*), purple nutsedge (*Cyperus rotundus*), Jimson weed (*Datura stramonium*) and a variety of other weed species failed to control the weeds. However, when KN_3 was applied at rates 20-200 mg/kg soil, the number of weeds declined proportionately to the rates used. Rates≥140 mg/kg soil resulted in ≥80% control of weeds. Among the weed species crabgrass was the least sensitive to KN_3 applications but purple nutsedge and the other species could be controlled (≥80%) by rates of 100-120 mg/kg soil.

COMPOSITIONS OF BENZALDEHYDE, CORN COBS AND UREA FOR CONTROL OF PLANT PARASITIC NEMATODES [COMPOSICIÓN DE BENZALDEHIDO, CAROZO DE MAÍZ Y ÚREA PARA EL COMBATE DE NEMATODOS FITOPARÁSITOS]. R. Rodríguez-Kábana, and C. R. Taylor, Department of Entomology and Plant Pathology, Auburn University, Auburn, AL 36849, U.S.A.— The nematicidal activities of mixtures of benzaldehyde with ground corn (*Zea mays*) cobs and urea were studied in greenhouse experiments with a soil infested with root-knot (*Meloidogyne arenaria*) and soybean cyst (*Heterodera glycines*) nematodes. Benzaldehyde applied to soil at rates of 0.1-0.6 ml/kg soil reduced juvenile populations (J2) of *M. arenaria* at rates ≥0.2 ml and of *H. glycines* at ≥0.4 ml. The addition of urea to soil at 300 mg/kg soil diminished J2's of the nematodes by 50% but when urea was combined with benzaldehyde at rates ≥0.2 ml *M. arenaria* J2's were practically eliminated; benzaldehyde rates >0.4 ml combined with urea were required to obtain the same degree of control for *H. glycines* J2's. The addition of urea to soil resulted in noticeable phytotoxicity to 'Davis' soybean, the host plant used in the study. Combinations of ground corn cobs (cc) at 20 g/kg soil and benzaldehyde at ≥0.1 ml suppressed J2's of the nematodes by ≥80% but resulted in some phytotoxicity to the host plants. The addition to soil of amendments composed of benzaldehyde (≥0.1 ml/kg soil) + urea + cc resulted in ≥95% suppression of J2's of the nematodes and no phytotoxicity. The tripartite combinations sharply stimulated population development of microbivorous nematodes in soil.

EFFECTS OF COMBINATIONS OF CHITIN AND BENZALDEHYDE ON SOIL SUPPRESSIVENESS TO ROOT-KNOT AND CYST NEMATODES [EFECTOS DE LA COMBINACIÓN DE QUITINA Y BENZALDEHIDO EN LA SUPRESIVIDAD DE SUELOS A NEMATODOS AGALLADORES Y ENQUISTADOS]. R. Rodríguez-Kábana,[1] N. Kokalis-Burelle,[2] and J. W. Kloepper,[1] Department of Entomology and Plant Pathology, Auburn University, Auburn, AL 36849[1] and USDA, ARS, U.S. Horticultural Research Lab, Ft. Pierce, FL 34945, U.S.A.[2]— The effects of amending soil with chitin and benzaldehyde on populations of *Meloidogyne arenaria* and *Heterodera glycines* juveniles and on microbial antagonism against eggs of *M. arenaria* was studied in greenhouse experiments. Chitin was applied to soil from a soybean (*Glycine max*) field infested with *H. glycines* and *M. arenaria* at rates of 2.5, 5.0, and 10.0 g/kg soil, and benzaldehyde at 0.1, 0.2, 0.4, and 0.6 ml/kg soil. Chitin applications controlled soil juvenile populations (J2) of *M. arenaria*. For *H. glycines* J2 only the 5.0 and 10 g rates of chitin resulted in high levels of control, while the 2.5 g rate resulted in a 60% reduction in *H. glycines* J2. All benzaldehyde treatments resulted in 60-70% reductions in *M. arenaria* J2 but had no effect on *H. glycines* J2 except at the 0.6 ml rate which diminished populations by 42%. The combination of chitin and benzaldehyde amendments increased control of J2's for both nematodes. Benzaldehyde applications at ≥0.2 ml in combination with chitin amendments eliminated *M. arenaria* J2 and reduced *H. glycines* J2 by 70-100%. At the end of the experiment 7 wks after application of the amendments, alginate films containing *M. arenaria* eggs were inserted in soil for 4 days, removed, washed, and observed

microscopically. The number of parasitized eggs was highest in films from soils with 10 g chitin. Benzaldehyde applications at ≥0.2 ml increased parasitism of eggs but when combined with chitin at 2.5 or 5.0 g/kg soil it reduced the number of parasitized eggs in the films.

