Vol. 15 NEMATROPICA No. 2
December - 1985 - Diciembre

ABSTRACTS OF PAPERS PRESENTED AT THE XVII ANNUAL MEETING OF OTAN AT ST. AUGUSTINE, TRINIDAD, JULY 28 - AUGUST 2, 1985.

RESUMENES DE LOS TRABAJOS PRESENTADOS EN LA XVII REUNION ANUAL DE ONTA EN ST. AUGUSTINE, TRINIDAD, 28 DE JULIO - 2 DE AGOSTO, 1985.

SUITABILITY OF PIGEON PEA (*CAJANUS CAJAN*) CULTIVARS AND LINES TO *MELOIDOGYNE JAVANICA* [ADAPTACION DE LOS CULTIVARES Y LINEAS DEL GANDUL (*CAJANUS CAJAN*) AL *MELOIDOGYNE JAVANICA*]. N. Acosta, N. Vicente, and J. Toro, Dept. of Crop Protection, College of Agricultural Sciences, University of Puerto Rico, Mayaguez, Puerto Rico 00708—Greenhouse and field tests were carried out to determine the suitability of various pigeon pea cultivars and lines developed in Puerto Rico to a population of *Meloidogyne javanica* from Coamo, Puerto Rico. In the first greenhouse test, shoot dry weight values and number of bacterial nodules from inoculated plants were significantly higher than from noninoculated. Gall index values of 5, from a 0-5 rating, were found in all cultivars and lines evaluated. The cultivar Blanco grew higher than the others and had the highest values of shoot and root dry weights, although the values for number of *M. javanica* eggs and 2nd stage juveniles recovered from the roots were the second highest. The same cultivar showed the highest number of bacterial nodules in inoculated plants. Eight pigeon pea cultivars and lines tested in a second greenhouse experiment were found susceptible to the nematode population. Dry weight values in noninoculated plants were significantly higher than in inoculated. Even though nematode reproduction was high in all cultivars and lines, the highest values were recorded in line 98, which also showed the highest dry weight values. Similar results were obtained in the field. Based on root gall index values and on reproduction, all cultivars and lines are susceptible. This was evidenced by the many giant cells and different stages of development of the nematode found in root sections.

BACTERIZATION OF PEANUT ROOTS WITH *BACILLUS SUBTILIS*: EFFECTS ON NEMATODES, *RHIZOBIUM*, MYCORRHIZAE, ROOT DISEASE, AND YIELD [LA BACTERIZACION DE LAS RAICES DE MANI CON *BACILLUS SUBTILIS*: EFECTOS SOBRE NEMATODOS, *RHIZOBIUM*, MICORRIZAS, PUDRICION RADICULAR Y RENDIMIENTO]. P. A. Backman, J. T. Turner, and R. P. Clay, Dept. of Botany, Plant Pathology, and Microbiology, Auburn University, AL 36849, USA—Experiments conducted since 1980 indicate that seed treatment with *Bacillus subtilis* spores resulted in successful colonization of roots by this baterium, with yield improvements averaging 12% in nonrotated cropping systems. The antibiotics produced by *B. subtilis* were active against a broad range of fungi and bacteria, but they had no detectable effect on *Rhizobium* nodulation in peanuts. Similarly, there was no effect on vesicular arbuscular mycorrhizae of *Glomus* spp. Neither populations of *Meloidogyne arenaria*, nor root-knot severity were affected by bacterial colonization. Severity of root disease caused primarily by species of *Rhizoctonia* and *Fusarium*, was significantly reduced by bacterization of peanut roots with *B. subtilis*. Yields were negatively correlated with root rot severity. Strains of *B. subtilis* that produced antibiotics were more effective in controling root rot than nonantibiotic producing strains. *Bacillus subtilis* was registered as an inoculant for peanuts in 1985 under the

tradename Quantum 4000. By genetic engineering, this organism offers potential for the incorporation of other genes whose products are active on nematodes and insects.

AN OVERVIEW OF PLANT NEMATOLOGICAL RESEARCH CONDUCTED IN TRINIDAD AND TOBAGO [VISION GENERAL DE LAS INVESTIGACIONES EN NEMATOLOGIA VEGETAL CONDUCIDAS EN TRINIDAD Y TOBAGO]. George Bala, Ministry of Agriculture, Lands and Food Production, Crop Research Division, Central Experiment Station, via Arima P. O., Centeno, Trinidad & Tobago, W. I.—Plant nematological research conducted in Trinidad and Tobago is reviewed. Red ring disease of coconuts (*Cocos nucifera*) caused by *Rhadinaphelenchus cocophilis* Cobb, 1919, is one of the most intensively researched nematode problems, and current approaches to control using attractants and biological agents are mentioned. The root knot nematodes, *Meloidogyne* spp., are the most economically important nematodes of vegetable crops, and research findings on cultural and chemical means of control are presented. Research work on nematode problems of sugar cane (*Saccharum officinarum* L.), fruit, root and food crops, and grain legumes is outlined. Reference to research currently being conducted is included and the major constraints to effective research are listed. Integrated pest management, transfer of technology, and an improved training program are viewed as important components of future research.

