THE RELATIONSHIP BETWEEN ROOT-KNOT NEMATODE AND GROWTH OF COTTON

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Abstract

One hundred fields were sampled for nematodes and plant mapped in 1995. The proportion of fields infested with root-knot nematode in the Southern High Plains was 60% or higher in seven of the 20 counties surveyed and more than 1.4 million acres of cotton is grown in these seven counties. Root-knot nematode was found in 39% of all fields sampled and 18% of those fields had an average root-knot nematode population > 500/500 cm^3 soil (16% were greater than 1000 root-knot nematode/500 cm^3 soil). Root-knot nematode density was associated with a reduction in the nodes above white flower and number of squares in irrigated but not dryland fields.

Introduction

Root-knot nematode (*Meloidogyne incognita*) is the most important nematode parasite found on cotton in the Southern High Plains (2). Previous studies conducted over 16 years in west Texas with fumigant nematicides have demonstrated an average increase in yield of 26% over untreated cotton (2). Specific yield loss relationships between preplant density of root-knot nematode and cotton have been determined using artificially infested microplots (4). Invariably these studies are conducted with a single cultivar, in soils which have been fumigated before addition of the nematode, and with adequate irrigation (or rainfall). There are many factors which affect cotton yields in the Southern High Plains including cultivar, irrigation, soil borne diseases, insect pressure, and heat units needed to mature the cotton. The objective of this study was to determine the importance of root-knot nematode to growth of cotton in the Southern High Plains in 1995.

Materials and Methods

Five producer fields were chosen at random in 20 counties in the Southern High Plains. These fields were plant mapped in late July (2-3 months after planting) for the following traits: plant height (length from the cotyledons to the terminal), total nodes, nodes to the first fruiting branch, nodes above white flower, number of squares, number of missing squares, number of bolls, number of missing bolls, percent square set, height to total node ratio, and percent boll set. In each field, 20 plants were mapped (five adjacent plants from four quadrants of the field). During the month of August, composite soil samples were collected in these 100 fields. Three composite samples were taken in each field. Each sample consisted of approximately 100 cm^3 of soil taken from 8-20 cm deep in the soil at each of 20 locations (approximately ten paces between each location). The soil was mixed in a bucket and a subsample consisting of 1000 cm^3 soil was placed in a plastic bag. The soil was taken to Lubbock within one week of sampling, and refrigerated upon arrival. All samples were assayed within three weeks of arrival by the following methods: 200 cm^3 of soil was placed in a pie-pan apparatus (6) and vermiform stages of nematodes were collected, identified and counted after 24-48 hrs. Then 500 cm^3 soil was placed in a bucket, mixed for 15 s., allowed to settle for 15 s., and then the organic matter was collected on a 230-µm mesh sieve. This matter was treated with 10% chlorox for 5 min., and washed through a 117-µm mesh sieve over a 25-µm sieve. The eggs collected on the 25-µm sieve were stained with acid fuschin (1) and counted. The nematode density was estimated as the number of second-stage juveniles + eggs/500 cm^3 soil. In addition, each producer was asked to fill out a questionare on the field which was sampled. Information collected included: whether the producer thought they had nematode problems, seedling disease, or wilt problems; use of nematicides and seed treatments; conventional or other types of tillage; irrigation; and rotational crops in the field, or long-term cotton. The information of the questionaire, plant mapping, and average root-knot nematode density for each field were combined. For the analyses, seedling disease, wilt disease, conventional versus other tillage, irrigation, and rotation versus long-term cotton were all coded as 1 or 0. Nematicides were coded by rate applied per acre. The plant mapping data was tested for correlations with root-knot nematode density and these other coded factors from the questionaire. Two-way interactions between variables and single variables were included in a stepwise regression analysis (3) of the plant mapping factors. Only factors significant at $P \leq 0.05$ were included in the model. In addition, nematode density and all the factors addressed in the questionaire were examined for correlations (3).