ALTERACIONES EN EL COMPORTAMIENTO DE UNA CEPA DE *HETERORHABDITIS BACTERIOPHORA* [BEHAVIOUR ALTERATIONS OF A *HETERORHABDITIS BACTERIOPHORA* STRAIN]. L. Sánchez, M. G. Rodríguez, and L. Hidalgo, Div. Protección de Plantas, Centro Nacional de Sanidad Agropecuaria, Apdo. 10, San José de las Lajas, La Habana, Cuba.—*Heterorhabditis bacteriophora*** cepa HC1 aislada de campos de cítricos en Cuba, se seleccionó por sus potencialidades como agente de control biológico. Esta cepa se ha empleado con éxito en el combate del tetuan del boniato y chinches harinosas en cafeto, entre otras plagas. Como parte del trabajo para el establecimiento de los sistemas de calidad para su producción masiva sobre *Galleria mellonella* en Centros de Reproducción de Entomopatógenos (CRE), se realizó un estudio para conocer el comportamiento de los parámetros morfológicos y biológicos después de ser sometida a proceso de reproducción continua por más de 3 años. Se comparó el potencial reproductivo, sintomatología y patogenicidad sobre larvas de *G. mellonella*, así como la morfometría y la viabilidad después de su conservación en bandejas y en esponjas, con relación a la cepa original aislada de su habitat natural. Los resultados obtenidos indican, que excepto la morfometría, el resto de los parámetros resultaron estadísticamente diferentes en ambos aislados, resultando superiores en el caso de la cepa original recién aislada. En la primera, el potencial reproductivo se redujo a un 47% y se observaron larvas muertas del insecto sin la presencia del color pardo rojizo típico. La viabilidad en esponjas a los tres meses solo fue de un 29% frente a un 83% en el aislado del campo.

EVALUATION OF FOSTHIAZATE FOR CONTROL OF *MELOIDOGYNE CHITWOODI* ON RUSSET BURBANK POTATO [EVALUACIÓN DE FOSFOTHIAZATO EN EL COMBATE DE *MELOIDOGYNE CHITWOODI* EN PAPA "RUSSET BURBANK"]. G. S. Santo, and J. H. Wilson, Department of Plant Pathology, Washington State University, IAREC, Prosser, WA 99350, U.S.A.—Fosthiazate was evaluated for control of the Columbia root-knot nematode, *Meloidogyne chitwoodi* on 'Russet Burbank' potato (*Solanum tuberosum*) in a loamy sand field from 1991-94, and 1998-99. Plots were three rows wide (13.4 cm row spacing), 7.6 m long and arranged in a randomized complete block design with five replications. Treatments included fosthiazate 900EC at 3.24, 4.86 and 6.48 kg a.i./ha, and 1,3-dichloropropene at 187 L/ha and ethoprop 6EC at 12.96 kg a.i./ha served as the standard nematicide checks, and untreated plots served as controls. 1,3-dichloropropene was applied as a broadcast by tractor-drawn chisels 45.7 cm deep, spaced 45.7 cm apart and packed immediately with a cultipacker 3-4 weeks before planting. Ethoprop and fosthiazate were applied as a broadcast spray in with a CO_2 pressurized backpack sprayer, rototilled 15 cm deep, and sealed with a cultipacker just before planting. Results showed that fosthiazate at 4.86 and 6.48 kg a.i./ha were comparable to 1,3-dichloropropene in yield and tuber infection in each of the six years tested.

POTENTIAL OF MANAGING *MELOIDOGYNE KONAENSIS* ON COFFEE IN HAWAII WITH RESISTANCE AND A NEMATICIDE [POTENCIAL DEL MANEJO DE *MELOIDOGYNE KONAENSIS* EN CAFETALES DE HAWAII CON PLANTAS RESISTENTES Y NEMATICIDAS]. D. P. Schmitt, F. Zhang, and M. Meisner, Department of Plant and Environmental Protection Sciences, University of Hawaii at Manoa, Honolulu, HI 96822, U.S.A.—The goal of this research was to determine if *Meloidogyne konaensis* could be managed with nematicides and/or with resistant rootstocks. *Coffea arabica* cv. typica selection 'Guatemala' scions were grafted onto *C. dewevrei* stocks and compared to Guatemala and *C. arabica* cv. typica selection '502' grown on their own roots. These trees were planted in plots of five trees each, two of which were treated bimonthly with 5.6-ml fenamiphos in 8-L water for two years. The Guatemala scions grafted onto *C. dewevrei* roots were more vigorous and gave greater yields than 502 and Guatemala grown on their own roots. The rate of tree growth was relatively constant within treatments. The nematicide treated Guatemala and 502 on the own roots grew at a slightly faster rate

than those growing in untreated soil. The growth rate of the grafted trees was the same in nematicide treated and untreated soil. Nematode numbers were greatest in November through January of each year of the experiment. In the first year, numbers were decreased by fenamiphos on *C. dewevrei* and 502 roots, but enhanced on Guatemala. The nematicide decreased the population of the nematode on Guatemala in the second year. The greatest economic benefit was realized with the Guatemala scion grafted onto the moderately resistant *C. dewevrei* roots without nematicide treatment.