EFFECT OF INITIAL POPULATION DENSITIES OF *MELOIDOGYNE ARENARIA*, RACE 1 ON POD INFECTION AND YIELD OF 'FLORUNNER' PEANUT. [EFECTO DE LAS DENSIDADES DE POBLACION INICIAL DE *MELOIDOGYNE ARENARIA* RAZA 1 EN LA INFECCION DEL EPICARPO Y EL RENDIMIENTO DE MANI 'FLORUNNER']. E. Candanedo and D. W. Dickson, Dept. of Entomology and Nematology, University of Florida, Gainesville, FL 32611, USA—Evaluations were made two consecutive years in 76-cm-d field microplots to determine the economic damage level of *Meloidogyne arenaria* on peanut. Plots, replicated 10 times, were infested with *M. arenaria*, race 1 at 0, 2, 10, 50, 150, and 250 eggs/100 cm^3 soil (first year), and 0, 2, 10, 30, 50, 100, and 150 eggs/100 cm^3 soil (second year). 'Florunner' peanut (5 plants/plot) was grown for 133 days. The first year, yield was reduced significantly ($P=0.01$) from initial population densities of 50 nematodes/100 cm^3 soil. Even the lower Pi densities caused some yield losses. The losses ranged from 0.55 to 3.76 metric tons compared with untreated plots. The percent of galled pods ranged from 26.5 to 86. For the second year, yields ranged from 0.68 metric tons/ha (highest Pi) to 10.24 metric tons/ha (untreated) and losses ranged from 4.70 metric tons/ha (Pi=2 eggs/100 cm^3 soil) to 9.56 metric tons/ha (Pi=150 eggs/100 cm^3 soil). Yields were significantly reduced by 10 eggs/100 cm^3 soil ($P=0.01$). The percent of galled pods ranged from 49 to 96. Damage was more severe the second year, which illustrates the importance of 'seasonal effects'. A linear regression model was used to explain the relationship of the initial population density with yield.

METODOS DE EXTRACCION E INOCULACION DE *PRATYLENCHUS FLAKKENSIS* [EXTRACTION AND INOCULATION METHODS OF *PRATYLENCHUS FLAKKENSIS*]. Manuel Canto-Saenz, Centro Internacional de la Papa, Apartado 5969, Lima, Perú—Métodos de extracción factibles de usar en países en desarrollo, fueron comparados en tres experimentos. A partir de raíces el rociador de Oostenbrink fue significativamente mejor que bandejas de plástico 12 x 10 cm ó 10 cm de diámetro con o sin papel facial, placas de petri con tela-tamiz adherida a un anillo plástico y el agitador mecánico. El uso de papel facial sobre una malla de plástico ó tela tamiz y la temperatura incrementaron significativamente el número de nematodos extraídos. El licuado de raíces ó la forma de bandeja no tuvieron este efecto. El método más práctico aún cuando no el mejor, fue el

uso de bandeja redonda con tela tamiz, adherida a un anillo de plástico colocado a 2 cm del fondo de la bandeja. A partir de suelo, se compararon 100 y 50 cm^3 de suelo, utilizando bandejas rectangulares y redondas (todas con papel facial), de 5 y 2 cm de profundidad. La bandeja rectangular de 2 cm de profundidad con mallas de plástico y 50 cm^3 de suelo rendió un número significativamente mayor de nematodos extraídos. Sin embargo, el método mas práctico (por su fácil manejo) fué la bandeja redonda con anillo de plástico - tela tamiz y 50 cm^3 de suelo. La mejor frecuencia de recolección de los nematodos extraídos de raíces o suelo fue cada dos días. A los 8 días se habian recuperado el 80% del total de nematodes. Los nematodos extraídos a partir de suelo fueron más infectivos que los nematodos extraídos de las raíces. Los siguientes métodos de inoculación se compararon en verano, utilizando las siguientes cantidades por planta: 1 kg de suelo esteril + raíces infectadas; 750 cm^3 de suelo esteril + 250 cm^3 de suelo infestado + raíces infectadas; 1 kg de suelo esteril mas nematodos en suspensión ye el control. Las mejores fuentes de inóculo fueron: suelo esteril + nematodos en suspensión y suelo infestado + raíces infectadas. En el invierno se compararon los mismos tratamientos y además 1 kg de suelo infestado + raíces infectadas. La mejor fuente de inoculo para la reproducción de nematodos fue 750 cm^3 de suelo esteril + 250 cm^3 de suelo infestado + raíces infectadas.

THE USE OF CELLULOSE AND CHITIN FOR REDUCTION OF THE PHYTOTOXIC EFFECTS OF CHITIN AND CONTROL OF ROOT-KNOT NEMATODES [UTILIZACION DE LA CELULOSA PARA REDUCIR LOS EFECTOS FITOTOXICOS DE LA QUITINA Y COMBATIR LOS NEMATODOS NODULADORES]. A. K. Culbreath, R. Rodríguez-Kábana, and G. Morgan-Jones, Department of Botany, Plant Pathology and Microbiology, Auburn University, Agricultural Experiment Station, Auburn, AL 36849, USA—In a greenhouse experiment, cellulose was added to soil at six levels (0-2.0% w/w) alone and in combination with two levels (0 and 2.0% w/w) of crustacean chitin to control *Meloidogyne arenaria* (Neal) Chitwood. The treated soils were kept moist for one week before being planted with yellow crookneck squash (*Curcurbita pepo* L.). Six weeks after planting, survival rate of the seedlings in chitin-amended soils was improved by the addition of cellulose at levels of 1.5% w/w in comparison to those from soil treated with chitin alone. No plants survived in chitin-amended soil with cellulose at rates less than 1.5%. Cellulose alone was ineffective in reducing galling of the roots by *M. arenaria*. Galling was not reduced on plants from soil with chitin plus cellulose at either 1.5% or 2.0% w/w. Soils receiving chitin plus cellulose had higher pH than those amended with chitin alone. Upon removal of the squash plants, 'Rutgers' tomato (*Lycopersicon esculentum* Mill.) seedlings were planted in the same soils. Six weeks after planting, roots and shoots of plants grown in soil amended with chitin plus cellulose were heavier than those of plants grown in soils treated with chitin alone. Chitin eliminated galling of tomato roots by *M. arenaria* but cellulose alone had no effect on galling. Addition of cellulose to chitin-amended soil did not affect control of *M. arenaria* by chitin.

