THE INFLUENCE OF SOIL TEXTURE ON REPRODUCTION AND PATHOGENICITY OF *ROTYLENCHULUS RENIFORMIS* ON COTTON

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ABSTRACT

Xavier D. M., C. Overstreet, E. C. McGawley, M. Kularathna, and C. M. Martin. 2014. The influence of soil texture on reproduction and pathogenicity of *Rotylenchulus reniformis* on cotton. Nematropica 44:7-14.

Sixty-day duration studies were conducted under greenhouse conditions to evaluate the influence of three soil textures on reproduction and pathogenicity of three isolates of *Rotylenchulus reniformis* on Phytogen 375WF, Stoneville 5288B2F, and Stoneville LA887 cotton. Soil with clay content of 25.9% had a significant negative effect on reproduction of the nematode on all three cultivars. Soil texture had a significant main effect on heights of Stoneville 5288B2F and Phytogen 375WF plants. Across the cotton cultivars, there were significant differences in reproduction among the three isolates of reniform nematode. Overall, the Avoyelles isolate reached the highest population density. There was significant soil texture by reniform isolate interaction that affected population density of the nematode only for Phytogen 375WF.

Key words: cotton, population dynamics, reniform nematode, soil texture.

RESUMEN

Xavier D. M., C. Overstreet, E. C. McGawley, M. Kularathna, y C. M. Martin. 2014. La influencia de la textura del suelo en la reproducción y patogenicidad de *Rotylenchulus reniformis* en algodón. Nematropica 44:7-14.

Se realizarón estudios de sesenta días de duración a escala de invernadero con el fin de evaluar la influencia de tres texturas de suelo en la reproducción y patogenicidad de tres aislados de *Rotylenchulus reniformis* (nematodo reniforme) sobre las variedades de algodón Stoneville LA887, Stoneville 5288B2F, y Phytogen 375WF. Suelo con un contenido de arcilla de 25.9% tuvo un efecto negativo significativo en la reproducción del nematodo sobre las tres variedades de algodón. La textura del suelo tuvo un efecto significativo sobre las alturas de las plantas Stoneville 5288B2F y Phytogen 375WF. También se observaron diferencias significativas en la reproducción de los tres aislamientos de nematodos reniformes en las distintas variedades de algodón. En general, el aislado Avoyelles alcanzo la densidad más alta de población. La interacción entre textura de suelo y aislados del nematodo afecto significativamente las densidades de población de todos los aislados del nematodo evaluados en los diferentes tipos de suelo solo en la variedad Phytogen 375WF.

Palabras clave: algodón, dinámica de poblaciones, nematodo reniforme, textura del suelo.

INTRODUCTION

According to the National Cotton Council of America (2010), cotton (*Gossipium hirsutum* L.) yield losses due to nematodes have increased substantially since 1990. Yield loss due to *Rotylenchulus reniformis* Linford and Oliveira in the cotton-producing areas of the U.S. in 2011 was approximately 280,000 bales (Blasingame and Patel, 2012). Currently, *R. reniformis* is the most important nematode pest of cotton in Louisiana and other southern states with yield losses estimated at $166 million USD (Koenning *et al*., 2004; Gazaway, 2005; Robinson, 2007). In Louisiana, the reniform nematode was responsible for the loss of about 23,000 bales of cotton in 2011 (Blasingame and Patel, 2012).

Variation in reproduction and pathogenicity within and among geographical isolates of *R. reniformis* has been confirmed both in soybean (McGawley *et al*., 2011) and cotton (Agudelo *et al*., 2005; McGawley *et al*., 2010). Such variation in reniform reproduction and pathogenicity is a significant factor impacting the identification of new resistant germplasm (McGawley *et al*., 2012).