ESTUDIO DE NIVELES DE INFESTACIÓN, DISPERSIÓN Y MANEJO DE *MELOIDOGYNE INCOGNITA* EN PLANTACIONES DE ROSAS EN EL ECUADOR [STUDY OF INFESTATION LEVELS, SPREAD AND MANAGEMENT OF *MELOIDOGYNE INCOGNITA* IN ROSES IN ECUADOR]. P. Silva y J. Gómez Tovar, Asesora Técnica de Ecuaquimica, Marketing Arm Del Ecuador y Casilla portal # 7559-Guayaquil, Ecuador.—Dentro de las provincias de Cotopaxi, Imbabura, Pichincha y Tungurahua, se siembran 2064 hectáreas de rosas (*Rosa* sp.), cuya producción, se exporta hacia los Estados Unidos de Norte América y otros países de Europa. El "Nemátodo del nudo de la raíz," *M. incognita*, es una de las principales plagas limitantes de este cultivo, que favorecido por temperatura entre 22-24°C, humedad del 80% y alta densidad de plantas (80 000 plantas/Ha), en un área útil de 5 600 m^2 alcanzan niveles muy altos de población. Desde Marzo de 1998 hasta Julio de 1999 se realizaron muestreos nematológicos en 16 fincas (tabla N.1) y se obtuvieron 320 muestras. Los resultados mostraron poblaciones variables desde los 10 000 hasta los 88 000 larvas/100 grs. de raíz y de dispersión general. En Abril de 1998 se realizaron aplicaciones comerciales de nematicidas químicos y biológico Azadirachtina (Neem-X) en 4 fincas (Inflores, Flaris, Rosas Cotopaxi y floreva). Se hicieron las evaluaciones del nivel de población inicial y variación bimensual con intervalos de aplicación de cada 4 meses. Los productos evaluados comparativamente entre la población inicial, antes de cada aplicación y al final de cada 4 meses, permitieron establecer que tanto Azadirachtina así como los nematicidas químicos mostraron ser eficaces contra *M. incognita,* con una acción residual de 4 meses.

SUSTAINABLE NEMATODE CONTROL IN HAWAIIAN PINEAPPLE. [CONTROL SUSTENTABLE DE NEMATODOS EN PIÑAS DE HAWAII]. B. S. Sipes, and K.-H. Wang, Department of Plant and Environmental Protection Sciences, University of Hawaii, Honolulu, HI 96822, U.S.A.—*Rotylenchulus reniformis* and *Meloidogyne javanica* infections can decimate pineapple yield. Whereas the pineapple industry has relied primarily upon soil fumigants for nematode control, growers now seek replacements that are environmentally friendly. Sustainable nematode control practices can be incorporated into the pineapple cropping system as either pre- or postplant treatments. Current practices include fallow periods and residue incorporation. In the future, genetically-engineered nematode resistance or cover crops planted for nonhost or allelopathic effects may be used. Postplant options could be the incorporation of cover crops to enhance nematode antagonistic microorganisms and application of biologically based nematicides. Since *Ananas* germplasm does not have a good source of host-plant resistance, a team is working to genetically modify pineapple for nematode resistance. After investigating many potential cover crops, we are focusing on *Crotolaria juncea* and *Brasica napus. C. juncea* enhances the biodiversity of nematodes and increases fungal populations. *Pennistum ciliare*, as a living mulch, is under investigation for sustainable nematode control. Evaluation of biological products such as DiTera, Agri 50, Sincocin, and Maxicrop are also underway. None of these products offer the level of control provided by the soil fumigants. Sustainable nematode control in pineapple in the future may necessitate the use of multiple tactics to achieve acceptable levels of control.

