# DIMENSIONAL MOVEMENT OF ROTYLENCHULUS RENIFORMIS THROUGH A DECATUR SILT LOAM SOIL UNDER VARIABLE SOIL MOISTURES

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## Abstract

The vertical, horizontal and temporal movement of *Rotylenchulus reniformis* from the initial point of infestation was evaluated in a 2007 field study under both irrigated and non-irrigated conditions. Selected rows in each field were inoculated with vermiform life stages of *R. reniformis* at planting. Vertical movement of both *R. reniformis* males and vermiform females and juveniles was observed to the maximum sampling depth of 91cm in both the irrigated and non-irrigated test. Horizontal movement of *R. reniformis* vermiform life stages did not differ between tests, as both were observed approximately 75cm from the inoculated row. Movement of *R. reniformis* males was affected by irrigation, with males in the irrigated test being observed to have moved >150cm from the inoculated row at 60 and 90 days after planting (DAP) then reducing to approximately 100cm at 120 DAP. Males in the non-irrigated test had moved 25cm from the inoculated row at 60 DAP, increasing to approximately 125cm at 90 DAP and finally reducing to approximately 75cm at 120 DAP. These results illustrate how quickly *R. reniformis* can spread upon introduction in a cotton system.

## Introduction

The reniform nematode, *Rotylenchulus reniformis*, has developed into the most economical nematode pathogen of cotton (*Gossypium hirsutum*) in Alabama. Loss estimates have risen steadily in the past decade to 9% in 2006 (Blasingame et al, 2007). The initial introduction of *R. reniformis* into a field is believed to be most often due to infested equipment. However, once the nematode is present in the field, the rate of unaided spread and natural factors involved is largely unknown.

Many studies of the distribution of *R. reniformis* have been conducted. Several studies on the depth distribution of *R. reniformis* have shown that the nematode is consistently found at depths greater than one meter. For example, Heald & Thames (1980) observed *R. reniformis* on cotton at depths between 1.25 and 1.75m. In 2000, Robinson et al. studied the depthwise distribution of *R. reniformis* in three cotton producing states and observed them at depths greater than one meter in half of the fields sampled. Similarly, in two 2005 studies of damage to cotton caused by *R. reniformis* below plow depth, with and without fumigation, respectively, Robinson et al. (2005a, 2005b) reported consistently finding reniform nematodes up to and beyond one meter. Westphal and Smart (2003) and Westphal et al (2004) studied the depth distribution of *R. reniformis* under different tillage and crop sequences, and under crops of different host status and fumigation, also reported the reniform nematode at depths greater than one meter. Newman and Stebbins (2002), in addition to finding *R. reniformis* at depths of near one meter in Tennessee, also found that the usual increase that occurs in the upper 30cm of soil also occurs at the 30 – 90cm depth. Furthermore, in their study, and in many of the previously mentioned studies, (Robinson et al., 2000; Westphal & Smart, 2003; Westphal et al., 2004; Robinson et al., 2005a; 2005b;) the highest population of *R. reniformis* in the soil profile was observed below 30cm. Lee et al. (2002) also observed *R. reniformis* to depths of greater than one meter under cotton in Mississippi, however, the density distribution varied over the course of the season. *Rotylenchulus reniformis* have also been observed to prefer soils with higher silt and clay percentages, (Robinson et al., 1987, Starr et al., 1993) and less often in soils with more than 40% sand (Starr et al. 1993). In sandy soils however, Rich and Wright (2002) studied densities of *R. reniformis* in row stubble and in row middles in Florida cotton fields, and found that the densities were generally more concentrated in the previous year's row stubble.

The objective of this study is to monitor the natural spread of *R. reniformis* vertically, horizontally, and temporally through the soil profile from the initial point of infestation and determine if irrigation has any effect on movement.

