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• Plant Parasitic Nematodes • in Texas

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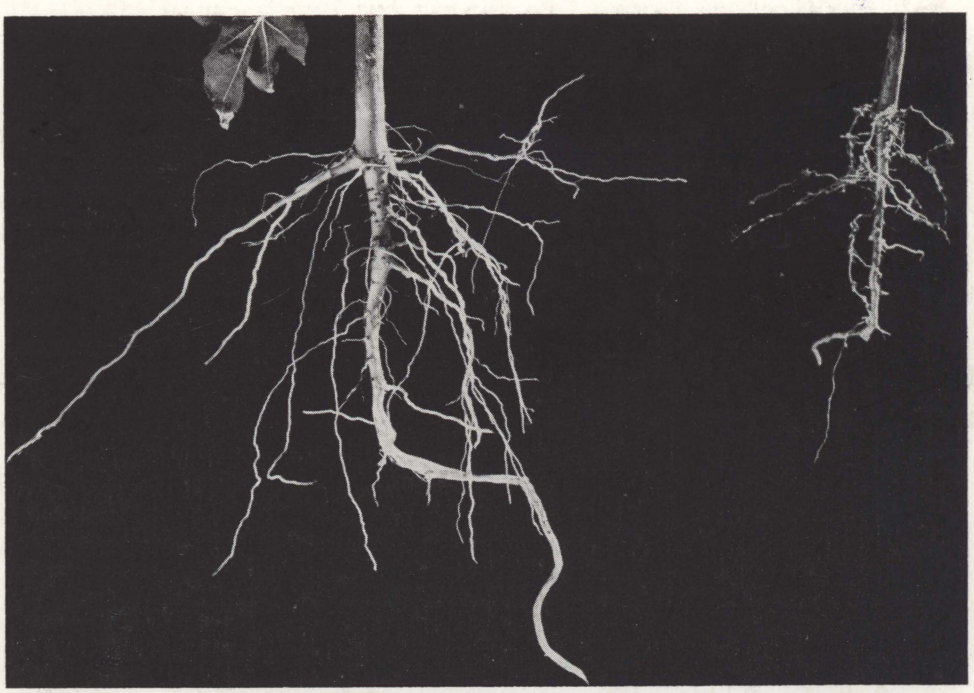

LEFT—Cotton grown in fumigated soil. RIGHT—cotton grown in root-knot-infested soil. Courtesy, Dow Chemical Company.

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SUMMARY

A total of 2,406 soil samples obtained from around the roots of plants in 175 Texas counties were processed for plant parasitic nematodes. The major agronomic, horticultural and ornamental crops were surveyed.

Twenty different nematode genera were found whose species are believed capable of causing plant decline in some instances. The more abundant genera found in order of frequency of occurrence were Tylenchorhynchus, Pratylenchus, Trichodorus, Xiphinema, Helicotylenchus and Meloidogyne.

Some nematodes appear to be present or more abundant on some crops and in some areas of the State than in others. Highest nematode populations generally were obtained in the regions of greatest rainfall.

ACKNOWLEDGMENTS

The writer appreciates the assistance of J. G. Atkins, A. L. Harrison, Bailey Sleeth, H. E. Smith and P. A. Young for supplying information of their observations of plant parasitic nematodes in Texas. The technical assistance of Elmer Jacob, Patricia Darling, Jane Champion, Joanne Bucher and Billie Farris is greatly appreciated.

CONTENTS

Plant Parasitic Nematodes in Texas

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ALTHOUGH TEXAS FARMERS have been confronted with nematode problems for many years, the presence of these microscopic organisms largely is unknown to them. The major exception in Texas is root knot, galls of which usually are easily discernible on infected roots (Figure 1). Most nematodes do not form galls and the damage usually is less obvious and often is attributed to other causes.

Most of the previous work on nematodes in Texas has been directed toward the screening of tomatoes to the root knot nematodes, *Meloidogyne* spp., and soil fumigation studies. A. L. Harrison has been carrying on such a screening program for several years at the Plant Disease Investigations Laboratory at Yoakum. G. H. Godfrey and P. A. Young (10) reported the results of several years of fumigation studies as a means of controlling soil-borne nematodes.

No previous attempt has been made to conduct a general survey for plant parasitic nematodes in Texas. The present report is the result of such an investigation.

METHODS

Surveys were made during a 4-year period, beginning September 1954, in an attempt to find which plant parasitic nematodes are the most prevalent in areas of intensified crop production. A total of 2,406 samples were obtained from 175 of the 254 Texas counties. These counties are shown in Figure 2. Soil samples were not collected in the Coast Marsh, East Cross Timbers or the Central Basin. Most surveying was done as the crops approached maturity. Single or composite samples were taken from soil around the roots of plants. Nematodes were extracted in the laboratory at College Station by a slight modification of the technique of Christie and Perry (4).