POTENTIAL HERBICIDE PARTNERS FOR FUMIGANT ALTERNATIVES TO METHYL BROMIDE [POTENCIAL DE HERBICIDAS PARENTALES COMO FUMIGANTES ALTERTANTIVOS AL BROMURO DE METILO]. W. M. Stall, Horticultural Sciences Dept., 1243 Fifield Hall, University of Florida, Gainesville, FL, 32611-0690, USA.—Most of the alternative fumigants that can be used in vegetable production are weak on the control of many weeds. The greatest concern

is the control of nutsedges, which can penetrate and grow through polyethylene mulches. The only herbicides that now have labels for use under mulches are pebulate on tomatoes and napropamide on the fruiting vegetable group and strawberries. Trials on potential herbicides for use PRE under the mulch and with postemergent (POST) herbicides on vegetables in the fruiting vegetable group, the cucurbit vegetable group and strawberries have been carried out the past several years. The potential of several of these herbicides for use in a methyl bromide alternative situation will be discussed.

A COMPARISON OF DAMAGE FUNCTIONS FOR PEANUT CULTIVARS SUSCEPTIBLE AND RESISTANT TO *MELOIDOGYNE ARENARIA* [UNA COMPARACIÓN DEL DAÑO FUNCIONAL EN CULTIVARES DE MANÍ SUSCEPTIBLES Y RESISTENTES A *MELOIDOGYNE ARENARIA*]. J. L. Starr, E. R. Morgan, and C. E. Simpson, Department of Plant Pathology and Microbiology, Texas A&M University, TX 77843-2132 and Texas Agricultural Experiment Station, Stephenville, TX 76401, U.S.A.—The first peanut cultivar (cv COAN) with a high level of resistance to *M. arenaria* was released in 1999. The effect of different initial population densities of *M. arenaria* on yield of COAN was compared to yield responses of the susceptible cultivars Florunner and Tamrun 96 in field microplots. A factorial experimental design was used with three cultivars and six initial populations densities (0, 1, 5, 10, 50, and 100 eggs and juveniles/500 cm^3 soil). Nematode population densities were measured at midseason and at crop maturity. At both sample dates, nematode population densities on COAN were less than 1% of those on the two susceptible cultivars. Less than 15% of the pods from COAN were galled at crop maturity at the highest Pi level, whereas a Pi of 10 eggs and juveniles/500 cm^3 soil resulted in galls on >75% of the pods for Florunner and Tamrun 96. Pod yield of COAN was unaffected by any Pi tested, but yield suppression ($P = 0.05$) of the susceptible cultivars was observed at a Pi level of 5 nematodes/500 cm^3 soil. The resistance of COAN will increase peanut yields in severely infested soils and will suppress nematode population densities.

USE OF AN ADVANCED THERMOFILM-IR PLUS BLACK LATEX TO IMPROVE SOIL SOLARIZATION IN CENTRAL ALABAMA [USO DE UN PLÁSTICO AVANZADO "THERMOFILM-IR PLUS" DE LATEX NEGRO, MEJORADOR DE LA SOLARIZACIÓN DE SUELOS EN LA PARTE CENTRAL DE ALABAMA]. C. Stevens,[1] V. A. Khan,[1] R. Rodríguez-Kabana,[2] D. J. Collins,[1] M. A. Wilson,[1] and J. E. Brown,[2] Carver Agricultural Experiment Station, Tuskegee University, AL 36088[1] and Alabama Experiment Station, Auburn University, AL 36849, U.S.A.[2]—The objective of this study was to evaluate Thermofilm-IR in single layer and double layers soil solarization, during the summer of 1998 under three different solarization periods. Thermofilm-IR film was mulched from June 26 to September 15, 1998. PVC pipes containing soil artificially infested with sclerotia of *Sclerotium rolfsii* were buried in the center of each plot. These pipes were removed after soil solarization commenced. The column of soil within the PVC pipe was divided into segments of 0-10, 10-20, and 20-30 cm for analysis of sclerotia population. The analysis of the viability of sclerotia was determined by methanol extraction method. The Thermofilm-IR plus soil sprayed with black latex before applying a single layer (SL) mulching film increased the soil temperature by 5°C. The average maximum soil temperatures for the first 31 days at 5 cm and 20 cm were 53°C and 41°C, respectively. The average maximum soil temperatures at 5 cm and 20 cm depths under double layers solarization (DL) plus black latex were 76°C, and 48°C, respectively, for the first 28 days. The viability of artificially infested sclerotia of *Sclerotium rolfsii* at all depths was significantly reduced following Thermofilm-IR SL and DL soil solarization in combination with furfural (F) or urea (U). There were three solarization periods (31 days for SL and 28 days for DL [period 1]; 76 days for SL and 64 days for DL [period 2]; and 94 days for SL and DL [period 3]). Irrespectively of the amendments and solarization periods, the viability of sclerotia at 20-30 cm soil depth was reduced by 94 and 100% in SL and DL solarized soil, respectively.