## Materials & Methods

Two tests were established in May 2007 at the Tennessee Valley Research Center near Belle Mina, Alabama to determine the rate of natural spread of *R. reniformis* through the soil profile. The tests were established as one irrigated and one non-irrigated, each with five replications. The soil in both fields was classified as a Decatur silt loam (fine, kaolinitic thermic, Rhodic Paleudults: 23%, 49%, 28%, S-S-C), that had been planted in cotton under a no-till cultivation system for at least 10 years. Each replication of the test was planted in eight rows of DPL 444 BGRR, 7.8m long on 1m centers using a John Deere 1700 4 row vacuum planter. Adjacent replications were separated by 4.6m alleys. Two rows, row one and five, were inoculated at planting, using the in-furrow spray applicator with 8005 nozzles placed horizontal to the row using 93.6 L/ha with 8300 vermiform life stages of *Rotylenchulus reniformis* per meter of row. *Rotylenchulus reniformis* were increased from stock cultures grown on DPL 555 BG/RR at Auburn University Plant Science Research Center, Auburn, AL. At planting and at harvest, vertical populations of *R. reniformis* were determined by taking three core samples, one meter deep and 4.5cm diameter, from each replication in rows one, three, five and seven of each plot using a #5-UV4 Model GSRPSUV4G (Giddings Machine Company, Windsor, CO) These samples were cut into sub-sections at 15cm intervals, mixed thoroughly and evaluated for number of nematodes and soil moisture content. Horizontal observations of nematode population movement were determined by taking 15cm deep soil samples at 30 day increments throughout the season. Figure 1 illustrates the sampling scheme for each replication. The samples were taken from directly in the row, and 25cm and 50cm away from the row. These samples were evaluated for number of nematodes and soil moisture content.

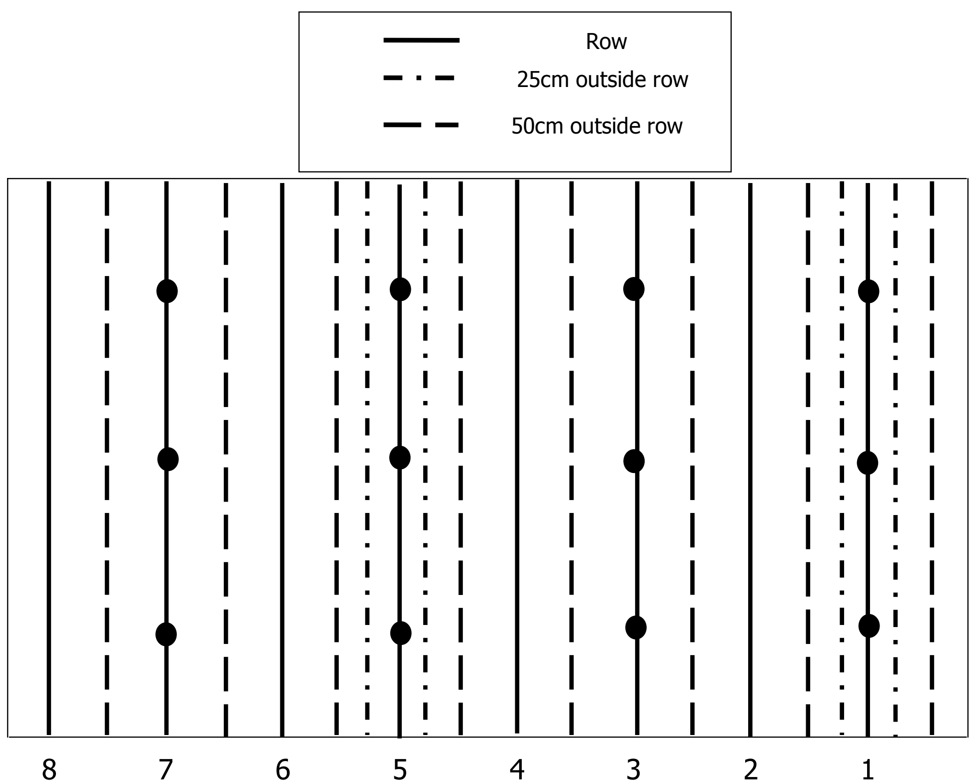


**Fig 1.** Sampling scheme for one replication. A • represents where a core sample was collected.

A 150 $cm^3$ sub-sample was taken from every soil sample for nematode extraction. Each sub-sample was extracted by combined gravity screening and sucrose (specific gravity = 1.13) centrifugal floatation and enumerated. A twenty gram soil sample was weighed, dried, and measured for soil moisture content.