Several nematode management strategies have been used over the years to reduce losses caused

by *R. reniformis*. Although some progress has been made towards producing upland cotton with resistance to reniform nematodes, currently, there are no commercially available resistant cultivars. Aside from genetic resistance, other possible management strategies for *R. reniformis* in cotton are crop rotation, biological control, and nematicide application. Since cotton is a good host for the reniform nematode, management strategies frequently require a combination of different approaches to be efficient (Blasingame *et al*., 2008).

Traditionally, nematicides have been the most common management strategy employed for the management of nematodes (Koenning *et al*., 2004; Starr *et al*., 2007; Overstreet *et al*., 2007). The use of nematicides as a short-term management strategy has resulted in increased yield and plant vigor (Davis *et al*., 2003; Faske and Starr, 2005; McGawley *et al*., 2006; Overstreet *et al*., 2007), but it has also increased the cost of production and elicited environmental concern (Starr *et al*., 2007).

Another potential management strategy involves the use of site-specific nematology. Dividing a field into zones according to soil texture, nematode species, or yield history makes possible the establishment of management zones within a field (Barker and Koenning, 1998; Wyse-Pester *et al*., 2002; Koenning *et al*., 2004; Erwin *et al*., 2007).The establishment of site-specific management zones reduces nematicide costs since only a portion of the field will be treated (Starr *et al*., 2007; Erwin *et al*., 2007; Ortiz *et al*., 2012).

Soil texture is an important characteristic to be considered when managing nematodes affecting agronomic crops (Sivakumar and Seshadri, 1972; Robinson *et al*., 1987; Koenning *et al*., 1996; Herring *et al.*, 2010). Reproduction of *R. reniformis* has been shown to be influenced by soil texture. Several studies have demonstrated that reproduction of this nematode, unlike *Meloidogyne* spp., is favored by soils with higher levels of silt and clay (Sivakumar and Seshadri, 1972; Robinson *et al.*, 1987; Koenning *et al*., 1996; Overstreet *et al*., 2010; Moore and Lawrence, 2011; Overstreet *et al*., 2011a).

In Louisiana, most cotton fields are located in areas where the predominant soil is a silt loam and where reniform nematode can reproduce rapidly and cause significant yield losses. Commerce silt loam soil is a common soil found in cotton production areas in Northeast Louisiana. Because of the variability of texture within this soil type, the response to nematicide application has not been consistent even within the same field (Overstreet *et al*., 2011b). The objective of this research was to evaluate the influence of Commerce silt loam soil on reproduction and pathogenicity of three isolates of *R. reniformis* on three cultivars of cotton.

MATERIALS AND METHODS

Isolates of Reniform Nematode

Isolates of *R. reniformis* from Louisiana were provided by E. C. McGawley. These isolates were from three locations in Louisiana (referred to herein as the Avoyelles, Evangeline, and Rapides isolates to indicate the Parishes where they were originally collected). Nematodes were obtained from axenic cultures maintained in the LSU Nematology greenhouse on tomato cv. Rutgers PS (Seedway; Hall, New York 14463) for use as inoculum. The three isolates were confirmed morphologically as R. reniformis (Robinson *et al.*, 1997; McGawley *et al*., 2010), differed in pathogenicity on cotton, and were isolated from fields with different soil textures.

Soils

The soil used in these studies was a Commerce silt loam (fine-silty, mixed, superactive, nonacid, thermic Fluvaquentic Endoaquepts) as defined by Natural Resources Conservation Service. The soil was collected from the LSU AgCenter Northeast Research Station, located at St. Joseph, LA. Three compositions of this Commerce silt loam soil, referred to hereafter as S1 (74.4 % sand, 20.7% silt, and 4.9% clay), S2 (31.4% sand, 55.3% silt, and 13.3% clay), and S3 (7.8% sand, 66.3% silt, and 25.9% clay) were used in all experiments. Percentages of sand, silt, and clay in S1, S2, and S3 were determined according to the Hydrometer method modified from Day (1965) and the American Society for Testing and Materials (1985).

Soil pH averaged 5.4 for S1, 7.2 for S2, and 6.8 for S3 (LSU Soil Testing Lab). In all experiments, the pH of S1 soil was amended with calcium hydroxide by hand mixing with 0.8 g per pot to adjust the pH to 7.0.

