SITE-SPECIFIC MANAGEMENT STRATEGIES FOR DEALING WITH MULTIPLE NEMATODE PESTS

C. Overstreet
E.C. McGawley
LSU Agricultural Center
Baton Rouge, LA
G. Burris
D. Burns
LSU Agricultural Center
St. Joseph, LA

Abstract

Both the Southern root-knot and reniform nematodes are often found together in the mid-South and Southeast areas of the United States. Site-specific management plans need to factor in both populations of the two nematodes and changes that will occur when rotation crops are utilized. Fields that have variability in soil texture often have areas that are more suited for each of the two nematodes. The Southern root-knot nematode is usually restricted to the lighter soil textures within a field while reniform seems to be more widespread and often occurs in fairly heavy soils. The use of rotational crops such as corn may drastically impact populations of the reniform nematode but maintain damaging populations of the Southern root-knot. The objectives of this study were to look at two fields infested with both the Southern root-knot and reniform nematodes and make predictions about the impact of one or two years rotation with corn. Since populations of the reniform nematode will decline with the use of corn, the heavier soil zones should be less impacted and not require treatment with a fumigant. Since corn would not reduce the Southern root-knot nematode, the lighter soil areas dominated by this nematode would still need treatment.

Introduction

Plant-parasitic nematodes have long been a major pest of cotton in the United States (Overstreet and McGawley, 2001). Three of the most damaging nematodes associated with cotton are present in Louisiana. These include the Southern root-knot (*Meloidogyne incognita*), reniform (*Rotylenchulus reniformis)*, and Columbia lances nematodes (*Hoplolaimus columbus*). The reniform nematode has been rapidly spreading during the past 25 years and has now become the dominant nematode in Louisiana that damages cotton (Overstreet and McGawley, 1998; 1999). The Southern root-knot nematode is frequently found in sandy areas of fields especially along the alluvial soils of the Mississippi River, Red River, Tensas River, or other numerous rivers and bayous in Louisiana (Overstreet and Wolcott, 2003). The Columbia lance nematode has only been found in about 50-60 fields during the past 10 years making it difficult to determine if this nematode is spreading or only has a very limited distribution.

Although reniform nematode has become the most important nematode in cotton in Louisiana, many fields may have both the reniform and Southern root-knot nematodes together. Corn has become a popular crop grown in rotation with cotton by many producers in our state due to economics. Corn is considered a very poor host for the reniform nematode but a relatively good host for the Southern root-knot nematode. Rotation may shift the population dynamics of both nematodes allowing the Southern root-knot to thrive when corn is planted and reniform to decline. Cotton may shift the population present in a field back to favor reniform development.

Soil texture is generally considered an important factor in the presence and distribution of many nematode species. Both the Columbia lance and Southern root-knot nematodes favor light, sandy soils. Reniform nematode can occur in a much wider range of soil types occurring in both sandy soils to those which have a considerable amount of clay present. The preferences by these three nematodes in soil types and areas of a field which are prone to exhibiting nematode injury makes it possible to utilize site-specific management zones. The use of apparent electrical conductivity or EC_a is becoming more widely utilized as a tool to identify soil texture within a field and in use to develop management zones for nematodes (Ortiz et al., 2008). Previously, we reported that soil texture impacts the damage potential of the Southern root-knot nematode with decreases in nematicide responses as clay content increased in fields (Overstreet et al., 2008). Most of the site-specific work to manage nematode problems has been based on the presence of a single nematode type consisting of either reniform or the Southern root-knot (Erwin et al., 2007; Overstreet et al., 2009). The objective of this study is to look at fields which have multiple nematode species present and predict how best to develop management zones based in these fields.

Materials and Methods

Two fields were included in these studies which have both the Southern root-knot and reniform nematodes present. The first field is located on the Allen Crigler farm. The field had been previous mapped using a Veris 3100 Soil EC Mapping System and could easily be broken down into different zones based on the shallow or deep readings that were obtained. The field was divided into four soil zones based on the $EC_{a\text{-}dp}$ readings. The field was zone sampled for nematodes in the fall of 2007 using these soil zones. Telone trials were conducted in 2008 in this field. Verification strips which included Telone and untreated controls through the various soil zones present in the field were established before planting. Yields were obtained at harvest using a cotton yield monitor and responses determined for each of the zones. We had reported on this field previously (Overstreet et al., 2009) as an example of how management zones are created. For this study, estimates were made for the changes in management zones if one or two years of corn were planted.

