

ABSTRACTS OF PAPERS PRESENTED AT THE SEVENTEENTH ANNUAL MEETING OF THE SOCIETY OF NEMATOLOGISTS HOT SPRINGS, ARKANSAS AUGUST 7-10, 1978

BARKER, K. R. *Relative sensitivity of flue-cured tobacco cultivars to four species of Meloidogyne.*

Tobacco cultivars, resistant and susceptible to *Meloidogyne incognita* (MI), were tested for sensitivity to *M. arenaria* (MA), *M. hapla* (MH), *M. javanica* (MJ), and MI in greenhouse and microplot experiments. Three susceptible ('Coker 319,' 'McNair 944,' and 'Virginia 115') and nine resistant cultivars ('NC-95,' 'Coker 86,' 'Coker 258,' 'Coker 347,' 'NC-79,' 'Speight G-28,' 'Speight G-23,' and 'Speight G-33') were tested in the greenhouse. Only Coker 319 and G-28 were used in microplots. The greenhouse tests involved 15-cm-diam pots filled with a 1:1 mixture of a loamy sand and river sand. The 76-cm-diam microplots contained a loamy sand amended 5 years earlier with 7,938 cm³ of peat moss/plot. Inoculum levels were: 40,000 eggs/pot and 3,200 eggs/500 cm³ of microplot soil. All treatments were replicated four times. In the greenhouse tests, all MI-resistant cultivars were severely stunted initially by MI, but largely recovered by harvest (68 days). In contrast, MI-susceptible cultivars became progressively stunted with time. Only G-28 and G-33 were stunted by MH. MI-resistant cultivars had varied tolerances to MA and MJ, but greater than those of the MI-susceptible cultivars. Coker 319 and McNair 944 were very sensitive to MA and MJ. The three MI-susceptible cultivars were more heavily galled by all four nematode species than were the resistant ones. The sensitivity of Coker 319 and G-28 to the four nematode species was similar in the microplots to that in the greenhouse test. Although there were statistically significant differences in repro-

duction of MH and MJ across cultivars, these differences were not great except for the suppression of reproduction of MH on G-28. Reproduction of MA differed little between cultivars. Thus, these resistant cultivars, in addition to being able to recover from heavy infection by MI, appear to have greater tolerance to MJ and MA than MI-susceptible tobacco.—*Department of Plant Pathology, North Carolina State University, Raleigh, North Carolina 27650.*

BIRD, G. W., and M. L. VITOSH. *Effects of chemical control of Pratylenchus penetrans on potato varieties grown at three levels of nitrogen fertilization.*

Three potato (*Solanum tuberosum*) varieties with different susceptibility to *Pratylenchus penetrans* (cvs Superior, very susceptible; Onaway, intermediate; and Russet Burbank, tolerant) were grown under commercial production procedures and evaluated for interactions among plant growth, control of *P. penetrans*, and nitrogen fertilization. Four treatments—1) untreated control; 2) disulfoton (3.3 kg ai/ha); 3) aldicarb (3.3 kg ai/ha); and 4) disulfoton (3.3 kg ai/ha) plus 1,3-dichloropropene and methylisothiocyanate (MIC; 93.5 L/ha)—were evaluated at three levels of nitrogen fertilization (82.2, 164.4 and 328.8 kg/ha). The 12 treatments were replicated four times for each potato cultivar in a randomized block design. Aldicarb and disulfoton plus 1,3-D and MIC significantly ($P = 0.05$) reduced soil and root populations of *P. penetrans*. Disulfoton provided 20% control of *P. penetrans*.

Disulfoton, aldicarb, and 1,3-D + MIC significantly increased yields of Superior at all nitrogen rates. The greatest tuber yield was with aldicarb at 164.4 kg/ha nitrogen. On-away yields were not enhanced as much by the treatments as yields of Superior. 1,3-D + MIC was the only treatment that significantly increased yields of Russet Burbank. There were no significant yield differences among the three nitrogen fertilization levels, and nitrogen had no influence on nematode control. No yield interactions between nematode control and nitrogen fertilization levels were detected. Aldicarb and disulfoton plus 1,3-D and MIC altered the nitrogen, phosphorus, manganese, and copper content of petioles at all nitrogen fertilization levels. Aldicarb significantly increased nitrogen, phosphorus, and copper in petioles. Both aldicarb and disulfoton plus 1,3-D + MIC significantly decreased manganese levels of petioles.—*Department of Entomology, Michigan State University, East Lansing, Michigan 48824.*

BRODIE, B. B. *Relation of population density of Globodera rostochiensis in soil to its spread on potato tubers.*

Potato tubers were harvested from plots with known soil population densities of *Globodera rostochiensis*. The tubers were then graded and packaged for marketing. This process removed most of the free soil that adhered to the tubers. From each plot was taken a random sample (4.5 kg) of tubers processed in this way. Each tuber was vigorously scrubbed with a vegetable brush. The resultant material was collected in a plastic container, and cysts were extracted by flotation. The numbers of viable eggs and larvae were determined by crushing the cysts. The number of viable eggs and larvae/4.5 kg of tubers was related directly to soil population density. At the highest density, 104 eggs and larvae/g of soil, an average of 1,045 eggs and larvae were recovered from 4.5 kg of tubers. Likewise, 362, 225, 40, and 10 eggs and larvae were recovered from tubers from plots with densities of 86, 30, 16, and 5 eggs and larvae/g of soil. No eggs and larvae were found on tubers from plots with densities of 1.8 eggs and larvae/g of soil or less. This

study shows that *G. rostochiensis* can be spread on potato tubers from fields with relatively low population densities.—*USDA, ARS, Department of Plant Pathology, Cornell University, Ithaca, New York 14853.*

BROWN, M. J., and R. M. RIEDEL. *Pratylenchus spp. associated with Solanum tuberosum cv 'Superior' in Ohio.*

During June, July, and August, 1977, soil and root samples from 440 ha (1100 A) of potatoes in 20 Ohio counties were examined for plant-parasitic nematodes. Sampled fields were subdivided into 1.6-ha (4 A) plots on the basis of cropping history and topography. From each plot, ten plants were lifted at random and roots and soil from these plants were bulked to represent the plot. Nematodes were extracted from roots and soil separately using a 24-hr incubation at room temperature in a modified Baermann funnel. *Pratylenchus* spp. occurred in 65% of the soil samples and 81% of the root samples. Corresponding percentages for other plant-parasitic nematode genera were *Hoplolaimus* spp. 7 and 1, *Meloidogyne* spp. 7 and 6, *Paratylenchus* spp. 16 and 4, *Tylenchorhynchus* spp. 15 and 4, *Xiphinema* spp. 3 and 0, and *Tylenchus* spp. 6 and 0. Six species of *Pratylenchus* were identified from potato roots. *Pratylenchus crenatus* was found in 79% of the fields sampled, *P. penetrans* in 39%, *P. scribneri* in 30%, *P. alleni* in 13%, *P. thornei* in 11%, and *P. neglectus* in 7%. While most samples contained mixed populations of *Pratylenchus* spp., monospecific populations of most species were not uncommon.—*Department of Plant Pathology, Ohio State University, Columbus, Ohio 43210.*

BURLANDO, T. M., G. NYLAND, B. F. LOWNSBERY, and N. W. ROSS. *Control of peach yellow bud mosaic with deep placement and high rates of 1,3-dichloropropene fumigants.*

Yellow bud mosaic (PYBM), a serious virus disease of peaches in California, is

transmitted by *Xiphinema americanum*. Control of PYBM by control of its nematode vector was tested at two locations in the field. After the 1971 harvest, PYBM-infected peaches were removed from 1-ha and 0.7-ha blocks, respectively at Modesto and Winters, California. Soil at both locations was ripped in two directions to a depth of 91 cm and then disked. Injections of 1,3-D fumigant (Dow Telone or Shell DD) were made at two depths, 76 and 30 cm, the deeper injection first. At Modesto, Telone was injected deep at the rate of 2060 L/ha, and shallow at 470 L/ha. At Winters, DD was injected deep at 1870 L/ha, and shallow at 470 L/ha. Chisel spacing was 46 cm at the greater depth and 30 cm at the shallower one. No PYBM has been detected in peach trees planted in spring 1972, and no *X. americanum* has been recovered from the soil since the treatments. Although PYBM has been controlled, root rots (*Phytophthora* at Modesto and *Armillaria* at Winters) threaten these plantings. These results reveal the danger in making a large expenditure for nematode control where other factors limiting growth are not under control.—*Division of Nematology and Department of Plant Pathology, University of California, Davis, California 95616, and Cooperative Extension Service, University of California, Modesto, California 95355.*

CAMPOS, V. P., and D. P. SCHMITT.

Disease complex of soybean created by inoculation with Macroposthonia ornata and Phytophthora megasperma var. sojae.

