SITE-SPECIFIC NEMATODE MANAGEMENT - POPULATION DYNAMICS

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Abstract

The alluvial soils of Louisiana are highly variable even within a field making recommendations for management options based on a single threshold level very difficult. Trials conducted during the past several years have indicated certain areas within these fields yield extremely well even in the presence of high levels of nematodes and fail to respond to the application of a pre-plant fumigant such as 1,D-dichloropropene. Nematode distribution within the soil profile to a depth of 24 inches may also be factor. In two locations that were the sites of a three-year nematicide study, the soils that responded to the application of the fumigant had root-knot nematode populations all the way to 24 inches while the non-responsive areas had root-knot nematode only within the upper six inches. Although nematode populations are important, several factors of the soil such as texture, nutrient availability, or pH may impact the amount of damage actually caused nematodes. Site-specific application for nematode problems should incorporate both nematode populations and nematicide response.

Introduction

Traditionally, most cotton producers have been managing nematode problems simply based on nematode populations alone. Most producers have obtained only one to a few nematode samples from a field and developed a management plan for that field based on the types and populations present. Although this technique has worked reasonable well for managing nematode problems, in all likelihood this results in areas of a field that are either treated unnecessarily or not treated sufficiently. Classical nematology has generally based recommendations on some "generic" threshold number that is applicable under certain conditions usually based on soil types that will be damaged at these numbers. The dominant soils in Louisiana where cotton is produced are alluvial and may be quite variable across a field. We have previously shown that these variable soils may respond differently to the application of a nematicide such as 1,D-dichloropropene (Erwin, et al., 2007; Overstreet, et al., 2005 & 2007; Wolcott et al., 2005).

Our objectives were to evaluate the relationship of nematode populations and yield in some of the highly variable soils found in Louisiana.

Methods and Materials

Telone strips were applied to two fields near St. Joseph, Louisiana during 2004-2006 that were infested with the southern root-knot nematode. A series of 6 or 7 transects were applied to the strips in each field to represent similar soil textural zones based on EC_a as determined by a Veris 3100 Soil EC Mapping system. The EC_a data is measured from two approximate soil depths; 0-12"or shallow EC ($EC_{a\text{-}sh}$), and 0-36"or deep EC ($EC_{a\text{-}dp}$). Telone II was applied each year in the spring at a rate of 3.0 gallons of material per acre in five 12-row plots using a modified Yetter Avenger coulter applicator, operating at a depth of 12". An additional five 12-row plots were not treated. Nematode samples were collected in three transects in the Cemetery North field and four transects in the Levee field primarily in the fall of 2005 and 2006. Each field was harvested using a six row John Deere cotton picker equipped with a John Deere cotton yield monitor using microwave sensor technology. The yield monitor data and all other spatially referenced data were processed and correlations calculated using SSToolbox GIS. Analysis of variance was performed using Statistix 8.0. Additionally, each field was extensively sampled after a corn crop in 2007 in these same transects. A tractor-mounted soil probe was utilized and two soil samples collected to a depth of 24 inches from the center of each plot within each transect. The soil cores were divided into six inch increments, pooled, and processed for nematode extraction.

The Goldman field was located near Waterproof, Louisiana in 2007. This field has extremely high levels of both the southern root-knot nematode and the reniform nematode. The field was extensively sampled for nematodes during the summer based on EC_a zones. The field was harvested with a six row John Deere cotton picker equipped with a John Deere cotton yield monitor.

Results

The relationships that are normally perceived for cotton and nematodes are best described in Figure 1. In this hypothetical illustration, very little damage occurs by low levels of the nematode. As the population increases to a certain level, damage begins and increases with higher numbers of nematodes. Eventually, there is a leveling off of the amount of damage even though populations continue to increase.

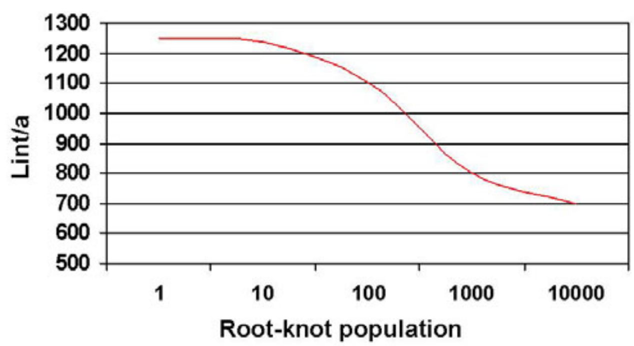

Figure 1. Hypothetical damage response used in classical nematology to increasing populations of root-knot nematode in cotton.