The genera included are those whose members are suspected of causing crop decline. Many genera of the family *Dorylaimidae* as well as the genera *Aphelenchus, Psilenchus, Tylenchus* and others are excluded, even though prevalent, since present evidence casts serious doubts on their ability, on the whole, to cause serious crop losses.

RESULTS

Table 1 presents the percentages of occurrence of different nematodes by land resource areas. A discussion of findings of the nematodes by genera follows:

ANGUINA (Wheat nematode—in part)

Although not found in the present survey, *Anguina tritici* (Steinbuch 1799) Filipjev, 1936, was reported as occurring on wheat in Texas (25).

APHELENCHOIDES (Bud and leaf nematodes—in part)

The most important species of *Aphelenchoides* found in Texas is *A. besseyi* Christie, 1942. It is not widespread. It is most destructive on the foliar parts of plants. J. G. Atkins reported it as occurring in rice around the Beaumont area and recently Bailey Sleeth found it causing severe damage on strawberries in the Lower Rio Grande Valley.

BELONOLAIMUS (Sting nematode)

The sting nematode, *Belonolaimus* Steiner, 1949, was found associated with corn in DeWitt, Goliad and Austin counties and with roses in Smith country. It was found in 0.4 percent of all samples taken within Texas. It was found also in an ornamental nursery by Bailey Sleeth in the Lower Rio Grande Valley and was reported by Dr. D. J. Raski (19) as occurring on Padre Island near Corpus Christi. The sting nematode is one of the most devastating in the Southeastern States (12). Where this nematode was found in cultivated fields in Texas, it has been associated

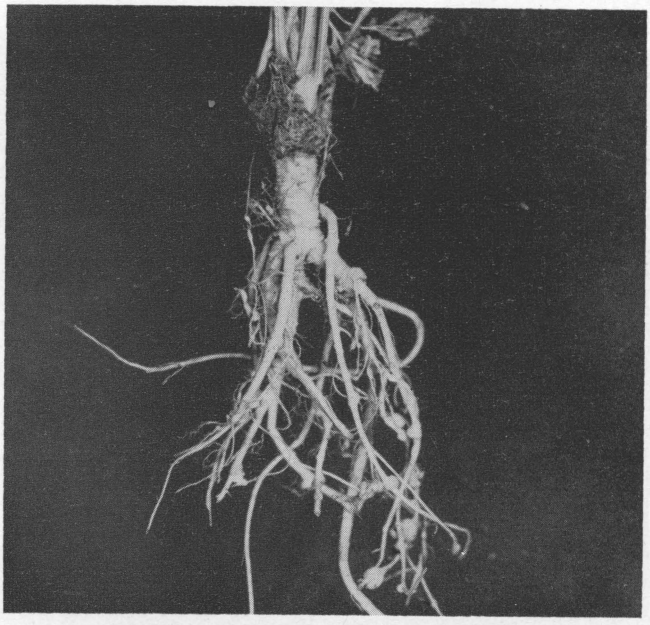

Figure 1. Root knot of parsley.

