

ROTYLENCHULUS RENIFORMIS DISPERSAL PATTERNS AND POPULATION FLUCTUATIONS IN A SOIL PROFILE AND POTENTIAL INFLUENCE OF RAINFALL

Scott R. Moore and K. S. Lawrence

Department of Entomology and Plant Pathology, Auburn University

Auburn, Alabama

F. J. Arriaga

USDA-ARS

Auburn, Alabama

C. H. Burmester and E. van Santen

Department of Agronomy and Soils, Auburn University

Auburn, Alabama

Abstract

Population growth of *Rotylenchulus reniformis* upon introduction into a cotton field was observed over a two year period under irrigated and non-irrigated production schemes. Additionally, the effects of rainfall on infiltration of *R. reniformis* through the soil profile were observed. Populations of *R. reniformis* in the irrigated trial were observed to increase in a linear fashion for the first 120 days of the season followed by a decline from 120 days after planting (DAP) to harvest in both 2007 and 2008. *Rotylenchulus reniformis* populations in the non-irrigated trial did not increase in a linear fashion. Populations were closely related to the amount of rainfall received between sampling dates in these two dry years. The effect of rainfall on the vertical movement of *R. reniformis* was observed in soil columns inoculated with vermiform life stages and subjected to simulated rainfall. Vertical movement through the soil profile was minimally affected by rainfall. *Rotylenchulus reniformis* injected at a 7.5 cm depth were transported to a 15.2 – 30.5 cm depth by 2.54 cm³, 7.62 cm³ and 12.7 cm³ of rainfall at an average of 1.60%, 1.83% and 1.32% of the applied population, respectively. *Rotylenchulus reniformis* were recovered at the 30.6 – 45.7 cm depth after 7.62 cm³ and 12.7 cm³ of rainfall at an average of 0.17% and 2.27% of applied population, respectively. A 12.7 cm³ rainfall event transported an average of 0.89% and 1.28% of the applied *R. reniformis* populations to depths of 45.8 – 61 cm and 61 – 76 cm, respectively.

Introduction

The reniform nematode, *Rotylenchulus reniformis*, has become the most economically damaging pest of cotton in Alabama. Disease loss estimates since 2000 have averaged more than 7% annually (Blasingame et al, 2000 - 2008). The first initial report of *R. reniformis* was in 1958 by Minton and Hopper (1959). This nematode is now established in at least 24 counties (36% of the state) throughout the state (Gazaway and McLean, 2003). The initial infestation rate which includes the temporal, vertical and horizontal spread of *R. reniformis* upon introduction into a cotton field was examined in 2007 (Moore et al, 2008). The authors observed that vermiform females and juveniles of *R. reniformis* moved an average of 75cm horizontally and to the maximum sampling depth of 91cm vertically from the point of inoculation in one season in both irrigated and non-irrigated trials. *Rotylenchulus reniformis* males were observed to move more than 150cm and 125cm horizontally in the irrigated and non-irrigated trials, respectively, horizontally in the trial. Males were found to the maximum sampling depth of 91cm in both irrigated and non-irrigated trials.

The objective of this study is to continue the observations made by Moore et al, 2008 and analyze the nematodes movement and population growth across the soil profile in both 2007 and 2008. Additionally, the effects of rainfall will be examined for influence on the vertical and horizontal movement of *R. reniformis*.

Materials and Methods

The observations of vertical and horizontal movement as well as population fluctuation were carried out at the Tennessee Valley Research and Extension Center near Belle Mina, AL during the 2007 and 2008 seasons. Two tests were established in 2007 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 core sampler (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. The horizontal movement samples were taken from directly in the row, 25cm and 50cm away from the row. These samples were evaluated for number of nematodes and soil moisture content.