The second field was located at Waterproof, Louisiana on the Tru Goldman farm. The field had been previously mapped with a Veris 3100 Soil EC Mapping System. This field had been planted to corn in 2008 and cotton the two previous years. Verification strips were used in 2009 with both Telone and untreated strips running through the various soil zones. The cotton was harvested with a yield monitor and yields determined in each of the soil zones in the field. The actual yield response of Telone was compared to the untreated areas in each of the soil zones after one year in corn.

Results and Discussion

Figure 1 shows the $EC_{a\text{-}dp}$ readings that were made for the Allen Crigler field. The range of measurements was from 7.0-96.9 mS/m in this field. Both the reniform and root-knot nematodes were detected in this field based on zone sampling (Figure 2). The root-knot nematode occurred in the lightest soil zone while reniform was found predominately in all the remaining zones within the field. Since both nematode species were at damaging levels throughout this field, it was anticipated that most of the field would respond to the application of the fumigant Telone with the possible exception of the heaviest soil zones. Figure 3 shows the areas of the field that had very

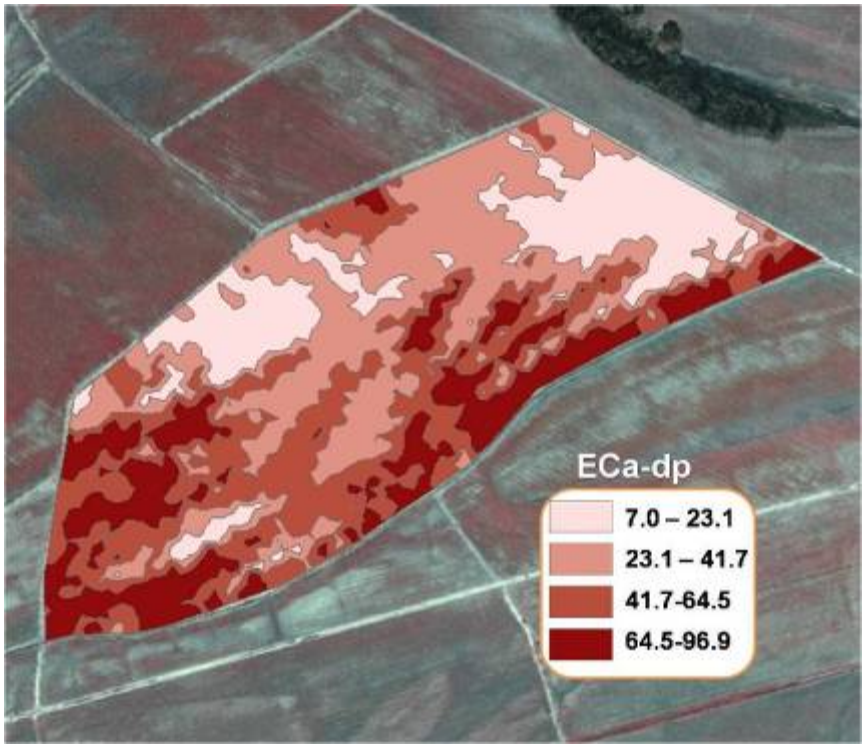


Figure 1. The Allen Crigler field divided into four soil zones based on the $EC_{a\text{-}dp}$ readings.