Soybean (cv. Ransom) was inoculated with *Macroposthonia ornata* (MO), *Phytophthora megasperma* var. *sojae* (PMS), MO and PMS (B), or neither (C). MO was obtained from greenhouse corn cultures, and PMS from V-8 juice broth. The four treatments were given in the field to 76-cm-diam microplots and in the greenhouse to 15-cm-diam clay pots containing methylbromide-treated sandy loam soil. Each microplot was sown with 30 soybean seeds, and each pot with 6 seeds. Microplot inoculum was 116,550 MO, six mycelial mats

of PMS, both, or neither. In the greenhouse test, inoculum per pot was 5,000 MO, 0.13 mat of PMS, both, or neither. All treatments were arranged in randomized blocks with four replications in the microplot test and 10 in the greenhouse test. Disease severity was greatest and weights of roots, shoots, and seed were least in the B treatment in both tests. The differences between the B and PMS treatments were large but not quite significant. In the microplot test, disease severity was greater ($P = 0.05$) and seed yield was less ($P = 0.05$) in the B treatment than in the MO and C treatments. In the greenhouse test, root and shoot weights were greater ($P = 0.05$) in the C and MO treatments than in the PMS and B treatments. The root and stem disease caused by PMS could be more severe under field conditions if MO is present.—*Department of Plant Pathology, North Carolina State University, Raleigh, North Carolina 27607.*

CHAPMAN, R. A. *Implications of differences in susceptibility among varieties of soybean resistant to Race 3 of the soybean cyst nematode.*

Detection of populations of Race 4 of *Heterodera glycines*, the soybean cyst nematode (SCN), would be facilitated if comparisons of relative SCN reproduction on Race 3 susceptible (R3S) and Race 3 resistant (R3R) commercial varieties of soybean were reliable. SCN reproduction on susceptible and resistant varieties is respectively 100 and <10. 'Peking' is the source of resistance for 'Pickett,' 'Mack,' and 'Custer,' and any one of these might be expected to be useful as the R3R host in these race-detection tests. However, such tests of several populations of SCN from western Kentucky gave conflicting results, depending on whether 'Pickett' or 'Custer' was used. Detailed analyses were made of five populations of SCN collected from fields in which 'Pickett' or 'Mack' produced low yields after two or more years of continuous planting with R3R varieties. Their relative reproduction was measured on R3S 'Lee' and R3R 'Pickett,' 'Mack,' 'Custer,' 'Peking,' P.I. 88788, and P.I. 90763. 'Lee,'

'Pickett,' and 'Mack' were susceptible, and 'Peking,' P.I. 88788, and P.I. 90763 were resistant to all five. 'Custer' was susceptible to three and resistant to two. Reproduction on 'Pickett' or 'Mack' indicates that all five populations are Race 4; reproduction on 'Custer' indicates that three are Race 4 and two are Race 3. The genetically complex resistance to Race 3 from 'Peking' has been combined with genetic material from various sources in these varieties, and modification of its effect may be expected. Reproduction of all five populations on 'Lee,' 'Peking,' P.I. 88788, and P.I. 90763 was that of Race 3, and it would be misleading to label them otherwise.—*Department of Plant Pathology, University of Kentucky, Lexington, Kentucky 40506.*

DEMEURE, Y., D. W. FRECKMAN, and S. D. VAN GUNDY. *The induction of coiled and anhydrobiotic nematodes in soil.*

A pressure plate was used to control moisture potential in a loamy sand (sand 75%, silt 24%, clay 1%) to determine the level and rate of nematode coiling of *Aphelenchus avenae* and *Scutellonema brachyurum* at various soil suctions. Active nematodes (1,000) were pipetted onto 5 cc of saturated soil contained in plastic rings on the pressure plate. Every 24 h, the pressure was increased to the following: 0.0, 0.1, 0.3, 0.5, 1, 3 bars. The respective soil moisture contents were 27, 4.7, 3, 2.4, 2.2, and 2%.

Five samples were removed from the pressure plate extractor at each pressure and kept in plastic bags for 6, 5, 4, 3, 2, and 1 days. To observe their morphology, the nematodes were extracted from soil by 1.25M sucrose centrifugation technique. The respective percentages of coiled *A. avenae* were 2, 9, 12, 81, 94, and 90%, and of coiled *S. brachyurum* were 9.9, 17.8, 21.4, 67.4, 85.0, and 82.1%.

Coiling of *A. avenae* and *S. brachyurum* occurred in drying soil when equilibrium was reached between the soil and suction control surface. Pressure alone had no effect on coiling. Since the relative humidity in all soil tests was greater than 99%, it ap-

pears that the physical force of the water films in soil may influence the initiation of coiling more than relative humidity in the soil.—*Laboratoire de Nematologie ORSTOM Dakar, BP 1386, Republique du Senegal; Department of Nematology, University of California, Riverside, California 92521.*

DICKERSON, O. J., T. J. FRANZ, and L. D. LASH. *Influence of crop rotation on nematode populations in Kansas.*

Rotation plots were established at four locations, under one of these cropping systems: 1) corn, sorghum, and soybeans grown in monoculture and in combinations; 2) soybeans, sorghum, and wheat grown in monoculture and in combination; and 3) wheat and sorghum grown in monoculture and in combinations that included fallow (two locations). Plots were sampled before crops were planted, and near their physiological maturity.

Responses of phytoparasitic nematode populations by crop during the growing season are summarized here. On sorghum: *Tylenchorhynchus martini*, *Quinisulcius acutus*, and *Xiphinema americanum* populations increased; populations remained constant and generally low for *Helicotylenchus pseudorobustus* and *Pratylenchus scribneri*; and *P. hexincisus* and *P. neglectus* populations decreased. On soybeans: *H. pseudorobustus*, *P. neglectus*, *P. scribneri*, and *X. americanum* increased, whereas *T. martini*, *Q. acutus*, and *P. hexincisus* populations were static. On corn: *Q. acutus*, *H. pseudorobustus*, *P. hexincisus*, and *P. scribneri* all increased; *T. martini* and *X. americanum* were present at low populations; and *P. neglectus* decreased. On wheat: only *P. neglectus* increased; populations of *T. martini* and *P. hexincisus* remained low; and *Q. acutus*, *H. pseudorobustus*, *P. scribneri*, and *X. americanum* all decreased.

These results suggest that nematode populations can be managed with some success by changing crops.—*Department of Plant Pathology, Kansas Agricultural Experiment Station, Manhattan, Kansas 66506.*

DICKSON, D. W., and R. E. WAITES. *Chemical control of Trichodorus christiei, Pratylenchus zaeae, P. brachyurus, and Criconemoides sp. on field corn in Florida.*

Nematicides applied at planting were evaluated for their efficacy on corn. Nematicides and rates (active) used were: aldicarb 15G, 1.7 and 3.4 kg/ha; carbofuran 10G, 2.2 kg/ha; O-[5-chloro-1-(1-methylethyl)-1H-1,2,4-triazol-3-yl]O,O-diethyl phosphorothioate 5G, 0.6 kg/ha; DBCP 12.1EC, 4.7, 7, and 14 liters/ha; 1,3-D, 28 and 46.8 liters/ha; O,O-diethyl-O-(6-fluoro-2-pyridyl) phosphorothioate 10G and 15G, each at 2.2 kg/ha; ethoprop 10G and 6EC, each at 2.2 kg/ha; fonofos 10G, 2.2 kg/ha; parathion 8E, 1.7 kg/ha; phenamiphos 15G and 3EC, each at 2.2 kg/ha; and terbufos 15G, 1.1 and 2.2 kg/ha. Parathion was applied also to plots treated with DBCP, 1,3-D, and phenamiphos to control soil insects. Nonfumigant nematicides were applied in a 17.8-cm band. Fumigant nematicides were injected 20 cm deep in the row, except for a single treatment of DBCP sprayed on the surface and incorporated. Treatments were replicated six times. Each plot consisted of paired rows (a treated row and an adjacent untreated row). Soil and root samples were analyzed for nematodes before treatment, in mid-season, and at harvest.

None of the nematode species, singly or in combination, were significantly reduced at midseason. At harvest there was a significant reduction of *Pratylenchus* in roots and in total numbers of plant-parasitic nematodes in soil and roots in most treatments. Both reductions were significantly correlated with increases in yield, and the respective values of the simple correlation coefficients obtained from 114 pairs were $r = +0.23$ and $+0.21$.

Grain yields were significantly increased with all treatments except DBCP of 4.7 liters/ha and parathion. Twelve of the 19 treatments resulted in average increases of at least 1,000 kg/ha over their untreated neighboring rows. The largest increase (2,623 kg/ha) was in plots treated with 1,3-D at 46.8 liters/ha.—*Department of Entomology and Nematology, University of Florida, Gainesville, Florida 32611.*

E. M. DUTKY and R. M. SAYRE. *Some factors affecting infection of nematodes by the bacterial spore parasite Bacillus penetrans.*

Soil from greenhouse cultures of *Meloidogyne incognita* (soil A) and *Pratylenchus brachyurus* (soil B) infected with a bacterial spore parasite (*Bacillus penetrans*), and field soil containing infected *P. brachyurus* (soil C) were used as the source of the parasite. Uninfected larvae and adults of the following nematode species were exposed to each infested soil, extracted, and examined for attached spores: *Aphelenchoides ritzemabosi*, *Ditylenchus dipsaci*, *D. trifomis*, *Tylenchorhynchus claytoni*, *Pratylenchus penetrans*, *P. brachyurus*, *Meloidogyne incognita*, *M. hapla*, *M. javanica*, and *Meloidoderita* sp. Spores from soil A became attached only to *M. incognita*, *M. hapla*, and *M. javanica*. Spores from soil B became attached only to *P. brachyurus*. For determination of the thermal inactivation point of the spores in soil, *M. incognita* larvae were exposed to soil A incubated previously for 30 min to 1 h at 40, 60, 80, 100, and 130 C. Prevention of spore attachment required 130 C for 1 h. After 30 min at 80 C, attachment occurred, though not infection. No correlation was found between the number of spores attached per larva and the soil pore size or soil moisture level. *M. incognita* larvae were exposed to soil A diluted with spore-free greenhouse soil. At a dilution of 1:10 a noticeable reduction in number of attached spores was seen. At 1:100 dilution more than half the larvae had no spores and the rest had only one or two spores per larva. At 1:1,000 dilution none of the larvae were observed with attached spores.—*Department of Botany, University of Maryland, College Park, Maryland 20742, and Nematology Laboratory, Plant Protection Institute, U.S. Department of Agriculture, Beltsville, Maryland 20705.*

EISENBACK, J. D. and HEDWIG HIRSCHMANN. *Morphological comparison of second-stage juveniles of Meloidogyne hapla, M. arenaria, M. incognita, and M. javanica by scanning electron microscopy.*

The external morphology of second-stage juveniles of six populations of *Meloidogyne hapla*, belonging to two cytological races (A and B), and one population each of *M. arenaria*, *M. incognita*, and *M. javanica* was compared by scanning electron microscopy (SEM). Race A of *M. hapla* included three facultatively parthenogenetic populations whose haploid chromosome numbers were 15, 16, and 17. Race B consisted of three mitotically parthenogenetic populations whose somatic chromosome numbers were 45, 45, and 48. The mitotically parthenogenetic populations of *M. arenaria*, *M. incognita*, and *M. javanica* had 54, 41–43, and 44 chromosomes, respectively. Observations were made on head structures, lateral field, excretory pore, anal opening, and tail. Head morphology, including shape and proportion of labial disc and lips, expression of labial and cephalic sensilla, and markings on head annule, was distinctly different for each species studied. *M. hapla* populations of race A were distinct from each other but showed much intrapopulation variation in head morphology. Populations of race B were quite similar to each other, and very stable in their head morphology, but different from populations of race A. The structure of the lateral field, excretory pore, anal opening, and tail was of little value in distinguishing species or populations, because of considerable inter- and intra-population variation. —Department of Plant Pathology, North Carolina State University, Raleigh, North Carolina 27650.