Observations of the effects of rainfall on the vertical movement of *R. reniformis* were carried out at the Plant Science Research Center in Auburn, AL. Soil cores, 7.6cm diameter by 91cm deep, were collected from the Tennessee Valley Research and Extension Center in the field adjacent to the inoculated field. Soil cores were collected as previous described using a #5-UV4 Model GSRPSUV4G core sampler and were tested for the absence of *R. reniformis* prior to beginning the trial. The soil cores were placed vertically in racks with nylon wicks placed on the bottom of each to facilitate water drainage. *Rotylenchulus reniformis* was added to the top 2.54 cm of soil by pipetting in 50,000 vermiform life forms in 2 ml of water. The cores were then subjected to one of four different rainfall amounts: no rainfall, 2.54cc (1 inch), 7.62cc (3 inches), and 12.7cc (5 inches) using a drip rainfall simulator. The trial was arranged in a randomized complete block design with six replications. Forty-eight hours after the simulated rain event, the cores were separated into 15.24cm sections and the nematodes extracted from all of the soil in each section by combined gravity screening and sucrose centrifugation and enumerated.

Data analysis: 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 $\text{count} = \text{sampling date} + \text{distance} \times \text{distance}$ (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 and Discussion

Irrigated Field Trial

Rotylenchulus reniformis populations increased (Figs. 1 and 2) in a linear fashion from planting to 120 days after planting (DAP) in both 2007 and 2008. Populations were further observed to decline between 120 DAP and harvest in both years.

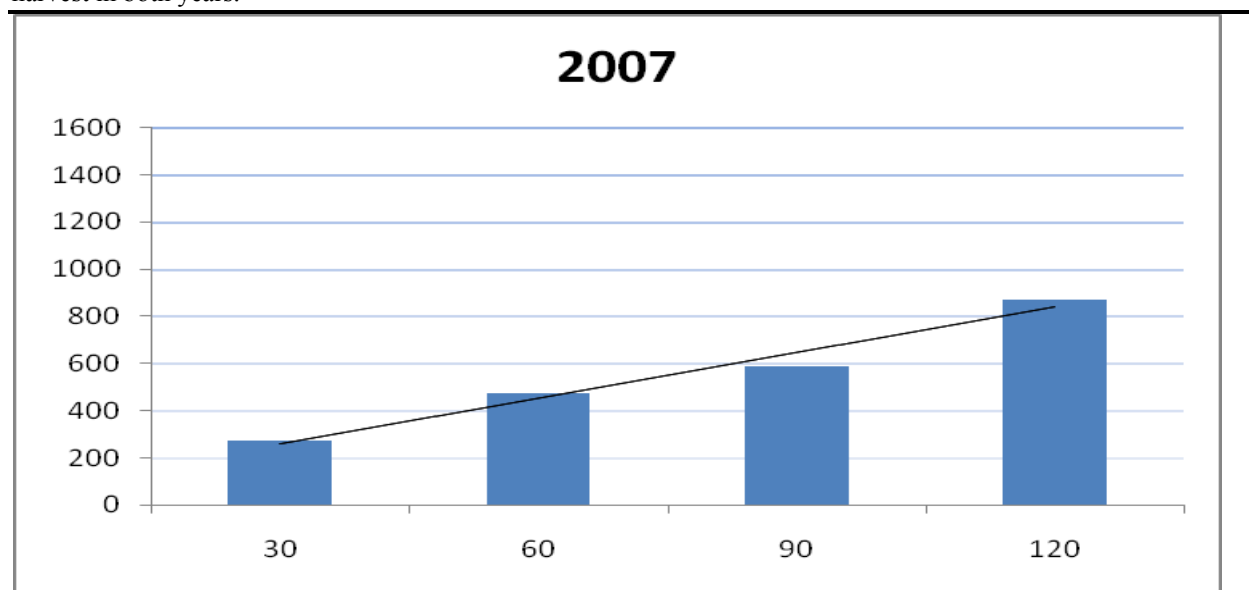


Fig 1. *Rotylenchulus reniformis*/ 150cc of soil at sampling dates (DAP).