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Results and Discussion

The proportion of fields infested with root-knot nematode in the Southern High Plains was 60% or higher in the counties of Cochran, Dawson, Gaines, Hockley, Lubbock, Terry, and Yoakum (Table 1). These counties account for close to 1.5 million acres of cotton (5). Fields with an average density of 500 root-knot nematode/500 cm^3 soil or greater were present in all the counties mentioned above except Lubbock, as well as Bailey, Crosby, and Lamb counties (Table 1). Root-knot nematode was found in 39% of all fields sampled and 18% of those fields had an average root-knot nematode population > 500/500 cm^3 soil (16% were greater than 1000 root-knot nematode/500 cm^3 soil).

The recommendations for root-knot nematode based on density from soil samples vary between nematode laboratories. An arbitrary nematicide application table was devised with high rate of nematicide for a root-knot density over 500 (per 500 cm^3 soil, taken late in the growing season), a lower rate of nematicide is recommended for densities > 0, but less than 500, and no nematicide is recommended for densities=0. With this rating system, the percentage of "wrong decisions" can be estimated from the three composite samples that were taken from each field versus if just a single composite sample was taken from a field. In this data set, the location of the sample made a difference in 16% of the 100 fields sampled for a nematode recommendation. If just the fields with root-knot nematode are examined, then in 41% of the fields, recommendations would have been altered depending on where the sample was taken. There was an example in the survey of a field with populations > 9000 root-knot nematode/500 cm^3 soil in one location but 0 root-knot nematode in another location.

The questionaire for each field sampled was returned by 86% of the producers. There were 72% of the producers that correctly identified if they had root-knot nematode. On the question about whether there were seedling disease problems present in the field, 27% of all producers answered "yes". However, when broken into clean tillage versus some sort of terminated wheat or minimum tillage, then 25% of the fields with clean tillage had seedling disease problems, while in 38% of the fields without clean tillage the producer noticed seedling disease problems. The fields were predominately clean tillage (85%) and irrigated (69%).

There was intercorrelation between factors described on the survey and nematode density. Seedling disease was correlated positively with use of nematicides, producers perception of nematode problems, and irrigation. Nematode density was correlated positively with producer perception of nematode problems, and negatively with clean tillage. This means that lower nematode densities were associated with clean tillage while higher nematode densities were associated with terminated wheat or other types of tillage. For the plant growth factors and nematode density: plant height was correlated only with irrigation, total number of nodes was correlated only with irrigation, and nodes above white flower and number of squares was associated negatively with nematode density only in the irrigated fields (Figure 1 and 2, respectively). Number of squares was also related positively to the presence of any plant rotation. The other plant measurements (nodes of first fruiting branch, number of missing squares, boll number, height to node ratio, and percent boll set was not associated with nematode density. The number of bolls was associated positively with rate of nematicide in irrigated cotton. In dryland cotton, both number of squares and number of missing bolls were associated positively with rate of nematicide.

The cotton season in 1995 was stressful due to extended cool temperatures until June, excessive wind until July, high evapotranspiration and insufficient rainfall, and insect infestations (boll worm and boll weevil). Yet, inspite of all these factors, root-knot nematode still had a significant negative impact on nodes above white flower and number of squares. In irrigated fields, and in the absence of the root-knot nematode, there was an average of six nodes above white flower in early August. When nodes above white flower drops below four, then cutout has occurred. The trend to decrease nodes above white flower (and increase early cutout) was associated with root-knot nematode.

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References

1. Hussey, R. S., and K. R. Barker. 1973. A comparison of methods of collecting inocula of *Meloidogyne* spp., including a new technique. Plant Dis Rept 57:1025-1028.

2. Orr, C. C., and A. F. Robinson. 1984. Assessment of cotton losses in western Texas caused by *Meloidogyne incognita*. Plant Dis. 68:284-285.

3. SAS Institute, Inc. 1986. SAS User's Guide: Statistics. 1986 ed. Cary, NC

4. Starr, J. L., R. D. Martyn, M. J. Jeger, and K. Schilling. 1989. Effects of *Meloidogyne incognita* and *Fusarium oxysporum* f. sp. *vasinfectum* on plant mortality and yield of cotton. Phytopath. 79:640-646.