ANATOMY OF THE VAGINA, VULVA, AND MATRIX GLANDS OF *MELOIDOGYNE* SPP. [ANATOMIA DE LA VAGINA, VULVA Y GLANDULAS MATRICES DEL *MELOIDOGYNE* SPP.]. R. P. Esser and A. L. Taylor, Florida Dept. Agric. Cons. Serv., P. O. Box 1269, Gainesville, FL 32602, USA—A study of the vagina revealed it to consist of a narrow thick walled anterior portion, followed by a much wider thin walled posterior portion. The dilator vulva muscles are embedded deeply into the hypodermis and body wall and into the anterior part of the vagina. The posterior vagina is surrounded by muscle cells in a circular band. Measurements were made of the open anterior and posterior vagina lumens and walls so the vagina could be presented diagramatically.

Meloidogyne spp. females lack an anus. What has been characterized as an anus in the past is the matrix gland opening. The six matrix glands are illustrated and discussed.

TWO-DIMENSIONAL PROTEIN PATTERNS OF TEMPERATE AND TROPICAL NEMATODE SPECIES [MODELOS DE PROTEINAS DE DOS DIMENSIONES DE ESPECIES DE NEMATODOS DE REGIONES TEMPLADAS Y TROPICALES]. V. R. Ferris and J. M. Ferris, Dept. of Entomology, Purdue Univ., West Lafayette, IN 47907, USA—Protein patterns obtained by two-dimensional polyacrylamide gel electrphoresis are an effective means for comparing evolutionary divergence among isolates of nematodes of diverse taxa. In the Dorylaimidae, a species of *Labronema* from Indiana, U.S.A., has a pattern nearly identical to a pattern of a nominally different species originally collected in Scotland, but strikingly different from a species collected in Florida. These patterns differ from the patterns of an isolate of a *Labronema* species from Fiji and one from Hawaii, although patterns of the latter two isolates are nearly identical to each other. In the Heteroderidae, *Globodera virginiae* from Virginia, U.S.A., has a protein pattern nearly indistinguishable from that of an isolate of one cyst nematode species from Mexico, but markedly different from the pattern of an isolate of a second species from Mexico and from that of *Globodera tabacum* (from Virginia). *Heterodera trifolii, H. schachtii* and *H. glycines* have very different patterns, but share similarities with each other that they do not share with *Meloidogyne incognita*. Protein patterns from three species of Heteroderidae found commonly together in soil of weedy soybean fields of Indiana, U.S.A. (two species of *Cactodera* and *H. glycines*) are distinctly different from each other. Within a species, isolates from different fields have nearly identical patterns that are useful for identifying the species. The presence of unique protein spots (which are large and dark on radiographs) in the pattern of a Japanese isolate of *H. glycines* distinguishes it immediately from all patterns of U. S. isolates of *H. glycines* that we have examined.

ESTUDIO DEL COMPLEJO DE *VERTICILLIUM DAHLIAE* KLEB. Y *GLOBODERA PALLIDA* STONE SOBRE ALGUNOS CULTIVARES PERUANOS DE PAPA [INTERRELATIONSHIP OF *VERTICILLIUM DAHLIAE* KLEB. AND *GLOBODERA PALLIDA* STONE ON SOME PERUVIAN POTATO CULTIVARS]. J. Franco y E. Bendezú, Centro Internacional de la Papa, Apartado 5969 Lima, Perú—Bajo condiciones de invernadero se procedió a estudiar el efecto de inoculación concomitante de *G. pallida* y *V. dahliae* sobre los cultivares de papa Renacimiento y Yungay, susceptibles a *G. pallida* y tolerantes a *V. dahliae*; Revolución, susceptible a ambos; y el clon 702535, resistente a *G. pallida* (P_4A). La inoculación con *G. pallida* (520 quistes/maceta) se realizó a la siembra, mientras que *V. dahliae* en dos concentraciones, a la emergencia de las plantas y 20 días después de la misma. El efecto de ambos organismos en forma separada o conjunta se estableció por síntomas de marchitez, desarrollo y rendimiento de las plantas. Además se determinó la multiplicación de nematodo. Los cultivares Yungay y Renacimiento mostraron una marchitez posterior (78 y 105 días respectivamente) y menos severa duante su desarrollo que Revolución y el clon 702535. La presencia de *G. pallida* aumentó la severidad de las síntomas de las plantas inoculadas con *V. dahliae*. El desarrollo de planta expresado por su altura fue afectada por la presencia de *G. pallida* y del hongo a partir de los 78 días. No se observaron diferencias entre concentraciones de inóculo de *V. dahliae*, pero si en cuanto a época. Con respecto a los rendimientos, estos fueron afectados por la presencia de nematodos, a excepción del clon 702535. *V. dahliae*, por otro lado, también afectó el rendimiento pero sin diferencias significativas entre densidad y época de inoculación. Estos resultados demuestran el efecto sinergético entre ambos organismos. La presencia de *V. dahliae* incrementó la tasa de multiplicación expresada en número de quistes de *G. pallida* en el clon 702535. Este último efecto discrepa con lo determinado en otros estudios para nematodos endoparásitos de tipo sedentario.