ENDO, B. Y. *Morphology and interaction of an intracellular microorganism in tissues of the soybean cyst nematode, Heterodera glycines.*

Ultrastructural studies of the anterior regions of second-stage larvae of the soybean cyst nematode, *Heterodera glycines*, revealed bacteriallike microorganisms, rod

shaped, averaging 0.4 by 1.8 μm . Both the outer wall, about 9 nm thick, and the plasma membrane, about 8 nm thick, are trilaminar. These membranes are separated by an inner region of variable width. Rod and tubular structures, respectively 14 and 17 nm in diameter, extend from the plasma membrane either into the lumen or across the width of the cell. The microorganisms, present throughout most of the tissues of the larvae, are especially prominent as intracellular particles in the sarcoplasm of the protractor and median bulb muscles. They generally occur throughout the highly reticulate and ribosome-rich regions of the dorsal and subventral esophageal glands. The intimate contact between the microorganisms and the host nuclei and the presence of multiple layers of host-provided membranes indicate that a symbiotic relationship may exist between the microorganism and the host. However, a moderate cytopathic effect is also indicated by an apparent physical association between the microorganisms and the microbodies that occur in the esophageal gland. —Nematology Laboratory, Plant Protection Institute, Beltsville Agricultural Research Center, U.S. Department of Agriculture, Beltsville, Maryland 20705.

FERRIS, H. *Development of nematode damage functions and economic thresholds using Meloidogyne incognita on tomatoes and sweet potatoes.*

Knowledge of damage functions relating nematode densities and yield losses, for specific situations, is a prerequisite to the estimation of nematode economic thresholds. The effects of growing season, geographic location, and soil type on the slope and position of the regression line are being investigated. In processing tomatoes, (cv Roma VF) on a loam soil, the slope of the regression line was the same in 1976 and 1977 for *Meloidogyne incognita* larval (L_2) counts. Based on 1977 crop values and current nematocide costs and trends, this results in economic threshold (ET) estimates of 20 L_2 /1000 g soil for 1978 and 26 L_2 /1,000 g soil for 1979. With cv VF-145-FS tomatoes, the slope of the regression line

was steeper (-0.236) on a loamy sand than on a loam soil (-0.15). Nutrient and moisture stresses were greater on the loamy sand. The change in slope resulted in ET estimates of $5 \text{ L}_2/1,000 \text{ g soil}$ for the loamy sand and $11 \text{ L}_2/1,000 \text{ g soil}$ for the loam for 1978 economic data. A similar change in slope with increased sand was measured with sweet potatoes ($\text{ET} = 30 \text{ L}_2/1,000 \text{ g on loam and } 5 \text{ L}_2/1,000 \text{ g on sand}$). Optimizing approaches to economic thresholds, considering nematode damage and varying control costs, would improve efficiency of nematode pest management, but require development of control cost functions.—*Department of Nematology, University of California, Riverside, California 92521.*

FORTNUM, B. A., and S. A. LEWIS.

Interaction between Cyldrocladium root rot and polyspecific nematode populations on soybean.

Population levels and disease expression were examined after *Meloidogyne incognita*, *Hoplolaimus columbus*, and *Pratylenchus scribneri* were added singly or in combination with *Cylindrocladium* (*Calonectria*) *crotalariae* to soybean (*Glycine max*, cv Davis) roots. Nematode inoculum levels (Pi) were 5,000 and 10,000/species, and effects were measured 14, 45, and 75 days after inoculation. (Effects of the 10,000 Pi were measured only at 75 days.) After 14 days, penetration by individual nematode species was not affected by other nematode species. *Cylindrocladium* was applied after the 14-day sampling. At 45 and 75 days, populations of adult and juvenile *H. columbus* in roots were unaffected by other organisms, but in the soil adults and juveniles were more numerous ($P = 0.05$) in the presence of *C. crotalariae* (75 days). *Pratylenchus scribneri* populations were significantly lower after 75 days in the presence of *H. columbus* and *C. crotalariae*. At 75 days *Meloidogyne incognita* galling indices were depressed ($P = 0.05$) by the presence of *H. columbus* or *C. crotalariae*. Root necrosis caused by *C. crotalariae* was not significantly increased by nematode feeding, but on all sampling dates necrosis tended to

increase slightly where *H. columbus* and *P. scribneri* were present. Fresh and dry weights of roots and tops reflected the degree of root necrosis on all sampling dates. *Rhizobium* nodulation was significantly decreased ($P = 0.05$) by the combined addition of *P. scribneri*, *H. columbus*, and *C. crotalariae* at Pi 10,000.—*Department of Plant Pathology and Physiology, Clemson University, Clemson, South Carolina 29631.*

FRANCO, J. *Electrophoretic protein patterns of different populations of Globodera pallida and G. rostochiensis.*

The protein patterns of immature females of British and Peruvian populations of potato cyst nematodes, *Globodera* spp., developing on potato plants (*Solanum tuberosum* ssp. *tuberosum*) were compared by disc electrophoresis. Females were produced by inoculating potato plants grown in 9-cm-diam plastic pots with 6,000 freshly hatched juveniles. The potato plants were grown under controlled conditions in growth cabinets. The populations studied were from Feltwell and Puno (British and Peruvian *G. rostochiensis* Ro 1, respectively), and from Dumminning, Cadishead, and Otuzco (British Pa 1 and Pa 3, and Peruvian Pa 3 of *G. pallida*, respectively). Forty-two days after inoculation, females were collected from potato roots. A solution of soluble nematode proteins was prepared by grinding about 200 females ($45 \mu\text{l}$) with $45 \mu\text{l}$ of extraction buffer. This suspension was centrifuged and processed as described by Ornstein and Davis (1964). A control population with known protein patterns was included in each run. Soluble proteins of potato plant roots were also examined. Differences in protein patterns were observed between the British and Peruvian populations of *G. pallida* but not between British and Peruvian *G. rostochiensis*. The *G. pallida* populations possessed common bands which differed from those found in *G. rostochiensis*. The protein patterns of immature females found for the two species of potato cyst nematodes differ from those described by earlier workers.—*The International Potato Center, Apartado 5969, Lima, Peru.*

FRIEDMAN, PAUL A., and EDWARD G. PLATZER. *Colchicine-binding properties in fertilized eggs of Ascaris suum*.

(withdrawn)

barley, corn, strawberry, and peanut were not. *M. incognita incognita* and *M. i. acrita* did not develop on pin oak. Female specimens of a second form, from camellia in Japan, were about 1 mm long and had striking perineal patterns composed of widely spaced coarse striae, producing a ropelike effect, sometimes interspersed with fine close striae. Pattern shape in the camellia form is squarish to rectangular, and vulva and anus are sunken in a squarish bare area. Larvae average 480 μm long, with a tail of 45 μm and a short blunt tail terminal only 6 μm long. Males were common, about 2 mm long, and had prominent lateral fields 1/3 the body width. These two nematodes, being described as new species on basis of the above and other structures, further indicate the morphological diversity and complexity of root-knot nematodes, and the need to examine all kinds of plants for infection to better understand the total *Meloidogyne* systematics.—*Nematology Laboratory, Plant Protection Institute, Beltsville Agricultural Research Center, United States Department of Agriculture, Beltsville, Maryland 20705*.

GOLDSTEIN, P. and A. C. TRIANTAPHYLLOU. *Electron microscopic comparison of oogenesis in a meiotic and mitotic race of Meloidogyne hapla*.

Cytological studies have revealed the existence of two races of *M. hapla*. Race A is facultatively parthenogenetic (meiotic) and includes populations, most of which have a haploid chromosome number of $n=17$. Race B is obligatorily parthenogenetic (mitotic) and has a somatic chromosome number of $3n=45$. Meiosis and, therefore, synapsis of homologous chromosomes is believed to occur in Race A, but not in Race B. However, the behavior of the chromatin during early prophase of maturation of oocytes, as seen by light microscopy, is similar in the two races. The present electron microscopic study showed that synaptonemal complexes and recombination nodules are present in pachytene nuclei of Race A, but are absent in nuclei of Race B. These observations suggest that synapsis and, possibly, chiasmata and recom-

GOLDEN, A. MORGAN. *Morphology of undescribed root-knot nematodes from pin oak in Virginia, and from camellia in Japan*.