Cotton Cultivars

The cotton cultivars Phytogen 375WF (DOW AgroSciences LLC, 9330 Zionsville Rd., Indianapolis, IN 46268), Stoneville 5288B2F, and Stoneville LA887 (Bayer CropScience LP, 2 TW Alexandria Drive, RTP, NC 27709), well known by their field performance (Anonymous, 2011) and susceptible to *R. reniformis,* were used in these studies (McGawley *et al*., 2010; Sikkens *et al*., 2012). Phytogen 375WF and Stoneville 5288B2F were widely planted in Louisiana in 2011 and 2012. Stoneville LA887 is no longer a commercially available cultivar but is an excellent host for *R. reniformis* and has been used in microplot studies by McGawley *et al.* (2010) to demonstrate variation in reproduction and pathogenicity among geographic isolates of *R. reniformis*.

General Information

Three experiments, each repeated once, that were 60 d in duration, were conducted during 2012 and 2013. Terracotta pots with an inside top diameter of 15.0 cm containing 1.6 kg of soil were used for all experiments. Pots and soils were autoclaved at 116°C for 8 hr prior to use.

Nematode inoculum for all tests consisted of juveniles, pre-adult females, and males extracted from soil by wet-sieving through nested 250-µm-pore and 38-µm-pore sieves followed by sugar flotation and centrifugation (Jenkins, 1964). Two cotton seeds were planted in each pot to a depth of 2.5 cm and thinned to one per pot after germination. Soils in pots were infested with nematodes by pipetting aqueous suspensions containing vermiform individuals of *R. reniformis* into a series of depressions arranged into a triangular pattern in soil, 0.5 cm diameter × 5-7.5 cm deep, surrounding the seedling.

Seventy ml of water-soluble Miracle-Gro (Scotts Company LLC, Marysville, OH) fertilizer (18-18-21) was applied every 2 wk according to label rates. Plant height was measured from soil line to terminal node every 2 wk, and air temperature was measured daily. Treatments in all experiments were arranged as a randomized complete block design.

At the conclusion of experiments, reniform nematodes were extracted from a 500 cc subsample of soil from each pot. Numbers of nematodes per 500 cc were multiplied by 3.2 to estimate population density per pot. Soil samples were processed by semi-automatic elutriation (Byrd *et al*., 1976) and centrifugal-flotation (Jenkins, 1964). Vermiform stages of reniform were enumerated at 40× using an inverted microscope. Eggs were extracted from the entire root system of each plant by agitating the roots in 0.6% NaOCl for 10 min (Hussey and Barker, 1973) and enumerated as described for vermiform stages.

At the conclusion of experiments, plant height and weights of dry root and shoot systems were determined. Plant shoots were excised and placed into a paper bag prior to drying at 45ºC for 2 d. After egg extraction, root material was handled in a similar manner.

Data Analysis

Experiments involved the 3 isolates of reniform nematode, the 3 soils, and infestation levels of 0 and 10,000 nematodes per pot. Treatments were replicated 6 times.

Data were examined by analysis of variance (ANOVA) for a 2 × 3 × 3 factorial design (nematode × soil × reniform isolate) using the "Fit Model" module of SAS JMP, version 10.0 (SAS Institute, Cary, NC). Means of data were separated by Tukey's HSD at $P \leq 0.05$.

RESULTS

Experiments with Phytogen 375WF

Soil and reniform isolate significantly influenced numbers of vermiform stages per 500 cc of soil and numbers of eggs per g of root (Table 1). There was a significant soil-by-isolate interaction which influenced the numbers of eggs per g of root significantly (Fig. 1).

There was a significant and stepwise decrease in vermiform stages of *R. reniformis* per 500 cc of soil, from 111,144 in S1, 69,956 in S2, to 29,542 in S3. The pattern for eggs per g of root was identical to this with numbers for S1, S2, and S3 averaging 36,500, 12,669, and 4,810, respectively.

