Incidence and Economic Importance of Plant-Parasitic Nematodes on Peanut in Texas

T. A. Wheeler and J. L. Starr*[1]

ABSTRACT

The distribution of plant-parasitic nematodes in five Texas peanut producing counties was determined during 1985 and 1986 growing seasons. *Criconemella,* the most frequently detected genus, was present in 83.4% of the samples; evidence of crop damage was not observed. *Meloidogyne arenaria* was detected in 15.5% of the samples. In microplot tests, there was a significant negative relationship between initial populations of *M. arenaria* and peanut yields; a linear model estimates a 10% yield loss with initial populations of 44-83 *M. arenaria*/500 cm^3 soil. At least 10% of the survey samples were estimated to have root-knot nematode populations exceeding that necessary for a 10% yield loss. Other parasitic genera found in the survey were *Pratylenchus* (15.7% of the samples) and *Belonolaimus* (0.8% of the samples). While pod symptoms of *Pratylenchus* damage were observed, reliable yield loss estimates can not be made with existing data.

Key Words: yield losses, lesion nematodes, *Pratylenchus* spp., ring nematodes, *Criconemella* spp., sting nematodes, *Belonolaimus* spp., root-knot nematodes, and *Meloidogyne* spp.

Peanut (*Arachis hypogaea* L.) in the southern United States is susceptible to several species of nematodes of which *Meloidogyne arenaria* (Neal) Chitwood is commonly believed to be one of the most important. There are little data available, however, on the distribution of this pathogen in peanut production regions of Texas, nematode population densities, or on the relationship between nematode populations and peanut yield responses.

In Alabama 41.1% of the peanut fields were infested with *M. arenaria* (8), and in North Carolina 18% of the peanut fields were infested with root-knot nematodes (primarily *M. hapla*) (11). Ten percent of the peanut fields in southwest Georgia were infested with root-knot nematodes (12); *M. arenaria* is the predominant species (S. Thompson, pers. comm.). Candanedo and Dickson (4) reported significant yield loss of peanuts at initial populations of 10 to 50 *M. arenaria*/100 cm^3 soil. Rodriguez-Kabana *et al.* (14) reported that populations of 50 juveniles (J_2)/100 cm^3 soil present at crop maturity suppressed yield.

We report herein the distribution of *M. arenaria* and other parasitic nematodes on peanuts in Texas, the relationship between initial populations of *M. arenaria* and peanut yield loss, and the frequency with which populations of *M. arenaria* exceed an estimated damage threshold.

Materials and Methods

Survey of nematode distribution. Five counties which account for 44% of the peanut production in Texas were selected for the survey. The survey was completed during the 1985 and 1986 growing seasons; all samples were collected during August and September when nematode populations were near maximum levels (8). Individual fields were selected arbitrarily so as to represent major production areas within each county. Each field was divided into 8-ha quadrants and one composite sample covering 0.4-ha was removed from each quadrant, with a maximum of four samples per field. Composite samples contained 20 soil cores, each 2.5-cm-d x 25-cm deep. A 500-cm^3

[1]Former Graduate Student and Associate Professor, Department of Plant Pathology and Microbiology, Texas Agricultural Experiment Station, College Station, TX 77843. Current address of senior author - Department of Plant Pathology, North Carolina State University, Raleigh, NC 27695.

aliquot from each sample was processed by elutriation and centrifugation (3). Eggs of *Meloidogyne* spp. were counted after treating the root debris fraction obtained during elutriation with 1.0% NaC10 (2, 7). Estimates of *Meloidogyne* J_2 *were adjusted to account for a 20% extraction efficiency. Meloidogyne* spp. identification was based on J_2 stylet and tail lengths (5, 9).