The data exhibited a non-normal distribution and was analyzed by SAS (SAS Institute, Inc) using generalized linear models with lognormal distribution of fixed effects and normal distribution of residuals. A fitted regression model was also utilized with the formula count = sampling date + distance*distance (sampling date). Residuals were modeled with a compound symmetry structure to account for correlation among sampling dates and regression coefficients were outputted into EXCEL to generate graphs.

## Results

### Horizontal Movement

*Rotylenchulus reniformis* were consistently observed moving horizontally across both the irrigated and non-irrigated fields throughout the season. At 30 DAP, *R. reniformis* had moved 50cm on either side of the inoculated rows in both the irrigated and non-irrigated fields. At 60 DAP, differences in the distance moved were initially observed among *R. reniformis* males and vermiform females and juveniles, as well as in the movement of the males between irrigated and non-irrigated fields (Fig. 2). Male *R. reniformis* had moved more than three times the distance (> 150cm) as vermiform females and juveniles (50cm) in the irrigated field at 60 DAP, and nearly four times the distance of the males in the non-irrigated field (25cm). There were no differences in movement of vermiform females and juveniles between the irrigated and non-irrigated fields at 60 DAP. At 90 DAP, *R. reniformis* males in the irrigated field were not observed to move much farther than at 60 DAP, however the populations compared to the inoculated row followed a positive parabola with the focus at the inoculated rows. This illustrates the lowest populations in the originally inoculated row. Males in the non-irrigated field moved from approximately 25cm at 60 DAP to approximately 125cm at 90 DAP with populations following a negative parabola with the focus at the inoculated rows. This parabola indicates the highest populations in the originally inoculated row. Vermiform females and juvenile populations of *R. reniformis* in both fields moved from approximately 50cm at 60 DAP to 75cm at 90 DAP with populations following a negative parabola with the focus at the inoculated row. At 150 DAP, *R. reniformis* male populations in both irrigated and non-irrigated fields were observed at 50cm less distance from the inoculated row than were observed at 90 DAP (100cm and 75cm respectively). Male populations in the irrigated field continued to follow positive parabola as observed at 90 DAP, and male populations in the non-irrigated field continued to follow a negative parabola. Vermiform female and juvenile populations were not observed to move between 90 and 120 DAP in either fields; however populations were the highest in the inoculated rows at 120 DAP fitting a negative parabola curve.