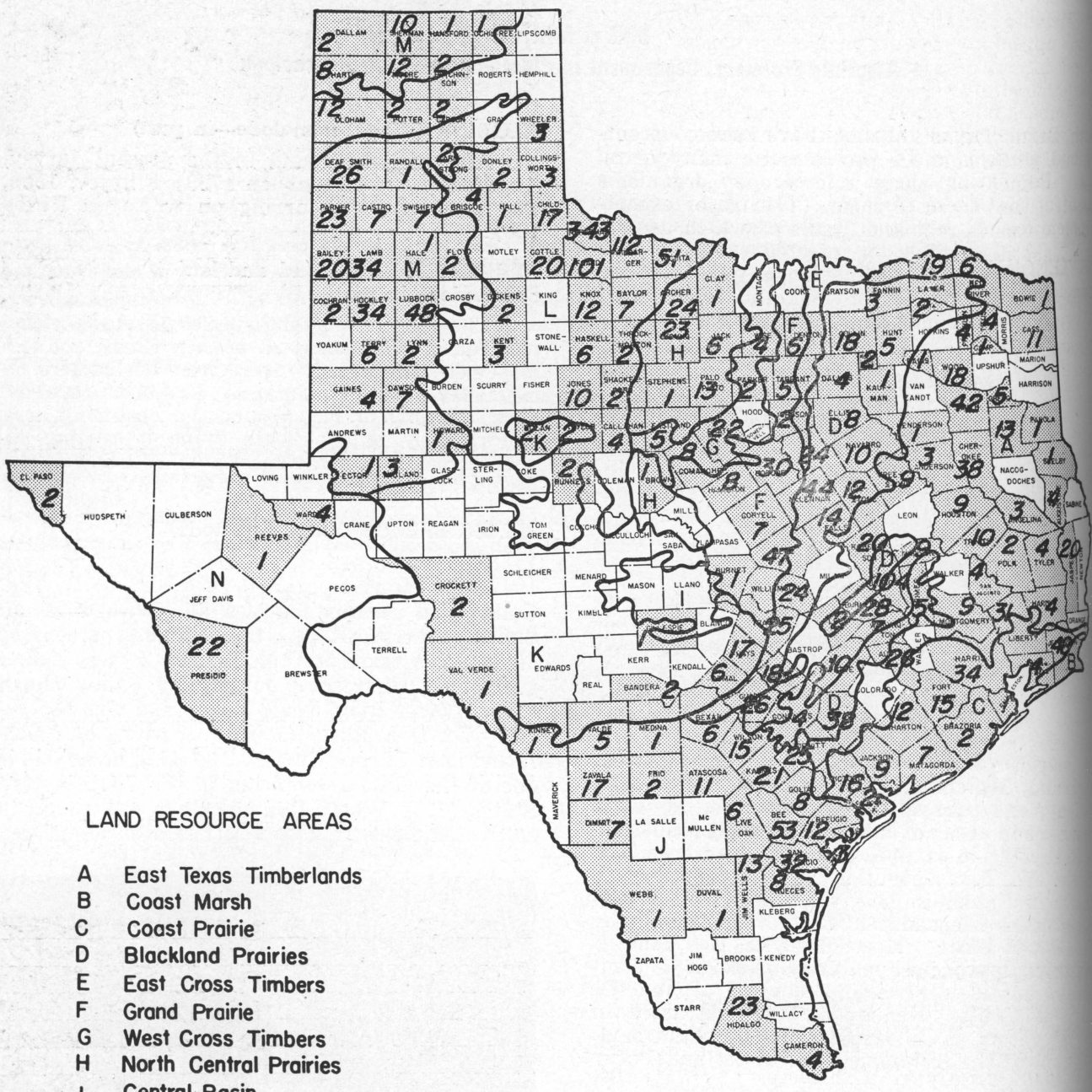

Figure 2. Counties (shaded) from which soil samples were obtained for plant parasitic nematodes. The figures under the shading indicate the number of samples obtained in the respective county.

with crop decline and probably constitutes a problem in local areas (Figure 3).

CRICONEMOIDES (Ring nematodes)

Members of the genus *Criconemoides* Taylor, 1936, appear to be uncommon in Texas, being found in only 0.8 percent of the total samples taken. Most of these were found in the East Texas Timberlands and the Coast Prairie associated with Bermudagrass, St. Augustinegrass, peach, redbud, stock, crimson clover, sorghum, corn and oak. Populations usually were low and it is doubtful that these nematodes constitute a major problem except, perhaps, in isolated areas.

DITYLENCHUS (Stem and bulb nematodes—in part)

The most important species of the genus in Texas is *Ditylenchus dipsaci* (Kuhn, 1857) Filipjev, 1936. It was found causing severe damage to garlic in Webb county (Figure 4); this being its only occurrence in the present survey. Reports from the Agriculture Research Service, U. S. Department of Agriculture at Beltsville, Maryland, indicate that it also occurs in Dimmit, Hidalgo and Harrison counties.

HELICOTYLENCHUS (Spiral nematodes)

Members of this genus were found in 7.3 percent of the total samples taken. In the field, it occurs mainly in the eastern part of Texas. The most common species appears to be *Helicotylenchus nannus* Steiner, 1945, and was found associated with cotton, several native grasses, oats, wheat, camellia, guayule, peanuts, sorghum, elm, strawberry and many ornamentals. It seems to be most common in the heavy soils of the Blackland and Coast Prairies although occasionally it is found in sandy soils. *H. erythrinae* (Zimmermann, 1904) Golden, 1956, was found associated with barley, wheat, beech and azalea in the Coast Prairie region. The pathogenic status of these nematodes is somewhat uncertain although they are suspected of causing considerable damage.

HEMICYCLIOPHORA (Sheath nematodes)

Hemicycliophora spp. are not common in Texas, being found in about 0.2 percent of the total samples taken. *H. typica* de Man, 1921, was found associated with peaches and St. Augustinegrass in the East Texas Timberlands. Populations usually are low. Although it was shown that members of this genus feed and reproduce on plant roots (23, 27), the amount of economic damage done, if any, is not known.