1,3-D FOR CONTROL OF *MELOIDOGYNE ARENARIA* IN PEANUT: METHODS OF APPLICATION [COMBATE DE *MELOIDOGYNE ARENARIA* CON 1,3-D EN EL MANI: METODOS DE APLICACION]. P. S. King, R. Rodríguez-Kábana, and D. G. Robertson, Department of Botany, Plant Pathology, and Microbiology, Auburn University, Agricultural Experiment Station, Auburn, Alabama 36849, USA—The effect of 3 methods of application on the efficacy of 1,3-D (Telone® II) against *Meloidogyne arenaria* was studied in field experiments with 'Florunner' peanut (*Arachis hypogaea*). The nematicide was applied one week before planting at rates of 0, 17.2, 25.8, 34.4, and 51.6 L/ha. The fumigant was injected into the soil to a depth of 35-46 cm using a single subsoiler chisel/row fitted with appropriate bedding (SB) discs ("Ripper Hipper®") or with no-till subsoiling (RS) equipment (Ro-Til®). The third method of application consisted of delivering the 1,3-D directly ahead of a moldboard plow (MP) to bury the nematicide 30-35 cm deep. 1,3-D treatments resulted in increased yields and reduced soil populations of *M. arenaria*. Applications with SB were the most effective for increasing yields and those with MP the least. Treatments using RS were least effective for reducing larval populations of *M. arenaria* while those with MP or SB were equally efficacious.

CHEMICAL CONTROL OF NEMATODES ASSOCIATED WITH THE LOOFAH GOURD CROP (*LUFFA CYLINDRICA*) IN IGUALA, GUERRERO, MEXICO, 1984 [CONTROL QUIMICO DE LOS NEMATODES ASOCIADOS CON LA COSECHA DEL ESTROPAJO (*LUFFA CYLINDRICA*) EN IGUALA, GUERRERO, MEXICO, 1984]. N. Marban-Mendoza and D. Noreiga-Cantu, Centro de Fitopatologia, Colegio de Postgraduados, Chapingo 56230, Mexico—Loofah gourd is one of the highest cash value crops in Mexico (U. S. $0.4 million for 250 ha in 1983). However, during the last 5 years growers have noticed yield reduction. A nematode field survey throughout Mexico's only commercial area in Iguala, Gro. (250 km S of Mexico City) showed 98% infestation with *Meloidogyne incognita, M. arenaria,* and *Rotylenchulus reniformis*. The effect of selected non-fumigant nematicides and growth promoters were studied on loofah growing in natural infested soil. Treatments were: 1) control, 2) phenamiphos (3.0 kg ai/ha), 3) aldicarb (1.5 kg ai/ha), and 4) carbofuran (3.0 kg ai/ha), applied in furrows; 5) oxamyl (0.36 kg ai/ha) sprayed on loofah foliage 2 and 4 wk after seeding. Seed treatments were: 6) carbofuran 75 (0.3 kg ai/ha) and 7) biozyme P (0.2 kg ai/ha). All treatments increased yields (number of individual fruits) but only aldicarb and phenamiphos were significantly ($P=0.05$) higher than control plots. Yield loss ranged from 10 to 80% compared with untreated controls and was correlated with nematode control. Nematode populations were depleted for about 8 wk after aldicarb and phenamiphos treatments only. Cost-benefit ratios ranged from 23 to 500 among treatments, but aldicarb (C/B = 36) was the best economic treatment with net cash return of U. S. $1750/ha (1984) compared with the untreated control.

THE EFFECT OF SIX SELECTED CROPS ON THE POPULATION DENSITIES OF ROOT-KNOT, ROOT-LESION, AND RENIFORM NEMATODES [EL EFECTO DE SEIS COSECHAS SELECCIONADAS EN LAS DENSIDADES DE LAS POBLACIONES DE LOS NEMATODOS DE LOS NODULOS Y DE LAS LESIONES DE LAS RAICES Y DEL NEMATODO RENIFORME]. F. D. McDonald, Caribbean Agric. Res. and Devel. Inst., Kingstown, St. Vincent—Intercropping (mixed cropping, row cropping, and relay cropping) has recently received much attention as a means of reducing noxious population levels of parasitic nematodes in preference to fallowing. Row cropping studies demonstrated that onion, chives, corn, and eddoe grown in nematode-infested soil following sweetpotato (*Impomoea batatas*) reduced populations of *Meloidogyne incognita* after four months while the populations drastically increased on carrot and bean. *Pratylenchus brachyurus* populations were maintained on eddoe but were significantly reduced on the

remaining five crops. *Rotylenchulus reniformis* populations were reduced to zero under all six crops.

INTERACCION ENTRE *PRATYLENCHUS FLAKKENSIS* Y *PSEUDOMONAS SOLANACEARUM* RAZA 3 EN PAPA [INTERACTION BETWEEN *PRATYLENCHUS FLAKKENSIS* AND *PSEUDOMONAS SOLANACEARUM* RACE 3 ON POTATO]. R. Mejia-Anaya and M. Canto Saenz, Centro Internacional de la Papa, Apartado 5969, Lima, Perú—Para determinar si *Pratylenchus flakkensis* y *Pseudomonas solanacearum* Raza 3 interaccionan en papa, se inocularon separada y conjuntamente a tubérculos de los cultivares Revolución y Molinera. La densidad de inóculo de *Pratylenchus* fue 2500/maceta (en forma de suelo infestado) y el de la bacteria fue 20 x 10^7 cel/maceta. Cada tratamiento y el contr' tuvieron 10 repeticiones. El suelo utilizado fue una mezcla de tierra agricola, musgo y arena fina (2-1-1) esterilizada a vapor a 121C durante 8h. En los tratamientos con el nemátodo el suelo infestado se mezcló y homogenizó con suelo estéril en la siembra, la bacteria se inoculó 15 días después. En presencia de *P. flakkensis*, la marchitez causada por *P. solanacearum* en papa aparece mas rápidamente y es más pronunciada que cuando se inocula la bacteria sola. Esta es una interacción sinergística y situación similar ocurre en cuanto al número de plantas marchitas. La variedad Molinera considerada resistente a la bacteria se vuelve susceptible a ésta en presencia de *P. flakkensis*. El grado de susceptibilidad sin embargo es menor que el de 'Revolución'. En 'Revolución' el efecto de la bacteria sola y el de ambos patógenos es mayor a 26-32C que a 16-26C.