Perineal patterns of females from pin oak had a distinctive oval to squarish pattern with heavy striae, and a sunken vulva surrounded by a prominent clear area devoid of striae. Larvae measured about 445 μm , with a tail length of 45 μm and a short blunt tail terminal. Males were rare. In greenhouse tests, pin oak, red oak, and chestnut were parasitized by this nematode, but oats,

binations occur in Race A and not in Race B. Synaptonemal complexes seem to lack a central element and this may represent an evolutionary step toward ameiotic type of maturation of oocytes and, consequently, a step toward mitotic parthenogenesis. Serial sectioning and three-dimensional reconstruction of nuclei of an *M. hapla* population with 17 chromosomes revealed 17 synaptonemal complexes. One end of each synaptonemal complex is attached to the nuclear envelope and the other end is free in the nucleoplasm. Cylindrical granular complexes present in the cytoplasm at pre-pachytene stages are intimately associated with the nucleus at pachytene in Race A, but are absent in Race B. The behavior of these complexes is similar to that of extranuclear "polycomplexes" previously described in *Ascaris*. Polycomplexes are thought to contribute material necessary for the formation of synaptonemal complexes.—*Departments of Plant Pathology and Genetics, North Carolina State University, Raleigh, North Carolina 27650.*

GOODELL, P. B., and H. FERRIS. *Investigations into optimum sample size and pattern for estimating nematode population densities.*

The accuracy and reliability of the sampling system is essential to pest management decisions based on estimates of population densities. The importance of reliable sampling technique increases as knowledge of economic thresholds becomes more refined, and as the cost of controlling nematodes increases. The economic limitation of increasing the number of samples is an important consideration. The reliability-cost balance must be optimized. A 7-ha alfalfa field in Blythe, California, was divided into a 6×6-m grid, and a single core soil sample, 45 cm long × 2.45 cm diam, was taken at each grid intersection. A total of 1,936 cores were taken, each identified by its grid coordinates. Soil cores were weighed and rated for soil texture. Nematodes were extracted by a semiautomatic elutriator and sugar flotation process, preserved in 5% formalin solution, and counted. Data were recorded on IBM cards. A simple computer program allows combination of individual

cores into multicore samples of varied size and sequence. Thus, the single data set provides flexibility in investigating sample size, sample numbers, sample patterns, comparison of the reliability of various sampling schemes, and the influence of edaphic and cultural factors on the sampling scheme. The efficiency of each approach is measured by determination of variability among many repeated samples.—*Department of Nematology, University of California, Riverside, California 92521.*

GRIFFIN, G. D., and B. D. THYR. *Interaction of Meloidogyne hapla and Fusarium oxysporum on alfalfa.*

Fourteen-day-old *Meloidogyne-hapla*-resistant (Nev Syn XX) and susceptible (Ranger) alfalfa seedlings were inoculated with *M. hapla* larvae and *Fusarium oxysporum*, singly and in combination, or left uninoculated. There were no differences in the plant growth resulting from these three treatments after 120 days at 22 ± 4 C. However, when 14-day-old alfalfa seedlings of the same variety and selection were inoculated with *M. hapla* larvae 30 days before inoculation with *F. oxysporum*, a combination of the two pathogens significantly reduced the growth of Ranger alfalfa after 120 days at 22 ± 4 C. The sequential inoculation did not reduce the growth of Nev Syn XX alfalfa seedlings, nor did *F. oxysporum* affect the alfalfa selection's resistance to *M. hapla*. A repetition of this same sequential inoculation of Ranger with the two organisms significantly reduced plant growth at 20 and 25 C but not at 15 or 30 C.—*U. S. Department of Agriculture, Science and Education Administration, Crops Research Laboratory, Utah State University, Logan, Utah 84322; and USDA, SEA, University of Nevada, Reno, Nevada 89507.*

IBRAHIM, I. K. A., and M. A. REZK. *Reaction of corn to Meloidogyne javanica and M. incognita.*

The reaction of 17 corn cultivars, double hybrids, and strains to *Meloidogyne javanica* and *M. incognita* was tested in

the greenhouse. Plants were grown in autoclaved clay soil in 20-cm-diam clay pots, two plants per pot, for 70 days. Nematode inoculum of 2,500 larvae/pot was placed in the soil around the infested seedlings, 3 days after emergence. In the harvested corn plants, reactions were categorized as resistant (few or no galls on roots and no growth reduction), moderately resistant (some galling and no growth reduction), or very susceptible (much galling and growth reduction). Strains Jelli cross and H-24-1, cultivars Early American and Giza 102, and double hybrids 80 and 186 were resistant to *M. javanica*; Giza 102, 186, and Jelli were resistant to *M. incognita*. Cultivars Alexandria, Chedwan, Giza 4, Giza 69, Giza 213, and Giza 303, double hybrid 355, and strain I.C.B. were moderately resistant to *M. javanica*; Alexandria, Chedwan, Giza 4, and double hybrid 355 were moderately resistant to *M. incognita*. Giza 249, Giza 251, and double hybrid 17a were highly susceptible to *M. javanica*; Giza 251 and 17a were very susceptible to *M. incognita*.—*Department of Plant Pathology, College of Agriculture, Alexandria University, Alexandria, Egypt.*

INGRAM, E. G. and PEGGY S. KING.
Meloidogyne populations in Alabama peanut fields.

From 1976 to 1977, a nematological survey was conducted over the peanut-producing area of Alabama. The combined number of field sites surveyed totaled 114, each represented by a 3.7 x 30.5-m plot. Soil and plant samples were taken four times, from April through November. Pods (1976), and pods and roots (1977), were cut from the peanut plants, and each was incubated in water for 72 hr. Nematodes were extracted from a 50-cm³ soil subsample by a modified sugar flotation method. Tomatoes were planted in 12-cm-diam pots of the remaining soil. After 30 days of growth in the greenhouse, the tomato roots were washed and rated for galling. Results from the soil extraction and tomato assay indicated that 58 of the 114 field sites were infested with *Meloidogyne* spp. Of the *Meloidogyne* populations recovered from

field sites in 1977 (25 of 51 sites surveyed), 56% were parasitic on peanuts. *Meloidogyne arenaria* represented the main peanut parasite, with isolated occurrences of *M. hapla*. Assuming that the 1977 survey is representative of the peanut area, 27.4% of the peanut fields are infested with *Meloidogyne* spp. parasitic on peanuts.—*Department of Botany and Microbiology, Auburn University, Auburn, Alabama 36830.*

JATALA, P., and RENATE KALTENBACH.
Reaction of some Peruvian potato cultivars to Pratylenchus pratensis.

Tubers of three Peruvian potato cultivars, 'Mariva', 'Revolucion' (*Solanum tuberosum* ssp. *tuberosum* x *S. lbr.* ssp. *andigena*), 'Renacimiento' (*S. lbr.* ssp. *andigena*), and a clone of *S. sparsipilum* CIP 760147.7 were planted in 12-cm clay pots and grown in a screenhouse with a temperature range of 18–25 C. A 1-g mixture of comminuted potato roots infected with *Pratylenchus pratensis* was added to each pot at planting. Three months later the roots and tubers were carefully removed from the pots, examined, weighed, and rated for symptoms caused by the root-lesion nematodes on a scale of zero to four (0 = no apparent infection, 4 = very severe infection). Roots and tubers of the cultivar 'Revolucion' had significantly higher disease ratings than the other cultivars. Severity of root disease symptoms was higher for 'Renacimiento' than 'Mariva,' whereas tuber symptoms were higher in 'Mariva' than 'Revolucion.' There was no evidence of root or tuber symptoms on clone 760147.7. Tuber production was highest in 'Mariva' followed by 'Revolucion,' CIP 760147.7, and 'Renacimiento.' Low production of 'Renacimiento' was attributed to a combination of late maturity and susceptibility to disease caused by *P. pratensis*. CIP 760147.7 is a low-yielding wild type, but is useful as a source of resistance to root-lesion nematodes in breeding programs.—*The International Potato Center, Apartado 5969, Lima, Peru.*

JATALA, P., and C. MARTIN. *Interactions of Meloidogyne incognita acrita and Pseudomonas solanacearum on tomatoes.*

Two-week-old seedlings of *Pseudomonas*-resistant tomato cultivars 'Venus' and 'Saturn,' and a susceptible local Peruvian cv 'Huando' were transplanted into 17-cm-diam clay pots containing steam-sterilized potting soil. Two weeks later, plants were inoculated with *P. solanacearum* (20 ml water suspension, 2×10^8 cells/ml; *M. incognita acrita* (2,000 freshly hatched larvae in 20 ml water/pot); both organisms; or neither. Inocula were introduced through three 12 x 1-cm glass tubes protruding 3 cm above the soil, placed around the roots at transplanting. Plants were maintained in a greenhouse with a temperature range of 20–29 C. Five days after inoculation only 20% of the 'Huando' plants inoculated with bacteria alone were wilted, whereas 100% inoculated with both organisms were wilted. After 8 days all of the 'Huando' plants receiving both organisms were dead. Only 40% of plants inoculated with bacteria alone had died 11 days after inoculation. Forty percent of plants of cvs 'Venus' and 'Saturn' wilted 5 days after inoculation with both organisms. After 11 days these potato plants had died. When inoculated with bacteria alone, 20 and 60% of cultivars 'Venus' and 'Saturn', respectively, wilted after 8 days, and only 40% of cultivar 'Saturn' died after 11 days. Results indicated the existence of a synergism between *M. incognita acrita* and *P. solanacearum* on all three cultivars. Cultivars 'Saturn' and 'Huando' are very similar in their reaction to race 3 of *P. solanacearum* in presence or absence of *Meloidogyne*. This could be due to elevated temperature, which may be a cause for severity of bacterial wilt in cultivar 'Saturn.' If so, cultivar 'Venus' is relatively temperature-insensitive to race 3 of *P. solanacearum*, a result similar to that reported for race 1 of this organism.—*The International Potato Center, Apartado 5969, Lima, Peru.*

JOHNSON, A. W., C. A. JAWORSKI, and D. R. SUMNER. *Effects of soil treatments on yields of sequentially cropped cucumbers and nematode and fungus populations.*

Treatments tested were: a) plastic film (1.5 mil) mulch; b) nonmulch; c) DD-MENCs (Vorlex, 327 liters/ha) unmulched; d) DD-MENCs + plastic mulch; and e) methyl bromide + chloropicrin mixture (2:1), 336 kg/ha + plastic mulch. All plots received trickle irrigation. A single line of Viaflo tubing was placed on the soil surface in the center of each bed. The trickle irrigation system was designed to deliver 3.8 liters of water per minute from 305 m of tubing. Soil chemical treatments were made only once, before three successive crops of cucumber interrupted only by a five-month fallow period after the second crop. Average yields of marketable cucumbers in quintals/ha from the three crops with these treatments were: a) 456; b) 178; c) 610; d) 1095; and e) 1208. Best plant growth and greatest yield resulted when nematode and fungus populations were suppressed to a very low level. Nematodes and fungi identified in the experimental area included *Meloidogyne incognita*, *Criconeoides ornatus*, *Fusarium oxysporum*, *F. solani*, and *Pythium* spp. Treatments d and e suppressed populations of *Pythium* spp. and *F. solani* for 14 months. Sequential cropping allows fixed production costs to be borne by two or three crops.—*U.S. Department of Agriculture, SEA Federal Research, Coastal Plain Experiment Station, Tifton, Georgia 31794.*