HOPLOLAIMUS (Lance nematodes)

Found in 1.7 percent of the total samples, members of this genus, mostly *Hoplolaimus tylenchiformis* Daday, 1905, were obtained primarily in the East Texas Timberlands and the West Cross Timbers. They commonly were found associated with St. Augustinegrass, but also were associated with cotton, vetch, guayule, strawberry, iris, chinese elm, fern, Liriope, pansy, rose and tomato. Highest populations were obtained around St. Augustine roots. Damage is uncertain. Krusberg and Sasser (14) found that cotton plants in the greenhouse could support rather high populations of *H. tylenchiformis* with little damage. Field evidence suggested that high populations of this nematode may be contributing to the severe stunting and defoliation of cotton under low moisture conditions.

Figure 3. Corn planted in sterilized soil (left) and soil infested with Pratylenchus zeae and Belonolaimus sp. (right).

LONGIDORUS

Members of this genus were found in about 0.3 percent of the total samples taken. The only species identified was *Longidorus elongatus* (de Man, 1876) Thorne and Swanger, 1936. In all cases, populations were low and were scattered over the State in association with roots of corn, vetch, privet, palm and live oak.

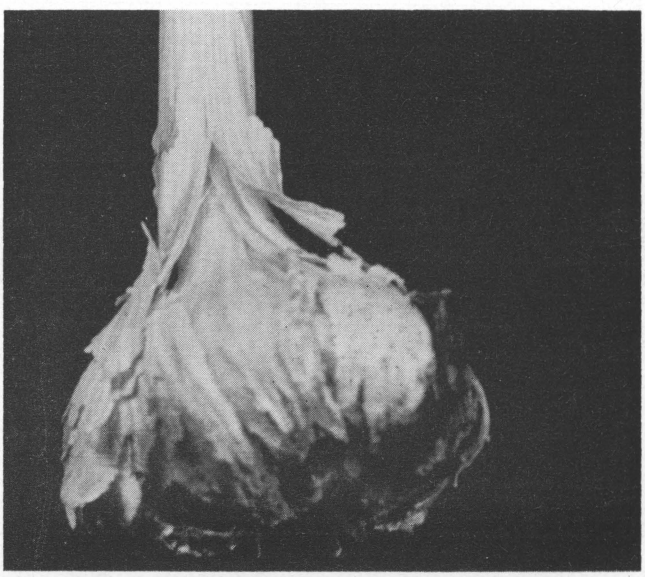

Figure 4. Stem and bulb nematode damage to garlic.

TABLE 1. DISTRIBUTION OF NEMATODES IN TEXAS BY LAND RESOURCE AREAS

Nematode	Land resource areas and total samples in each										
	East Texas Timberlands	Coast Prairie	Black-land Prairies	Grand Prairie	West Cross Timbers	North Central Prairie	Rio Grande Plain	Edwards Plateau	Rolling Plains	High Plains	Trans-Pecos
	480	186	234	54	44	72	258	6	704	338	30
	Percent occurrence in area										
Belonolaimus spp.	0.8						2.4				
Criconemoides spp.	1.9	3.2					.4		.2	.3	
Ditylenchus dipsaci							.4				
Helicotylenchus spp.	5.8	10.2		1.8	2.3	4.2	6.9		.4	2.4	
H. erythrinae		2.5									
H. nannus	2.3	7	17.9	1.8		2.8	2.4	50	1	1.2	
Hemicycliphora typica	1										3.3
Hoplolaimus spp.	2.3		1.1	1.8	2.3		1.9		.4		
H. tylenchiformis	7.3	1.6			2.3		2.7		.1	.3	
Longidorus	.4	.5					.4		.1	.3	
L. elongatus	.2										
Meloidedera spp.	.8	.5	.4							.3	3.3
Meloidogyne spp.	5.2	5.4	2.5	1.8			4.6		2.7	19.8	20
M. arenaria					4.6						
M. hapla	.2										
M. incognita											
M. incognita acrita	2.5	8.1	.4				1.9			3	
M. javanica				1.8							
Paratylenchus spp.	.4		.4	1.8		16.3					
P. projectus				20.4	4.6	13.9			11.5	.5	
Pratylenchus spp.	14.4	4.8	15.8	7.4	13.6	4.2		50	10.4	10.1	3.3
P. brachyurus	.2										
P. hexincisus	1.4	.5	9.8	3.7	2.3	2.8	1.2		4.8	9.3	
P. penetrans	1.3	.0					.8		1	.6	3.3
P. zeae	2.7	.5				1.4					
Radopholus gracilis						1.4					
Rotylenchulus reniformis							.4				
Rotylenchus spp.	.4	.1	4.3	1.8	4.6	1.4	.8		.9		
Scutellonema brachyurum							1.6				
Trichodorus spp.	24.8	13.9	2.1	1.8	6.8	1.4	5.8		2	5	10
Tylenchorhynchus spp.	76.5	11.8	14.1	9.2	20.9	27.7	26.4	16.6	25	13.9	3.3
T. acutus	4.4		22.6	16.6	18.2	11.1	.8		5.8	14.8	
T. brevidens			12.6	16.6	2.3	8.3			22	.8	
T. capitatus	.2		1.7				1.6		1.1	1.5	6.6
T. claytoni	.4	.5									
T. cylindricus	.2						.4				
T. latus	.8						.4				
T. martini		.5				2.8	.4				
T. parvus		1.6					.8				
Tylenchulus semi-penetrans											
Xiphinema americanum	10.6	4.3	33.3	7.4	9.1	4.2	7.7	50	.4	5	6.6
X. chambersii	.4										
X. diversicaudatum							.4				