Relationship between initial populations of M. arenaria and peanut yield loss. Two field microplot tests were conducted during the 1986 growing season to determine the effect of different initial populations (Pi) of *M. arenaria* race 1 on peanut yields. Microplots were 55-cm diameter x 45-cm deep and contained a loamy sand soil (85% sand, 8% clay, 7% silt, and less than 1% organic matter) at pH 7.8. Plots were fumigated with ethylene dibromide (3 mL/plot for test I) using a hand-held injector or methyl bromide (1 kg/10 m^2 applied under a 4-mil plastic tarp for test II) prior to planting to eliminate existing nematode populations. Inoculum for microplots consisted of infested soil and infected tomato root segments from greenhouse reared cultures of *M. areneria.* Different densities of inoculum ranging from 76 to 19,454 eggs and J_2 were added to appropriate plots and incorporated by hand mixing to a depth of 30 cm to establish a Pi range of 0 to 256 eggs and J_2/500 cm^3 soil. Test I had ten Pi, whereas test II had nine Pi. The experimental design was a randomized complete block with five replications of each Pi. Each plot was planted with three plants of Spanish market-type peanut cultivar Tamnut 74. Peanut seed were treated with a commercial preparation of *Bradyrhizobium* sp. (*Arachis*) prior to planting. All plots were fertilized according to soil test recommendations and irrigated as needed.

Egg and J_2 populations were estimated as described above, at mid-season and at harvest. Plants were harvested 130 days after planting and the pods air-dried for two weeks before threshing. Total pod yield and yield of sound mature kernels plus sound splits (SMK + SS) were determined; the latter grade factor was obtained by weighing kernels that rode a 2.4-cm x 1.9-cm mesh screen (17).

Statistical analyses included analysis of variance and linear regression analysis. Data were further analyzed by the Seinhorst model (15) according to the method of Ferris *et al.* (6).

Estimation of spring populations of M. arenaria which exceed the damage threshold. To estimate spring populations of *M. arenaria,* fall populations detected during the survey were arbitrarily placed into population density classes of 1-100, 101-500, 501-1,000, 1,001-5,000, and > 5,000 eggs and J_2/500 cm soil. For each fall population density class a minimum and maximum spring population was calculated based on a mean survival rate of 9% of the fall population (16). Alternatively, the percent survival was calculated from a linear model derived from a previous report which indicates a density dependent effect on percent survival (16). The model used was % survival = 71.35-17.3 (log X), where X equals the nematode population the preceding fall.

Results

Survey of nematode populations. A total of 343 samples were collected from 127 peanut fields. *Criconemella* spp, the most frequently encounted genus of plant-parasitic nematodes, was present in 91.3% of the fields (Table 1). Other nematode genera present were *Pratylenchus* (27.6%), *Meloidogyne* (26.0%) and *Belonolaimus* (0.8%). The percentage of individual samples infested with *Criconemella* was nearly equal to the percentage of infested samples, while for the other genera the percentage of infested samples, was approximately one-half of the percentage of infested fields (Table 1).

Table 1. Distribution of plant-parasitic nematodes in Texas peanut fields.

County	No. Fields Samples	Total Samples Collected	Percentage Infested							
			Meloidogyne		Pratylenchus		Criconemella		Belonolaimus	
			Fields	Samples	Fields	Samples	Fields	Samples	Fields	Samples
Atascosa	10	30	10.0	3.3	10.0	3.3	100	96.7	0	0
Comanche	50	115	30.0	16.5	8.0	3.5	82	65.2	0	0
Eastland	42	118	26.2	19.5	45.2	29.7	95.2	89.8	0	0
Erath	15	46	26.7	17.4	60.0	23.9	100	93.5	6.7	2.2
Frio	10	34	20.0	5.9	20.0	8.8	100	97.0	0	0
Totals	127	343	26.0	15.5	27.6	15.7	91.3	83.4	0.8	0.3

* Each sample was a composite of 15-20 soil cores, each core was 2.5-cm-d x 30-cm deep.

The highest population of *Meloidogyne* detected was 13,200 eggs and J_2/500 cm^3 soil, and 57.4% of those samples containing root-knot nematodes had populations $\geq$ 1,000 eggs and J_2/500 cm^3 soil. A minimum of 10 J_2 from each of 20 *Meloidogyne* populations were examined morphometrically (5, 9); all were *M. arenaria.* For *Criconemella,* the highest population detected was 7,100 nematodes/500 cm^3 soil and 16.6% of the infested samples had populations $\geq$ 1,000 nematodes/500 cm^3 soil. In contrast with these two genera, the highest population of *Pratylenchus* was 450 nematodes/500 cm^3 soil with $\leq$ 10% of the infested samples having populations $\geq$ 50 nematodes/500 cm^3 soil. *Belonolaimus* was detected in one sample only.