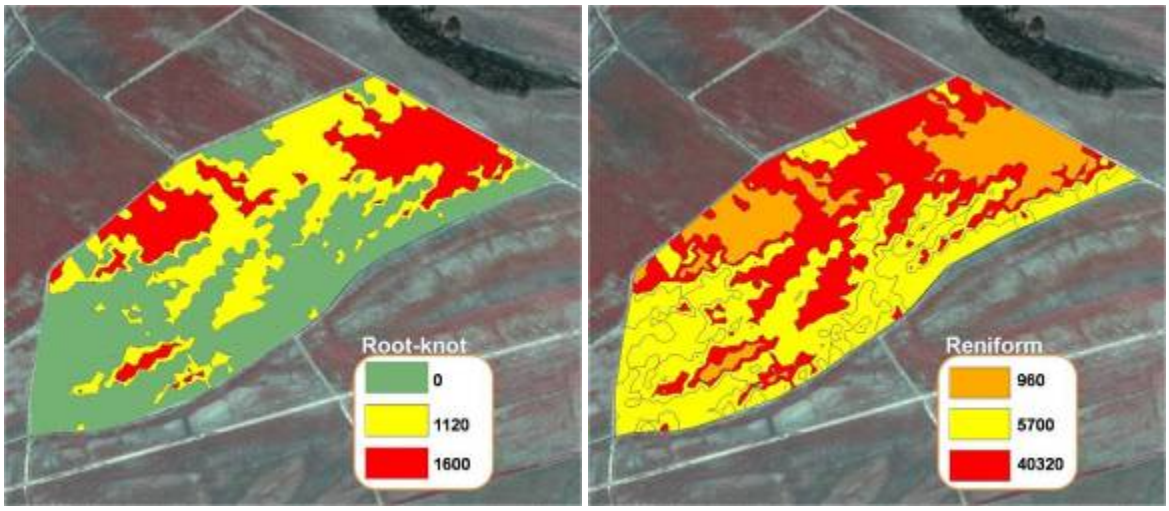


Figure 2. The distribution of both reniform and root-knot nematodes within the Allen Crigler field based on fall sampling in 2007.

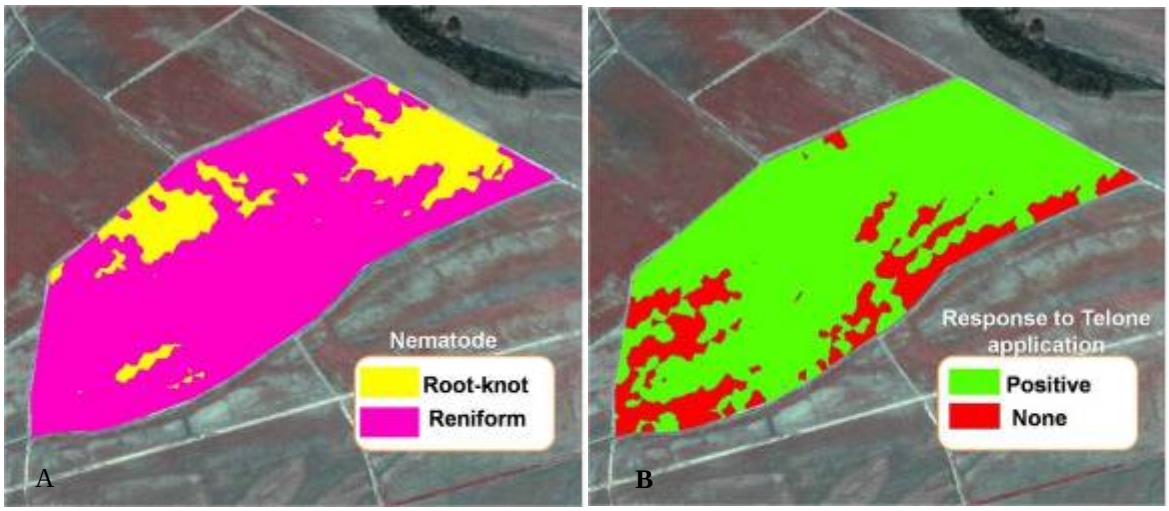
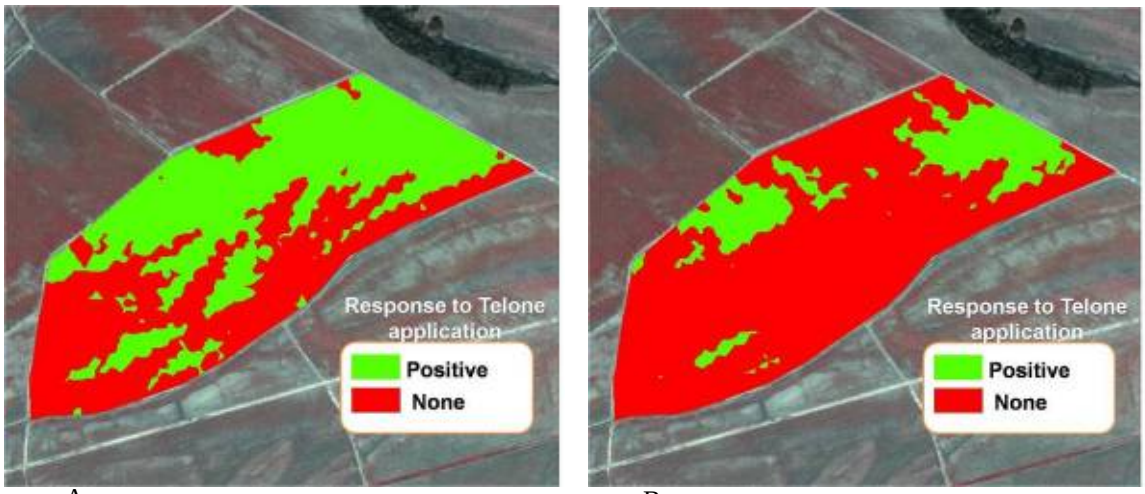