In our real world fields that have variability with soil texture, the response to increasing nematode populations doesn't look like the classic response. Figure 2 shows the response that was observed in the Levee field to increasing levels of root-knot nematode. Nematode samples were collected in the fall of 2005 from the untreated plots and the yield is reported from 2006. There apparently is a very poor correlation with the fall population levels of root-knot nematode and actual yield. Since the general threshold that is used for the southern root-knot nematode is considered to be about 250 per 500cm^3 of soil, all of the locations within the field were above the levels where nematode damage was likely to occur. Since the R^2 was only 0.02, no relationship between nematode numbers and yield was observed.

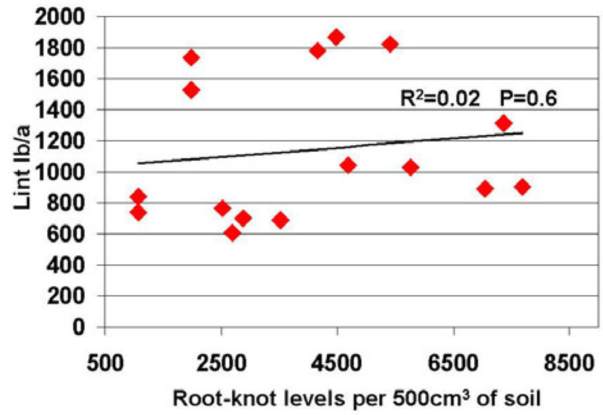

Figure 2. The yield response during 2006 of the untreated controls in Levee field to various population levels of the southern root-knot nematode (fall levels in 2005).

The response to increasing nematode levels in the Cemetery North field was very similar to the Levee field (Figure 3). Only a very slight decrease in yield was observed even though extremely high levels of root-knot nematode were found in the previous fall. Figures 4 & 5 look at the relationship of yield response (difference between the Telone vs. no Telone treatment in the side-by-side rows within transects) and soil texture as defined by the $EC_{a\text{-}dp}$. In both locations, the greatest response to the nematicide occurred in the soils with the lowest $EC_{a\text{-}dp}$ values. At higher $EC_{a\text{-}dp}$ values, response to the nematicide was reduced. Figures 6 & 7 shows the average response to Telone across $EC_{a\text{-}dp}$ and relationships with root-knot populations in each of the two fields. In both locations, nematode populations clearly remained particularly high even after there was no longer a response to the nematicide.

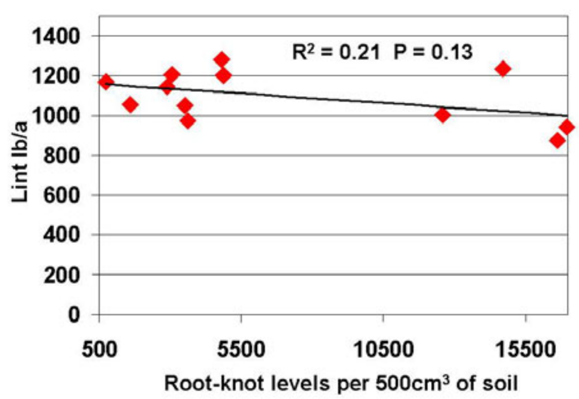

Figure 3. The yield response during 2006 of the untreated controls in the Cemetery North field to various population levels of the southern root-knot nematode (fall levels in 2005).

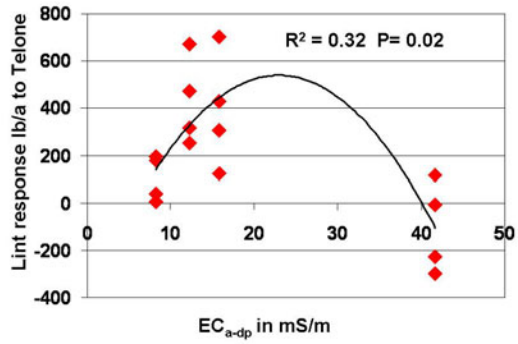

Figure 4. The yield response (difference between Telone vrs. no Telone) during 2006 in the Levee field based on $EC_{a\text{-}dp}$ within transects.