Relationship between initial populations of M. arenaria and peanut yield loss. In both microplot tests there was a significant, negative relationship between nematode Pi and pod yield (Table 2). In test I, the highest nematode Pi resulted in a 43.2% yield loss in terms of pods/plot, whereas in test II a 67.1% yield loss was observed at the highest Pi. A significant, negative relationship between Pi and SMK + SS yield per plot was also observed for test II (Table 2). Test I had significant pod rot and no correlation between Pi and SMK + SS was detected. No correlation between *M. arenaria* populations at crop harvest and yield was detected in either microplot test.

Table 2. Regression analysis of the relationship between initial populations (Pi) of *Meloidogyne arenaria* and peanut yields in microplot tests.

	Regression Equation	r^2	Estimated Pi required for 10% yield loss
Test I-Pod yield:	$y = 171.9 - 0.207\ x$	0.73	83.0
Test II-Pod yield:	$y = 131.0 - 0.298\ x$	0.47	44.0
SMK + SS yield*:	$y = 73.3 - 0.208\ x$	0.47	35.2

* SMK + SS yield is yield of sound mature kernels plus sound-split kernels.

Values are numbers of eggs and J_2/500 cm^3 soil.

Neither data set gave an acceptable fit to the Seinhorst model ($r^2 < 0.10$), therefore, a tolerance value (damage threshold) was not calculated. Based on the linear regression models, it was estimated that a Pi = 83 eggs and J_2/500 cm^3 soil for test I or Pi = 44 eggs and J_2/500 cm^3 soil for test II were sufficient to reduce pod yields by 10%.

Estimates of spring populations of M. arenaria which exceed the damage threshold. If winter survival of *M. arenaria* is calculated as a simple 9% of the population present the preceding fall, then 10.7% of the samples collected during the survey were within those density classes which would give a spring population in excess of that amount needed to suppress pod yields by 10% (44 to 83 eggs and J_2/500 cm^3 soil). If winter survival rates are adjusted by the regression model then 13.6% of the samples were within those density classes predicted to have spring populations sufficient to cause at least a 10% yield loss (Table 3).

Table 3. Estimated spring populations of *Meloidogyne arenaria* based on populations present the preceding fall and incidence of populations which exceed the value necessary for a 10% yield loss of peanuts.

Fall Population Density Class	Percentage of Total Samples	Estimate Spring Population Range A	B
1-100	2.0	0-9	0-37
101-500	2.9	9-45	37-123*
501-1,000	1.7	45-90*	123-194*
1,001-5,000	6.4	90-450*	194-368*
5,000	2.6	450*	368*

All population values are eggs and J_2/500 cm^3 soil.

A = Survival equal to 9% of the fall population.

B = Percentage survival adjusted based on fall populations and linear model.

* Indicates populations which exceed the levels needed to cause a 10% yield loss (44 to 83 eggs and J_2/500 cm^3).

Discussion

Meloidogyne arenaria was widely distributed in peanut fields in the major production regions of Texas. *M. hapla* was not detected in this survey, although it has been previously reported from Texas (13). While the methods used to estimate damage threshold values (arbitrarily set at a Pi estimated to cause a 10% yield loss) and spring populations levels which exceed that population need vertification, and will undoubtedly require some adjustment, the data presented indicates that *M. arenaria* is causing substantial yield loss of peanut in Texas. It is noteworthy that our estimate of the *M. arenaria* Pi required to cause significant yield loss is similar to that reported by Candanedo and Dickson (4). In contrast with Rodriguez-Kabana *et al.* (14); however, we were unable to detect any significant correlation between late-season *M. arenaria* populations and peanut yields. The differences in the method of estimating nematode populations between this study and that of Rodriguez-Kabana *et al.* (14) may partially explain the different results.

While *Criconemella* spp. were the predominant plant-parasitic nematodes in this study, in no field was visual evidence of damage by *Criconemella* spp. observed, nor was the peanut yellows syndrome (10) observed. Barker *et al.* (1), however, reported that a Pi of 178 *C. ornata*/500 cm^3 was sufficient to suppress peanut yields in microplot tests. The sting nematode, *Belonolaimus* spp., is likewise believed to be of minor importance on peanut in Texas due to its rare occurrence.