Figure 3. Areas of the field where high populations of both nematodes occur (A); and areas of the field which responded to the application the nematicide Telone (B).

damaging levels of nematodes and the actual soil zones that responded to the application of the fumigant. Most of the field did respond with a significant yield response to the fumigant. Only the zone with the highest EC reading (64.5-96.9) failed to show a response to the nematicide. We predict that the use of corn as a rotation crop would certainly impact the population of reniform nematode but not root-knot nematode. Figure 4 shows our estimates of areas of the field that would respond to the application of a nematicide after either one or two years in corn. Since corn historically reduces the populations of nematodes such as reniform as much as 50-60% in one year, we predict that after one year of corn the area that might need to be treated would be only the two lowest zones (7.0 – 41.7). After two years in corn, reniform nematode populations should decline by as much as 70-80%. Our prediction after two years in corn would be that only the lowest EC zone would require treatment. Since this zone has root-knot nematodes present in high levels, populations of this nematode would not likely been reduced enough not to require treatment.



A B

Figure 4. The management zones that would be predicted after the use of corn for one year (A); and the management zones that would expected after using corn as a rotation crop for two years before cotton (B).

The Waterproof field was sampled in June of 2007 after significant damage from nematodes was observed in this field. Figure 5 shows the field and the various soil zones in the field based on $EC_{a\text{-}dp}$ ranging from 33.2 – 152 mS/m and the distribution of both the root-knot and reniform nematodes. Root-knot nematodes were found only in the lightest soil zone while reniform was found throughout the field. The field was planted in corn in 2008 and back to cotton again in 2009. Figure 6 shows the populations of nematodes collected from the various soil zones in the verification strips in the fall after harvest. Root-knot nematode is still primarily located in the lighter soil zones although this nematode does seem to be now in the two lightest soil zones compared to one found in 2007. Reniform nematode is still widespread in the field occurring in all the soil zones. Because of the location of the verification strips in the field, the soil zone that had the highest EC_a reading (110-152 mS/m) was not included.

The zones of the field that responded to the application of Telone are included in Figure 7. We define a positive response to the fumigant as being economically significant. All three of the lightest soil zones responded to the application of Telone. The fourth zone which had an ECa-dp reading of from 87-110 mS/m did not show any response to the application of Telone. The heaviest soil in the field was fairly limited and not considered to be very prone to nematode injury. Since corn had been grown in rotation in this field the previous year, nematode injury was expected to occur in only the lightest two soil zones. However, there was a 131 pound lint increase with the application of Telone in the third soil zone. The use of corn as a rotation crop for two years may have resulted in fewer soil zones that would require treatment. Previous work with the Southern root-knot nematode has indicated that as soil texture increases, the response to a soil fumigant decreases (Overstreet et al., 2007; Wolcott et al., 2008). Since corn is a known host for the Southern root-knot nematode, this crop can only be useful for population management of the reniform nematode. A more successful crop may be grain sorghum which appears to be very resistant to both nematode species. Soybeans could also be used except there are very few varieties with resistance against the reniform nematode and even fewer with resistance to both nematodes.