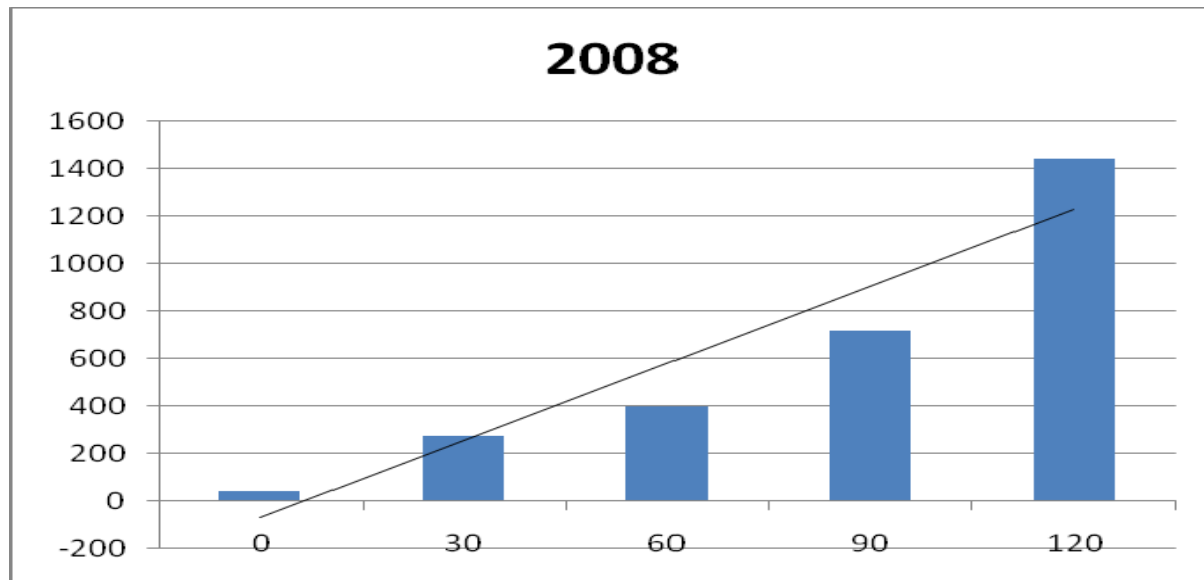


Fig 2. *Rotylenchulus reniformis*/ 150cc of soil at sampling dates (DAP).

R-squared values for linear population trends between planting and 120 DAP were 0.9731 and 0.8921 for 2007 and 2008, respectively, which indicates uniform population growth throughout the growing season. The decline of *R. reniformis* populations can most probably be related to the slowing of active plant growth during late season boll maturation.

Non-irrigated Field Trial

Rotylenchulus reniformis populations in the non-irrigated trial did not exhibit growth as near to linear as was observed in the irrigated trial. Rather, population growth of *R. reniformis* was closely related to rainfall amounts throughout both 2007 and 2008. Fig. 3 illustrates *R. reniformis* numbers compared with Fig. 4 and the rainfall amounts in 2007. Likewise, Figures 5 and 6 illustrate the comparison for 2008. *Rotylenchulus reniformis* populations in 2007 were observed to decline between 30 and 60 DAP, when rainfall was less than 2 inches for the 30 day period, rise between 60 and 90 DAP with the 7.8 inches of rainfall, and decline again from 90 DAP to 120 DAP when rainfall events were less than 2.2 inches. Rainfall and *R. reniformis* populations in 2008 were observed to decline from 30 to 60 DAP with only 2.64 inches of rain, rise from 60 to 90 DAP with 3.42 inches of rain, continue to rise from 90 to 120 DAP with rain events totaling 3.69 inches, and finally decline from 120 DAP to harvest with only 0.8 inches of rainfall.