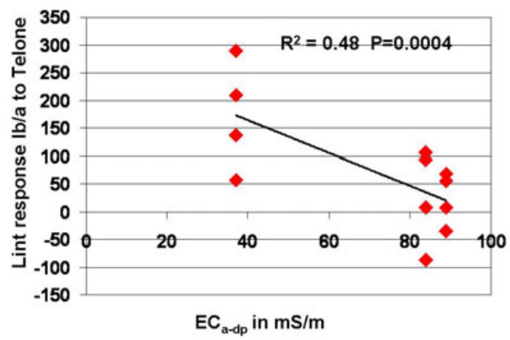

Figure 5. The yield response (difference between Telone vrs. no Telone) during 2006 in the Cemetery North field based on $EC_{a\text{-}dp}$ within transects.

When the deep core samples were examined after a growing season in corn, an interesting observation was made. The three transects that had the highest $EC_{a\text{-}dp}$ values were the ones that were not responsive to the addition of Telone and also had root-knot populations detected only in the upper six inches of soil. The four transects that were responsive to Telone had substantial root-knot populations down much deeper and to 24 inches in three of the four transects. Nutrient status was extremely important but will not be discussed in this paper.

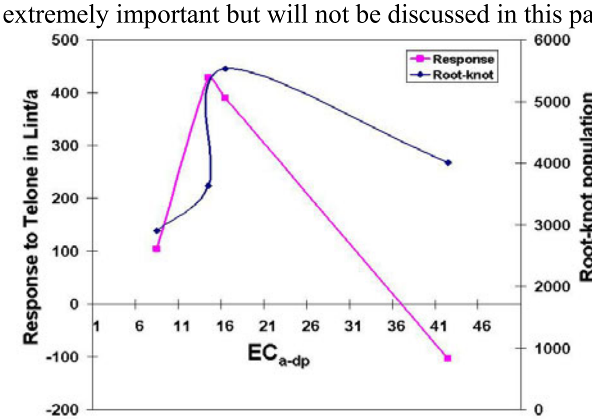

Figure 6. The average response to Telone across ECa-dp and relationship with root-knot population in the Levee field.

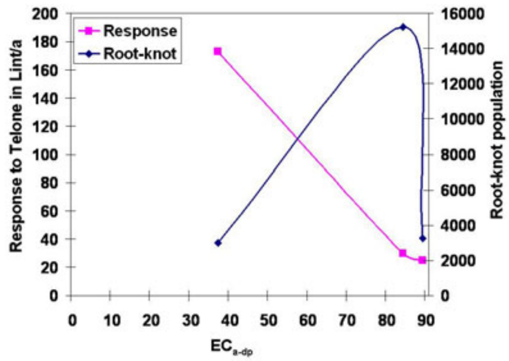

Figure 7. The average response to Telone across ECa-dp and relationship with root-knot population in the Cemetery North field.

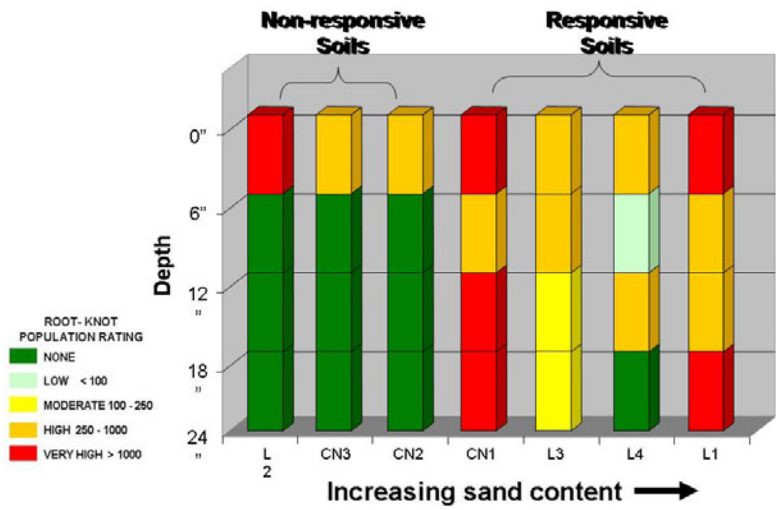

Figure 8. Nematode populations at various soil depths (0-6, 6-12, 12-18, 18-24 inches) in the Levee field and Cemetery North field after three years of cotton and one year of corn. The transects are identified as L 1-4 for the Levee field and CN 1-3 for Cemetery North and are arranged by increasing sand content throughout the profile. Responsive and non-responsive soils relates to the response to Telone application at each transect during the 3-year study.

