EFFECTS OF SOIL TYPE ON THE REPRODUCTIVE POTENTIAL OF *ROTYLENCHULUS RENIFORMIS* ON COTTON

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Abstract

The reniform nematode, *Rotylenchulus reniformis*, is the most damaging nematode pathogen of cotton in Alabama. Trials to determine the reproductive potential of *R. reniformis* as affected by soil type were conducted in both microplot and greenhouse settings in 2008 – 2010. The soil types evaluated were a Dothan sandy loam (S-S-C = 57-28-15), a Decatur silt loam (S-S-C = 23-49-28), a Hartsells fine sandy loam (S-S-C = 51-38-11), a Ruston very fine sandy loam (S-S-C = 59-33-8), a Lloyd loam (52-23-25 S-S-C), and a Vaiden clay (S-S-C = 5-42-53). Within the microplot trials, populations of *R. reniformis* were significantly different between soils and between irrigated and non-irrigated plots of the same soil. However, reproductive factors differed very little either between soils or between irrigated and non-irrigated plots of the same soil. For the greenhouse trials, reniform nematode populations were again significantly different between soils and differing initial populations resulted in significant changes in shoot/root ratio both within soils and between soils. Shoot/root ratios were not significantly different at any initial population (PI) in the Decatur silt loam and the Ruston very fine sandy loam, but decreased significantly at a PI of 1000 or greater for the Lloyd loam, 2000 or greater for the Vaiden clay and 5000 or greater for the Hartsells fine sandy loam and the Dothan sandy loam. These results indicate that differences in soil growth potential have a direct effect on the nematode/cotton interaction.

Introduction

Site-specific management of the reniform nematode, *Rotylenchulus reniformis*, is a developing management strategy for cotton growers. This strategy has been successfully employed for other species of nematode such as the root-knot (*Meloidogyne incognita*) and Columbia lance nematodes (*Hoplolaimus columbus*) by delineating management zones based on various soil edaphic factors (e.i. soil particle size, elevation, slope, etc.) and assigning a risk level to each zone. However, for the reniform nematode, which soil characteristic, or combination of characteristics, constitutes a higher or lower risk is not well defined. Therefore, the objective of this study was to evaluate how one of the aforementioned soil characteristics affects the reproductive potential of the reniform nematode on cotton and how soils from different regions should be considered in yield loss risk assessment.

Methods

Two trials were conducted during 2008 – 2010 in six different soil types from the major cultivated regions of Alabama to evaluate the effect of soil particle size on: 1) the reproductive potential of the reniform nematode on cotton over a three year period from a standard initial population under both irrigated and non-irrigated conditions and 2) the reproductive potential of the reniform nematode on cotton and its effects on early season cotton development from differing initial populations. The soil types used in the trials were: Decatur silt loam (23-49-28 S-S-C), Hartsells fine sandy loam (51-38-11 S-S-C), Vaiden clay (5-42-53 S-S-C), Lloyd loam (52-23-25 S-S-C), Dothan sandy loam (57-28-15 S-S-C), and Ruston very fine sandy loam (59-33-8 S-S-C). Both trials were conducted at the Auburn University Plant Science Research Center in Auburn, AL.

The first trial was conducted from 2008 – 2010 in 4,400cm^3 outdoor microplots arranged in a 6 x 2 factorial design replicated 5 times with the first factor designated as soil type and the second factor designated as irrigation. At planting in 2008, 5,000 vermiform life stage reniform nematodes were added to each pot. Pots were planted each season with DP161B2RF and the plants were evaluated at 60 and 150 days after planting (DAP) for height and number of nodes and the cotton hand-picked at 150 DAP and weighed. Reniform nematode populations were evaluated at 60 and 150 DAP by taking four, 2.5 x 15 cm core samples from each pot. The four samples were homogenized and the nematodes extracted by combined gravity screening/sucrose centrifugation and enumerated.