MELOIDODERA

Members of this genus were found in 0.3 percent of the total samples taken. It produced severe stunting to mesquite seedlings in the greenhouse. It was not found in the field around this plant, but only limited attempts were made. This nematode has been associated occasionally with St. Augustinegrass.

MELOIDOGYNE (Root knot nematodes)

Although species of *Meloidogyne* were found in only 6.5 percent of the total samples taken, it is more common than this figure indicates. The primary reason for this, in this survey, is that emphasis was placed on detecting the non-gall producing nematodes. Where some attempt was made to find the root-knot nematode, as on the High Plains and in the Trans-Pecos area, it was found in 22.8 percent and 20 percent, respectively, of the total sample obtained from those areas. Combining the records of the Section of Nematology, Agricultural Research Service, USDA, Beltsville, Maryland, with those of the present survey, the root-knot nematodes are known to occur in 145 Texas counties (Figure 5). It probably will be only a short time before this nematode is found in all Texas counties. Root knot probably is the main nematode problem in the State.

In the present survey, species of *Meloidogyne* were found in 34 different species of host plants. They are especially common on cotton, fruits, vegetables and ornamentals, but also have been found associated with some grains and grasses. The most common form appears to be *M. incognita acrita* Chitwood, 1949 (Figure 6). This was the most common nematode on cotton, peach, tomato and other vegetables. *M. incognita* (Kofoid and White, 1919) Chitwood, 1949, was found occasionally on cotton. *M. arenaria* (Neal, 1889) Chitwood, 1949, was found causing extensive damage to peanuts in Comanche county. *M. hapla* Chitwood, 1949, was found associated with tomato, strawberry and nandina, but does not appear to be widespread. The only record of *M. javanica* (Treub, 1885) Chitwood, 1949, was on roots of mimosa in an ornamental nursery.

Root knot is probably the best known trouble due to nematodes. Damage to various crops in Texas has been reported (10, 20). Although root knot has been found in many different soil textures and types, it is most common and destructive in the sandier soils.

PARATYLENCHUS (Pin nematodes)

With few exceptions, all identifications of *Paratylenchus* have been *P. projectus* Jenkins, 1956. It commonly is associated with small grains and native grasses of the Rolling Plains, North Central Prairie and Grand Prairie, but is rare around many of the same plants on the High Plains and Blackland Prairies. Although Coursen and Jenkins (6) noted a slight stunting and increased tillering when tall fescue was inoculated

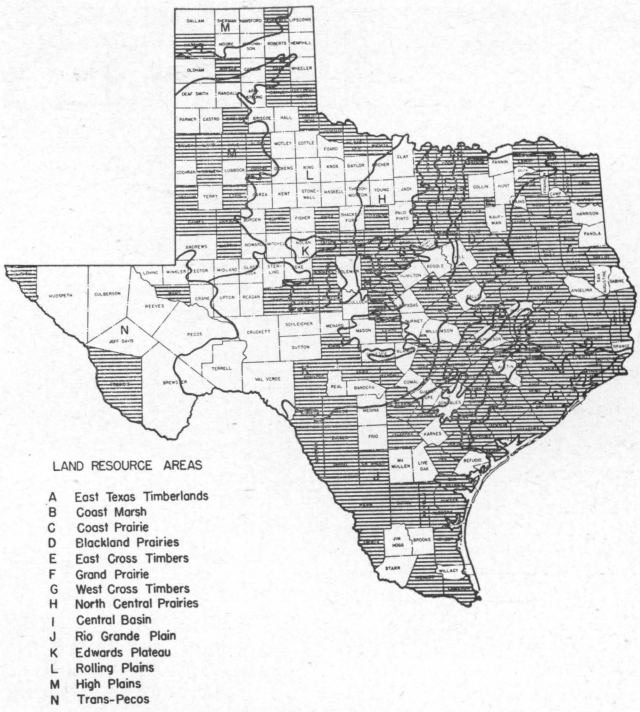

Figure 5. Distribution of Meloidogyne spp. in Texas.

in the greenhouse with individuals of *P. projectus*, results of soil fumigation field tests in wheat plots at Chillicothe showed that control of this nematode, when associated with other root-disease organisms, did not significantly increase yields. Members of the genus *Paratylenchus* have been found only rarely in Texas outside of the north central areas.

