NEMATODES PARASITIC ON PEANUTS IN ALABAMA AND EVALUATION OF METHODS FOR DETECTION AND STUDY OF POPULATION DYNAMICS [NEMATODOS PARASITOS DEL MANI EN ALABAMA Y EVALUACION DE METODOS PARA SU DETECCION Y PARAEL ESTUDIO DE DINAMICA POBLACIONAL].

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ABSTRACT

A study was made to determine the nematode genera present in the peanut producing area of Alabama, observe their seasonal population development, and to evaluate different methods of nematode detection. Field plots were located throughout the peanut producing area of Alabama in 1976 and 1977. Soil and plant samples were taken in June, July, September, and November-December of each year. Nematodes were extracted from soil and corn and tomatoes were used as bioassay plants for *Pratylenchus* spp. and *Meloidogyne* spp., respectively. Soil extractions showed fields infested (season maximum) with *Criconemoides* spp., *Trichodorus* spp., *Tylenchorhynchus* spp., *Xiphinema* spp. and tylenchoid nematodes at 83.0, 50.9, 3.6, 19.6, and 69.6 percent, respectively. Corn bioassays showed fields (season maximum) with aphelenchoid nematodes, *Pratylenchus* spp. and *Helicotylenchus* spp. at 97.3, 83.9, and 33.0 percent, respectively. Tomato bioassays indicated fields infested with *Meloidogyne* spp. (season maximum) at 41.1 percent. Populations of *Criconemoides* spp., *Meloidogyne* spp., and *Pratylenchus* spp. generally reached highest numbers from July to September. *Helicotylenchus* populations declined significantly by July.
Key Words: nematode survey, root-knot, lesion, stubby, dagger, and ring nematodes, Meloidogyne arenaria, Meloidogyne hapla, Pratylechus brachyurus.

INTRODUCTION

The importance of nematodes as pests on peanuts has been amply demonstrated by researchers over the years. *Belonolaimus* spp., *Criconemoides* spp., *Meloidogyne* spp., and *Pratylenchus* spp. represent the most common genera containing nematodes parasitic to peanuts (7, 8, 9, 10, 11, 12). Determination of the species of nematodes present in a peanut field is a prerequisite for development of control strategies. Motsinger's Georgia survey of 1974 (12) is the most recently reported nematode survey on peanuts while Minton's nematode survey of 1963 (10) is the latest one to include peanut fields in Alabama. Thus, although some information was available on nematode occurrence in peanuts in Alabama, little was known about the population dynamics, the influence of soil depth on development of the parasites, or the adequacy of assay methods for determination of nematode numbers. Since this information is essential for establishment of recommendations to farmers a study was initiated to determine changes in nematode distribution in the peanut producing area of Alabama since Minton's survey, to determine the development of nematodes with respect to time (season) and depth, and to evaluate different methods of assaying nematode population levels.

MATERIALS AND METHODS

Field Selection and Sampling. Peanut fields were located in Barbour, Bullock, Coffee, Covington, Crenshaw, Dale, Geneva, Henry, Houston, and Pike counties, Alabama, in 1976 and 1977; Barbour county was excluded in 1977. County Extension Agents were relied upon to select from 4 to 6 fields representative of their total peanut growing area. Geographic representation was stressed and no special attention was paid in selecting fields with nematode problems. A single plot measuring 3.7 x 30.5 m was established in each field in an area as representative of the entire field as possible. Totals of 63 and 49 plots were established in 1976 and 1977, respectively. Plant and soil samples were taken 4 times each year between June and December. Plants were collected from 4 locations within the plot and soil samples were taken from 8 locations. Soil cores were taken with a 7.6-cm bucket-type auger (Art's Machine Shop, American Falls, Idaho) and were separated according to depth (0-15 cm and 15-30 cm). Plants from each plot were combined to make one composite sample for each plot and soil cores were composited for each depth for each plot.

Processing of Plant Samples. In 1976, pods were removed from the plants and shelled. The shells were weighted and incubated for 72 hr in enough water for coverage. In 1977, both roots and pods were removed from the plants. Roots were cut into approximately 3-cm lengths, weighed and incubated as described for pod shells. Pods were removed, weighted and incubated whole. After the 72-hr incubation period, the nematodes were collected by pouring the water through a 400-mesh (38 micrometer) sieve and the residue was washed into a petri dish. Dishes were stored in the incubator (14C) until nematodes were counted.