The second trial was conducted during 2010 in 500-cm^3 polystyrene pots placed in the greenhouse arranged in a randomized complete block design with four replicates and repeated three times. At planting, six levels of reniform nematodes were added to the designated pots: 0, 500, 1000, 2000, 5000, and 10000 vermiform life stages/500cm^3. Pots were planted with DP161B2RF and plants were evaluated at 30 DAP for height and number of nodes and at 60 DAP for height, number of nodes, and root and shoot fresh weight. Reniform nematode populations were evaluated at 60 DAP using the previously described method. Data for both trials was analyzed using the GLIMMIX procedure of SAS 9.1.3. Significant differences both within and between soils were determined using either the difference of least squares means or a Dunnett's test where $p \leq 0.05$.

Results

Reniform populations within the microplots at planting were significantly higher in the Decatur silt loam for the irrigated trial compared to all other soils (Figure 1). Within the non-irrigated trial, populations were significantly higher in the Decatur silt loam and the Ruston very fine sandy loam compared to all other soils. Populations differed significantly between the irrigated and non-irrigated trials for the Vaiden clay and Lloyd loam only.

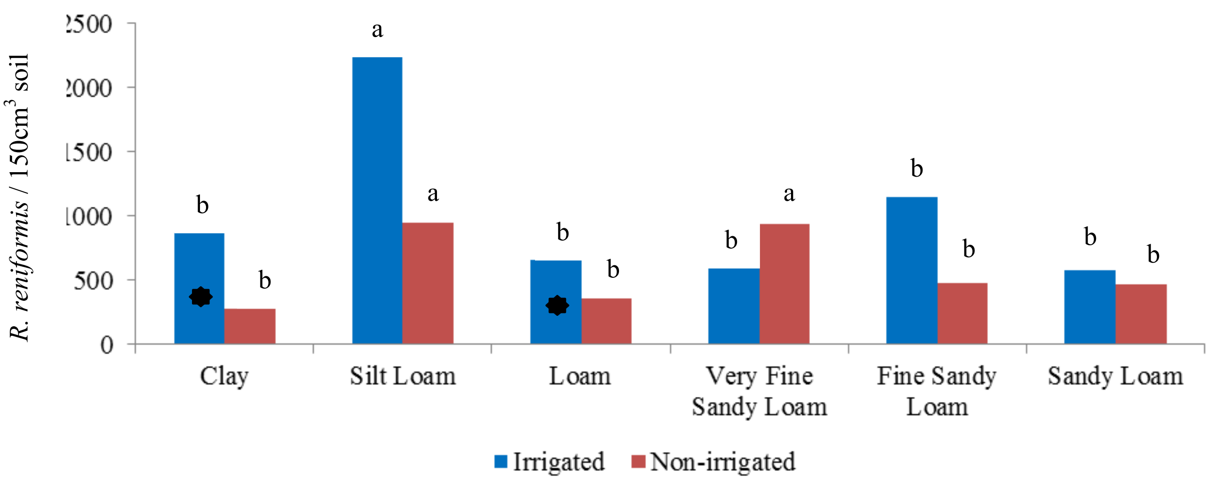


Figure 1. Reniform populations per 150cm^3 soil at planting in the microplot trial for each soil type. The blue bars represent the irrigated plots while the red bars represent the non-irrigated plots. Bars with the same letter are not significantly different ($p \leq 0.05$) within their respective plots (irrigated or non-irrigated). A * represents a significant difference ($p \leq 0.05$) between the irrigated and non-irrigated pots of the same soil type.

Reniform nematode populations at 150 DAP within the microplots trials are illustrated in Figure 2. Populations in the Decatur silt loam were significantly higher than all other soils with the exception of the Vaiden clay in both the irrigated and non-irrigated plots. Within the irrigated trial the Vaiden clay produced significantly higher populations compared to the Ruston very fine sandy loam. Reniform nematode populations were significantly higher within the irrigated plots compared to the non-irrigated plots in the Decatur silt loam, the Lloyd loam, and the Hartsells fine sandy loam.