PRATYLENCHUS (Root-lesion or meadow nematodes)

Members of the genus *Pratylenchus* were obtained from 16.5 percent of the total soil samples. Their occurrence usually was scattered and in low populations when compared with many other nematodes, but on occasion high populations

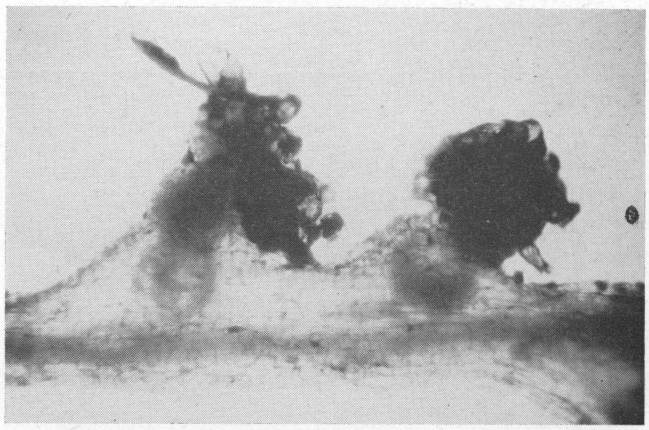

Figure 6. Small galls of tomato produced by the root knot nematode Meloidogyne incognita acrita. The pear-shaped outline of the female may be seen inside the galls. Soil particles adhere to a gelatinous matrix produced by the females.

Figure 7. Pratylenchus hexincisus and eggs inside cotton roots.

were obtained. The number of *Pratylenchus* spp. in the soil is not indicative of the total number attacking a plant since these nematodes may lodge inside the root (Figure 7) and may not be recovered from the soil. *P. hexincisus* Taylor and Jenkins, 1957, is common on cotton, small grains, sorghum and native grasses over wide areas of Texas. It also was found attacking peach and zinnia. This species causes damage to sorghum grown under low moisture conditions (17). When plants were kept adequately moist, damage by this nematode was not apparent. Workers in Louisiana (7) failed to increase sorghum yields even though members of *Pratylenchus* were controlled by soil fumigation. *P. penetrans* (Cobb, 1917) Filip and Stek, 1941, was found scattered over the State on corn, cotton and muskmelon. *P. zeae* Graham, 1951, was found on rice and corn in the Coast Prairie (Figure 3), East Texas Timberlands and the North Central Prairies. *P. brachyurus* (Godfrey, 1929) Filip and Stek, 1941, was found on ornamentals in the East Texas Timberlands. Godfrey (9) reported a species of *Pratylenchus* to cause root failure of chrysanthemum in Texas. The root-lesion nematode is suspected of causing severe damage to peanuts in some fields in Comanche county.

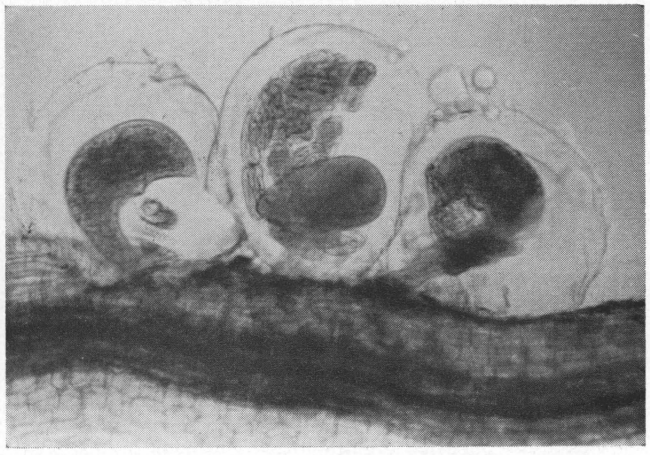

Figure 8. Rotylenchulus reniformis on cotton.

Damage by *Pratylenchus* spp. outside of Texas has been reported on other occasions (8, 11).