The density of vermiform stages of *R. reniformis* averaged 97,311 per 500 cc of soil for the Avoyelles isolate. This was significantly greater than the 54,178 recovered for the Evangeline isolate or the 59,153 for the Rapides isolate.

Figure 1 shows the significant soil-by-reniform isolate interaction, which influenced the numbers of eggs per g of root. In S1 soil, the number of eggs per g of root for the Avoyelles isolate was significantly greater, averaging 51,473 per g of root, than those for either the Evangeline, 24,850, or the Rapides, 33,178, isolates. In S2 and S3 soils, the patterns were similar to that of S1, but there were no significant differences in number of eggs per g of root. For all three isolates, there were significantly more eggs per g of root in S1 soil than in S2 and S3 soils.

Soil significantly affected plant height of this cotton cultivar at 15 days after inoculation (DAI) (Table 2). At 15 DAI, plants growing in S2 soil averaged 20.5 cm in height and were significantly taller than plants growing in S1 soil, which averaged 18.2 cm. There were no main or interactive effects of reniform isolate on the other plant parameters measured.

Over the course of these experiments, temperatures in the greenhouse ranged from 23.9 to 40.6°C in the first run and from 26.7 to 41.1°C in the second run.

Experiments with Stoneville 5288B2F

Numbers of vermiform stages per 500 cc of soil and numbers of eggs per g of root were significantly affected by both soil and reniform isolate (Table 3). There was a significant stepwise decrease in the numbers of *R. reniformis* per 500 cc of soil, 130,049; 83,413 and 49,373 nematodes per 500 cc of soil, with increasing content of clay in S1, S2, and S3. Numbers of eggs per g of root followed the same pattern as that for vermiform stages. In S1, S2, and S3 soils, the numbers of eggs per g of root were 24,048; 11,600 and 4,239, respectively. The density of vermiform stages for the Evangeline and the Rapides isolates, 79,449 and 73,422 per 500 cc of soil, respectively, did not differ from each other, but both were lower than

Table 1. Main and interaction effects (*P* values) of soil and reniform isolate on Phytogen 375WF cotton in a greenhouse environment – nematode density[x].

Source	DF	Vermiform stages/ 500 cc of soil	Eggs/g of root
Soil[y] (S)	2	< 0.01*	< 0.01*
Reniform isolate[z] (I)	2	< 0.01*	< 0.01*
S x I	4	0.31	< 0.01*

[x]Data combined over two 60-d duration experiments with a total of 12 replications. Data was analyzed with ANOVA and Tukey's HSD ($P \leq 0.05$).
[y]Soils were from three different locations within a Commerce silt loam field. Percentages of sand, silt, and clay were 74.4, 31.4, and 7.8 for S1; 20.7, 55.3, and 66.3 for S2; and 4.9, 13.3, and 25.9 for S3, respectively.
[z]Reniform nematode isolates were collected from Avoyelles, Evangeline, and Rapides Parishes.
*Indicates a significant *P* value.

Table 2. Main and interaction effects (*P* values) of soil and reniform isolate on Phytogen 375WF cotton in a greenhouse environment – plant parameters[v].

Source	DF	Plant height 15 DAI[y]	Plant height 30 DAI	Plant height 50 DAI	Root weight[z]	Shoot weight[z]
Soil[w] (S)	2	< 0.01*	0.08	0.64	0.59	0.21
Reniform isolate[x] (I)	3	0.89	0.69	0.81	0.99	0.89
S x I	6	0.56	0.61	0.89	0.99	0.99

[v]Data combined over two 60-d duration experiments with a total of 12 replications. Data was analyzed with ANOVA and Tukey's HSD ($P \leq 0.05$).
[w]Soils were from three different locations within a Commerce silt loam field. Percentages of sand, silt, and clay were 74.4, 31.4, and 7.8 for S1; 20.7, 55.3, and 66.3 for S2; and 4.9, 13.3, and 25.9 for S3, respectively.
[x]Reniform nematode isolates were collected from Avoyelles, Evangeline, and Rapides Parishes.
[y]DAI = days after inoculation.
[z]Data are dry weight obtained after 2 d at 45ºC.
*Indicates a significant *P* value.