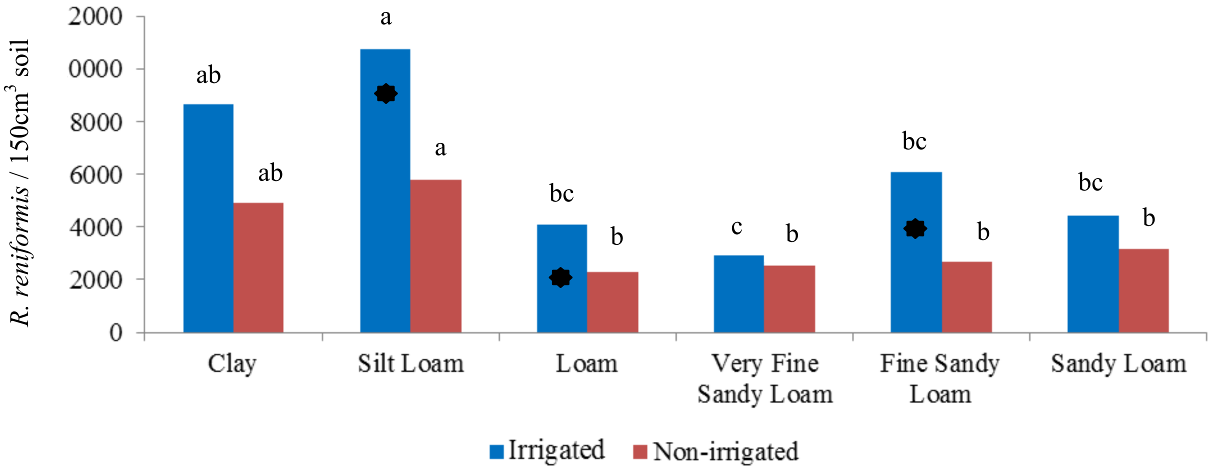


Figure 2. Reniform populations per 150cm^3 soil 150 DAP in the microplot trial for each soil type. The blue bars represent the irrigated plots while the red bars represent the non-irrigated plots. Bars with the same letter are not significantly different ($p \leq 0.05$) within their respective plots (irrigated or non-irrigated). A * represents a significant difference ($p \leq 0.05$) between the irrigated and non-irrigated pots of the same soil type.

The average reproductive factor (final population/initial population) did not differ significantly between soil types within the irrigated plots (Figure 3). However within the non-irrigated plots, the reproductive factor was significantly higher in the Decatur silt loam compared to the Dothan sandy loam. No significant difference in reproductive factor occurred between the irrigated and non-irrigated plots within soil types. Seed cotton yields and plant heights were similar for all soil types, both irrigated and non-irrigated, with the only significant difference occurring between the irrigated and non-irrigated plots of Decatur silt loam (not shown).