THE RESPONSE OF THE AUSTRALIAN PINEAPPLE INDUSTRY TO THE DECLINING AVAILABILITY OF SOIL FUMIGANTS [RESPUESTA DE LA INDUSTRIA PIÑERA AUSTRALIANA A LA DECLINACIÓN DE LA DISPONIBILIDAD DE FUMIGANTES DEL SUELO]. Graham Stirling, and Eric Sinclair, Biological Crop Protection, 3601 Moggill Road, Moggill, QLD, 4070, Australia and Golden Circle Ltd., P.O. Box 106, Virginia, QLD, 4014, Australia—Root-knot nematode (*Meloidogyne javanica*), symphylids (various species of Symphyla, families Scutigerellidae and Scolopendrellidae), white grubs (Coleoptera: various Scarabaeidae) and the root rotting fungi *Phytophthora cinnamomi* and *Pythium* spp. are the main causes of soil-borne disease problems in the Australian pineapple industry. The soil fumigants used in the past had some impact on all of these problems, but growers now have to target each pest or disease with more specific control measures. A monitoring service has therefore been established to enable growers to determine which components of the root disease complex are the main limiting factors on their farms. Roots are inspected regularly for symptoms of rotting, galling or branching, changes in root health during the cropping cycle are documented and nematode populations are measured. This information is recorded in an industry-wide data-base and is also used by individual growers as a management tool. Growers are also showing interest in more sustainable methods of managing pineapple soils. Initial observations suggest that soils can be made more suppressive to root-knot nematode by adding pineapple trash or sawdust plus poultry manure to beds. However, there have been indications that in some situations, such treatments may enhance root rotting caused by *P. cinnamomi* and increase root damage caused by symphylids.

NEMATODES: A COMPONENT OF THE YIELD DECLINE COMPLEX OF SUGARCANE IN AUSTRALIA [NEMATODOS: UN COMPONENTE DE LA DECLINACIÓN DE RENDIMIENTO DE LA CAÑA DE AZÚCAR EN AUSTRALIA]. G. Stirling,[1] Brenden Blair,[2] Peter Whittle,[3] and Alan Garside,[4] (Sugar Yield Decline Joint Venture), Biological Crop Protection, 3601 Moggill Road, Moggill, QLD, 4070,[1] QDPI, C/- BSES, P.O. Box 566, Tully, QLD, 4854,[2] BSES, P.O. Box 86, Indooroopilly, QLD, 4068[3] and BSES, C/- CSIRO, PMB Aitkenvale, Townsville, QLD, 4814, Australia.[4]—In 1993, a multi-disciplinary research program was established within the Australian sugar industry to identify the causes of yield decline and develop solutions to the problem. For the purposes of this program, yield decline was defined as the loss of productive capacity of sugarcane soils under long-term monoculture. Results to date have shown that high acidity, high levels of exchangeable aluminium, low cation exchange capacity, low water infiltration rates, low amounts of labile organic carbon, sub-optimal levels of soil silicon and low microbial biomass are associated with yield decline soils. Root pathogens are also a factor because substantial responses (14-84% increases in plant crop yield) were obtained following fumigation, various periods of bare fallow and different rotation crops. One of the most important pathogens appears to be *Pratylenchus zeae*, as it is ubiquitous in the fine- textured soils in which much of Australia's sugarcane is grown. Pathogenicity studies and field trials with non-volatile nematicides have shown that this nematode destroys fine roots and reduces yield in soils with clay contents ranging from 8-66%.

NEMATODE PROBLEMS OF MEDICINAL CROPS IN NORTH VIETNAM [PROBLEMAS NEMATOLÓGICOS EN CULTIVOS MEDICINALES DE VIETNAM DEL NORTE]. Xuyen Thi Ngo, Department of Plant Pathology, Hanoi Agricultural University, Hanoi, Vietnam.—A survey of 12 medicinal plant species in 7 families that are produced commercially was conducted in Hanoi and in Red River Delta of North Vietnam. The genus Meloidogyne was widely distributed in this region with *Meloidogyne incognita*, *M. arenaria* and *M. javanica* the most frequently detected species. Other nematode genera found in medicinal crops include: *Hirschmanniella*, *Trichodorus*, *Tylenchorhynchus*, *Tylenchina*, *Mononchus*, *Dorylaimus*, *Discolaimus*, and *Rhabditis*. *M. incognita* caused major losses to 4 of 5 commercial medicinal crops. The effect of crop rotation in a field experiment of *Angelica dahurica* B. after *Achyranthes bidentata*/*Angelica uchyamana* Y. and *Oryza sativa* L.; *Altractylodes macrocephala* after *Oryza sativa L.* and *Solanum tuberosum* L. resulted in low population densities (<33 J_2/100 cm^3 soil) of *M. incognita*. A crop of *Altractylodes macrocephala* after *Altractylodes macrocephala* and *Angelica dahurica* B. after *Dianthus caryophyllus* L. rotation resulted in high population densities (>350 J_2/100 cm^3 soil). The

percentage of galls decreased by 84%; egg masses/plant decreased by 78%. In a *Achyranthes bidentata* microplot experiment in 1998, *Arthrobotrys oligospora* reduced *M. incognita* J_2/100 cm^3 by 35%. In 1999 *Achyranthe bidentata* pot experiments using *Arthrobotrys oligospora*, *M. incognita* galls were decreased by 64%; egg masses/plant by 60% and J_2/100 cm^3 soil by 32%.