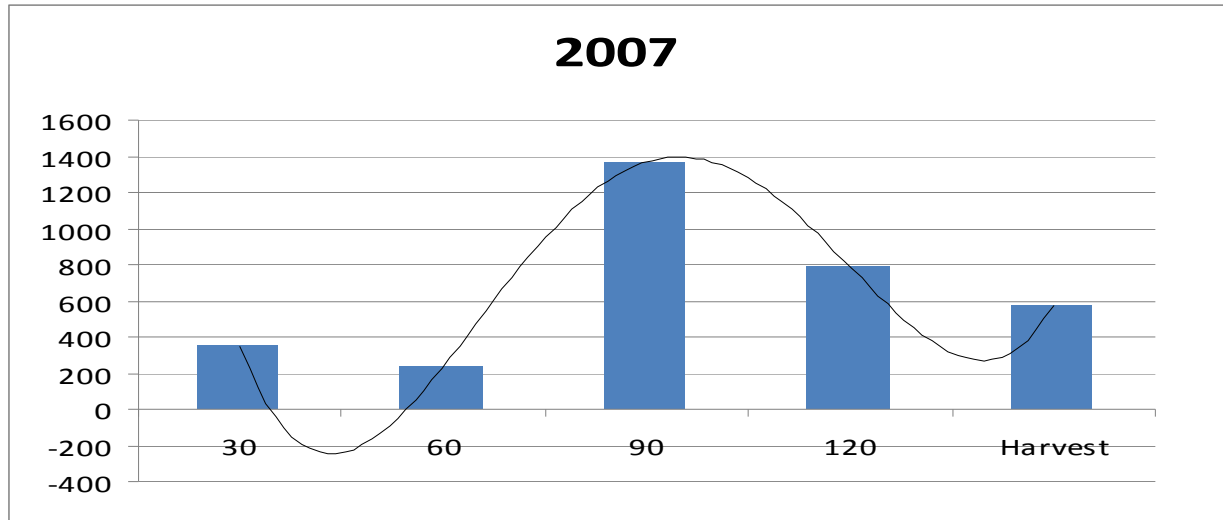


Fig 3. *Rotylenchulus reniformis*/ 150cc of soil at sampling dates (DAP).

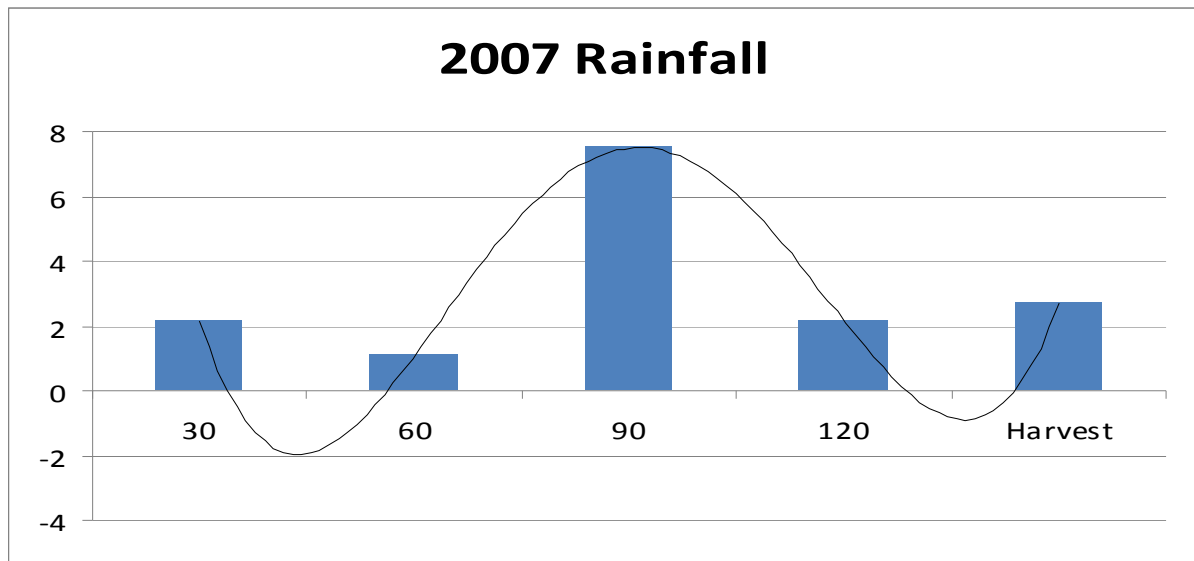


Fig 4. Rainfall amount (cm) between sampling dates.