Processing Soil Samples. Soil samples were sieved (1 cm^2 sieve orifice) and thoroughly mixed. Nematodes were extracted from a 50 cm^3 subsample by the molasses flotation-sieving technique (14). The remaining soil was portioned into 4 plastic pots (12 cm diam), 500 g/pot. 'Rutgers' tomatoes were planted in 2 pots, 2 plants per pot; and 2 'Yellow dent' corn seed were planted in each of the 2 other pots. Tomato was used as a bioassay for *Meloidogyne* spp. and corn for *Pratylenchus* spp. (2,15). Plants were maintained in the greenhouse for 28-30 days.

Processing Indicator Plants. After the prescribed growth period, the plants were removed from the pots, roots washed free from the soil, and shoot height and shoot and root weights were determined for each. Tomato roots were examined for degree of galling and were rated according to a scale in which 0 represented no galling and 10 represented severe galling with extensive root breakdown (16). Corn roots were suspended in water as described for peanut roots and incubated for 72 hr. Nematodes in the water were collected as previously described, counted, and identified.

Statistical Analyses. Analyses of variance were performed treating each experiment as a split plot design with date and depth as factors and fields as replications. The error terms for determining differences in date, depth, and the interaction of date-depth were the mean squares from field-date, field-depth and field-date-depth, respectively (1). Fields with insignificant numbers of nematodes in both depths were deleted from ANOVA calculations.

RESULTS

Soil Extraction. Soil extraction results from 1976 and 1977 were combined to give an overall view of the incidence of the various nematodes. These combined results are given as percent fields infested (Table 1, 2); all values represent season maxima. Aphelenchoid nematodes were found in all of the fields surveyed. *Criconemoides*

Table 1. Percent frequency of occurrence of nematodes in peanut fields determined by soil extraction and corn bioassay.

Nematode	Depth (cm)	Sampling Time							
		June		July		Sept.		Nov.-Dec.	
		soil	corn	soil	corn	soil	corn	soil	corn
Aphelenchoids	0-15	32.1	93.7	49.1	97.3	64.3	88.4	72.1	94.6
	16-30	25.0	91.1	46.4	92.0	46.4	83.0	57.1	92.8
Criconemoides spp.	0-15	56.2	27.7	78.6	47.4	83.0	51.8	77.7	72.3
(*Macroposthonia* spp.)	16-30	51.8	27.7	75.9	39.3	75.0	62.5	70.5	80.3
Helicotylenchus spp.	0-15	29.5	30.3	20.5	22.3	15.2	23.2	17.0	33.0
	16-30	28.6	24.1	19.6	20.5	14.3	22.3	15.2	20.5
Pratylenchus spp.	0-15	28.6	58.9	23.2	75.9	25.0	83.9	33.0	83.9
	16-30	34.8	69.6	27.7	82.1	27.7	83.0	37.5	81.2
Trichodorus spp.	0-15	34.8	17.0	27.7	22.3	23.2	29.5	30.3	33.9
(*Paratrichodorus* spp.)	16-30	50.9	27.7	31.2	32.1	25.0	42.0	28.6	45.5
Tylenchorhynchus spp.	0-15	0.0	-	3.6	-	2.7	-	1.8	-
	16-30	0.9	-	2.7	-	0.9	-	1.8	-
Tylenchoids	0-15	69.6	-	58.9	-	42.0	-	42.0	-
	16-30	67.8	-	61.6	-	38.4	-	39.3	-
Xiphinema spp.	0-15	18.7	-	11.6	-	16.1	-	11.6	-
	16-30	19.6	-	16.1	-	14.3	-	18.7	-

Percent frequency of occurrence based on data from 112 fields surveyed in 1976 and 1977.

Table 2. Percent frequency of occurrence of *Meloidogyne* spp. in peanut fields determined by soil extraction and bioassay with tomato and corn.