FUNGI ASSOCIATED WITH THE PATHOLOGY OF POTATO CYST NEMATODES IN PERÚ [HONGOS ASOCIADOS CON LA PATOLOGÍA DE LOS NEMATODOS ENQUISTADORES DE LA PAPA EN EL PERÚ]. G. Morgan-Jones and R. Rodríguez-Kábana, Dept. of Botany, Plant Pathology, and Microbiology, Auburn University, AL 36849, USA—A survey of fungi associated with cysts of *Globodera pallida* and *G. rostochiensis* on potato at various localities in Perú indicated the presence of a diverse but consistent mycoflora occupying this unique ecological niche. Fungi encountered most frequently as cyst colonizers were *Cylindrocarpon destructans, Drechslera australiensis, Fusarium* spp., *Gliocladium roseum, Penicillium* spp. [subgenus *Aspergilloides*], *Scolecobasidium tshawytschae, Trichocladium asperum* and *Ulocladium atrum. Fusarium oxysporum* and *F. semitectum* were equally common. Unlike preceding reports by other researchers, cysts of *Globodera* were found to be colonized to a similar degree as those of *Heterodera glycines* reported in previous studies by us. Severe egg necrosis was evident in the majority of the cysts colonized, indicating biological control activity on the part of the fungi.

RESEARCH METHODOLOGY FOR ANALYTIC OPTIMIZATION OF CROPPING SYSTEMS DESIGNED TO MINIMIZE LOSSES DUE TO PLANT-PARASITIC NEMATODES [METODOLOGIA DE INVESTIGACION PARA LA OPTIMIZACION ANALITICA DE SISTEMAS DE COSECHAS DESIGNADOS PARA REDUCIR AL MINIMO LAS PERDIDAS DEBIDAS A LOS NEMATODOS PARASITICOS DE LAS PLANTAS]. J. P. Noe, Dept. of Plant Pathology, North Carolina State University, Box 7616, Raleigh, NC 27695-7616, USA—A systems approach is presented for analysis of cropping sequences to manage plant-parasitic nematodes. Using standardized research techniques, the methodology will be implemented at a number of international sites to quantify the relationship of important plant-parasitic species to crop yields and to quantify the population dynamics of the nematodes under various hosts in a cropping sequence. Crop yields will be related to preplant nematode densities by selecting and computing the parameters of appropriate damage functions through analysis of data from replicated field plots. End-of-season nematode densities also will be described as a function of pre-

plant densities, by quantifying the reproductive curves of nematode/host combinations in the selected cropping sequences. Mathematical representations of the systems will then be simulated and optimized to project the best possible cropping sequences for long-term production and profitability. Projected crop sequences will be analyzed by combining functions representing the nematode/host relationships in the appropriate order. Linear programming techniques and constraint analysis, using yield, economic, and cultural constraints, will be used to select the best from among all possible combinations.

CONTROL DE PROBLEMAS DE NEMATODOS EN PANAMA DESDE UNA PERSPECTIVA DE MANEJO INTEGRADO DE PLAGAS [A PEST MANAGEMENT APPROACH TO NEMATODE PROBLEMS IN PANAMA]. J. Pinochet, Centro Agronómico Tropical de Investigación y Enseñanza, CATIE, Apartado 6-3786, El Dorado, Panamá.—En 1985, CATIE inició un Proyecto de Manejo Integrado de Plagas en Panamá, con el objeto de determinar los pricipales problemas nematológicos que ocasionan pérdidas durante el proceso productivo y establecer prioridades de investigación con énfasis en estimación de péridas y control, especialmente en diferentes combinaciones y buscando alternativas al control químico en la medida que sea factible bajo condiciones reales de la agricultura local. *Meloidogyne* spp. es el nemátodo de mayor importancia en la agricultura panameña. Su daña oscila de leve a pérdida total como en el caso de algunos cultivos hortícolas. Este nemátodo interactúa frecuentemente con bacterias y hongos. En la actualidad su control es limitado y sus alternativas bajo condiciones locales poco estudiadas. Las más indicadas son la rotación de cultivos, el uso de variedades tolerantes y resistentes y ocasionalmente control químico cuando su uso es rentable. En Panamá, *Meloidogyne* spp. es en problema serio en tomate industrial, tomate de mesa, tabaco, zapallo, sandía, melón, pimentón, zanahoria y frijol. Le sigue en importancia el nemátodo de las lesiones *Pratylenchus* spp. el cual se detecta con frecuencia en frutales y cultivos extensivos como plátano, café, caña de azúcar, maíz, sorgo y maní respectivamente. En la mayoría de los casos, se desconocen sus daños, aunque en cultivos extensivos se sospecha que puedan ser elevados. En cultivos perennes como la caña de azúcar y café, pueden llegar a ser limitantes del cultivo. Otros nemátodos que atacan un rango más limitado de hospederos como *Globodera rostochiensis* en papa, *Tylenchulus sempenetrans* en cítricos, y *Radopholus similis*, en banano y plátano, se encuentran más localizados. Medidas de control se aplican regularmente en banano y papa. El nemátodo del anillo rojo, *Rhadinaphelenchus cocophilus* está ampliamente distribuido en la región atlántica del país, donde su ocurrencia es aparentemente cíclica.