5. Texas Agricultural Statistics. 1994. Texas Department of Agriculture and the Texas Agricultural Statistics Service. 170 pp.

6. Thistlethwayte, B. 1969. Hatch of eggs and reproduction of *Pratylenchus penetrans* (Nematoda: Tylenchida). Ph.D. Thesis. Cornell Univ., Ithaca, NY. 166 pp.

Table 1. Frequency of Root-knot nematode in counties in the Southern High Plains.

County	Frequency	Average density of Root-knot Nematode[1]/field (SD)
Bailey	0.40	340 (363); 577 (499)
Borden	0	0
Castro	0.40	17 (20); 17 (29)
Cochran	0.60	1,430 (1,715); 167 (67); 1,097 (1,026)
Crosby	0.20	3,187 (1,662)
Dawson	0.60	1,017 (1,131); 467 (206); 270 (106)
Floyd	0.20	33 (58)
Gaines	0.80	1,447 (2,506); 12,967 (18,701); 177,840 (104,530); 5,020 (-)
Garza	0	0
Hale	0	0
Hockley	0.80	3,203 (5,445); 840 (608); 3,353 (2,182); 3,750 (4,718)
Lamb	0.40	120 (60); 1,273 (1,853)
Lubbock	0.60	173 (300); 107 (185); 227 (255)
Lynn	0.40	33 (58); 400 (693)
Mitchell	0.20	197 (341)
Parmer	0.40	20 (35); 17 (29)
Scurry	0	0
Swisher	0	0
Terry	1.0	130 (225); 1,117 (1,203); 11,283 (9,084); 40 (69); 2,780 (3,551)
Yoakum	0.80	160 (227); 3,207 (2,777); 33 (58); 53 (6)

[1]Nematode density are eggs + second-stage juveniles/500 cm^3 soil.

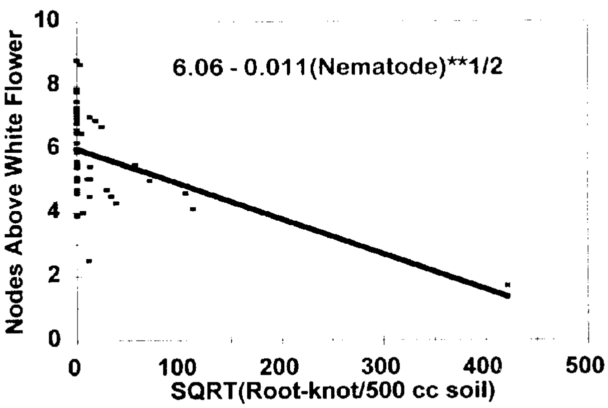

Figure 1. The affect of nematode density on nodes above white flower when plants were mapped 2-2.5 months after planting. A square root transformation was used to normalize nematode density. The R^2 of the equation was 0.27.

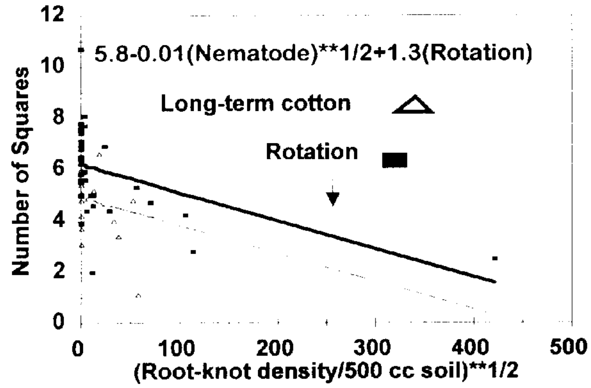

Figure 2. The effect of nematode density and crop rotation on number of squares in cotton, 2-2.5 months after planting. A square root transformation was used to normalize nematode density. The R^2 of the equation was 0.29.