	Depth (cm)	Sampling Time			
		June	July	Sept.	Nov.-Dec.
Soil Extraction	0-15	11.6	21.4	25.0	20.5
	16-30	21.4	23.2	23.2	23.2
Tomato	0-15	25.9	24.1	35.7	29.5
	16-30	29.5	25.9	40.2	41.1
Corn	0-15	8.9	16.1	18.7	3.6
	16-30	13.4	8.9	14.3	0.9

Frequency based on data from 112 fields surveyed in 1976 and 1977.

Table 3. The incidence of nematodes as determined by peanut shell incubations in 1976.

Nematode	July (%)[y]	September (%)[y]
Criconemoides spp.	6.35	38.10
Helicotylenchus spp.	3.17	7.94
Meloidogyne spp.	4.76	44.40
Pratylenchus spp.	12.70	53.90
Xiphinema spp.	0.00	1.60

[y] Percent frequency of fields infested with the respective nematodes. (Number of fields sampled: 63)

(Macroposthonia) spp., *Meloidogyne* spp., and *Pratylenchus* spp. were found in 83.0, 23.2, and 37.5 percent of the fields surveyed, respectively. *Helicotylenchus* spp. *Trichodorus (Paratrichodorus)* spp., *Tylenchorhynchus* spp., tylenchoid and *Xiphinema* spp. were recovered (season maximum) from 29.5, 50.9, 3.6, 69.6, and 19.6 percent of the fields surveyed, respectively.

Corn Bioassay. As with the results from soil extraction, results from 1976 and 1977 were combined and are presented as percent fields infested (Table 1, 2). *Criconemoides* spp., *Meloidogyne* spp., *Pratylenchus* spp., *Helicotylenchus* spp., and *Trichodorus* spp. were found in 80.3, 18.7, 83.9, 33.0, and 45.5 percent of the fields surveyed, respectively.

Tomato Bioassay. Data indicate that 41.1 percent of the fields (season maximum) were infested with *Meloidogyne* spp. (Table 2).

Table 4. The incidence of nematodes as determined by peanut root incubations in 1977.

Nematode	June (%)[y]	July (%)[y]	September (%)[y]
Criconemoides spp.	30.6	69.4	67.3
Helicotylenchus spp.	2.0	8.2	8.2
Meloidogyne spp.	18.4	30.6	30.6
Pratylenchus spp.	69.4	81.6	73.5
Xiphinema spp.	4.1	2.0	2.0

[y] Percent frequency of fields infested with the respective nematodes. (Number of fields sampled: 49)

Peanut Shell and Root Incubations. Isolations from incubated shells and roots (Table 3, 4) yielded lower frequencies of occurrence for *Criconemoides* spp., *Helicotylenchus* spp., and *Xiphinema* spp., and equal to or higher frequencies for *Meloidogyne* spp. and *Pratylenchus* spp. compared to soil extractions. Data for pods collected and incubated in 1977 were omitted because this method was considered unsatisfactory, giving insignificant numbers of nematodes.

Population Development

Soil Extraction. Significant differences in numbers of nematodes among dates were indicated for the 1976 populations of aphelenchoid nematodes, *Criconemoides* spp., *Helicotylenchus* spp., *Meloidogyne* spp., *Pratylenchus* spp., and tylenchoid nematodes and for 1977 populations of *Criconemoides* spp. and *Meloidogyne* spp. Significant date-depth interactions occurred in the 1976 populations of *Helicotylenchus* spp.

In 1976, numbers of *Criconemoides* spp. reached a season maximum by the September sampling and in 1977 by the July sampling. These maxima occurred at both depths (Fig. 1 A, B). Numbers of *Meloidogyne* larva reached maxima in September for both 1976 and 1977. However, in 1976 the significant differences in numbers of *Meloidogyne* larvae occurred in the 15-30 cm depth and in 1977 in the 0-15 cm depth (Fig. 1 C, D). In 1976, the number of *Helicotylenchus* spp. declined to a seasonal low in July and remained at this low level with the significant differences occurring in the 0-15 cm depth. No significant difference was found for numbers of *Helicotylenchus* spp. in 1977. Numbers of *Pratylenchus* spp. as determined by soil extraction were too low for significant differences to be valid.