KAPLAN, D. T., N. T. KEEN, and I. J. THOMASON. *Glyceollin accumulation related to expression of resistance in soybeans to the root-knot nematode.*

Accumulation of the isoflavonoid glyceollin is correlated with the resistance of cv. 'Centennial' soybeans to *Meloidogyne incognita*, whereas the compatible interaction of *M. javanica* with cv. 'Centennial' as well as the compatible interactions of *M. javanica* and *M. incognita* with cv. Pickett 71 do not result in significant accumulation. Glyceollin appears to accumulate primarily in the stele of 'Centennial'

roots infected by *M. incognita*, the site of the hypersensitive-type response within the root. Concentrations in the cortical tissues are comparatively low. Glyceollin accumulation begins within 48 hours of inoculation and continues as the phloem parenchyma cells become necrotic. Glyceollin is nematostatic *in vitro* and significantly reduces the motility of *M. incognita* at concentrations of 10 $\mu\text{g/ml}$ in a modified Moje test. Although we have not thoroughly investigated the precise mode of action of this compound, it does not inhibit cholinesterase activity. The data suggest that glyceollin may function as a phytoalexin in cv. 'Centennial' soybeans infected by *M. incognita* and may be involved in resistance.—*Department of Nematology, University of California, Riverside, California 92521.*

KAYA, H. K., and R. D. MOON. *Ecological studies of the face fly, Musca autumnalis, and its nematode parasite, Heterotylenchus autumnalis, in a northern California pasture.*

Adult face flies, trapped on white sticky traps from May through October 1977 at a Yuba County ranch, were dissected and examined for ovarian development, gut content, presence or absence of nematodes, and nematode stages present. Nematode-infected flies collected on traps showed no signs of egg development and were considered sterile. Examination of gut content of nematode-infected and healthy female flies showed that they fed with equal frequency on a creamy substance which was probably acquired from faces of cattle. As they aged, nematode-infected females fed less frequently on blood and more frequently on cow dung than did healthy female flies of similar age. Fresh cow dung formed into 800-g artificial cow pats was exposed to insects in full sun, partial sun, and full shade. After 48 to 72 h, the pats were collected and placed individually in sand-filled trays. The face fly puparia forming in the sand under each pat were counted. A representative sample of adults emerging from these puparia was dissected and examined for nematodes. Pats in full sun yielded an average of 106 puparia, of

which 39% were infected with *H. autumnalis*. Pats in partial sun averaged 14 puparia with 13% infected. No puparia were recovered from pats which were in the shade all day. Analysis of the distribution of gamogenetic nematodes within face flies showed that healthy flies with more than 1 gamogenetic female were more frequent than the random Poisson distribution predicted. Estimates of the abundance of nematode-infected and healthy flies from traps and from cow dung were consistent. Nematode infection rates and host densities were highest in spring and early summer, declined to a midsummer low, and then increased slightly in fall.—*Division of Nematology and Department of Entomology, University of California, Davis, California 95616.*

KHAN, ZAINAB N., and W. H. THAMES. *SEM study of perineal patterns of four species of Meloidogyne.*

Techniques were developed to utilize adult root-knot females fixed and preserved in lactophenol, 5% formalin, formalin-acetic acid, or ethyl alcohol for scanning-electron microscope (SEM) studies. The perineal patterns were not distorted by any of the fixatives. Both critical-point drying and freeze-drying were satisfactory for dehydration, but freeze-drying produced females which were easier to mount on aluminum stubs. Double-stick adhesive tape was superior to aluminum paint as a mounting medium, and long-time storage in a desiccator containing calcium chloride was satisfactory. No distortion of specimens was noted at 2 years. SEM was superior to light or interference microscopy for observing details of the perineal patterns. Patterns of *Meloidogyne arenaria*, *M. hapla*, *M. incognita*, and *M. javanica* were studied in individuals from the same hosts, species from different hosts, and species from different localities. Basic features of the patterns were found to be consistent and independent of host or locality.

In development studies of the four species, the appearance of patterns at 16, 20, 28–30, and 50 days after inoculation of hosts showed considerable changes in vulval

widths, distance from vulva to anus, and extent of pattern. All specimens exhibited typical patterns by the 28th day.—*Department of Plant Sciences, Texas A&M University, College Station, Texas 77843.*

KIMPINSKI, J., and C. B. WILLIS. *Effect of soil temperature and pH on Pratylenchus penetrans and P. crenatus.*

Pots containing five Iroquois alfalfa plants in 4.5 kg of soil were inoculated with about 25,000 *Pratylenchus penetrans* or *P. crenatus* one week after seeding. Inoculated plants were grown 14 weeks at 10, 18.5, or 27 C. Then nematodes were extracted from roots by incubation under a mist, and from soil by the Baermann pan method. Nematodes/g of dry root and kg of dry soil (in brackets) at 10, 18.5, and 27.0 C for *P. penetrans* were 454 (3,034), 1,213 (2,432), and 23,659 (1,858), respectively. Corresponding values for *P. crenatus* were 157 (1,811), 100 (789), and 20 (847). In an auxiliary experiment, about 40 active *P. penetrans* were added to the top of vertical soil columns 1 cm in diam and 2 cm in depth. After 4 hours, 10, 30, and 26% of the nematodes had migrated to the bottom of the columns at 10, 19, and 30 C, respectively.

In the third experiment, 5 plants of Iroquois alfalfa or Climax timothy were grown in pots containing 4.5 kg of soil adjusted to pH 4.9, 6.3, and 7.3. About 13,000 nematodes of either *P. penetrans* or *P. crenatus* were added to each pot. Root subsamples were taken 5 weeks later and stained with methyl blue in lactophenol. There were no significant differences between the two species in numbers of nematodes entering either plant host. The number of nematodes of both species increased significantly as pH increased, with geometric means of 35, 587, and 594/g of fresh root at pH 4.9, 6.3, and 7.3, respectively.—*Research Station, Agriculture Canada, P. O. Box 1210, Charlottetown, P.E.I., Canada C1A 7M8.*

KINLOCH, R. A. *Seasonal changes in soil populations of Meloidogyne incognita and their correlation with the yields of susceptible and resistant soybean cultivars.*

Populations of *Meloidogyne incognita* in two adjacent sites in a field were manipulated by planting site I with a root-knot-susceptible soybean cultivar (Pickett 71) and site II with a resistant cultivar (Centennial). Mean numbers of juvenile root-knot nematodes at harvest in I and II were respectively 246 ± 28 and 32 ± 7 per 10 cm³ soil. The following year, replicated plots of each cultivar were planted in both sites. Soil populations of nematode juveniles were monitored every 2 weeks from 24 weeks before the second planting until 20 weeks after harvest to determine seasonal changes in nematode numbers and to correlate the numbers with soybean yield.

In all plots, numbers of nematodes were lowest at planting (25 May) and highest at harvest. Significant increase ($P = 0.05$) did not occur with the susceptible plantings until after 12 weeks in site I and 16 weeks in site II. Such increases with resistant plantings occurred after 16 weeks in site I and not until harvest (12 Oct), 20 weeks after planting, in site II. At harvest there were no significant differences in numbers of juvenile nematodes between sites I and II in the susceptible plantings (328 and 397 / 10 cm³ soil, respectively) or in the resistant plantings (163 and 73 / 10 cm³ soil). However, yields of Pickett 71 were significantly higher in site II than in site I (2455 to 705 kg/ha), as were yields of Centennial (3879 to 3296 kg/ha).

The nematode populations decreased so slowly after harvest that there were no significant reductions in numbers 20 weeks later. The yield of Pickett 71 was negatively correlated ($P = 0.05$) with numbers of nematode juveniles in soil at all sampling dates from 24 weeks before planting to 4 weeks after planting. The yield of Centennial was similarly correlated with nematode population density in soil samples taken 14 to 8 weeks before planting.—*University of Florida, Agricultural Research Center, Jay, Florida 32565.*

McKENRY, M. V., and P. NAYLOR. *Influence of plant roots or liming on DBCP concentrations in soil.*

Gas chromatography was used to sample 1,2-dibromo-3-chloropropane (DBCP) in the soil atmosphere following its application to three adjacent sites in a sandy loam soil. One plot each of fallow soil, soil supporting a 7-week-old planting of Sudan grass (*Sorghum vulgare*), and fallow soil receiving a shallow incorporation of lime at 5.4 m tons/ha were treated with a 2.5-cm water application of 81 kg/ha Fumazone 86 EC followed with a 9-cm irrigation. DBCP was applied in fall with soil temperatures ranging from 20 to 10C at the 30-cm depth. Soil atmospheres were repeatedly sampled through gas-sampling probes, and DBCP dispersal patterns were determined.