DINAMICA POBLACIONES EN DOS CAFETALES PANAMEÑOS [POPULATION DYNAMICS IN TWO COFFEE PLANTATIONS IN PANAMA]. J. Pinochet, D. Cordero y A. Berrocal, Centro Agronómico Tropical de Investigación y Enseñanza, Apartado 6-3786, El Dorado, Panamá; Facultad de Agronomía, Universidad de Panamá, Casilla 37, David, Chiriquí, Panamá; y Departamento de Sanidad Vegetal, Ministerio de Desarrollo Agropecuario, Región II, Santiago Veraguas, Panamá.—Un estudio comparativo de fluctuación estacional de las poblaciones de nemátodos fitoparásitos en café fue llevado a cabo durante el período de un año en Boquete, provincia de Chiriquí y Sante Fe, provincia de Veraguas en la República de Panamá. Las poblaciones de los tres nemátodos de mayor interés en cada región se correlacionaron con temperatura y precipitación. En Santa Fe, *Discocriconemella repleta* y *Xiphinema americanum* fueron los nemátodos más abundantes, seguidos de una especie no identificada de *Helicotylenchus*. La época de mayor actividad nematológica fue de Julio a Noviembre, meses que coincidieron con el período de mayor precipitación. La población de *Helicotylenchus* fue baja durante todo el año y sus fluctuaciones erráticas sin guardar ninguna relación con factores ambientales. En Boquete *Meloidogyne* spp. fue el nemátodo predominante seguido por *Helicotylenchus erythrinae*. La

época de mayor actividad nematológica coincidió con el inicio de las lluvias durante los meses de Marzo, Abril y Mayo. En los meses de mayor precipitación, de Junio a Noviembre, se registró una reducción general de las poblaciones de nemátodos en el suelo. La población de *X. americanum* fue baja durante todo el año con un leve incremento en el mes de Julio. En ambas localidades la precipitación fue el factor determinante en la fluctuación de la fauna nematológica. La temperatura fue constante durante el año y no parece tener influencia en cambios poblacionales.

SOIL AND PLANT WATER RELATIONS IN TOBACCO AS INFLUENCED BY *MELOIDOGYNE INCOGNITA* AND *M. JAVANICA* [INFLUENCIA DEL *MELOIDOGYNE INCOGNITA* Y DEL *M. JAVANICA* EN LAS RELACIONES ENTRE EL SUELO Y EL CONTENIDO DE AGUA DE LA PLANTA DE TABACO]. G. S. Rahi and J. R. Rich, University of Florida, IFAS Agricultural Research Center, Live Oak, FL 32060, USA—A greenhouse test was conducted to evaluate the influence of nematode infection on water use in 'NC2326' tabacco (*Nicotiana tabacum* L.). Two tobacco transplants were placed into lysimeters (57 cm dia. x 45 cm high) previously inoculated with *M. javanica* or *M. incognita* (30 eggs/100 cm^3 soil) or left uninfested. A completely randomized block design with 8 replications of the three treatments was used. After initial establishment, tobacco plants in the uninfested lysimeters generally maintained relatively higher plant water potential than those containing either *M. javanica* or *M. incognita*. Despite relatively lower water potential in the soil, water potentials in the uninfested lysimeters were sometimes higher by as much as 2 bars. Little difference in comparative evapotranspiration (ET) were observed in the three treatments in the initial stages, but ET values of plants in the inoculated lysimeters had declined by 10-15% 13 weeks after transplanting. Water use by the control plants increased more than 50% in the later stages of growth despite the lower soil water potentials experienced by these plants. Few differences in plant water relations were found between the *M. incognita* and *M. javanica* infected plants.

EFFECTS OF SUMMER COVER CROPS AND FALLOWING ON POPULATIONS OF *BELONOLAIMUS LONGICAUDATUS* AND *MELOIDOGYNE INCOGNITA* AND YIELDS OF SUBSEQUENT VEGETABLE CROPS [EFFECTO DE LAS COSECHAS DE VERANO Y BARBECHO LIMPIO EN LAS POBLACIONES DE *BELONOLAIMUS LONGICAUDATUS* Y *MELOIDOGYNE INCOGNITA* EN LOS RENDIMIENTOS DE LAS SUBSEQUENTES COSECHAS DE VEGETALES]. H. L. Rhoades, Central Florida Research and Education Center, Box 909, Sanford, FL 32771, USA—Experiments were conducted on Myakka fine sand (approximate % composition = sand 92.2, silt 5.7, clay 2.1) in central Florida (U.S.A.) to determine the effects of summer cover crops and fallowing on nematode populations and yields of subsequent winter vegetable crops. Populations of the sting nematode, *Belonolaimus longicaudatus*, were high following cover crops of sorghum-sudangrass (*Sorghum bicolor* X *S. sudanense*), sesbania (*Sesbania exaltata*), cowpea (*Vigna unguiculata*), and a natural growth of weeds, but were low following crotalaria (*Crotalaria spectabilis*), hairy indigo (*Indigofera hirsuta*), jointvetch (*Aeschynomene americana*), and fallowing. Populations of root-knot, *Meloidogyne incognita*, were high following sesbania and weeds and moderately high after cowpea and sorghum-sudangrass, but were low following crotalaria, hairy indigo, jointvetch and fallowing. Application of a nematicide following the cover crops that increased one or both of the nematode species significantly increased yields of subsequent vegetable crops in most instances but gave very little increase after fallowing and crops that did not build up the nematodes.