BIOLOGICAL CONTROL OF NEMATODES USING INTRODUCED ANTAGONISTS [CONTROL BIOLÓGICO DE NEMATODOS MEDIANTE LA INTRODUCCIÓN DE ANTAGONISTAS]. Patricia Timper, USDA-ARS, P.O. Box 748 Tifton, GA 31794, U.S.A.—Root-knot and cyst nematodes have been the primary targets for biological control because of their importance as crop pests, and their vulnerability to fungal and bacterial antagonists. A wide variety of fungi and a few bacteria have been shown to parasitize or otherwise antagonize one or more life stages of these nematodes. The typical approach to biological control of nematodes is to isolate a potential antagonist, determine its effectiveness in suppressing nematode populations in sterilized soil or native soil in the greenhouse, and then proceed with small plot experiments in the field. For the most part, we have failed to achieve the level of nematode suppression in field trials that we have observed in greenhouse trials. This has led many nematologists to conclude that biological control is not a viable management option for nematodes. However, there are several well documented cases of nematode suppression by naturally-occurring antagonists which suggests that in some cropping systems, antagonists can regulate nematode populations. Our expectations for an introduced antagonist may be too high (i.e., rapid and substantial suppression of the nematode population). Perhaps greater emphasis should be placed on long-term persistence of an antagonist or an antagonistic community that results in a moderate, but sustained level of nematode suppression.

NEMATODOS FORMADORES DE QUISTES (NFQ) (NEMATA: *HETERODERIDAE*) EN CEREALES DE LOS VALLES ALTOS DE MÉXICO: TAXONOMÍA, DISTRIBUCIÓN Y DENSIDAD DE POBLACIÓN [CYST NEMATODES (NEMATA: *HETERODERIDAE*) IN CEREALS IN THE HIGH VALLEYS OF MEXICO: TAXONOMY, DISTRIBUTION AND POPULATION DENSITY]. A. Tovar-Soto,[1] I. Cid del Prado-Vera,[2] J. M. Nicol,[3] K. Evans,[4] J. S. Sandoval-Islas,[2] and A. Martínez-Garza,[5] ENCB- IPN. C. P. 11340, México, D. F. (becario COFAA)/IFIT-Colegio de Postgraduados. C. P. 56230, Montecillo, México,[1] IFIT-Colegio de Postgraduados, C. P. 56230, Montecillo, México,[2] CIMMYT, C. P. 06600, México, D. F.,[3] IACR Rothamsted Experimental Station, AL52J, Harpenden, U. K.,[4] ISEI-Colegio de Postgraduados, C. P. 56230, Montecillo, México.[5]—Durante 1999 se muestrearon 86 campos en 39 localidades de los estados de Hidalgo y Tlaxcala, México en donde se cultiva cebada, trigo y avena. Las muestras se procesaron por las técnicas de flotación de Fenwick y disección de raíces. La identificación se llevó a cabo tomando en cuenta características morfológicas y morfométricas de quistes, hembras y juveniles (J_2). La estimación de la densidad de población se hizo siguiendo la técnica citada por Shepherd (1985). Se han identificado cuatro poblaciones de (NFQ) que corresponden a *Cactodera* sp., *Heterodera* del grupo goettingiana, *Globodera rostochiensis* y patrones de otra población de este último género. *Cactodera* sp. estuvo presente en el 70% de las localidades, *Heterodera* en el 21% y *Globodera* en el 9%. Se encontró que existe mezcla de poblaciones en el 48% de las localidades. *Cactodera* presentó una densidad de población entre 0.41 y 12 huevos/g de suelo, y *Globodera* de 0.35-27 huevos/g de suelo. La densidad de población de *Heterodera* aún no se ha determinado.