Corn Bioassay. Significant differences in numbers of nematodes among dates occurred for 1976 populations of aphelenchoid, *Criconemoides* spp., *Helicotylenchus* spp., *Pratylenchus* spp., and tylenchoid nematodes. Differences in numbers among dates for 1977 were significant for aphelenchoid nematodes and *Pratylenchus* spp. No significant differences in numbers of nematodes between depths were evidenced for either year. Although significant date-depth interactions were indicated for 1976 populations of *Criconemoides* spp. and tylenchoid nematodes, the low numbers obtained make the validity of the comparison questionable.

Numbers of aphelenchoid nematodes generally reached a seasonal maximum in

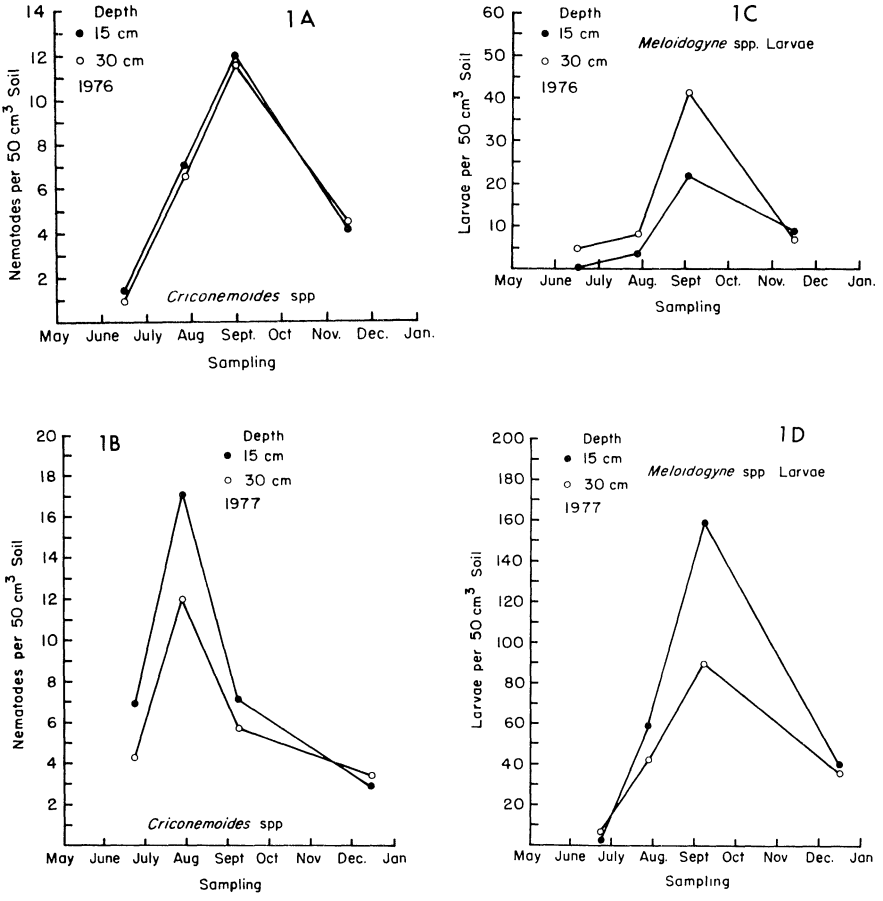

Fig. 1. Relation between sampling date and soil depth and changes in soil populations of *Criconemoides* spp. (A, B) and larvae of *Meloidogyne* spp. (C, D) in peanut fields.

July or September. Although significant differences were observed, numbers of *Criconemoides* spp., *Helicotylenchus* spp., *Trichodorus* spp., and tylenchoid nematodes were too low for valid comparisons.

Numbers of *Pratylenchus* spp. reached a seasonal maximum in July for 1977 at both depths (Fig. 2); numbers in 1976 were not significantly high to arrive at any definite conclusion.

Tomato Bioassay. Significant differences among dates were evidenced for the amount of galling in 1977 and for the gall rate in both years. Amount of galling reached a maximum in July (Fig. 3 A, B). Maximum gall rates were evidenced in September (0-15 cm depth) in 1976 and at both depths in 1977 (Fig. 3 C, D).