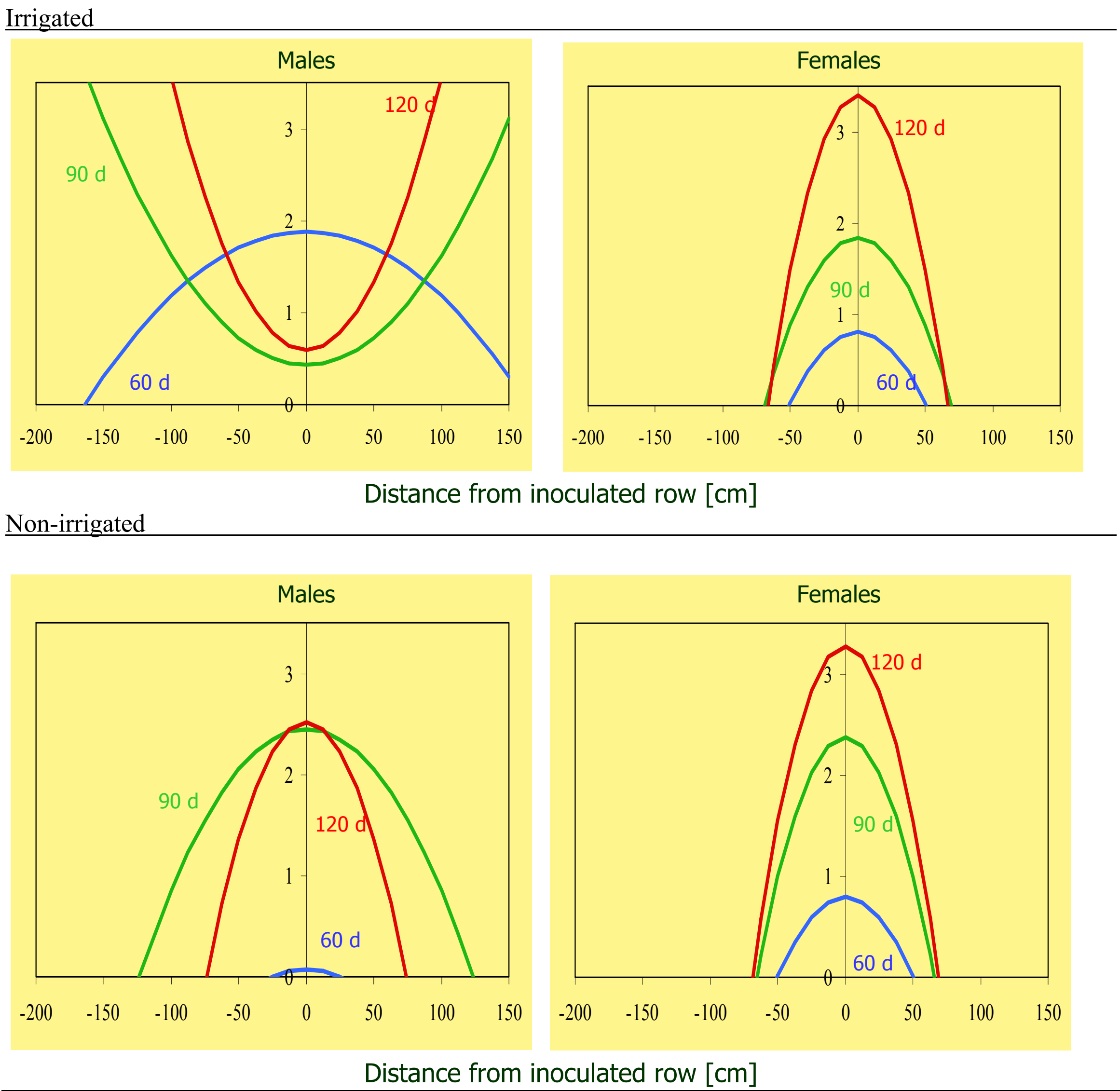


**Fig 2.** Spatial distribution of *Rotylenchulus reniformis* at 60, 90, and 120 DAP in both the irrigated and non-irrigated tests. Numbers are measured as the $Log_e(count/150cm^3)$ averaged at distances from the inoculated rows.

**Vertical Movement**

*Rotylenchulus reniformis* also exhibited movement of considerable distance vertically in both irrigated and non-irrigated fields. At planting, *R. reniformis* was injected and subsequently detected only in the top 15cm. However, at harvest it was found distributed throughout the profile to the maximum sampling depth of 91cm. Figure 3 shows the average number of *R. reniformis* found at each depth. Larger populations of *R. reniformis* were observed in the irrigated field. The greatest populations at harvest in the irrigated plots were observed in the 1-15 cm range on the inoculated rows while populations were higher in the 16-30 cm range where they had spread. Populations were similar between the inoculated area and non-inoculated rows for the 30-91 cm depths. In the non-irrigated inoculated plots, populations were similar from the 0-30 cm depths on the inoculated rows.