Table 3. Main and interaction effects (*P* values) of soil and reniform isolate on Stoneville 5288B2F cotton in a greenhouse environment - nematode density[x].

Source	DF	Vermiform stages/ 500 cc of soil	Eggs/g of root
Soil[y] (S)	2	< 0.01*	< 0.01*
Reniform isolate[z] (I)	2	< 0.01*	< 0.01*
S x I	4	0.09	0.57*

[x]Data combined over two 60-d duration experiments with a total of 12 replications. Data was analyzed with ANOVA and Tukey's HSD ($P \leq 0.05$).
[y]Soils were from three different locations within a Commerce silt loam field. Percentages of sand, silt, and clay were 74.4, 31.4, and 7.8 for S1; 20.7, 55.3, and 66.3 for S2; and 4.9, 13.3, and 25.9 for S3, respectively.
[z]Reniform nematode isolates were collected from Avoyelles, Evangeline, and Rapides Parishes.
*Indicates a significant *P* value.

Table 4. Main and interaction effects (*P* values) of soil and reniform isolate on Stoneville 5288B2F cotton in a greenhouse environment - plant parameters[v].

Source	DF	Plant height 15 DAI[y]	Plant height 30 DAI	Plant height 50 DAI	Root weight[z]	Shoot weight[z]
Soil[w] (S)	2	< 0.01*	< 0.01*	0.16	0.84	0.47
Reniform isolate[x] (I)	3	< 0.01*	0.66	0.91	0.36	0.99
S x I	6	0.09	0.11	0.46	0.38	0.99

[v]Data combined over two 60-d duration experiments with a total of 12 replications. Data was analyzed with ANOVA and Tukey's HSD ($P \leq 0.05$).
[w]Soils were from three different locations within a Commerce silt loam field. Percentages of sand, silt, and clay were 74.4, 31.4, and 7.8 for S1; 20.7, 55.3, and 66.3 for S2; and 4.9, 13.3, and 25.9 for S3, respectively.
[x]Reniform nematode isolates were collected from Avoyelles, Evangeline, and Rapides Parishes.
[y]DAI = days after inoculation.
[z]Data are dry weights obtained after 2 d at 45ºC.
*Indicates a significant *P* value.

Table 5. Main and interaction effects (*P* values) of soil and reniform isolate on Stoneville LA887 cotton in a greenhouse environment – nematode density[x].

Source	DF	Vermiform stages/ 500 cc of soil	Eggs/g of root
Soil[y] (S)	2	< 0.01*	< 0.01*
Reniform isolate[z] (I)	2	0.02*	< 0.01*
S x I	4	0.21	0.09

[x]Data combined over two 60-d duration experiments with a total of 11 replications (reflecting the loss of one replication in the original experiment). Data was analyzed with ANOVA and Tukey's HSD ($P \leq 0.05$).
[y]Soils were from three different locations within a Commerce silt loam field. Percentages of sand, silt, and clay were 74.4, 31.4, and 7.8 for S1; 20.7, 55.3, and 66.3 for S2; and 4.9, 13.3, and 25.9 for S3, respectively.
[z]Reniform nematode isolates were collected from Avoyelles, Evangeline, and Rapides Parishes.
*Indicates a significant *P* value.