RADOPHOLUS

Radopholus spp. have been found infrequently and in restricted areas. During the present survey, *R. gracilis* (de Man, 1880) Hirschman, 1955, was found associated with roots of Virginia wild rye in the North Central Prairies (16). *R. oryzae* (v. Breda De Haan, 1920) Thorne, 1949, was reported previously from rice in Southeast Texas (2). Damage, if any, is uncertain.

ROTYLENCHULUS (Reniform nematode)

Rotylenchulus reniformis Linford and Oliveria, 1940 (Figure 8), has been found only once in Texas and that was in an ornamental nursery in the Lower Rio Grande Valley. It is known however, to have a wide host range (15).

ROTYLENCHUS (Spiral nematodes)

Members of the genus *Rotylenchus* were found in 1.9 percent of the total samples. Due to a revision of this and closely related genera by Andrassy (1), it is possible that some individuals identified only to genus should be included elsewhere. *Rotylenchus* sp. was associated commonly with many native grasses, but not with small grains. It also was found associated with muskmelon. Its pathogenicity is uncertain.

SCUTELLONEMA

Scutellonema brachyurum (Steiner, 1938) Andrassy, 1958, was found associated with corn on the Rio Grande Plain. Its pathogenicity is uncertain.

TRICHODORUS (Stubby root nematodes)

Members of this genus were found in 8.4 percent of the total samples obtained. Species identification were not made in most cases, but *T. christiei* Allen, 1957, appears to be common. *Trichodorus* spp. were found associated with 36 widely diversified Texas crops. It has a wide host range (5, 22). It is especially prevalent around cotton and corn in the East Texas Timberlands and the Coast Prairie. Although it has been found in several different soil texture and types, it appears most frequently and in the highest populations in the sandy soils of these regions. In those areas, crop declines are associated frequently with high populations of these nematodes. Pathogenicity of *Trichodorus* sp. has been demonstrated (3, 22).

TYLENCHORHYNCHUS (Stylet nematodes)

Members of the genus *Tylenchorhynchus* were obtained from 37.8 percent of the samples taken. *Tylenchorhynchus* spp, were the most widely distributed of all the nematodes reported here. They were abundant in many soil textures and types and were associated with a variety of plants. The most abundant and widespread species is *T. acutus* Allen, 1955, but it is most com-

mon in the small grain area of the High Plains and North Central Texas. *T. brevidens* Allen, 1955, was associated only with small grain and grasses. *T. capitatus* Allen, 1955, was associated mainly with cotton, but was found around other plants. Other members of the genus *Tylenchorhynchus* found occasionally were *T. claytoni* Steiner, 1937, associated with camellia, cherry laurel and azalea; *T. cylindricus* Cobb, 1913, associated with corn; *T. latus* Allen, 1955, associated with blackeye peas, cotton and sorghum; *T. martini* Fielding, 1956, associated with rice and azalea; and *T. parvus* Allen, 1955, associated with sorghum. By our present knowledge, *T. claytoni* appears to be one of the most pathogenic members of the genus.

The pathogenicity of some members of the genus *Tylenchorhychus* have been demonstrated (13, 21). While widespread, much work needs to be done to clarify the pathogenicity status of these parasites.

TYLENCHULUS

Tylenchulus semi-penetrans Cobb, 1913, is found only around citrus. It is known to occur in many citrus groves in the Lower Rio Grande Valley. Its pathogenicity has been demonstrated (26).

XIPHINEMA (Dagger nematodes)

Members of the genus *Xiphinema* were found in 8.1 percent of the samples taken. They were most common in the heavy clay soils of the Blackland Prairies. With rare exceptions, all individuals belonged to the species *X. americanum* Cobb, 1913. It was most common on cotton and other woody plants. *X. chambersii* Thorne, 1939, and *X. diversicandatum* (Micoletzky, 1927) Thorne, 1939, were found associated with roots of corn. Members of this genus usually are found in comparatively low numbers. Highest populations usually are found around perennial plants rather than annuals. Schindler (24) demonstrated the pathogenicity of *X. diversicandatum* to roses and strawberry, while Perry (18) demonstrated it for *X. americanum* and *X chambersi* on strawberry.

DISCUSSION

This report terminates the general survey work for plant parasitic nematode over wide areas of Texas during 1954-58. It is realized fully that a complete or even adequate picture of the plant parasitic nematode picture in the State has not been obtained. New areas of investigation were opened, however, and sufficient information was gained to serve as a basis for future research. In some cases, problems already have been investigated (17, 20).

In an area such as Texas, it is difficult to make even a reasonable estimate of the amount of damage caused by nematodes. Plant decline may be produced by a number of factors acting alone or in combination. Lack of adequate fertilizer, drouth, plant disease other than nematode and salt toxicities are just a few of the many agents which can produce unthriftiness in plants. It may be, however, that nematodes may add to damage produced by drouth, but under adequate moisture no damage is evident (14, 17). The association of high populations of plant parasitic nematodes is not always indicative of nematode damage. Sometimes high nematode populations are observed with no apparent damage to the host plant.