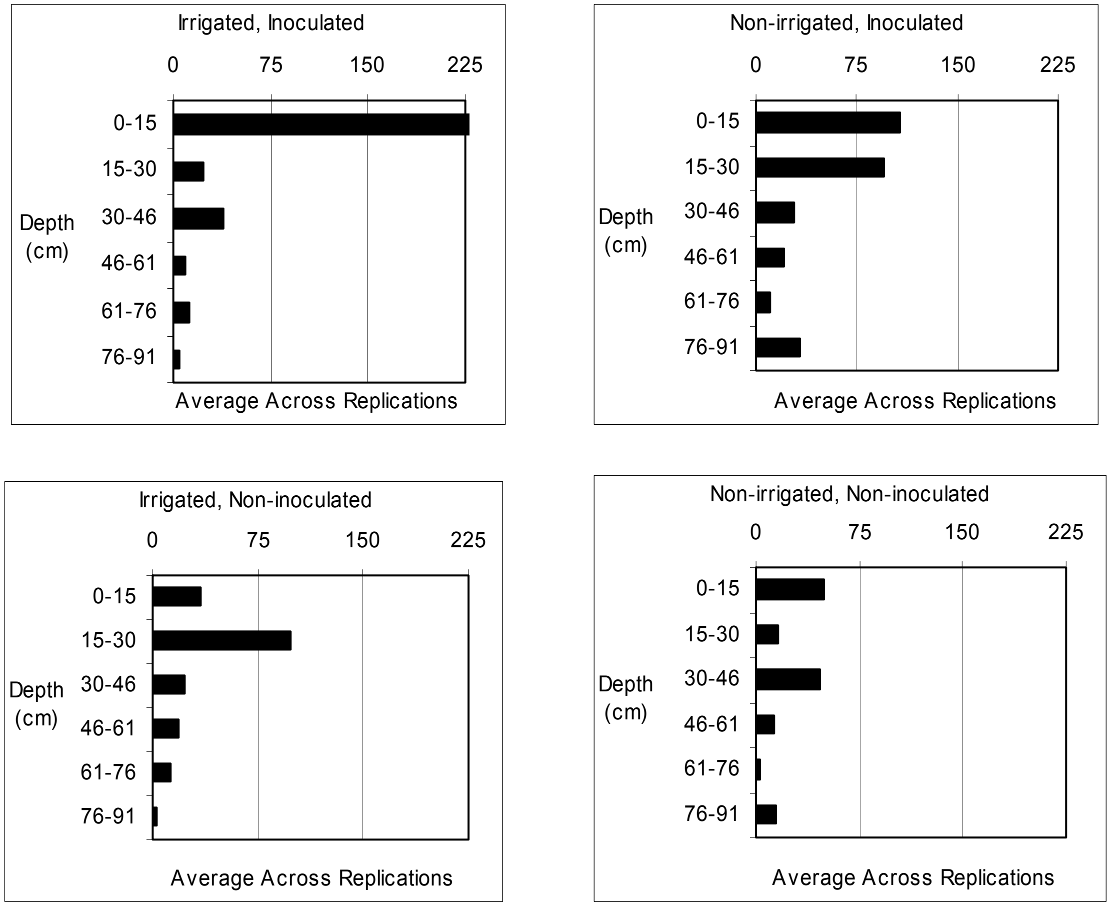


**Fig 3.** Vertical distribution of *R. reniformis* at harvest. Numbers are the average number of *R. reniformis* per 150cm$^3$ of soil, averaged across replications.

## Discussion

*Rotylenchulus reniformis* vermiform females and juveniles, while moving much farther than expected, did behave as anticipated and remained concentrated about the root systems (Rich & Wright, 2002). The rate of movement of *R. reniformis* vermiform females and juveniles appeared to be constant and possibly consistent with generation turnover. The distance that *R. reniformis* was observed to move vertically over the season is consistent with the distance moved horizontally. Males of the species also moved much farther than anticipated, especially in the irrigated field. North Alabama experienced extreme drought conditions throughout the 2007 season and soil moisture levels, and total nematode populations, were consistently low. Vermiform females and juvenile reniform nematode movement was not affected by irrigation or rain events; however male reniform movement appeared to be greatly affected as males in the irrigated field moved farther and faster than males in the non-irrigated field. Further studies must be conducted to determine if, in, fact moisture content of the soil does affect movement through the soil profile.

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