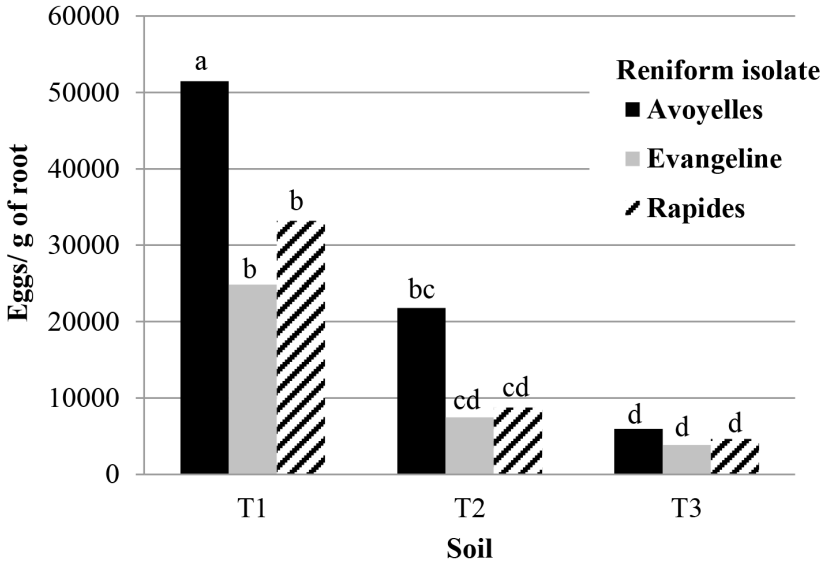

Fig. 1. Individual treatment means for the interaction between soil and reniform isolate on egg production on the cotton cultivar Phytogen 375WF in a greenhouse environment. Across all columns, means followed by the same letter do not differ significantly according to Tukey's HSD test, $P \leq 0.05$.

the number (109,964) recovered from the Avoyelles isolate. Only the Avoyelles and Rapides isolates differed significantly in the number of eggs per g of root, 17,451 and 9,146, respectively.

There were significant main effects of both soil and reniform isolate on this cotton cultivar. However, the main effect for soil was confined only to plant height at 15 and at 30 DAI while those for the reniform isolate were significant for plant height only at 15 DAI (Table 4). Plants growing in S2 soil averaged 20.6 cm at 15 DAI and 45.6 cm at 30 DAI and were significantly taller than those growing in S1 soil, which averaged 18.8 and 42.2 cm at 15 and 30 DAI, respectively. At 15 DAI, plants inoculated with the Rapides isolate were significantly taller and averaged 21.4 cm in height, while those inoculated with the Evangeline isolate averaged 18.7 cm.

Over the course of these experiments, temperatures in the greenhouse ranged from 23.9 to 37.2°C, and from 26.7 to 41.1°C in the first and second runs of this experiment, respectively.

Experiments with Stoneville LA887

For Stoneville LA 887, the main effects of soil and reniform isolate significantly impacted nematode (Table 5) but not plant parameters (data not included). Numbers of vermiform stages in the soil and eggs per g of root were both significantly influenced by soil and by reniform isolate (Table 5). With respect to eggs per g of root, the interaction of soil and reniform isolate was not significant although the *P* value obtained was 0.09. Numbers of vermiform stages were significantly lower in S3 soil (52,785 per 500 cc of soil) than in S1 (108,693 per 500 cc of soil) and S2 (88,759 per 500 cc of soil) soils. Numbers of eggs per g of root followed the same pattern with the 9,664 per g of root in S3 soil and significantly greater numbers, 38,681 and 27,276

per g of root in S1 and S2 soils, respectively. Numbers of vermiform stages in soil for the Evangeline isolate (48,996 per 500 cc of soil) were significantly lower than those in soil for the Avoyelles and Rapides isolates (92,334 and 108,896, respectively). Significantly greater numbers of eggs, 36,514 per g of root, were recovered from the Avoyelles isolate than from the Evangeline isolate (17,093).

Over the course of these experiments, the temperature in the greenhouse ranged from 28.9 to 36.7°C during the first run and from 23.9 to 43.3°C during the second run.