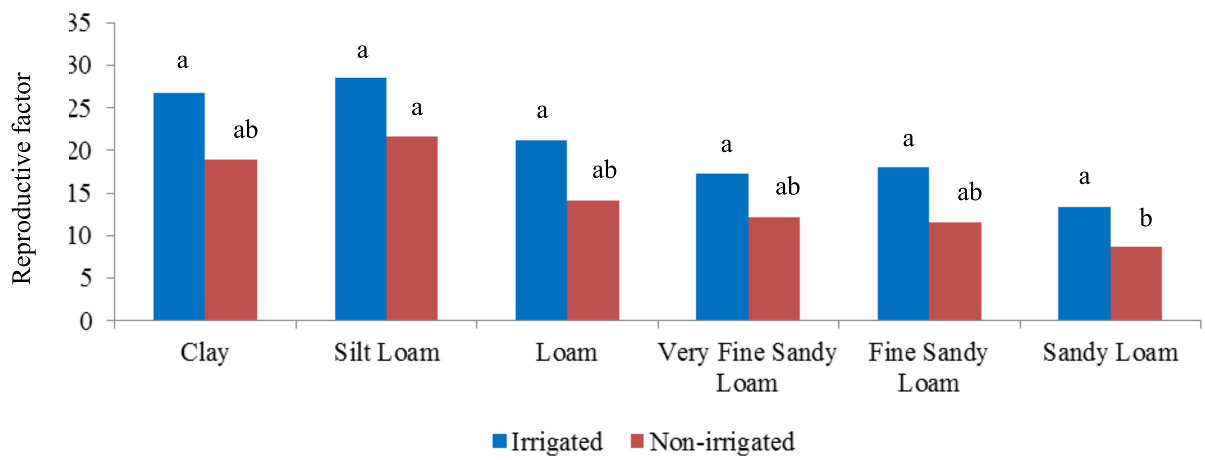
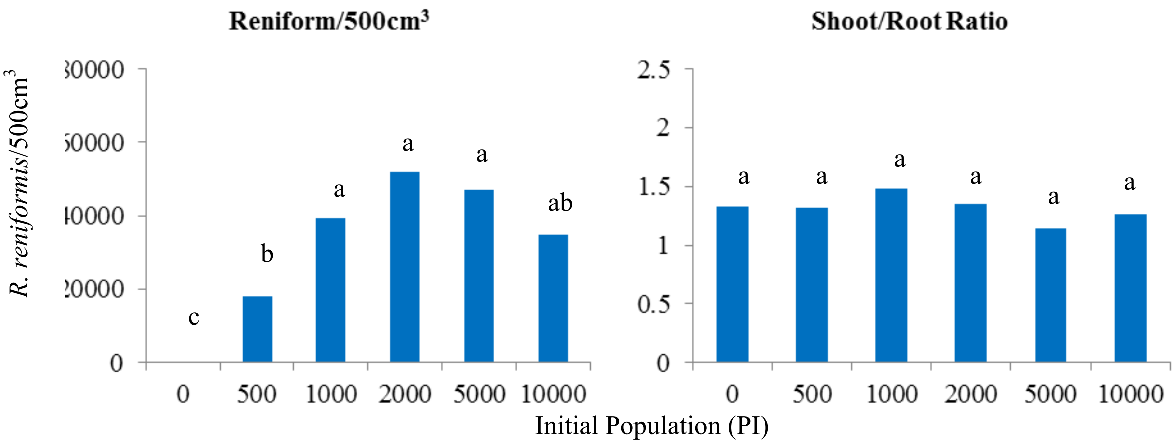


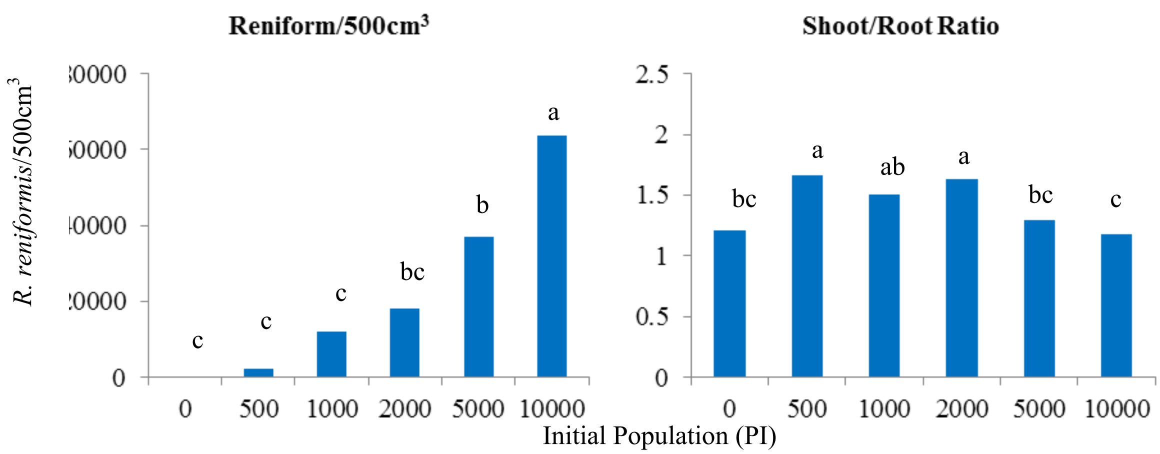
Figure 3. Reniform nematode reproductive factors in the microplot trial for each soil type. The blue bars represent the irrigated plots while the red bars represent the non-irrigated plots. Bars with the same letter are not significantly different ($p \leq 0.05$) within their respective plots (irrigated or non-irrigated). A * represents a significant difference ($p \leq 0.05$) between the irrigated and non-irrigated pots of the same soil type.