Although there have been several studies in Louisiana that have shown the Southern root-knot nematode seems to be greatly impacted by soil texture (Erwin et al., 2007; Overstreet et al., 2008; 2009), the reniform nematode apparently doesn't seem to be as greatly impacted. Both fields in this study had reniform nematode in soils with fairly high EC_a reading and these zones still gave a strong positive response to the addition of a soil fumigant. However, the Southern root-knot nematode seems to occur and cause problems only in the lightest soils in fields. Although crop rotation may not be as useful in decreasing populations of the Southern root-knot, it certainly can reduce populations of the reniform nematode which primarily occur in the heavier areas of afield. More research is still needed in understanding the impact of reniform nematode populations and soil texture. Additionally, neither 2008 or 2009 were considered to be great production years in Louisiana with wet weather occurring in the fall. Reniform nematode has historically been considered to be greatly impacted by weather and less damage occurring in years with adequate rainfall in the growing season. In both 2008 and 2009, severe dry weather occurred during the growing season and would likely have resulted in even greater differences in nematicide response if a normal dry fall had occurred.

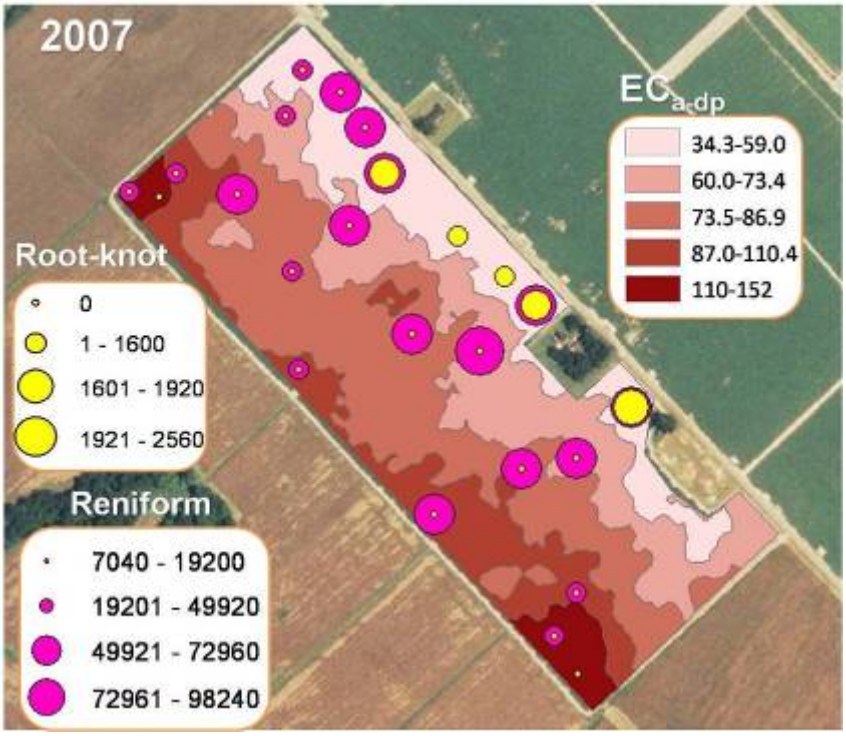


Figure 5. The Waterproof field in 2007 showing the field divided into five EC_{a-dp} soil zones and the population levels of both the root-knot and reniform nematodes from soil samples collected in each of the various soil zones..

