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

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Abstract

Observations in cotton fields infested with reniform nematode led to speculations regarding a possible correlation between soil texture, cotton cultivars and nematode population development. The objective of this research was to evaluate the influence of soil texture on reproduction and pathogenicity of reniform nematode on cotton. This study consisted of a series of greenhouse experiments where three cotton cultivars (Stoneville LA887, Stoneville 5288B2F, and Phytogen 375WF) were tested with three distinct isolates of *R. reniformis* in different soil textures. Soil type had a significant effect on nematode population development in all three cotton cultivars. Soil type also significantly affected plant height and dry weight in Stoneville 5288B2F and plant shoot weight in Phytogen 375WF, but did not affect plant growth of Stoneville LA887. The population development of the different isolates of *R. reniformis* was affected in distinct ways in the three cultivars and soil types. The interaction between soil type and nematode population had significantly affected population development of all the reniform nematode isolates tested among the multiple soil types when Stoneville 5288B2F and Phytogen 375WF were present, but had no effect on population development of any isolate when Stoneville LA887 was present.

Introduction

The reniform nematode, *Rotylenchulus reniformis*, has a wide host range, and most of the damage caused by this nematode is associated with plant stunting and yield reduction. In Louisiana, one of the major crops affected by the reniform nematode is cotton. Over the past several years, the reniform nematode has become a major nematode pest in Louisiana cotton fields. According to the National Cotton Council, the losses caused by reniform nematode in the cotton growing areas in the U.S. has steadily increased, reaching approximately 280,000 bales lost in 2011. Observations made in cotton fields where reniform nematode is present have resulted in observations that suggest there are areas within a field that are not equally affected by this nematode. Reniform nematode has been associated with more fine textured soils (Overstreet et al., 2008; Starr et al., 1993). Cotton growth and nematode development has been reported to be impacted by reniform nematode isolates (McGawley et al., 2010). This research was conducted with the objective of evaluating the influence of soil texture on reproduction and pathogenicity of the reniform nematode on cotton. Additionally, the reproductive variations of three geographic isolates of *R. reniformis* were tested in three cotton cultivars growing in different soil textures.

Materials and Methods

The three isolates of reniform nematode used in this study are from Louisiana and were supplied/collected by E. C. McGawley. The three geographic isolates (identified as Avoyelles, Evangeline, and Rapides) were obtained from axenic cultures maintained in the LSU Nematology greenhouse on tomato (cultivar Rutgers PS Seedway; Hall, New York 14463) for use as inoculum. Each of isolates was confirmed to be *R. reniformis* as described by McGawley et al, 2010 and Robinson et al, 1997. The duration of the experiments was 60 days, and the parameters evaluated at the end of the experiments were plant measurements (plant height, dry root and shoot weights) and population development of *R. reniformis* (nematode numbers in 500 cm^3 of soil and number of eggs per gram of root). Each experiment was repeated once. Soil used in these studies originated from the Northeast Research Station, located in St. Joseph, Louisiana. Soil from three different sites within the same field was selected based on apparent electrical conductivity (EC_a) data obtained employing a Veris® Soil EC Mapping System (Table 1). The location of each site was georeferenced in the field using a Trimble Juno handheld GPS receiver and FarmWorks SiteMate Pro software. Soil from the three sites differed in sand and clay content according to the Hydrometer method modified from Day (1965) and the American Society for Testing and Materials (1985) as listed in Table 1. All of the soil was steam sterilized prior to use.

Table 1. Particle size distribution and electrical conductivity (EC_a) values for the three sampling sites in the field located at St. Joseph, Louisiana.