The presence of a fibrous root system or lime in the surface 10 cm provided a two-to-six-fold decrease in soil atmosphere concentrations of DBCP present throughout the surface 120 cm of soil profile, although DBCP persistence was not greatly affected. The lime incorporation increased soil pH from 7.2 to 11.2 in the surface 5 cm. Application of DBCP to the limed plot caused an unidentified peak in our alkyl-halide-sensitive chromatographic column which was present in soil air at all depths sampled. Reduction in DBCP concentrations in the limed soil probably resulted from DBCP hydrolysis. Reduction in root-bearing soil may have been caused by root sorption. Effective dispersal of nematotoxic concentrations of DBCP is influenced by chemical and biological entities within the soil profile.—*San Joaquin Valley Research and Extension Center, Parlier, California 93648.*

MINTON, N. A., and W. C. ADAMSON. *Control of Meloidogyne javanica and M. arenaria on kenaf and roselle with genetic resistance and nematicides.*

Kenaf (*Hibiscus cannabinus*) and roselle (*H. sabdariffa*) were evaluated in nematicide-treated and untreated field soil infested with *Meloidogyne javanica* and *M. arenaria*. Root-knot indices indicated that the kenaf breeding line j-1-113 had a moderate level of resistance to *M. javanica*

and a low level of resistance to *M. arenaria*. Kenaf cv. Everglades 71 was highly susceptible, and roselle breeding line A59-56 highly resistant to both *M. javanica* and *M. arenaria*. Both nematode species reproduced on all plant entries, but the number of larvae recovered from the soil was greater in plots planted to Everglades 71 than in plots planted to j-1-113 and A59-56. In untreated soil infested with *M. javanica*, dry-matter yields were greater ($P = 0.05$) for j-1-113 and A59-56 than for Everglades 71. The percentages of live plants at harvest were: j-1-113, 87.5; A59-56, 93.3; and Everglades 71, 8.8. EDB (1,2-dibromoethane) at 73.9 kg a.i./ha and DBCP (1,2-dibromo-3-chloropropane) at 17.6 kg a.i./ha increased dry matter yields significantly for all entries when planted in soil infested with *M. arenaria*. Carbofuran (2,3-dihydro-2,2-dimethyl-7-benzofuranyl methylcarbamate) at 5.9 kg a.i./ha did not increase dry-matter yields of any entry. None of the nematicides improved the growth of any entry in soil infested with *M. javanica*.—*Science and Education Administration, United States Department of Agriculture, Coastal Plain Experiment Station, Tifton, Georgia 31794; U.S. Plant Introduction Station, Savannah, Georgia 31405; and University of Georgia College of Agriculture Experiment Stations, Coastal Plain Station, Tifton, Georgia 31794.*

NARDACCI, J. F., and K. R. BARKER. *Influence of temperature and soil type on Meloidogyne incognita on soybean.*

The effects of temperature, soil type, and inoculum level of *Meloidogyne incognita* (MI) on soybean growth and nematode reproduction were investigated in the greenhouse, controlled-growth chambers, and/or microplots. The greenhouse-temperature-tank tests involved single 'Lee 68' plants in 15-cm-diam pots (1,500 cm³ soil) with five inoculum levels (P_i) at 18, 22, 26, and 30 C. Suppression of growth by MI was greatest at 30 C, where 27,000 and 81,000 eggs/pot resulted in plant death. Of the four temperature regimes [20/16, 24/20, 28/24, 32/28 C (day/night)] in growth chambers, p_i 's of 9,000 to 81,000 eggs/pot effected

plant death at 32/28 C. Only the highest P_i (81,000 eggs/pot) suppressed growth at the lowest temperature in the greenhouse and growth chambers. The interactions of P_i and temperature on shoot growth in both experiments were adequately described by multiple regressions. Nematode reproduction was generally related directly to temperature. The influence of soil type and P_i of MI on soybean growth was tested in the greenhouse and 20 x 20-cm microplots. Soils used in the greenhouse included: 1) Cecil clay loam; 2) Norfolk sandy loam; 3) Fuquay loamy sand; 4) Pungo organic; and 5) a mixture of sandy loam and 65-mesh (120–370 μ m) sand. Differences in plant growth because of P_i 's of 375 to 6,000 larvae/15-cm pot were not significant. The P_f (final larvae density) in sandy loam did not differ ($P = 0.05$) from the P_f in clay, though the mean was 49% higher in sandy loam. In a second experiment, a P_i of 54,000 eggs/pot suppressed ($P = 0.05$) shoot weight in all but the clay soil. P_f was greatest in the loamy sand. Microplots containing a clay loam or loamy sand were infested with eight P_i 's (0 to 144,000 eggs). A P_i of 72,000 eggs in the sand suppressed ($P = 0.01$) yield by 26%. Yield losses for a P_i of 144,000 eggs in the clay loam and loamy sand were respectively 6% (N. S.) and 36% ($P = 0.01$). P_f for larvae was 49% greater ($P = 0.01$) in the sand than in the clay soil. The integration of environmental factors with nematode-plant interactions as tested has much potential in developing more efficient predictive capabilities for control practices.—*Department of Plant Pathology, North Carolina State University, Raleigh, North Carolina 27650.*

NICKLE, W. R. *On the biology and life history of some terrestrial mermithids parasitic on agricultural pest insects.*

Living specimens of *Hexamermis* spp. were obtained from the fall armyworm, *Spodoptera frugiperda* (Smith and Abbot), from Nicaragua; the gypsy moth, *Lymantria dispar* L., from the USSR, Austria, and Japan; and *Lygus* spp. from the South of France. *Filipjevimermis leipsandra* Poinar and Welch from the corn rootworm,

Diabrotica undecimpunctata howardi Barber, was obtained from South Carolina. Biological and taxonomic studies are being conducted with these nematodes. All mermithids have been reared to the adult stage. Eggs of the *Hexamermis* from *S. frugiperda* hatched at room temperature in 8 weeks, releasing the infective preparasitic stage which readily entered larvae of the beet armyworm, *S. exigua* (Hüber), under laboratory conditions. Twenty postparasitic mermithids, averaging 20 cm long, emerged during a 16–24-day period after the infection of 20 larval insects at 31 C. The parasitized insect always died. A long life cycle, possibly 2 years, seems probable for the *Hexamermis* from the gypsy moth.—*Nematology Laboratory, Plant Protection Institute, United States Department of Agriculture, Science and Education Administration, Beltsville, Maryland 20705.*

O'BANNON, J. H., and S. NEMEC. *Interaction of Tylenchulus semipenetrans and Glomus mosseae on Citrus limon.*

The influence of a vesicular-arbuscular mycorrhiza (VAM) (*Glomus mosseae*) and the citrus nematode (*Tylenchulus semipenetrans*), and both in combination, on the growth of rough lemon (*Citrus limon*) was studied in the greenhouse. Thirty *T. semipenetrans*-infected and 30 uninfected 9-month-old seedlings were transplanted into 20-cm pots containing Astatula fine sand subsoil. Mycorrhizal inoculum was added to pots of 15 *T. semipenetrans*-infected and 15 uninfected seedlings by amending the soil with 100 g/pot of soil containing 160 *G. mosseae* chlamydospores. Determined at harvest, after 8 months' growth, were plant measurements and nematode and mycorrhizal numbers. Dry weights of VAM seedlings only were 70 and 126% greater ($P = 0.01$) than non-VAM nematode-infected and non-VAM (control) seedlings, respectively, and 21% greater ($P = 0.01$) than VAM-nematode-infected seedlings. The nematode-VAM combination significantly suppressed seedling growth compared with seedlings with VAM only. *G. mosseae* sporulated well alone and in combination with the nematode. Chlamy-

dospores/25 cm³ soil in VAM soils alone were 177, and with the nematode were 186. Citrus nematode numbers/g root were 314 in the presence of *G. mosseae* and 662 without it. These values were not significantly different. Significant growth differences between VAM and non-VAM seedlings indicate that mycorrhizae can provide citrus seedlings certain nutrient requirements for growth stimulation, with or without the citrus nematode. Our results show that VA mycorrhizae reduce the adverse effect of the citrus nematode on root and shoot growth of citrus seedlings, and VAM colonization may affect nematode feeding sites.—*Science and Education Administration, United States Department of Agriculture, Orlando, Florida 32803.*

O'BRIEN, P. C. *Effect of carbofuran, aldicarb, and a resistant host on development of Globodera rostochiensis in potato.*

In a field experiment, the development of *Globodera rostochiensis* was followed in a resistant potato (cv. Hudson) and in a susceptible one (cv. Katahdin). In the same experiment, development of *G. rostochiensis* in Katahdin was studied in untreated soil and in soil treated with either aldicarb or carbofuran. Both chemicals were applied in furrow during planting at a 5.5 kg (a.i.)/ha rate. Hatching of larvae was similar in all treatments, and neither invasion nor development of larvae in Katahdin was affected by carbofuran. Larval invasion into roots of plants treated with aldicarb was restricted during the first 30 days of plant growth. After this period, larval invasion increased and aldicarb inhibited larval establishment and development. The final number of nematodes in all stages of growth in the roots of plants treated with aldicarb was 50% of the number in the control, and 50% of these were second-stage larvae.

Development of *G. rostochiensis* in Hudson grown in the field experiment was supplemented by a trial conducted in 13-cm clay pots. Larval invasion was not affected until 4 weeks after planting, when numbers of larvae in Hudson decreased because

larvae migrated from the roots, and larval invasion continued to increase numbers of larvae in the control for a further 2 weeks. The maximum number of nematodes within Hudson was 30–40% of the maximum number in the control, with only 20% of these larvae developing into adults, and all became males. In the control, 98–100% of larvae developed to adults, with 60–70% becoming males. Therefore, about 10% of the total number of males developed in the control developed into males in the resistant potato.—*Department of Plant Pathology, Cornell University, Ithaca, New York 14853.*

ORR, C. C. *Parasitism of Solanum elaeagnifolium by Nothanguina phyllobia.*

A population of *S. elaeagnifolium* was artificially inoculated with *N. phyllobia* in a field test. Nematode symptoms on plants increased 10-fold each year for 2 years after inoculation. Fifty percent of infected plants died during each year, and growth and reproduction of infected plants was reduced 50% for plants that remained alive. At the end of the third year of the experiment, a 90% reduction in growth and reproduction of *S. elaeagnifolium* was recorded. *N. phyllobia* overwinter in the soil. *S. elaeagnifolium* was infected before emergence, and nematodes ascended and infected plants throughout the growing season when environmental conditions were favorable. Laboratory tests showed that larvae ascend stems to 15 cm in a few hours. Entry into plant tissue occurred at apical meristems, where larvae penetrated directly through the epidermis. Serial sections of plant tissue 5 days after inoculation showed galling of leaf tissue, and eggs developing in the nematodes.—*Texas A&M University Agricultural Research and Extension Center, Route 3, Lubbock, Texas 79401.*

RICKARD, D. A., and A. W. DUPREE, JR. *The effectiveness of ten kinds of marigolds and five other treatments for control of four Meloidogyne spp.*