CROP ROTATION SYSTEMS FOR CONTROL OF *MELOIDOGYNE ARENARIA* IN PEANUT [SISTEMAS DE ROTACION DE CULTIVOS PARA COMBATIR *MELOIDOGYNE ARENARIA* EN MANI]. R. Rodríguez-Kábana and H. Ivey, Department

of Botany, Plant Pathology, and Microbiology, Auburn University, Agricultural Experiment Station, Auburn, AL 36849, USA—An eight-year study with peanut (*Arachis hypogaea*), soybean (*Glycine max*) and corn (*Zea mays*) was established to determine the effect of selected rotation systems with these crops on population dynamics of *Meloidogyne arenaria*. The study was conducted in a field lightly infested with the nematode. The size of the final population of the nematode near harvest time increased with each succeeding year in plots with continuous peanuts. The pattern of increase was best described by the logistic equation $L = 600/[1 + e^{3.08799-0.32887T}]$, where L represented the number of larvae per 100 cm^3 soil and T the number of years in peanut. A rotation system of one year of peanut (P) followed by 2 years of corn (C) was most effective in maintaining low (<100 larvae/100 cm^3 soil) populations of the nematode. A rotation of peanut followed by a year each of Bragg soybean (S) and corn was almost as effective as the P-C-C system. The P-S-C rotation resulted in populations ≥100 larvae/100 cm^3 soil in the 7th year but maintained larval numbers <50/100 cm^3 soil in all previous years. Systems in which peanut was alternated with corn (P-C), or soybean (P-S) or in which corn was followed by two years of peanut (C-P-P) resulted in larval populations in the peanut years that were as large as those of plots in continuous peanut. The inclusion of a winter cover crop of rye (*Secale cereale*) in each rotation system had no effect on final populations of *M. arenaria*; however, the cover crop resulted in significant increases in yields of soybeans and corn.

NEMATODE CROPPING SYSTEMS RESEARCH METHODOLOGY [INVESTIGACIONES METHODOLOGICAS DE LOS SISTEMAS DE SEQUENCIAS DE LAS COSECHAS PARA REDUCIR LOS DANOS CAUSADOS POR LOS NEMATODOS]. J. N. Sasser, Dept. of Plant Pathology, N. C. State University, Box 7616, Raleigh, NC 27695-7616, USA—The loss of the fumigant nematicides DBCP, EDB, and D-D is already being felt by growers, and the impact will probably increase since available nematicides are less effective, yet more costly. The length of time required to develop a resistant cultivar, the polyspecific nature of field populations of nematodes, and the tendency of some nematode populations to adapt to a resistant cultivar all indicate that resistant cultivars will not solve our nematode problems in the near future. In view of these constraints, it is generally agreed that alternative management tactics must be explored and that one of the most promising for managing nematode populations is the use of cropping sequences that favor the reduction of specific nematode population densities over time without the sacrifice of crops of high per-hectare value. Methodology, however, for accurately monitoring nematode populations in various cropping systems regimes and relating these population densities to crop yields and values needs to be developed. Thus, one of the major thrusts of the USAID-funded Crop Nematode Research and Control Project (CNRCP), with headquarters at North Carolina State University, is the development of nematode cropping systems research methodology for use in developing countries. Such methodology must lead to the development of a broad data base adequate for the selection and recommendation of optimum cropping systems for growers with nematode problems.

REACTION OF SOME HYBRIDS OF *CENTROSEMA* SPP. AND *LEUCAENA LEUCOCEPHALA* TO *MELOIDOGYNE JAVANICA* [REACCION DE ALGUNOS HYBRIDOS DE *CENTROSEMA* SPP. Y *LEUCAENA LEUCOCEPHALA* AL *MELOIDOGYNE JAVANICA*]. Ravi Datt Sharma, E. M. Hutton, and F. B. de Sousa, EMBRAPA/CPA Cerrados, Caixa Postal 70.0023, 73.300 - Planaltina-DF, Brazil—The root-knot nematode, *Meloidogyne javanica*, causes serious damage to the majority of the crops grown in the savannah region of Brazil. Nine genotypes of *Centrosema* spp. and five of *Leucaena leucocephala* were evaluated under greenhouse conditions for response to the savannah population of *M. javanica*. The nematode inoculation level used was 5 eggs/g soil in a 1000

g PVC container with one 4-day-old seedling per container grown at 27C. Each treatment was replicated 10 times of which 5 were maintained as uninoculated checks in a completely randomized block design. Forty-five days after inoculation, the reaction to *M. javanica* infestation varied according to the genotypes tested. The genotypes of *Centrosema pubescens* CIAT 5052, *C. pubescens* CIAT 5189, *C. macrocarpum* CIAT 5274, and other hybrids of *C. pubescens* x *C. macrocarpum* F4 146 AB, F4 151 AB, F4 151 C + 152 C, *L. leucocephala* cv. *Cunningham* cv. Peru, CPAC 335, CPAC 338, K4 Peru type, and giant type showed immunity. The *Centrosema* spp. hybrids F6-88 and F5-100 were highly resistant to *M. javanica*. The *Centrosema* spp. hybrid F4 152 AB showed resistance to *M. javanica*.

OBSERVATIONS ON *CHONDRONEMA PASSALI* (LEIDY, 1852) FROM PASSALID BEETLES IN TRINIDAD, WITH NOTES ON THE SYSTEMATIC POSITION OF *CHONDRONEMA* [OBSERVACIONES EN *CHONDRONEMA PASSALI* (LEIDY,1852) COLLECTADOS DE ESCARABAJOS DE LA FAMILIA PASSALIDAE CON NOTAS SOBRE LA POSICION SISTEMATICA DE *CHONDRONEMA*]. Mohammed Rafiq Siddiqi, Commonwealth Institute of Parasitology. 395A Hatfield Road, St. Albans, Herts, U.K.—Juveniles of *Chondronema passali* (Leidy, 1852) Christie & Chitwood, 1931, were found to parasitize the haemocoel of passalid or betsy beetles, *Passalus cornutus (=Popilius disjunctus)* in Trinidad. Morphological studies made on the juveniles and on male and female specimens collected and studied by Christie & Chitwood (1931) and Nickle & Pilitt (1969) revealed that the species is not a tylenchid but is a relative of the members of the suborder Drilonematina which parasitize the haemocoel of annelids. The genus *Chondronema* has so far been classified with *Allantonema, Bradynema,* and *Sphaerularia,* but it is unique among the various insect haemocoel-parasitic nematode genera in that adults and juveniles have sucker-like phasmids, a complicated stylet-like oral armature, a wide-lumened oesophagus, free-living adult females packed with eggs and egg-like juveniles being taken *per os* by the insect host, and only the juveniles parasitizing the host's haemocoel. In the last mentioned character, *Chondronema* resembles the genera of the Order Mermithida but the morphology, especially that of the oesophagus, easily differentiates it. Morphologically, *Chondronema passali* is close to the members of the Drilonematida and is newly assigned to this order. However, due to it representing a new line of parasitism in which only juveniles are parasitic in the haemocoel of insects, the nematode merits a new suborder of its own.