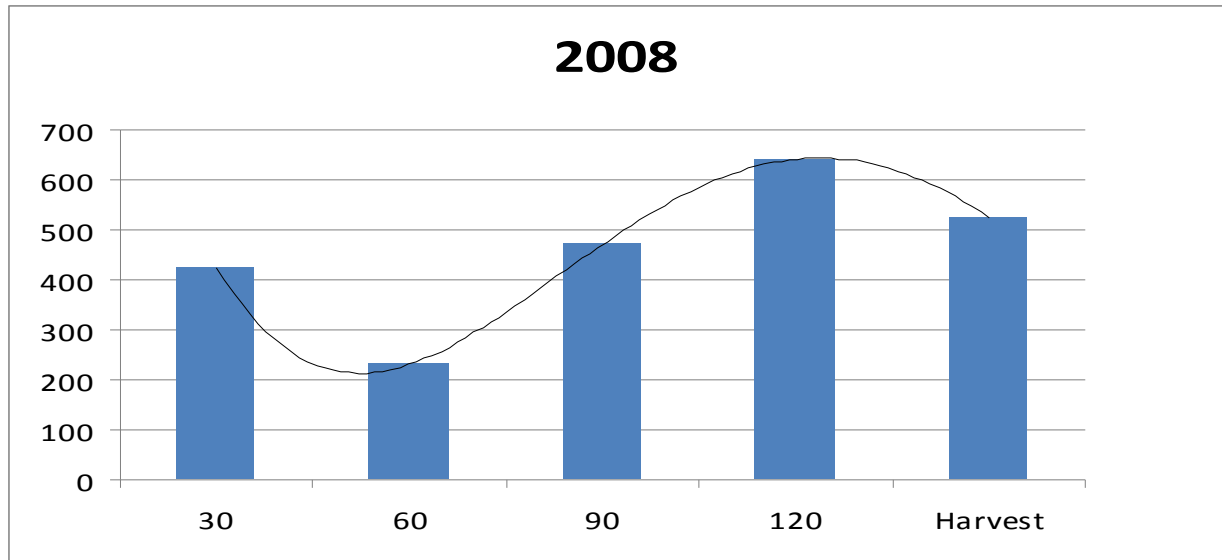


Fig 5. *Rotylenchulus reniformis* per 150cc of soil at sampling dates (DAP).