The results of the greenhouse trials on the effects of differing initial populations (PI) are illustrated in Figure 4. Total reniform populations/500cm^3 for the Decatur silt loam soil were significantly higher at 60 DAP for PI 1000, 2000 and 5000 compared to PI's 0 and 500 (Figure 4A). Shoot/root ratio was the largest at PI 1000, however no PI's resulted in a significantly different ratio compared to the 0 PI control. Reniform nematode populations in the Hartsells fine sandy loam (Figure 4B) increased linearly from 500 to 10,000 PI, with the 10,000 PI having significantly higher populations compared to all other PI's, and 5000 PI resulting in significantly higher populations compared to all PI's 0 – 2000. Shoot/root ratio was significantly higher for the 500 and 2000 PI's compared to the 0 PI control and the 5000 and 10000 PI's. The 1000 PI resulted in a significantly higher shoot/root ratio compared to the 10000 PI. The Vaiden clay produced significantly higher reniform nematode populations at PI 5000 and 10000 compared with all other PI's (Figure 4C). Shoot/root ratios were significantly higher at the 500 PI compared to the 2000, 5000 and 10000 PI's. Reniform nematode populations increased linearly in the Lloyd loam from 0 to 10000 PI, with the 5000 and 10000 PI's producing significantly higher populations compared to the 0, 500 and 1000 PI's (Figure 4D). Shoot/root ratios decreased linearly from 0 to 10000 PI, with the 0 PI resulting in a significantly higher ratio compared to the 1000, 2000, 5000 and 10000 PI's. The Dothan sandy loam produced a linear increase in reniform nematode populations from 0 to 10000 PI, with the 5000 and 10000 PI's resulting in significantly higher total populations compared to all other PI's (Figure 4E). The 0, 500, 1000 and 2000 PI's resulted in significantly higher shoot/root ratios compared to the 5000 and 10000 PI's. Reniform nematode populations in the Ruston very fine sandy loam were significantly higher at a PI of 10000 compared to the 0 and 500 PI's (Figure 4F). The shoot/root ratios were significantly higher for all PI's compared to the 0 PI.