This greenhouse experiment tested five cultivars of *Tagetes patula*, three of *T.*

erecta, one of *T. signata pumila*, and one triploid hybrid (*T. patula* × *T. erecta*). These were compared with tomato (*Lycopersicon esculentum* 'Rutgers'), pearl millet (*Pennisetum americanum* 'Common Cattail'), fallow, DBCP 27.1 kg/ha followed by Rutgers tomato, and fensulfothion 8.2 kg/ha followed by Rutgers tomato. The four replicates of the 15 treatments, in 16.5-cm-diam pots, were arranged in a completely randomized block design. After 12 weeks, control was evaluated by growing Rutgers tomato plants in each replicate for 8 weeks and then comparing galling of tomato roots in the various treatments. From that bioassay, all the *Meloidogyne* spp. reproduced on the signet marigold (*T. signata pumila* 'Golden Gem') and on pearl millet. The chemical treatments were ineffective against these root-knot nematodes under these greenhouse conditions. Fallow and nearly all the other marigold cultivars resulted in significantly less galling by all four *Meloidogyne* spp. than by the double-cropped tomato check. Two exceptions were noted. The American marigold (*T. erecta* 'Diamond Jubilee') and the French marigold ('Petite Harmony') allowed significant galling by *M. arenaria* on the tomato test plants.—*Nematode Advisory Section, Agronomic Division, North Carolina Department of Agriculture, Raleigh, North Carolina 27611.*

RODRIGUEZ-KABANA, R., R. L. HAA-
LAND, C. B. ELKINS, and C. S.
HOVELAND. *Relationship of root
diameter and number of roots to damage
of tall fescue by lance nematodes.*

The effect of *Hoplolaimus galeatus* on two tall fescue (*Festuca arundinacea*) genotypes was studied in 10-cm-diam plexiglass columns 60 cm tall filled with a sandy loam infested with the nematode. Columns with sterile soil were included as controls. Each column was planted with a single sprig and maintained for 3 months in a growth chamber (temperature: day = 26 C; night = 18 C). One tall fescue genotype (AU 7) was characterized by large-diam roots with few secondary roots; the other (AU 81) had small-diam roots with many secondary roots. Nematodes caused reductions in: Mg up-

take, forage and root production, and water uptake (measured manometrically and by weighing). These reductions were significantly greater in AU 7 than in AU 81. Nematodes also caused significant reductions in the number of root hairs in both clones. AU 7 sustained twice the number of nematodes/g of fresh root as AU 81. Root density decreased with depth in all columns. This decrease was greater ($P = 0.05$) for nematode-infected roots than for uninfected ones. Also, the nematode effect on root density was greater ($P = 0.05$) with AU 7 than with AU 81. Results indicate that tolerance of tall fescue to *H. galeatus* is associated with ability to produce large numbers of small-diam roots.—*Departments of Botany and Microbiology, and Agronomy and Soils, Auburn University, Auburn, Alabama 36830.*

RODRIGUEZ-KABANA, R., PEGGY S.
KING, and E. G. INGRAM. *Urea and
blackstrap molasses for control of
Meloidogyne arenaria.*

The nematicidal effect of urea, alone and combined with blackstrap molasses, was studied in the greenhouse. A series of aqueous urea solutions was prepared containing 0, 1, 2, 4, 8, and 16% (w/v) of the chemical. A second series contained the same concentrations but the urea was dissolved in a 20% (v/v) solution of blackstrap molasses (sp. gr. 1.300). Ten ml of each solution was added to a plastic bag containing 500 g of a sandy-loam soil heavily infested with *Meloidogyne arenaria*. After thorough mixing the mixture was transferred to 12-cm-diam plastic pots of 900 cm³ capacity. The treatments were replicated eight times, and the pots were arranged in a totally randomized design in the greenhouse and kept moist. After 3 weeks, squash seed (*Cucurbita pepo* L., cv. Summer Crookneck) were planted in each pot and grown for 6 weeks. Roots from the resulting plants were then examined to determine the galling index (GI) value, and the number of galls (GN) and eggs (EG) per gram of fresh root. Solutions of urea alone at 2% or higher reduced GI, GN, and EG values significantly; the 2% solution resulted in 95% reduction in these values,

and solutions with concentrations of 4% or higher eliminated the nematode. However, all solutions of urea in water resulted in heavy accumulations of NO_3^- and $\text{NH}_4^+\text{-N}$, severe phytotoxicity, and fewer surviving plants. All solutions containing both urea and molasses significantly reduced GN values. The 1% solution resulted in a 27% decrease, the 2% in 80.5%, and higher concentrations in 100% reductions. Values for GI and EG paralleled those for GN. In soils receiving molasses + urea, NO_3^- and $\text{NH}_4^+\text{-N}$ accumulated only with the two highest concentrations of urea, but phytotoxicity occurred with the three highest. The results suggest that some combined solutions of molasses and urea may be promising nematocides for the home-gardener or in greenhouse situations.—*Department of Botany and Microbiology, Auburn University, Agricultural Experiment Station, Auburn, Alabama 36830.*

SANTO, G. S. *Effect of 1,2-dibromo-3-chloropropane on yields of Concord grapes in central Washington.*

Two field trials to test the efficacy of 1,2-dibromo-3-chloropropane (DBCP) in controlling nematodes on Concord grapes growing in Warden silt loam soil were set up in 1976 in Prosser, Washington. Single rows (20 vines/row) were treated with DBCP at rates of 0, 23.6, and 39.3 liters (a.i.)/ha. Each treatment was replicated four times in Trial A and three times in Trial B. Four shanks, spaced 30.5 cm apart, were used to inject the material 10-15 cm deep on each side of the vine row (about 46 cm from the vine row). The plots in Trial A were fumigated in June 1976 and again in June 1977. The plots in Trial B received DBCP only once, in June 1976. No differences in yield between the treatments in each trial were observed in 1976. In 1977, yields were lower in the plots treated with 39.3 liters (a.i.)/ha DBCP than in the untreated plots ($P = 0.10$). No difference in yield was observed between the other treatments. In Trial A the untreated plots yielded 6.9 T/A and the low and high rates of DBCP respectively yielded 5.6 and 5.0 T/A. In Trial B the untreated plots yielded 2.6 T/A and the low and high rates of

DBCP respectively yielded 2.0 and 1.6 T/A. No differences in vine growth were observed between the treated and untreated plots. DBCP had no apparent effect on numbers of nematodes present (*Gracilacus* spp., *Paratylenchus* spp., *Pratylenchus* spp., *Meloidogyne hapla*, *Tylenchorhynchus* spp., and *Xiphinema americanum*).—*Department of Plant Pathology, Washington State University, Irrigated Agriculture Research and Extension Center, Prosser, Washington 99350.*

SASSER, J. N. *Identification of root-knot nematodes (*Meloidogyne* spp.) and predictability of their behavior.*

Taxonomy of *Meloidogyne* species is difficult, and confusion exists among workers as to which characters are reliable for identification. Furthermore, too little information is available on correlation of the characters used for identification with pathogenicity. A study of over 500 populations of *Meloidogyne* from diverse hosts and habitats around the world showed the following kinds of data useful in identification: 1) ecological (location, including altitude and climate); 2) morphological (shape of female and characteristics of perineal patterns); 3) differential host response and type gall; and 4) cytological (chromosome number and mode of reproduction). The combined data, used in making identifications, revealed wide differences between species of *Meloidogyne*. Although some variation was found within populations of the same species, uniformity of characters, including pathogenicity, far outweighed the variability. For the widely distributed and agriculturally important species *M. incognita*, *M. javanica*, *M. hapla*, *M. arenaria*, *M. naasi*, and *M. exigua* there was a strong relation between the standard characters used for identification and the behavior of the nematode. That relation has been observed for each of the important species, and on a large number of populations within the same species. Those studies suggest that, once the identity of the nematode is known, its pathogenicity can be predicted except for variations among races. If additional studies confirm that relation, it may be practical to develop resistant

cultivars and host ranges at a single location and expect the results to be applicable throughout the world. Such studies, using a few populations of each of the major species, could be conducted under standard conditions and at minimum cost compared with testing all crops against all populations in all countries.—*Department of Plant Pathology, North Carolina State University, Raleigh, North Carolina 27650.*

proteins also occurred in control mosquitoes. These results indicate that parasitism by *R. culicivora* causes major changes in the protein metabolism of *C. pipiens*.—*Department of Nematology, University of California, Riverside, California 92521.*

SCHMIDT, S. P., and E. G. PLATZER.
Hemolymph composition of mosquito larvae infected with a mermithid nematode.

Hemolymph composition of fourth-instar larvae of an autogenous strain of *Culex pipiens* was examined to determine the effects of parasitism by a mermithid nematode, *Romanomermis culicivora*. Mosquitoes were reared under two different pH regimes: 4.5 and 7.3. The wet weights of control and infected mosquito larvae were similar. Total carbohydrates of the hemolymph, determined by the anthrone reaction, were not significantly different in control and parasitized mosquito larvae. Total amino acid levels did not differ in control and infected mosquitoes reared at pH 4.5, but were significantly greater in control larvae raised at pH 7.3 (0.125 ± 0.007 vs. 0.076 ± 0.01 mmole amino N/ml hemolymph). Hemolymph proteins, determined by Lowry protein assay, were 3–6 times as high in controls as in infected larvae. Controls had 40–50 mg of protein/ml hemolymph, while infected larvae had 8–9 mg/ml. For electrophoretic studies, hemolymph was collected in Tris-citrate buffer. The samples were prepared for electrophoresis by treatment with sodium dodecyl sulfate and mercaptoethanol. Proteins were separated on vertical 12% SDS-polyacrylamide gels at 15 ma per slab. Electropherograms showed a nonspecific reduction in soluble proteins. Hemolymph from parasitized larvae contained two prominent proteins with molecular weights of 80,000 and 158,000. Comparison of electrophoretic mobilities indicated that these

SINGH, N. D. *Effects of intercropping maize with soybean on crop yields and populations of several plant-parasitic nematodes.*