Sample site	Particle size distribution (%)			EC_a (mS/m)	
	Sand	Silt	Clay	$EC_{a\text{-}sh}$	$EC_{a\text{-}dp}$
T1	74.4	20.7	4.9	7.4	27.5
T2	31.4	55.3	13.3	8.7	49.9
T3	7.8	66.3	25.9	33.4	88.1

Experiment 1

The cotton cultivar used was Stoneville LA 887, tested with two different soil types: greenhouse soil (72.1% sand, 25.4% silt, and 2.5% clay) and field soil from sampling site T2 (31.4% sand, 55.3% silt, 13.3% clay). A single isolate of reniform nematode was used (Avoyelles). The experiment was conducted in the LSU greenhouse using terra cotta pots with an inside top diameter of 10.2 cm, holding 0.5 kg of soil. The nematode concentrations used were 0 and 5,000 nematodes (juveniles, pre-adult females and males) per pot.

Experiments 2, 3, and 4

A different cotton cultivar was used for each experiment: Stoneville LA887 (experiment 2), Stoneville 5288B2F (experiment 3), and Phytogen 375WF (experiment 4). The three experiments were conducted in the LSU greenhouse using terra cotta pots with an inside top diameter of 15 cm, holding 1.6 kg of soil. Each experiment employed the three different soil types (T1, T2, and T3) from the field (Table 1). Also, three different geographic isolates of the reniform nematode were used. The nematode concentrations used were 0 and 10,000 nematodes (juveniles, pre-adult females and males) per pot.

Results and Discussion

In experiment one, the soil type had a significant effect on plant height, but did not significantly affect root or shoot dry weights (Table 2). Also, the nematode presence or absence did not significantly affect plant measurements (Table 2). Plants growing in T2 soil were significantly higher than plants growing in greenhouse soil. Soil type had no significant effect on population development of *Rotylenchulus reniformis*.

Table 2. Main and interaction effects (*P*-values) for Stoneville LA887 cotton grown in pots infested with *R. reniformis*.

Source	DF	Plant Height	Dry root weight	Dry shoot weight
Soil	1	0.05*	0.12	0.12
Nema	1	0.83	0.77	0.77
Soil × Nema	1	0.14	0.49	0.14
Analysis is based on 10 replications; * are significant at $P \leq 0.05$				

In the second experiment neither soil type nor nematode population had a significant effect on plant measurements. However, nematode numbers in the soil were significantly affected by both soil type and nematode population, but the interaction between soil type and nematode population did not significantly affect any of the parameters considered for population development of *R. reniformis* (Table 3). Nematode numbers were lower in T3 soil, and the Evangeline population had the least amount of reproduction. Also, the number of eggs per gram of root was significantly affected by both soil type and nematode population, but the interaction between soil type and nematode population did not significantly affect nematode population development (Table 3). In this case, plants growing in soil from the T3 site had a significantly lower number of eggs when compared to plants growing in the other soil types used. Also, plants inoculated with the Avoyelles population had a significantly greater number of eggs than plants inoculated with the Evangeline population.

Table 3. Main and interaction effects (*P*-values) on Stoneville LA887 cotton for population development of *R. reniformis* growing in pots with different soil types and different nematode populations.

Source	DF	Nema/500 cm^3 of soil	Eggs/g of root
Soil	2	< 0.01*	< 0.01*
Population	2	< 0.01*	0.02*
Soil × Population	4	0.21	0.09

Analysis is based on 11 replications; * are significant at P ≤ 0.05

In the third experiment, using the cotton cultivar Stoneville 5288B2F, soil type had a significant effect on all the plant measurements (Table 4). Both root and shoot dry weights were lower for plants in soil type T1. Also, there was a significant effect of the interaction between soil type and nematode population on plant height (Figure 1). There was no significant difference in plant height within each one of the soil types. Plants inoculated with the nematode populations from Evangeline and Rapides were greater in T2 soil when compared to plants inoculated with those populations in T1 soil (Figure 1).

Table 4. Main and interaction effects (*P*-values) for Stoneville 5288B2F cotton grown in different soil types in pots infested with different *R. reniformis* populations.