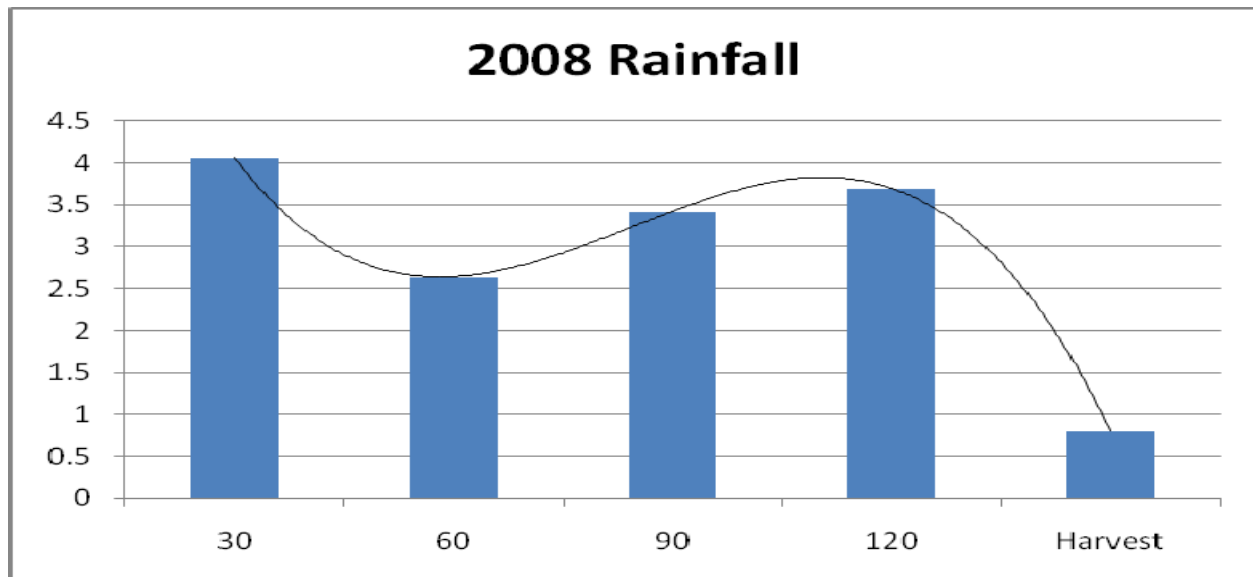


Fig 6. Rainfall amount (cm) between sampling dates.

Rainfall dispersion column trial

Rainfall minimally affected the dispersion of *R. reniformis* downward through the soil profile in our greenhouse soil core simulation test. Figure 7 illustrates the percentage of *R. reniformis* found at each depth sampled for each rainfall amount.