EFFECTS OF DESICCATION, OSMOTIC PRESSURE, AND STORAGE CONDITIONS OF GALLS ON SURVIVAL OF *PTEROTYLENCHUS CECIDOGENUS,* THE STEM GALL NEMATODE [EFFECTOS DE DESECACION, PRESION OSMOTICA Y CONDICIONES DE ALMACENAMIENTO DE AGALLAS EN LA SUPERVIVENCIA DE *PTEROTYLENCHUS CECIDOGENUS,* NEMATODO DE LAS AGALLAS DE TALLOS]. J. M. Stanton, Centro Internacional de Agricultura Tropical, Apartado Aereo 6713, Cali, Colombia—Galls on *Desmodium ovalifolium* plants caused by *Pterotylenchus cecidogenus* were stored in either sealed plastic or paper bags at 10, 17, 24, 30, or 35 C for 4 weeks. Although the total number of *P. cecidogenus* subsequently extracted was reduced by increasing temperature, the total number was higher when stored in paper than in plastic bags. At 10 C, females survived better than the larval stages in plastic bags. Air-drying of nematodes reduced with increasing osmotic pressure and time of exposure when treated with solutions of 0, 0.1, 1.0, and 2.0 M NaCI for 6 or 24 hours. In all of the above treatments, variation in body length of the nematodes decreased as constraints to survival increased, with the exception of paper and plastic bags at 10 C.

EFFECTS OF *PTEROTYLENCHUS CECIDOGENUS*, THE STEM GALL NEMATODE, ON ESTABLISHMENT AND GROWTH OF THE TROPICAL PASTURE LEGUME, *DESMODIUM OVALIFOLIUM*. [EFECTOS DE *PTEROTYLENCHUS CECIDOGENUS*, NEMATODO DE LAS AGALLAS DE TALLOS, EN EL ESTABLECIMIENTO Y CRECIMIENTO DE LA LEGUMINOSA DE PASTOS TROPICALES, *DESMODIUM OVALIFOLIUM]* J. M. Stanton, Centro Internacional de Agricultura Tropical, Apartado Aereo 6713, Cali, Colombia—*Pterotylenchus cecidogenus* causes galls on stems of *Desmodium ovalifolium* with associated cortical and vascular tissue breakdown, dieback, and plant death. Under glasshouse conditions, *P. cecidogenus* did not affect germination of *D. ovalifolium* but reduced plant survival, which was directly related to gall production. The nematodes considerably affected plant growth, reducing stem and root length, number of leaves, and shoot dry weight. When comparing three accessions of *D. ovalifolium* with different abilities to support reproduction of *P. cecidogenus*, effects on growth were related to resistance. Plant age (up to 8 weeks) at inoculation did not affect penetration by *P. cecidogenus* nor was wounding required for infection. The number of nematodes/plant increased 100-fold between 7 and 52 days after inoculation.

SEED TREATMENT FOR CONTROL OF NEMATODES IN WHEAT AND RYE [TRATAMIENTOS DE SEMILLAS PARA COMBATIR NEMATODOS EN TRIGO Y CENTENO]. C. Weaver and R. Rodríguez-Kábana, Department of Botany, Plant Pathology and Microbiology, Auburn University, Agricultural Experiment Station, Auburn, AL 36849, USA—The efficacy of seed treatments with thiodicarb for control of plant-parasitic nematodes was studied in greenhouse experiments with 'Elbon' rye (*Secale cereale*) and 'Coker 68-15' wheat (*Triticum aestivum*). Thiodicarb was applied at rates of 1.0, 1.5, and 2.0 kg ai/100 kg seed. The seeds were planted in soil from a soybean (*Glycine max*) field and allowed to develop for 6 wk when roots and soil were analyzed for nematodes. All thiodicarb treatments reduced numbers of galls caused by *Meloidogyne incognita* and diminished larval populations of the nematode in the roots; numbers of *Helicotylenchus dihystera* in the roots were also decreased by thiodicarb. The seed treatment had no effect on larval populations of *M. incognita* in the soil and reduced those of *Paratrichodorus christiei* and *H. dihystera*. The treatments had no effect on wheat shoot weight but increased root weights. Rye roots had 8-10 times fewer galls caused by *M. incognita* than wheat roots; the treatments reduced the number of galls caused by *M. incognita* and root populations of *H. dihystera* in rye. No significant numbers of *M. incognita* larvae were recovered from rye roots. Thiodicarb decreased populations of *P. christiei* in soils with rye but had little effect on *H. dihystera* in the soils. All thiodicarb treatments had no effect on rye shoot weights except for the 2.0-kg rate, which resulted in lighter shoots. Rye seed treated with the two lowest rates of thiodicarb produced plants with heavier roots than those developed from untreated seed; the 2.0-kg rate had no effect on root weights.