In this field experiment, cropping treatments were: 1) maize (cv x-306) in pure stand (M) with plants 45 cm apart in rows 45 cm apart; 2) soybean (cv Jupiter) in pure stand (S) 15 cm apart in rows 45 cm apart; 3) maize and soybean planted in the same row (MS), maize plants 45 cm apart with two soybean plants in the intervening space, rows 45 cm apart; 4) maize and soybean in alternate rows (M_1S_1), each crop spaced in the rows as in monocultures; 5) maize and soybean in alternating double rows (M_2S_2), each crop spaced in the rows as the monocultures; and 6) fallow. A single replicate consisted of four rows 6 meters long. A randomized block design was used with four replicates. The commonest nematodes in the plantings were *Rotylenchulus reniformis*, *Pratylenchus zeae*, *Meloidogyne incognita*, and *Tylenchorhynchus* sp. Fourteen weeks after planting, the largest ($P = 0.05$) number of *R. reniformis* (6370/200 cm³ soil) was recovered from S, and the largest ($P = 0.05$) number of *P. zeae* (610/200 cm³ soil) was recovered from M. There were no significant differences in numbers of *M. incognita* or *Tylenchorhynchus* sp. recovered from the different treatments. Maize planted as M produced a higher ($P = 0.05$) yield (3433 kg/ha) than maize planted in polyculture when compared on the basis of area planted. Soybean planted as S produced a higher ($P = 0.05$) yield (1892 kg/ha) than soybean in the mixed cultivations when compared on the same basis.—*Caribbean Agricultural Research and Development Institute, University of the West Indies, St. Augustine, Trinidad, West Indies.*

SLANA, L. J., and J. R. STAVELY. *Location of the factor for resistance to Meloidogyne incognita in NC 95 tobacco.*

To identify the chromosome carrying the factor for resistance to *Meloidogyne incognita* in tobacco, crosses were made between resistant tobacco ('NC 95') as pollen parent and each of the 12 tobacco monosomics (A-L) representative of the Tomentosae half of the *N. tabacum* chromosome complement. Of the F_1 seedlings, 997 were grown for observation. From these were morphologically selected 223 as possible monosomics. These plants were self-pollinated, and the resulting F_2 plants were inoculated with both *M. incognita acrita* and *M. incognita incognita*. Nine F_2 populations derived from haplo-G were all resistant plants. All of the F_2 populations derived from the other 11 monosomic crosses segregated into a 3:1 ratio of resistant to susceptible. These results indicate that the factor for resistance to *M. incognita* is located on the G chromosome of *N. tabacum*. This is the first report establishing which *N. tabacum* chromosome carries the root-knot resistance factor. The results are consistent with our earlier evidence that *M. incognita* resistance in tobacco is derived from *N. tomentosa*, a species in the section Tomentosae of the subgenus *Tabacum*, genus *Nicotiana*. The other 12 chromosomes of *N. tabacum* have affinities with *N. sylvestris*, section *Alatae*, subgenus *Petunioides*, genus *Nicotiana*.—*United States Department of Agriculture, Tobacco Laboratory, Plant Genetics and Germplasm Institute, Beltsville Agricultural Research Center, Beltsville, Maryland 20705; and Department of Botany, University of Maryland, College Park, Maryland 20742.*

TAYLOR, D. P. *On the identity of a species of Heterodera parasitizing banana.*

A large population of an unidentified species of *Heterodera* was found parasitizing banana in Senegal. Under greenhouse conditions this isolate reproduced well on banana and rice. *H. oryzae* from the type locality in the Ivory Coast also reproduced on banana. The isolate from banana re-

sponded positively to rice root exudates. No morphological or cytological differences were found between the banana isolate and *H. oryzae*. Reciprocal matings between the isolate and *H. oryzae* were successful, producing progeny which reproduced on rice. It is concluded that the isolate from banana is conspecific with *H. oryzae*. This is the first report of parasitism of banana by a *Heterodera*.—*Laboratoire de Nématologie, Office de la Recherche Scientifique et Technique Outre-Mer, Centre de Dakar, BP 1386, République du Sénégal.*

VAN ARKEL, R. G., and G. W. BIRD. *Effect of Meloidogyne hapla on carrot under two temperature progressions.*

Growth of carrot (*Daucus carota* cv Gold Pak) was studied under two soil temperature progressions with and without *Meloidogyne hapla*. The regimes, maintained in greenhouse temperature tanks, were designed to simulate temperature conditions associated with early and late planting in Michigan. The early simulation started with 9 C and the late one with 18 C. Both regimes were increased 1–2 C every 7 days. Pregerminated carrot seeds were planted in steamed organic soil in 15-cm-diam pots, and 7,500 *M. hapla* eggs per pot were added to half of the pots at planting. Each treatment was replicated six times. The experiment was terminated after 42 days. Shoot height, weight, and area, taproot length and quality, root weight and area, root galling, *M. hapla* per root system, and *M. hapla*/100 cm³ of soil were determined 21 and 42 days after planting. A visual rating of taproot deformity was used to rate carrot quality. In general, shoot and root development were retarded ($P = 0.05$) with the cooler progression and by *M. hapla* under both temperature regimes. The detrimental influence of *M. hapla* was less with the cooler progression than with the warmer one. Twenty-one days after planting, taproot quality in the presence of *M. hapla* under the cooler regime was better ($P = 0.05$) than taproot quality in the presence of *M. hapla* under the warmer regime. Twenty-one days after planting there were fewer ($P = 0.05$) root galls, *M. hapla* per root system, and *M. hapla* per 100 cm³ of

soil under the cooler than at the warmer regime. The data indicate that damage to carrot by *M. hapla* may be reduced by planting early. Control of *M. hapla* in the early part of the growing season is essential for production of fresh market carrots.—*Department of Entomology, Michigan State University, East Lansing, Michigan 48824.*

VEECH, J. A. *The toxicity of terpenoid aldehydes to nematodes.*

Crude terpenoid aldehyde extracts (gossypol and gossypol-like compounds = TA) from cotton plants were bioassayed to determine their toxicity to the free-living nematode (*Panagrellus redivivus*) and the root-knot nematode (*Meloidogyne incognita*). Larvae of these nematodes were incubated in aqueous solutions containing 0 to 4000 ppm TA (based on gossypol equivalents). Larva survivals, expressed as a percentage of the controls, were determined for various exposure times. Only 6% of the larvae of *P. redivivus* survived after 24 h on 4000 ppm TA; 43% survived after 24 h in 1000 ppm TA. No larvae survived after 72 h in TA of 1000 ppm or more. Sixty-three percent of the larvae of *M. incognita* survived exposure to 125 ppm TA for 24 h. Longer exposure or TA concentrations greater than 250 ppm resulted in less than 10% survival of the larvae. The data indicate that TA is toxic to *P. redivivus* and *M. incognita*.—*National Cotton Pathology Research Laboratory, P. O. Drawer JF, College Station, Texas 77840.*

WEINGARTNER, D. P., J. R. SHUMAKER, D. W. DICKSON, and R. C. LITTELL. *Nematode control on Irish potatoes in northeast Florida using a soil fumigant and a nonvolatile nematicide both alone and in combination.*

Aldicarb (A) at 3.36 kg ai/ha in the row and 1,3-D (T) at 51.5 ai/ha in the row were evaluated alone and in combination (A + T) for control of nematodes and associated tuber diseases on 'Sebago,' 'Red LaSoda,' 'Pungo,' and 'Green Mountain' potatoes in a split plot experiment.

Although the test area contained *Belonolaimus longicaudatus* (BL), *Criconeimoides ornatus* (CR), *Meloidogyne incognita* (MI), *Trichodorus christiei* (TR), *Tylenchorhynchus claytoni* (TC), *Helicotylenchus* spp. (HE), and *Hemicyclophora* sp. (HM), correlation coefficients and the small numbers of other nematodes observed suggested that BL was the principal nematode affecting tuber yields and general tuber quality (other than corky ringspot disease) in north Florida during 1977. Populations of BL in early, mid, and late-season soil samples showed highly significant ($P = 0.01$ to 0.001) negative correlations with yields of US Size A tubers ($r = -0.33, -0.52$, and -0.60 , respectively) and positive correlations with severity of tuber defects ($r = 0.31, 0.66$, and 0.72 , respectively). Numbers of BL were reduced significantly by all nematicide treatments on all three sample dates. At harvest, BL populations were significantly lower in A and A + T plots than in T plots. Respective yields from A, T, A + T, and control plots were 27.0, 23.7, 27.4, and 17.3t. All were significantly greater than the control except T. No significant variety $\times$ nematicide effects on yield were observed. All treatments improved tuber quality significantly; and a significant variety $\times$ nematicide interaction occurred wherein quality tended to be improved most in 'Sebago' and 'Red LaSoda'.—*Agricultural Research Center, Hastings, Florida 32045, and Departments of Entomology and Nematology, and Statistics, University of Florida, Gainesville, Florida 32611, respectively.*

WILLETT, J. D., D. W. FRECKMAN, and S. D. VAN GUNDY. *Determination of ATP levels in *Aphelenchus avenae* in the free-living and anhydrobiotic states.*

Adults of *Aphelenchus avenae* reared on *Rhizoctonia solani* growing on autoclaved wheat grains were harvested and rendered anhydrobiotic by desiccation over sulfuric acid. Rehydration of anhydrobiotic individuals from this population resulted in a 96% return to viability in 12 h. Twelve like lots of anhydrobiotic *A. avenae* were obtained by weighing. Six were treated with

0.1 ml each of sterile deionized-distilled water, and six were assayed directly for ATP. ATP was determined with an SAI Technology Co. Model 3000 integrating photometer and the luciferin-luciferase bioluminescence assay. One of the six lots in both the hydrated and unhydrated sets was killed by heating from room temperature to 100 C in 2 h and used as a control. The hydrated lots were assayed for ATP after exposure to water for 19 h. The ATP was extracted by adding the samples to 5 ml of boiling Tris buffer (pH 7.7) except for the controls, which had been killed by heating to 100 C before extraction. A 10- μ l sample was withdrawn from each lot, diluted with 0.4 ml of Tris buffer (pH 7.7), and added

to 0.4 ml of fire-fly luciferin-luciferase, and light emission was measured. ATP levels were determined from a standard curve of light emitted per μ g ATP in solution prepared the same day. *A. avenae* in the anhydrobiotic state was found to have ATP levels of 4.59 ± 0.78 μ g/mg dry weight, whereas in their hydrated motile state the ATP levels were 2.23 ± 0.33 μ g/mg dry weight ($n = 5$). *A. avenae* maintained a significantly higher energy charge in the anhydrobiotic state than it does upon rehydration.—*Department of Chemistry, University of Idaho, Moscow, Idaho 83843, and Department of Nematology, University of California, Riverside, California 92502.*