The root-knot nematodes, *Meloidogyne* spp., probably is the main nematode problem in Texas. Root-lesion nematodes probably are doing considerable damage since they were demonstrated to cause crop decline in several instances (8, 9, 11, 17). Wherever the sting nematode was found in cultivated fields, it has been associated with crop decline, even though soil moisture was adequate and good crop managing practices were followed. The pathogenicity of the stubby-root nematode has been demonstrated (3, 22) and, by its association with crop decline, it probably is causing moderate damage, especially in East Texas. Although members of the genus *Tylenchorhynchus* are among the most wide-spread plant parasitic nematodes in Texas, it is doubtful that they are causing nearly as much damage as the afore-mentioned genera. The status of the dagger nematodes (*Xiphinema* spp.) is even more uncertain than with other nematodes because of the low populations usually found. Although the stem and bulb nematode and the bud and leaf nematode are not widespread in Texas, they can cause considerable damage.

Except in irrigated areas, the highest populations of nematodes usually were found in the areas of greatest rainfall, which is in East Texas. Populations in areas of non-irrigated land of West Texas were low except during the rainy periods. It should not be inferred that most nematode problems occur in the eastern part of the State. Many major problems are known in irrigated areas of West Texas.

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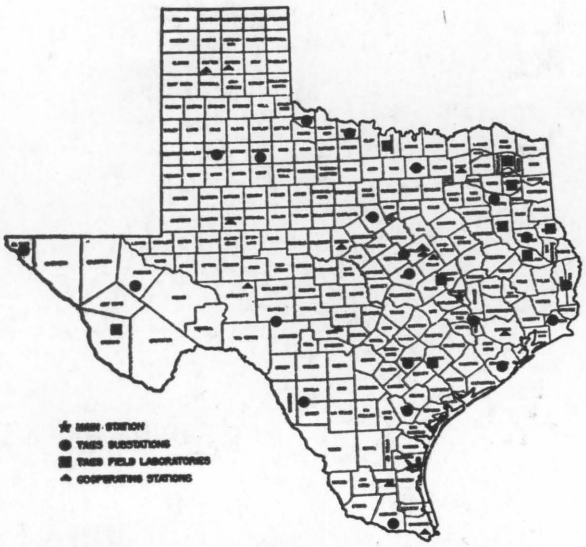

Location of field research units of the Texas Agricultural Experiment Station and cooperating agencies

State-wide Research

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The Texas Agricultural Experiment Station is the public agricultural research agency of the State of Texas, and is one of ten parts of the Texas A&M College System

ORGANIZATION

IN THE MAIN STATION, with headquarters at College Station, are 16 subject-matter departments, 2 service departments, 3 regulatory services and the administrative staff. Located out in the major agricultural areas of Texas are 21 substations and 9 field laboratories. In addition, there are 14 cooperating stations owned by other agencies. Cooperating agencies include the Texas Forest Service, Game and Fish Commission of Texas, Texas Prison System, U. S. Department of Agriculture, University of Texas, Texas Technological College, Texas College of Arts and Industries and the King Ranch. Some experiments are conducted on farms and ranches and in rural homes.

OPERATION

THE TEXAS STATION is conducting about 400 active research projects, grouped in 25 programs, which include all phases of agriculture in Texas. Among these are:

- Conservation and improvement of soil
- Conservation and use of water
- Grasses and legumes
- Grain crops
- Cotton and other fiber crops
- Vegetable crops
- Citrus and other subtropical fruits
- Fruits and nuts
- Oil seed crops
- Ornamental plants
- Brush and weeds
- Insects
- Beef cattle
- Dairy cattle
- Sheep and goats
- Swine
- Chickens and turkeys
- Animal diseases and parasites
- Fish and game
- Farm and ranch engineering
- Farm and ranch business
- Marketing agricultural products
- Rural home economics
- Rural agricultural economics
- Plant diseases

Two additional programs are maintenance and upkeep, and central services.

Research results are carried to Texas farmers, ranchmen and homemakers by county agents and specialists of the Texas Agricultural Extension Service

AGRICULTURAL RESEARCH seeks the WHATS, the WHYS, the WHENS, the WHERES and the HOWS of hundreds of problems which confront operators of farms and ranches, and the many industries depending on or serving agriculture. Workers of the Main Station and the field units of the Texas Agricultural Experiment Station seek diligently to find solutions to these problems.

Today's Research Is Tomorrow's Progress