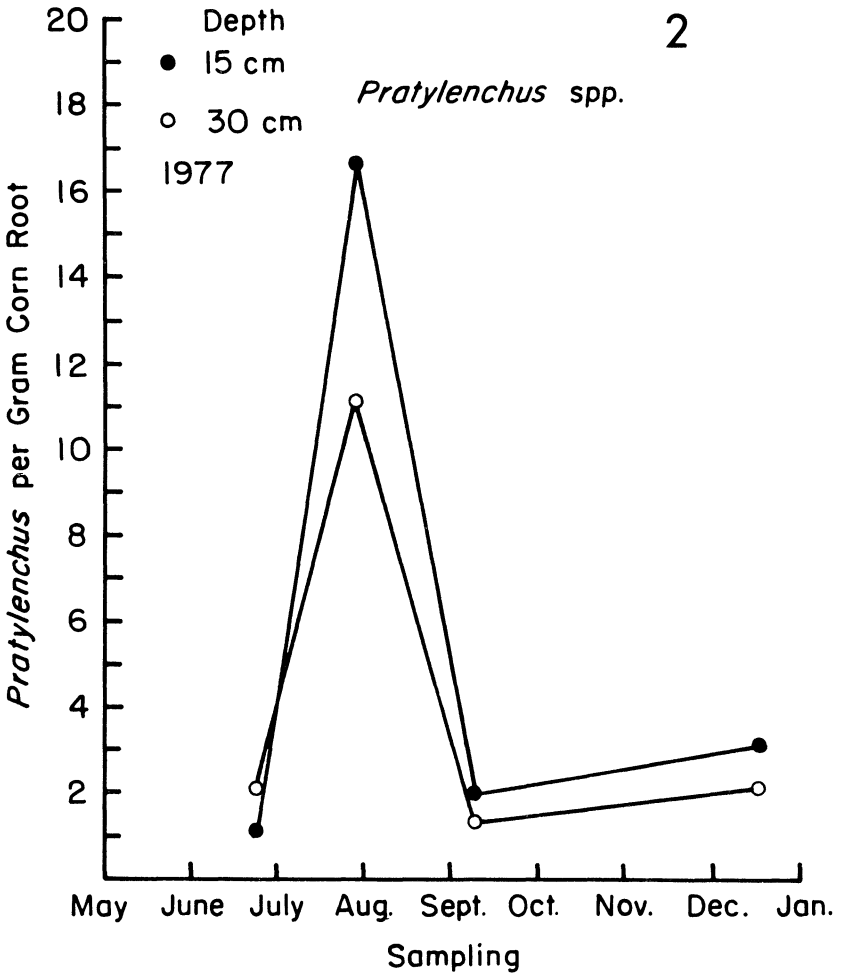

Fig. 2. Relation between sampling date and soil depth on poulations of *Pratylenchus* spp. in peanut fields as determined by corn (cv = "Yellow Dent") bioassay.

DISCUSSION

Higher percentages of field infestations of *Criconemoides* spp., *Trichodorus* spp., *Tylenchorhynchus* spp., *Xiphinema* spp., and tylenchoid nematodes were demonstrated by soil extraction than by corn bioassay. Higher percentages of field infestations of aphelenchoid nematodes, *Pratylenchus* spp. and *Helicotylenchus* spp. were obtained by corn bioassay, and the tomato bioassay demonstrated the highest percentage of field infestation of *Meloidogyne* spp.

Compared with the results of Minton *et al.* (14) and Motsinger *et al.* (16) the results from this survey showed greater percentages of field infestations of *Helicotylenchus*