THE ETIOLOGY OF ROOT-KNOT NEMATODE (*MELOIDOGYNE* SPP.) DAMAGE AND ITS SUPPRESSION WITH *PASTEURIA PENETRANS* [ETIOLOGÍA DEL DAÑO DE NEMATODO AGALLADOR (*MELOIDOGYNE* SPP.) Y SU SUPRESIÓN CON *PASTEURIA PENETRANS*]. D. L. Trudgill, Scottish Crop Research Institute, Invergowrie, Dundee, UK DD2 5DA.—Many colleagues, too numerous to list above, have contributed data and ideas to this communication which will chart progress in understanding the damage caused by root-knot nematodes (RKN), and the potential of *Pasteuria penetrans* as a biocontrol agent. To set the scene, the exceptional pest potential of the mitotically parthe-

nogenetic RKN, differences in host status as a factor influencing RKN damage, and mechanisms of host status differences will be firstly discussed. The extent of RKN damage and of *P. penetrans* in several tropical countries (EU-funded) will be summarised based on survey and trial data. Although *P. penetrans* was widespread in some countries, some environments were shown to be unfavourable to *P. penetrans*. But, where it occurred, levels of RKN infection were usually insufficient to be suppressive. In microplot and field trials, strong suppression was obtained in some trials, but not others. Reasons for these different results will be discussed in relation to laboratory experiments studying differences in the susceptibility of the RKN and specificity of the *P. penetrans*. It will be hypothesised that levels of infection in the field are rarely suppressive because there is dynamic, mutual selection between the RKN and the *P. penetrans*. Overall, in conducive environments, *P. penetrans* appears to a potentially effective biocontrol agent for inclusion in the integrated control of RKN in both developed and undeveloped agriculture.

SUSTAINABLE AND INTEGRATED MANAGEMENT OF PLANTAIN-PARASITIC NEMATODES BASED ON AN INTERCROPPING SYSTEM WITH TROPICAL LEGUMES [MANEJO SUSTENTABLE E INTEGRAL DE FITONEMATODOS DEL PLÁTANO CON BASES EN SISTEMAS DE LEGUMINOSAS TROPICALES EN ASOCIACIÓN]. R. Vargas-Ayala, J. A. Rubiano, and E. D. Saavedra, Department of Crop Protection, University of Puerto Rico, P.O. Box 9030, Mayagüez, P.R. 00681-9030, U.S.A.—Our primary goal in this multidisciplinary research project was to test the nematode-suppressive effect of four legumes (*Mucuna deeringiana*, *Canavalia ensiformis*, *Crotalaria juncea*, and *Dolichos lablab*) used as intercrops with plantain. To accomplish this objective, several field and greenhouse experiments were established. Results showed that velvetbean (*M. deeringiana*) and horsebean (*C. ensiformis*) are promising cover crops for use in a plantain production system to maintain low nematode populations. However, due to the aggressive growth of velvetbean vines, field studies were focused on the horsebean. This legume showed a strong bioremediative effect on *Meloidogyne incognita*, *Radopholus similis*, *Rotylenchulus reniformis*, and *Helicotylenchus dihystera*. Nematode populations in the plantain-horsebean intercropping were significantly decreased based on the reproduction index (*Pf/Pi*), compared to those on the chemical-treated plantain. In addition, a reduction of yellow sigatoka leaf spot caused by *Mycosphaerella musicola* was observed in the plantain-horsebean intercropping. Regarding infestation of the banana weevil (*Cosmopolites sordidus*), its population densities were not different between chemical and legume intercropping treatments. The success in establishing a sustainable and integrated management system for nematode control in plantain will depend on planting date and harvest time of the intercropped legume. Proper management of plantain-parasitic nematodes using horsebean could reduce pesticide applications by 30% and promote an environmentally safe approach to this crop protection problem.

NON-TARGET EFFECTS OF FUMIGATION WITH METHYL BROMIDE ON MICROBIAL POPULATIONS OF SOIL AND RHIZOSPHERE, SOIL ENZYME ACTIVITIES, AND NEMATOFAUNA [EFECTOS COLATERALES DE LA FUMIGACION CON BROMURO DE METILO SOBRE POBLACIONES MICROBIANAS DE SUELO, RIZOSFERA, ACTIVIDAD ENZIMÁTICA DEL SUELO Y NEMATOFAUNA]. J. Velasco Velasco,[1] R. Ferrera-Cerrato,[1] and R. Rodríguez-Kábana,[2] Instituto de Recursos Naturales, Colegio de Postgraduados en Ciencias Agricolas, Montecillo, Mexico,[1] and Department of Entomology and Plant Pathology, Auburn University, Auburn, Alabama 36849, U.S.A.[2]—The effect of fumigating soil with CH_3Br on soil microbiota and related biochemical activities was studied in two field experiments, one with lettuce in Mexico and another in a pine nursery in Alabama. Both fields had good fertility and no detectable problems caused by soil-borne pests. In the Mexican experiment total fungi were highly sensitive to CH_3Br-fumigation with few or no colony forming units (CFU) being detected (modified PDA) when lettuce were planted and 16 days after planting (dap); non-fumigated soil contained 12×10^2 and 58×10^3 CFU's g^{-1} soil, respectively. Planting time populations of total bacteria and free living N_2 fixing bacteria were higher (220×10^7 and 95