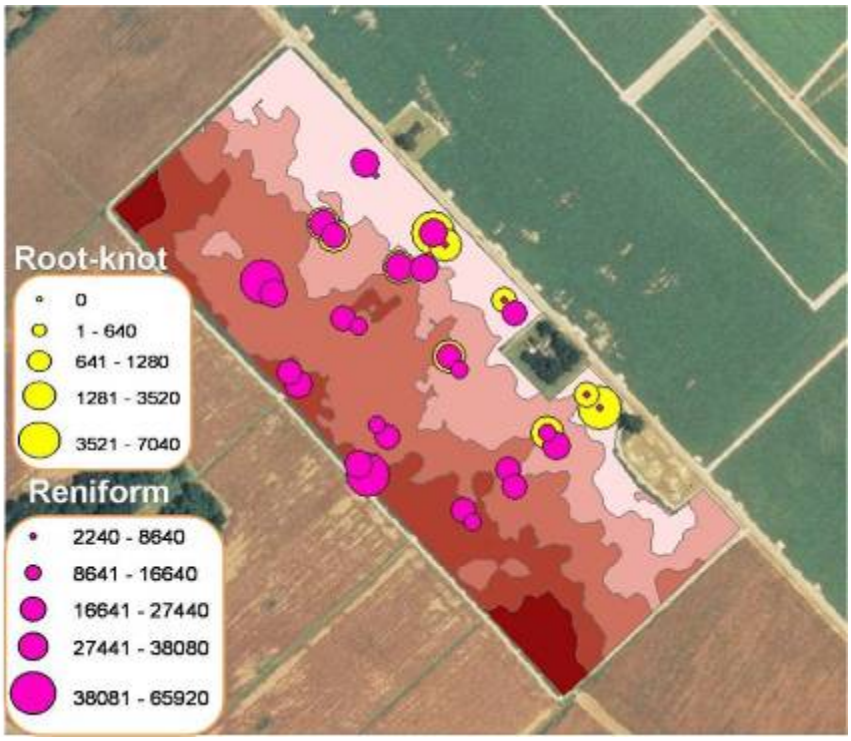


Figure 6. Nematode population densities along the verification strips collected in the fall of 2009 after harvest.

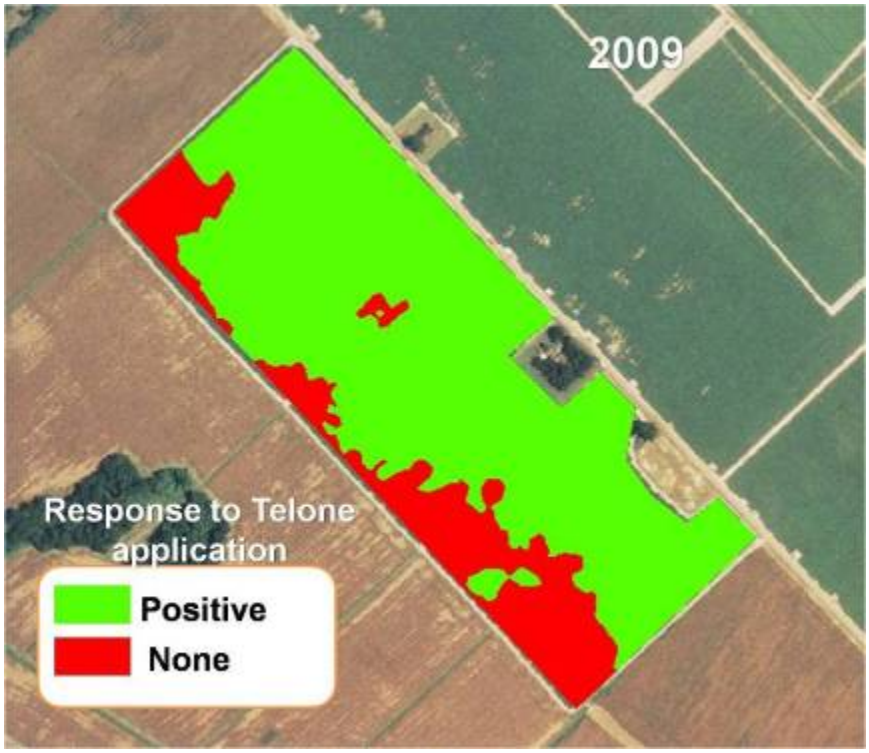


Figure 7. The area of the field that responded to the application of Telone during 2009.

Summary

Because of the widespread occurrence of nematodes in the cotton grown in the mid-South and Southeast United States, many fields have more than one problem nematode associated with them. The three nematodes that are considered the most important in cotton include the Southern root-knot, reniform, and Columbia lance. This study included two fields which have both the Southern root-knot and reniform nematodes. The Southern root-knot seems to be located in the lightest soil zones within a field while reniform is spread throughout the field. When rotation crops such as corn are used, reniform population should decline with either one or two years of use. Since the damage potential of the Southern root-knot nematode has been shown to be dependent on soil texture and decreases with increasing levels of clay, we have speculated that reniform nematode will follow similar trends but requiring higher amounts of clay than root-knot before injury is not detectable. Management zones will change over time if crop rotation is used particularly if the rotation crop alters the population dynamics of the various nematodes present in a field.

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