Source	DF	Plant Height	Dry root weight	Dry shoot weight
Soil	2	< 0.01*	< 0.01*	< 0.01*
Population	3	0.81	0.21	0.88
Soil × Population	6	0.03*	0.24	0.11

Analysis is based on 6 replications; * are significant at *P* ≤ 0.05.

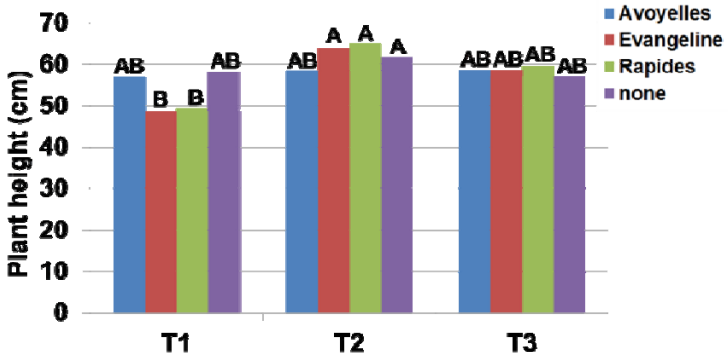

Figure 1. Individual treatment means of plant height from the cotton cultivar Stoneville 5288B2F for the interaction between soil type and nematode population. Means within columns followed by the same letter do not differ significantly according to Tukey's HSD test, *P* ≤ 0.05.

Population development of *R. reniformis* was significantly affected by soil type in the third experiment (Table 5). The number of eggs in plants growing in soil T1 was significantly greater than plants growing in soil T2, and T2 had significantly greater egg counts than T3 soil. The interaction between soil type and nematode population showed a significant effect on nematode numbers in the soil (Figure 2). Within each soil type, there was no significant difference in juvenile numbers for any of the nematode populations. The population development of the Rapides population was significantly greater in T1 soil than in T2 and T3 soils (Figure 2).

Table 5. Main and interaction effects (*P* values) on Stoneville 5288B2F cotton for population development of *R. reniformis* growing in pots with different soil types and different nematode populations.

Source	DF	Nema/500 cm^3 of soil	Eggs/g of root
Soil	2	< 0.01*	< 0.01*
Population	2	0.19	0.22
Soil × Population	4	0.01*	0.23

Analysis is based on 6 replications; * are significant at $P \leq 0.05$

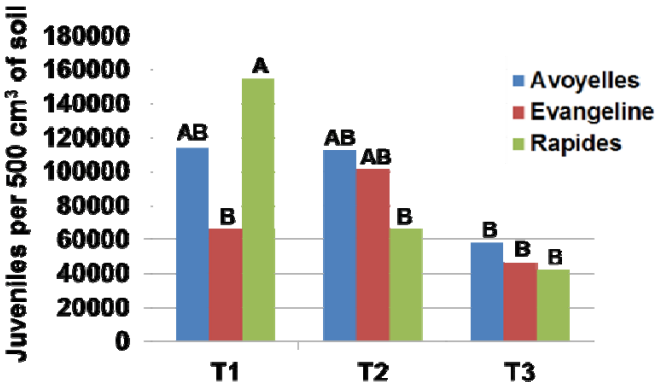

Figure 2. Individual treatment means of nematode numbers for the interaction between soil type and nematode population with the cultivar Stoneville 5288B2F. Means within columns followed by the same letter do not differ significantly according to Tukey's HSD test, $P \leq 0.05$.

In the fourth experiment, using Phytogen 375WF, the only significant effect observed in plant measurements between all the variables considered was the effect of soil type with shoot weight, where the lowest weight was observed in plants growing in T1 soil (Table 6). Both of the parameters considered in this study for nematode population development were significantly affected by soil type, nematode population, and the interaction between the two variables (Figures 3 and 4).

Table 6. Main and interaction effects (*P*-values) for Phytogen 375WF cotton grown in different soil types in pots infested with different *R. reniformis* populations.