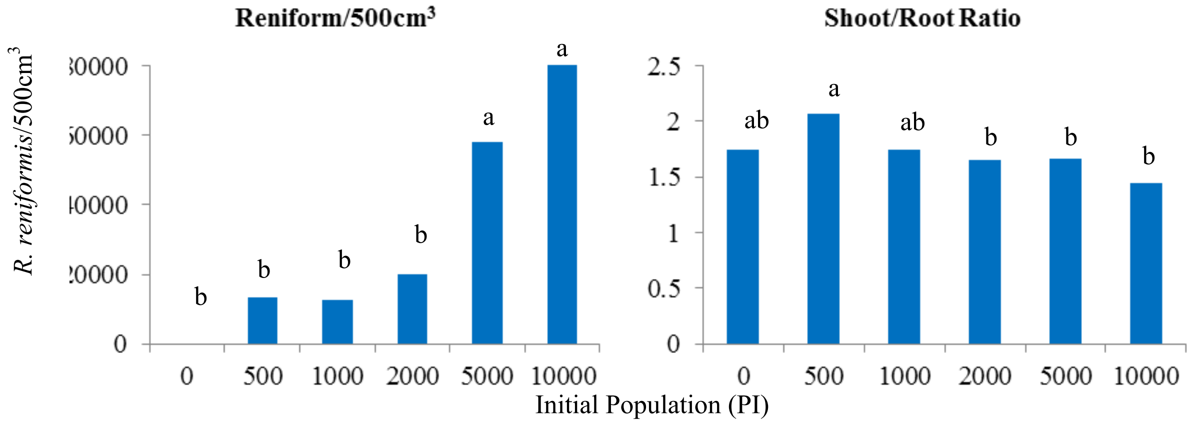
(A) Decatur silt loam



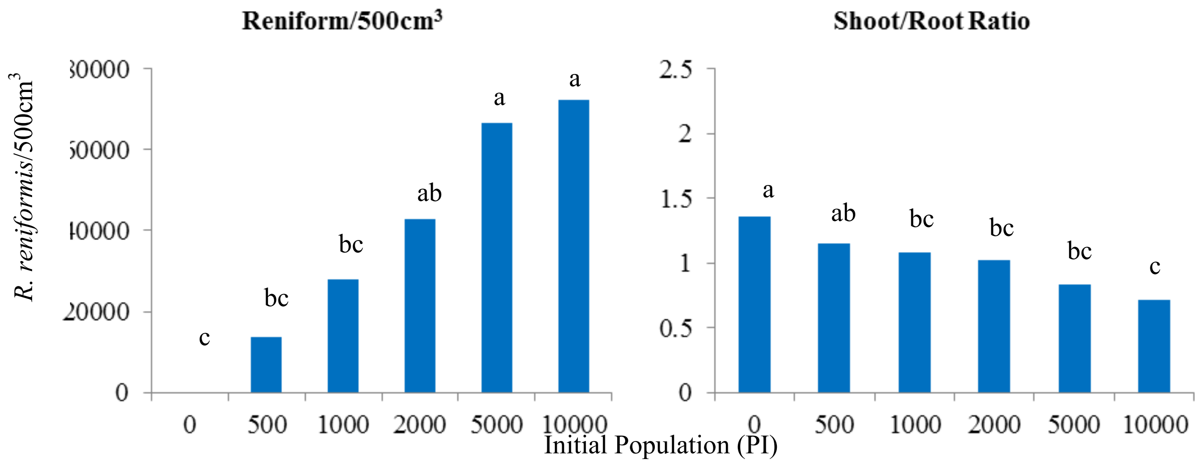
(B) Hartsells fine sandy loam



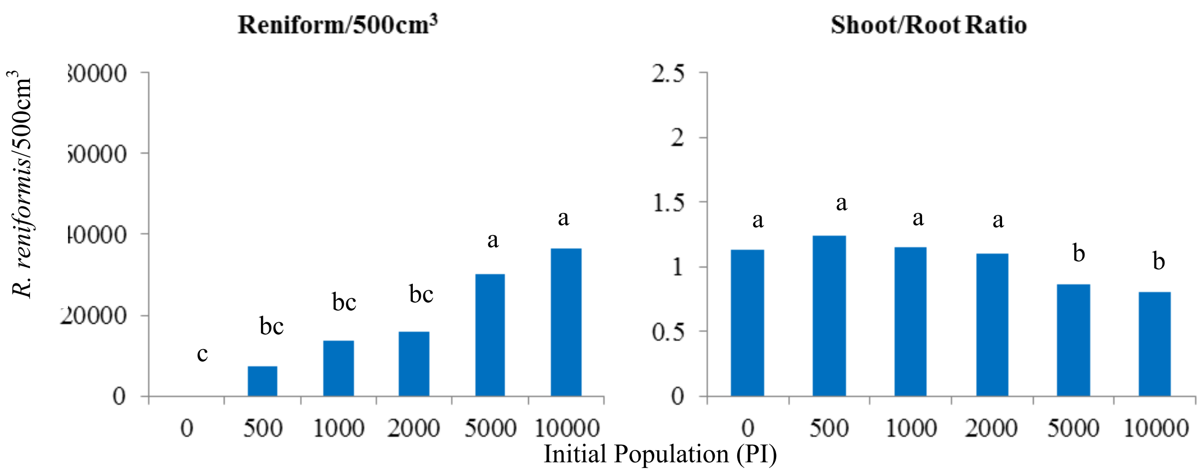
(C) Vaiden clay



(D) Lloyd loam



(E) Dothan sandy loam



(F) Ruston very fine sandy loam

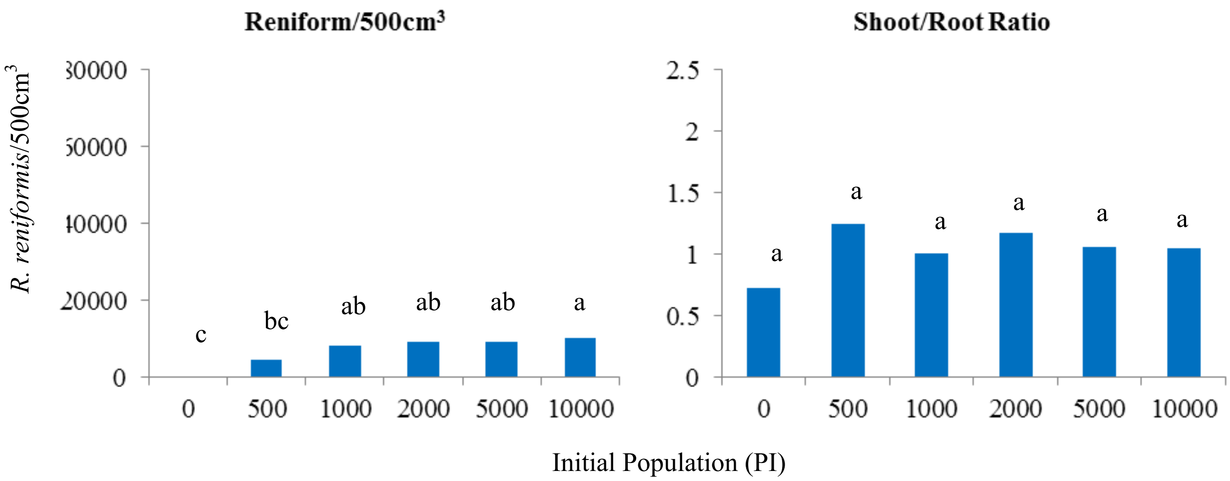


Figure 4. Total average reniform nematode populations/500cm^3 (left) and shoot/root ratio (right) for each PI for the Decatur silt loam (A), the Hartsells fine sandy loam (B), the Vaiden clay (C), the Lloyd loam (D), the Dothan sandy loam (E) and the Ruston very fine sandy loam (F). Columns with the same letters above are not significantly different.

Conclusion

Results from the microplot trial indicated that soil type alone did not have a significant effect on the reniform nematodes ability to reproduce and cause damage to cotton. Although populations were quite different between soil types the effect on the growth of the cotton plants were ultimately the same. While all plots began with an equal number of reniform nematodes, by the end of the first season each soil type was observed to reach a unique population plateau that persisted through the subsequent two seasons.

The greenhouse trials to determine the effects of differing initial populations on early season cotton development corroborate the differences in population potential between soils observed in the microplot trials and also indicated that there were differences in cotton response to nematode populations between soils. The changes in shoot/root ratio, a measure of plant development, were observed to occur at higher nematode populations within a soil. Both the Decatur silt loam and the Ruston very fine sandy loam exhibited to significant differences in shoot/root ratio at any PI, however the average total population of the Decatur silt loam was 5x higher in comparison to the Ruston very fine sandy loam. The Lloyd loam and the Vaiden clay exhibited a significant decrease in shoot/root ratio at PI's of greater than 1000 and 2000, respectively, while producing the highest average total populations of all soils. Both the Hartsells fine sandy loam and the Dothan sandy loam exhibited a significant decrease in shoot/root ratio at a PI of 5000 and greater however the total average population for the Hartsells fine sandy loam was 2x higher compared to those found in the Dothan sandy loam.

The significant decreases in shoot/ root ratio indicate that at higher reniform nematode infestation the plants do exhibit a change in growth in comparison to the lower reniform nematode infestations or to plants growing in nematode free conditions. That similar differences in plant growth occur at vastly different reniform nematode populations indicates that differences in soil growth potential have a direct effect on the nematode/cotton interaction.