DISCUSSION

This research demonstrates that reproduction of the three isolates of *R. reniformis* was significantly impacted by soil texture across the three cultivars of cotton. For Phytogen 375WF, Stoneville 5288B2F, and Stoneville LA887, soil with the highest clay content, S3, had significantly lower nematode populations than soils with low and moderate amounts of clay. The S1 and S2 soils probably produced more favorable environments for motility of the nematode as a result of their water-holding and aeration characteristics. The particle size distribution of S1 soil (74.4% sand, 20.7% silt, and 4.9% clay) is similar to that of the Portsmouth loamy sand soil (72% sand, 18% silt, and 10% clay) used by Herring *et al.* (2010) and Koenning *et al.* (1996). Both the Portsmouth soil from their studies and S1 soil from this research likely produced environments that were the most conducive to reproduction of reniform nematode. Moreover, Koenning *et al.* (1996) also observed that the least reproduction by reniform nematode was in two additional soils with textures similar to the S3 soil. Koenning *et al.* (1996) and Xavier *et al.* (2012) have also reported similar observations in microplot and field experiments, respectively, where population densities of reniform nematode were greater in soils with clay contents ranging from 18% to 20%. In these studies, as well as those of Koenning *et al.* (1996) soils with clay content above 20% limited reproduction of *R. reniformis*.

There were significant effects of nematode isolate for each of the three cultivars of cotton. With Phytogen 375WF and Stoneville 5288B2F, the Avoyelles isolate reached the highest population density, while with Stoneville LA887 the Rapides isolate reached the highest population density. Results for the reniform nematode isolate from Evangeline Parish were variable across the three cotton cultivars; population density was highest on Stoneville 5288B2F, lowest on Phytogen 375WF, and intermediate on Stoneville LA887. There was a significant effect of isolate on plant growth parameters only with Stoneville 5288B2F cotton and only at 15 DAI. Data from Cook *et al.* (1997), with a single population of *R. reniformis*, indicated that the nematode did not influence plant height or dry weight of cotton shoots in a greenhouse experiment 10 wk after inoculation.

Across the three cultivars, soil texture had less impact on plant parameters than it did on reproduction of reniform nematode. At 50 DAI, soil had no effect on height of plants, or weights of dry roots and shoots for any of the three cultivars. Effects on plant growth were limited only to plant height at 15 DAI with Phytogen 375WF and at 15 and 30 DAI with Stoneville 5288B2F. Data from Moore and Lawrence (2013), who worked with reniform nematode in multiple soil textures under greenhouse conditions, showed that soil texture had a significant effect on nematode reproduction and no effect on plant growth at 60 d after planting. These data are in agreement with results presented herein.

For the three isolates of *R. reniformis* employed in this research, a reduction in nematode reproduction is evident with an increase in clay content. The marked differences in population densities, observed with the Phytogen 375WF and the Stoneville 5288B2F cultivars are noticeable in S1 soil, but they decrease considerably in S2 soil and almost disappear in S3 soil. These observations re-emphasize the fact that there is a limit to the influence of clay content on population development of *R. reniformis*. Abiotic factors, such as soil formation from different parental materials (Petersen and Calvin, 1986) and differences in geographic isolates of reniform nematode (McGawley *et al.*, 2010), might also have contributed to the difference in nematode reproduction among the different cotton cultivars.

Data from this research further documents reproductive variation in populations of *R. reniformis*. These studies have focused primarily on the effect of soil texture on the reproduction of three isolates of reniform nematode from Louisiana. In spite of the fact that the three soils, S1, S2, and S3 originated from the same field, there was significant variation in reproduction of the nematode related to each soil texture, each isolate of the nematode, and each cultivar of cotton. These observations confound the ability to formulate proper management decisions since, even within a single field, the effect of soil texture on reproduction of reniform nematode is variable. Variability in soil texture within individual fields and the subsequent differential effect on reproduction of reniform and other plant-parasitic nematodes, makes the formulation of appropriate management recommendations difficult. Additional research on the influence of soil texture on nematode reproduction, such as that being done in the area of site-specific nematode management, addresses this issue.

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