Source	DF	Plant Height	Dry root weight	Dry shoot weight
Soil	2	0.49	0.46	< 0.01*
Population	3	0.37	0.98	0.16
Soil × Population	6	0.11	0.99	0.88

Analysis is based on 6 replications; * are significant at $P \leq 0.05$

The number of nematodes in the soil was significantly higher for the Avoyelles populations in T1 soil type. The same pattern was observed for T2 and T3 soils, but there was no statistical significance between the particular soil types (Figure 3). Also, the Avoyelles population developed better in T1 soil type than in T2 or T3.

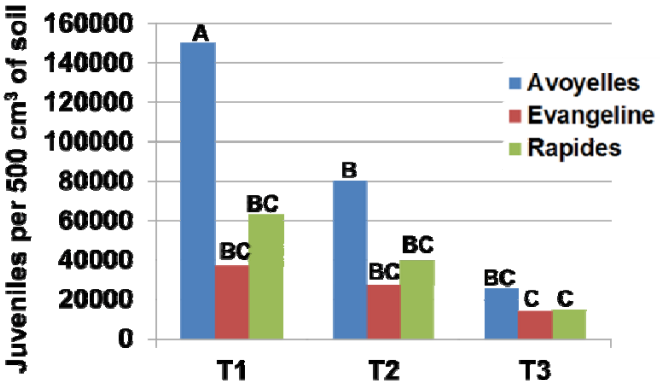

Figure 3. Individual treatment means of nematode numbers for the interaction between soil type and nematode population with cotton cultivar Phytogen 375WF. Means within columns followed by the same letter do not differ significantly according to Tukey's HSD test, $P \leq 0.05$.

While using the Phytogen 375WF cultivar, the number of eggs per gram of root was significantly greater in T1 soil for all the populations considered when compared to the same populations in T2 and T3 soil types (Figure 4). Also, in T1 soil type, the Avoyelles population had significantly more eggs per gram of root than the Rapides population, and Rapides had significantly more eggs than Evangeline in this soil type. The same pattern was observed in T2 and T3 soils, but there was no significant difference on the development of the different nematode populations in these soil types (Figure 4).

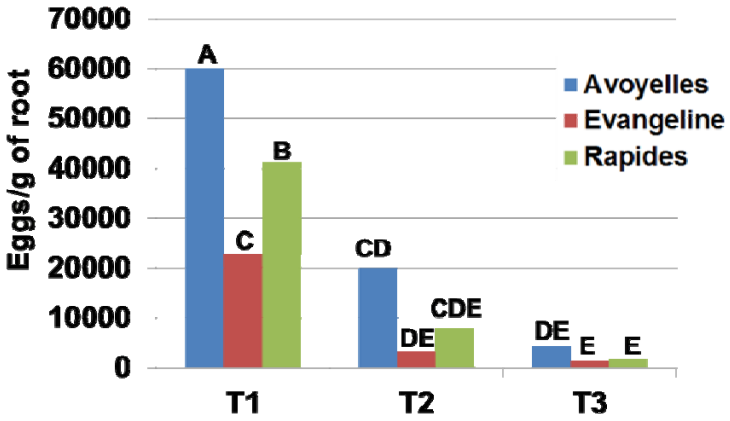

Figure 4. Individual treatment means of nematode eggs for the interaction between soil type and nematode population with cotton cultivar Phytogen 375WF. Means within columns followed by the same letter do not differ significantly according to Tukey's HSD test, $P \leq 0.05$.

Summary

In summary, these greenhouse experiments determined that soil type significantly affects reniform nematode population development in the different nematode population, as well as in the different cotton cultivars. Plant measurements were not as significantly impacted by soil type, nematode population isolate, or by the interaction between those two variables. A significant variation in reproduction was observed between the different *R. reniformis* populations in the various soil types and the cotton cultivars used in these experiments. These studies indicate a greater need to evaluate cotton cultivars growing in different areas where the pathogenicity of reniform nematode may vary. Additionally, soil types may have an impact on plant growth and population development of the nematode.

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