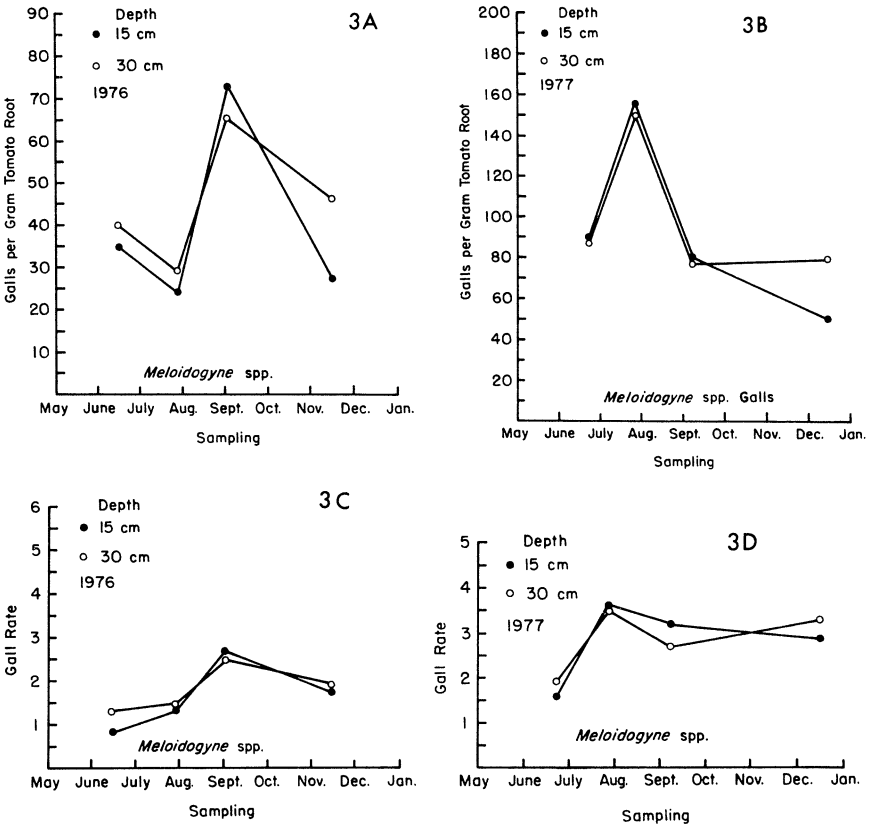

Fig. 3. Relation between sampling date and soil depth on populations of *Meloidogyne* spp. in peanut fields as determined by tomato (cv = "Rutgers") bioassay: A, B, galls per g of fresh tomato root; C, D, galling rate (scale: 1 = no galls to 10 = severest galling).

spp., *Pratylenchus* spp., *Trichodorus* spp., *Tylenchorhynchus* spp., and *Xiphinema* spp., whereas Minton *et al.* and Motsinger *et al.* found greater field infestations of *Criconemoides* spp. (97%) and *Meloidogyne* spp. (44%), respectively.

Differences among surveys, though slight in some instances, can be due to several factors including sample size, number of samplings, and time of sampling. In this study, samples were taken at four times, and a combination of soil extraction, peanut root and shell incubations, and indicator plants was used. Motsinger *et al.* (12) and Minton *et al.* (10) sampled only once and used soil extraction and plant samples. Whether populations are at detectable levels is dependent on time of sampling. The *Criconemoides* population is a good example; the June sampling showed 56.2% of the fields to be infested, while the September sampling showed 83.0% of infestation. Also, the possiblitiy of population shifts within a given area cannot be ruled out. These shifts may be due to changes in cultural practices (i.e. nematode control, crop rotation) and varieties.

Generally, *Criconemoides* spp., *Meloidogyne* spp., and *Pratylenchus* spp. reached peak populations from July to September regardless of procedure used. Such population buildups demonstrate that these genera contain species parasitic to peanuts. These results support those of Kinloch (5) and Johnson *et al.* (4) which showed that *Criconemoides ornatus* increased on peanuts with peak populations occurring in July. Good *et al.* (3) and Johnson *et al.* (4) demonstrated the buildup of *Pratylenchus* spp. on peanuts, and Johnson *et al.* (4) showed that peak populations occurred in July.

Our results show that *Trichodorus* spp., *Tylenchorhynchus* spp., and *Helicotylenchus* spp. did not increase in the peanut fields surveyed; these results support earlier work which indicated that these genera do not contain species parasitic to peanuts (4, 5, 6).

The paucity of significant differences among populations at different depths precluded valid comparisons or conclusions. However, as Potter (13) noted, populations located in the lower depths may represent the overwintering populations. Being located in the lower depths, nematodes could escape erradication and serve as sources of infestations the next year. The numerous date-depth interactions obtained in our study do not support a general trend for a population move to the lower depth.