× 10^7 CFU's g^{-1} soil, respectively) in fumigated soil than in untreated soil (3.11 × 10^7 and 5 × 10^7 CFU g^{-1} soil). The highest percentage of endomycorrhizal colonization of lettuce roots was at 75 dap when roots in fumigated soil evidenced 2% colonization and those from non-fumigated plots 35% colonization. Non-fumigated soil exhibited higher respiration (CO_2 production) and higher microbial biomass (C g^{-1} soil) than soil with CH_3Br-fumigation. In the Alabama experiment numbers of phytoparasitic and microbivorous nematodes and those in the Dorylaimida and Mononchida were suppressed by CH_3Br-fumigation for 100 weeks after treatment. CH_3Br-fumigation reduced catalase, saccharase and amylase activities of soil; these reductions were particularly long-lasting for catalase and amylase activities.

BIOTIPOS DE *TYLENCHULUS SEMIPENETRANS*, EN LA ZONA CENTRAL DE CHILE DETERMINADO POR EL TEST DE HOSPEDEROS DIFERENCIALES, Y RESISTENCIA AL NEMÁTODODE LOS PATRONES DE USO MÁS FRECUENTE [BIOTYPES OF *TYLENCHULUS SEMIPENETRANS* IN THE CENTRAL REGION OF CHILE DETERMINED BY DIFFERENTIAL HOST PLANT TEST AND RESISTENCE OF MORE COMMONLY USED ROOSTOCKS]. C. Villegas y J. C. Magunacelaya, Departamento de Sanidad Vegetal, Facultad de Ciencias Agronómicas, Universidad de Chile. Santa Rosa 11315, Santiago, Chile.—El Test de Hospederos Diferenciales es la única estrategia que permite identificar razas de *Tylenchulus semipenetrans*. El test permite reconocer los tres biotipos hoy válidos en el mundo, Mediterráneo, Poncirus y Citrus. Este ensayo se realiza ante la carencia de información de biotipos de *T. semipenetrans* en Chile, y el interés que este aspecto podría tener para la elección de patrones de cítricos. El ensayo también evalúa la resistencia a *T. semipenetrans* de *Troyer citrange* y *Citrus sinensis*, los patrones de mayor interés para los productores de la zona. Se confirma la presencia del Biotipo Citrus. El patrón Troyer citrange presentó mayor resistencia que *Citrus sinensis*. El patrón Troyer citrange impidió la reproducción del nemátodo.

BREEDING SOYBEAN FOR NEMATODE AND FOLIAR DISEASE RESISTANCE IN ALABAMA [FITOMEJORAMIENTO EN SOYA PARA LA RESISTENCIA A NEMATODOS Y ENFERMEDADES FOLIARES EN ALABAMA]. D. B. Weaver, and R. Rodríguez-Kábana, Department of Agronomy and Soils and Department of Entomology and Plant Pathology, Auburn University, AL 36849, U.S.A.—Disease and nematode resistance, along with yield improvement, are important objectives in developing soybean cultivars adapted to Alabama and the southeastern U.S. Of most importance is resistance to the root-knot nematodes (*Meloidogyne* spp.), cyst nematodes (*Heterodera glycines*) and frogeye leaf spot (caused by *Cercospora sojina*). These pathogens, either alone or in combination, can cause severe yield losses and render economic soybean production unfeasible without proper management. Management options are mainly confined to those that have lowest cost, in particular rotation with nonhost crops, and genetic resistance. Many studies in Alabama have shown that a combination of both management strategies are needed for maximum production. To generate experimental populations, we select as parents advanced lines from public breeding programs around the southeastern U.S. At least one parent must have superior yield, and the other must have good yield with superior nematode resistance. Using populations developed by this method, we have evaluated breeding lines for multiple-pest resistance in Alabama for 18 years, using a three-step process. First, genotypes are screened for frogeye leaf spot resistance and other agronomic traits in single-plant progeny rows. Second, selected lines are tested for yield in a preliminary screening, using two replicates of a multiple-row plot at a single location. In the third step, all advanced lines are simultaneously tested for yield at multiple locations, and nematode resistance in a single location. Resistance to nematodes is evaluated in a farmer's field infested with a mixture of *Meloidogyne* spp. and soybean cyst nematode. The criterion used to evaluate nematode resistance is seed yield, as nematode-susceptible lines rarely produce harvestable yield. As a result, we have developed several cultivars with the desired combination of traits.