Pratylenchus spp. (probably *P. brachyurus*) had mean distribution frequency similar to that of *M. arenaria,* but at lower mean population densities. The population estimates for this nematode are highly suspect, however, since only the soil was assayed. Treatment of the root fraction obtained during elutriation with NaC10 to extract eggs of *Meloidogyne* spp. precluded any attempt to assay this fraction of the samples for *Pratylenchus* spp. Since a major portion of populations of *Pratylenchus* is normally within the host tissues at the time the samples were collected in this study, our estimates of the *Pratylenchus* populations are expected to be well below actual values. We did observe symptoms of lesion nematode on peanut pods in several fields surveyed and believe that *Pratylenchus* spp. are probably causing some yield loss. Further study is required before the incidence of damaging populations of *Pratylenchus* spp. can be estimated.

Acknowledgement

This study was supported, in part, by a grant from the Texas Peanut Producers Board.

Literature Cited

1. Barker, K. R., D. P. Schmitt, and V. P. Campos. 1982. Response of peanut, corn, tobacco and soybean to *Criconemella ornata.* J. Nematol. 14:576-581.
2. Barker, K. R., J. L. Starr, and D. P. Schmitt. 1987. Usefulness of egg assays in nematode population-density determinations. J. Nematol. 19:130-134.
3. Byrd, D. W., K. R. Barker, H. Ferris, C. S. Nusbaum, W. E. Griffin, R. H. Small, and C. A. Stone. 1976. Two semi-automatic elutriators for extracting nematodes and certain fungi from soil. J. Nematol. 8:206-212.
4. Candanedo, E., and D. W. Dickson. 1985. Effect of initial population densities of *Meloidogyne arenaria* race 1 on pod infection and yield of 'Florunner' peanut. Nematologica 15:116 (Abstr.).
5. Eisenbach, J. D. 1982. Morphological comparison of headshape and stylet morphology of the second stage juveniles of *Meloidogyne* species. J. Nematol. 14:339-343.
6. Ferris, H., W. D. Turner, and L. W. Duncan. 1981. An algorithm for fitting Seinhorst curves to the relationship between plant growth and preplant nematode densities. J. Nematol. 13:300-304.
7. Hussey, R., and K. R. Barker. 1973. A comparison of methods of collecting inocula of *Meloidogyne* spp., including a new technique. Plant Dis. Rep. 57-1025-1028.
8. Ingram, E. G., and R. Rodriguez-Kabana. 1980. Nematodes parasitic on peanuts in Alabama and evaluation of methods for detection and study of population dynamics. Nematropica 10:21-30.
9. Jepson, S. B. 1983. The use of second-stage juvenile tails as an aid in the identification of *Meloidogyne* species. Nematologica 29:11-28.
10. Machmer, J. H. 1953. *Criconemoides* spp., a ring nematode associated with peanut yellows. Plant Dis. Rep. 37:156.
11. Main, C. E., and S. V. Byrne, (eds.). 1986. 1985 Estimates of crop losses in North Carolina due to plant diseases and nematodes. Department of Plant Pathology Special Publication No. 5, North Carolina State University, Raleigh, N.C. 183 pp.
12. Motsinger, R., J. Crawford, and S. Thompson. 1976. Nematode survey of peanuts and cotton in southwest Georgia. Peanut Sci. 3:72-74.
13. Norton, D. C. 1959. Plant parasitic nematodes in Texas. Texas Agr. Exp. Sta. Misc. Pub. 321:1-10.
14. Rodriguez-Kabana, R., J. C. Williams, and R. A. Shelby. 1982. Assessment of peanut yield losses caused by *Meloidogyne arenaria.* Nematropica 12:279-288.
15. Seinhorst, J. W. 1965. The relation between nematode density and damage to plants. Nematologica 11:137-154.
16. Starr, J. L., and M. J. Jeger. 1985. Dynamics of winter survival of eggs and juveniles of *Meloidogyne incognita* and *M. arenaria.* J. Nematol. 17:252-256.
17. United States Department of Agriculture. 1986. Farmers' stock peanuts inspection instructions. Washington, D. C. 101 pp.

Accepted January 18, 1988