CONCLUSIONS

Results from this study support the following conclusions:

1. Tomato bioassay was the most sensitive method of determining infestations of *Meloidogyne* spp. probably due to the detection of lower levels of infestation.
2. Corn bioassay was the most suitable method for determining infestations of *Pratylenchus* spp.
3. Soil extraction generally was the most sensitive method for determingng infestations of ectoparastic nematodes.
4. Greatest number of fields were infested with *Criconemoides* spp. followed by *Pratylenchus* spp. and *Meloidogyne* spp.
5. Peak populations of these three genera occurred from July to September indicating that the best time for sampling for these genera is in mid to late August.

RESUMEN

El trabajo presenta resultados de un estudio sobre los cambios estacionales de poblaciones de nematodos en la zona manicera de Alabama y otros obtenidos en una evaluación de métodos para reconocimiento de nematodos. Las parcelas para el estudio fueron dispuestas a través de la zona manicera en 1976 y 1977. Muestras de suelos y plantas fueron tomadas en Junio, Septiembre, y Noviembre-Diciembre cada año. Los nematodos fueron extraidos del suelo y se utilizaron maíz y tomate como bioindicadores para detectar *Pratylenchus* spp. y *Meloidogyne* spp., respectivamente. Las extracciones del suelo indicaron que en el punto del desarrollo máximo de las poblaciones de las especies de *Criconemoides, Trichodorus, Tylenchorhynchus, Xiphinema* y nematodos tilencoideos se encontraban en 83.0, 50.9, 3.6, 19.6, y 69.6 por ciento de los campos muestreados, respectivemente. Los resultados de pruebas con maíz indicaron que nematodos afelencoideos, y especies de *Pratylenchus,* y *Helicotylenchus* estaban presentes en 97.3, 83.9 y 33 por ciento de los campos, respectivamente. Los resultados de los análisis con tomate demostraron que el número de campos infestados con *Meloidogyne* spp. era 41.1 por ciento. Las poblaciones de especies de *Criconemoides, Meloidogyne* y *Pratylenchus* alcanzaron sus máximos en el período

entre Julio y Septiembre; las poblaciones de *Helicotylenchus,* por el contrario declinaron con el desarrollo del maní.

Claves: sondeo nematológico, nematodos noduladores, Meloidogyne arenaria, Meloidogyne hapla, Pratylenchus brachyurus.

LITERATURE CITED

1. Barr, A.J., J.H. Goodnight, J.P. Sall, and J.T. Helwig. 1946. A User's Guide to SAS 76. Dept. State Univ., Sparks Press, Raleigh, N.C., 329 pp.; *2.* Endo, B.Y. 1959. Phytopathology 49:417-421; *3.* Good, J.M., W.K. Robertson, and L.G. Thomason, Jr. 1954. Plant Dis. Reporter 38:178-180; *4.* Johnson, A.W., C.C. Dowler, and E.W. Hauser. 1974. J. Nematol. 6:187-190; *5.* Kinloch, R.A. 1974. J. Nematol. 6:144-145 (Abstr.); *6.* Kinloch, R.A. 1971. Nematropica 1:38-39; *7.* Miller, L.I., and G.B. Duke. 1961. Va. Agric. Exp. Sta. Bull. 520, 26 pp.; *8.* Minton, N.A. 1963. Phytopathology 53:79-81; *9.* Minton, N.A., and D.K. Bell. 1969. J. Nematol. 1:349-351; *10.* Minton, N.A. 1963. Plant Dis. Reporter 47:743-745; *11.* Minton, N.A., J.F. McGill, and A.M. Golden. 1969. Plant Dis. Reporter 53:668; *12.* Motsinger, R.E., J.L. Crawford, and S.S. Thompson. 1976. Peanut Sci. 3:72-74; *13.* Potter, J.M. 1967. Nematologica 13:150 (Abstr.); *14.* Rodríguez-Kábana, R. and P.S. King. 1977. Plant Dis. Reporter 56:1093-1096; *15.* Sasser, J.N. 1954. Md. Agric. Exp. Sta. Tech. Bull. A-77, 31 pp.; *16.* Zeck, W.M. 1971. Pflanzenschutz-Nachrichten 24:141-144.