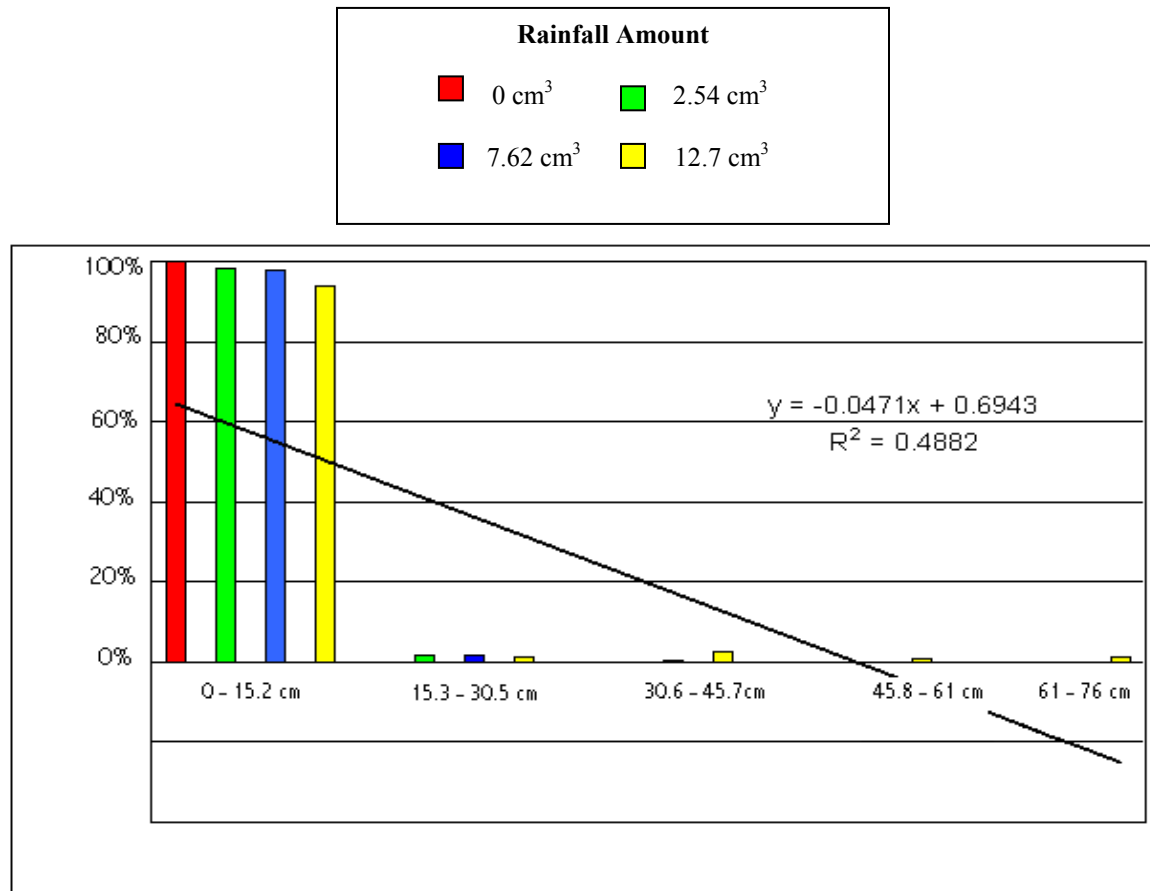


Fig 7. Percentage of *R. reniformis* extracted from each depth.

One hundred percent of the applied population of *Rotylenchulus reniformis* was recovered in the top 15.2 cm of the 0 cm³ rainfall treatment and thus exhibited no significant movement within 48 hours of application. The 2.54 cm³ rainfall treatment transported 1.60% of the applied population to the 15.3 – 30.5 cm sampling depth with the rest remaining in the upper 15.2 cm. The 7.62 cm³ rainfall treatment transported 1.83% of the applied population to the 15.3 – 30.5 cm depth, and an additional 0.17% to the 30.6 – 45.7 cm depth. The 12.7 cm³ treatment transported small portions of the applied *R. reniformis* population through out the soil core. The population dispersed with, 94.25% remained in the top 15.2 cm depth, 1.32% in the 15.3 – 30.5 cm depth, 2.27 % in the 30.6 – 45.7 cm depth, 0.89% in the 45.8 – 61 cm depth and 1.28% in the 61 – 76 cm depth.

Conclusions

Rotylenchulus reniformis populations develop and spread very quickly upon introduction into a reduced tillage cotton system. The observations in the first year of the study (Moore et al., 2008) demonstrated how quickly *R. reniformis* could extend across the soil profile. The observations included here illustrate how quickly *R. reniformis* populations can increase in numbers as the nematodes spread through the soil profile. Populations in 2007 increased to a peak of 322.9% above initial populations at planting in the irrigated trial, and 226.6% in the non-irrigated trial. Populations in 2008 increased 3,162.1% above initial populations at planting in the irrigated trial, and 1,381.7% in the non-irrigated trial. Additionally, the effect of available soil moisture increased by rainfall events can enhance the population growth of *R. reniformis*. Although small percentages of the nematode population were observed to be transported vertically in a single rain event, multiple rain events could produce additive effects on *R. reniformis* distribution through the soil profile.

References

Blasingame, D., Patel, M.V., Gazaway, W., Olsen, M., Kirkpatrick, T., Davis, M., Sprenkel, R. K., Kemerait, B., Colyer, P., Wrather, A., Goldberg, N., Koenning, S., Banks, J.C., Muller, J., Newman, M., Woodward, J., & Phipps, P. 2008. Cotton disease loss estimate committee report. Proceedings of the Beltwide Cotton Conferences of the National Cotton Council of America. www.cotton.org/beltwide/proceedings/2005-2008/index. Confirmed on Dec. 30, 2008.

Gazaway, W. S., McLean, K. S. 2003. A survey of plant-parasitic nematodes associated with cotton in Alabama. *Journal of Cotton Science* 7: 1-7.

Minton, N. A., Hopper, B. E. 1959. The reniform and sting nematodes in Alabama. *Plant Dis. Rep.* 43:47.

Moore, S. R., Lawrence, K. S., Arriaga, F. J., van Santen, E., Burmester, C. 2008. Dimensional movement of *Rotylenchulus reniformis* through a Decatur silt loam under variable soil moisture. Proceedings of the Beltwide Cotton Conferences of the National Cotton Council of America. www.cotton.org/beltwide/proceedings/2005-2008/index. Confirmed on Dec. 30, 2008.