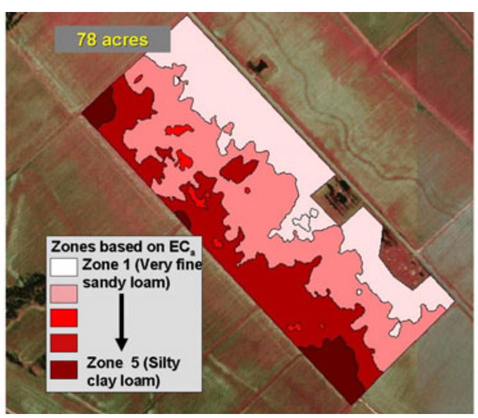

Figure 9. The Goldman field in Waterproof, LA divided into soil zones based on $EC_{a\text{-}dp}$.

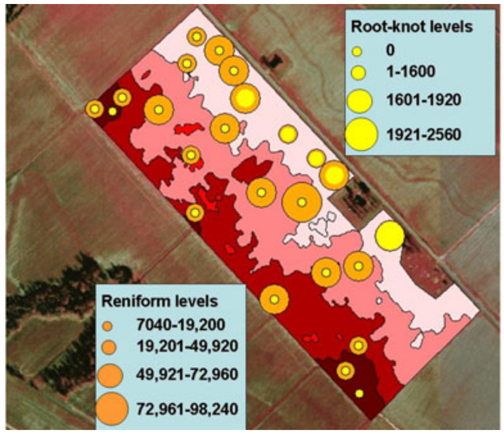

Figure 10. Both nematodes are found in high levels within the Goldman field. Root-knot is confined to the lightest soil zone while reniform nematode is widespread throughout the field.

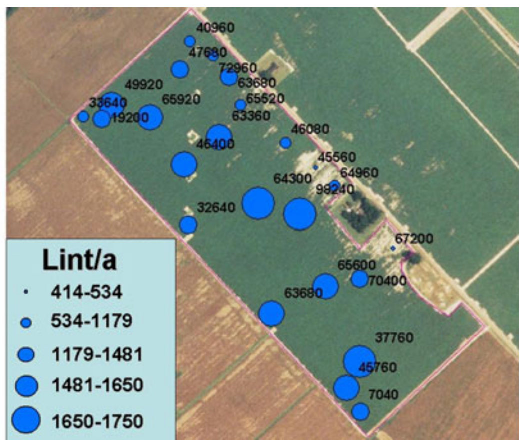

Figure 11. The yield range in the Goldman field at each of the sampling sites (blue circles) and the corresponding numbers beside the yield points are the population levels of reniform nematode.

The Goldman field had a number of different soils present within it (ranging from a very fine sandy loam to a silty clay loam) and is defined into a series of soil zones in Figure 9. Root-knot nematode is fairly specific to the one soil zone while reniform nematode is found across the field (Figure 10). Cotton yield was extremely low in soils where both root-knot and reniform nematode occurred. However, even as the soil texture became heavier, extremely high levels of the reniform nematode did not seem to impact yield.

Discussion

The presence of high populations of nematodes is not a good indicator of damage potential in variable soils found in Mississippi alluvial soils in Louisiana. Our study has shown that other factors such as soil texture within a field or particularly through the soil profile may have a great impact on the damage potential by nematodes such as root-knot or reniform. Nematode populations should not be considered unimportant but rather in context with the soil types that they are found within and potential for damage of these soils. Although every field is unique in regard to soils, some generalizations can be made about the damage potential in fields. The lightest soil zones within a field are usually the most likely to be the soils that are responsive to nematicides such as Telone. Additionally, texture through the soil profile is extremely important. Soils that are very sandy deep throughout the profile are generally the most responsive soils to a fumigant. The use of $EC_{a\text{-}dp}$ has been useful in the determination of these zones. Verification strips (rows of Telone treated and untreated) have been proposed as one means of pinpointing where in a field you are likely to get a response from a nematicide (Overstreet et al., 2007). Site-specific application of nematicides may become more widely adopted as our understanding of some of these relationships among nematode populations, soil texture, and yield response becomes clearer.

References

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