USING ELECTRICAL CONDUCTIVITY TO DETERMINE NEMATODE MANAGEMENT ZONES IN ALLUVIAL SOILS OF THE MID-SOUTH

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Abstract

The alluvial soils of Louisiana have considerable variability in soil texture often within the same field. The use of electrical conductivity as measured by a Veris 3100 Soil EC Mapping System has been successfully used in the mid-South for several years now as a method of determining soil texture variability within a field. After obtaining ECa reading from a field, the data is brought into a GIS program where it can be transformed into various zones for making management decisions. Most fields are typically divided into three to seven zones with four to five being the average. Four fields were used as an illustration of various ranges of EC_a that are typically found in the cotton production areas of Louisiana with ranges of $EC_{a\text{-}dp}$ from 7-117, 4-88, 26-150, and 7-97 mS/m. Additionally, these fields had nematicide trials with Telone conducted in them and showed which zones responded to the nematicide. Three fields that had Telone trials conducted in them had soil texture measured in 6 inch increments down to 24 inches in each of the zones. Soils with the highest amounts of sand responded well to the addition of the nematicide compared with the zones with the least amounts of sand. Zones with the highest levels of clay did not respond to the addition of a nematicide.

Introduction

In the alluvial soil areas of Louisiana, soil texture can exhibit extreme variability within agricultural fields. Patterns of meandering alluvial deposition can result in soil texture variation from coarse-textured (sandy loams) to fine-textured (clays) within each potential pass of application equipment. Soil type and texture have been shown to have a significant effect upon nematode population densities as well as distribution of nematode species. In South Carolina, increasing incidence of Columbia lance nematode (*Hoplolaimus columbus*) was positively correlated with sand content (Khalilian et al., 2001). In field microplots, reproduction of the root-knot nematode was greater in coarse-textured than in fine-textured soils, and population densities were inversely related to the percentages of silt and clay, while reniform nematode reproduced best in loamy sand with a silt and clay content of approximately 28% (Koenning et al., 1996). In Texas, the distributions of reniform and root-knot nematodes were found to be related to soil texture (Robinson et al., 1987). If the spatial distribution of soil texture within production fields could be economically and accurately mapped with sufficient detail, these maps might serve as the basis for site-specific nematode management.

In recent years the use of the Veris 3100 Soil EC Mapping System has been utilized to help identify some of the soil texture variability within fields. This technology allows for rapid, detailed, and cost-effective spatial mapping of soil texture in agricultural fields, and may prove to be useful as a surrogate in developing applications for site-specific nematode management. The use of EC_a has become one of the most reliable and frequently used measurements to characterize variability within a field of edaphic properties for use in site-specific management (Corwin and Plant, 2005). The use of EC_a technology is currently being investigated in several states for application to cotton to manage nematode problems (Overstreet et al., 2007; 2009; Monfort et al., 2007; Ortiz et al., 2008; Khalilian et al., 2001).

This paper outlines some of the research that has been conducted in Louisiana to use EC_a to develop management zones for nematode problems in cotton.

Materials and Methods

The Veris 3100 Soil EC Mapping System has been used in a number of fields to obtain measurements. The Veris is run every 40-50 feet across a field where it is collecting a shallow (0-1 foot) and deep (0-3 foot) measurement every second and recorded along with GPS coordinates within the field. The data is imported into a GIS program (either SSToolBox or ArcMap 9.2 for further processing. Kriging is applied to the data and delineated to within the boundary of the field. The field can be divided into a number of zones based on natural breaks within the data.

Two fields that had been defined by the use of EC_a were given as examples of the comparison between $EC_{a\text{-}sh}$ and $EC_{a\text{-}dp}$ within the same field. Field one was used as an illustration since there was very little difference detected between the two readings. The second field illustrates a field that had very different numbers between the shallow and deep readings. The second field was also divided into four different zone designations (3, 4, 5, and 6 zones) to show an example of how zones can be created within a field.

Four test fields are used as an example of the variability of EC_a within fields. These fields include two locations that had only Southern root-knot nematode and two fields which had reniform and Southern root-knot nematodes. These fields had nematicide trials conducted in them using verification strips (treated rows with Telone at 3 gal/a throughout the various soil zones as well as untreated rows). Telone was applied preplant to all these fields using either 30 inch Yetter coulters or a reduced tillage subsoiler. Yield data was collected at harvest using yield monitors and the areas which responded positively to the application of the fumigant (greater than 80 lbs/lint per acre) indicated.

Three test locations were used to compare soil texture within the profile and response of fumigation in the various soil zones. Two of the locations had only the Southern root-knot nematode and one had both reniform and Southern root-knot nematode. Telone was applied to these fields as previously reported using 30 inch Yetter coulters in strips and yields obtained with yield monitors. Soil samples were collected from each of the zones in these fields down to a depth of 24 inches in 6 inch increments. Soil texture was conducted on these samples using the soil hydrometer method. In these locations the response of the fumigant in the various zones was compared to either sand or clay content through the profile.

Results and Discussion

The Veris 3100 has been used quite successfully to define the variable soils present in Louisiana. Figure 1 illustrates a typical cotton field which has been divided into four soil zones based on the $EC_{a\text{-}dp}$ reading obtained from the Veris machine. The readings that were obtained from depth of 0-3 feet ranged from a low of 7 to a high of 96.9 in this field. The zone with the lowest reading has the least amount of electrical conductivity which corresponds to the highest sand content or lightest soil area within the field. Figure 2 and 3 illustrate the differences that can be obtained between the shallow and deep EC readings within a field. Figure 2 shows a field where the comparison of the shallow and deep readings is very similar. Since there is very little difference either of the two readings could be used to make zone designations. Figure 3 shows a field where the two reading at the different depths are quite different. These differences are related to soil deposition and profile and have considerable implications for management zones. In fields such as this one, the deep reading is often the best indicator of what is going on beneath the surface and may prove to be the better selection for use with management zone creation. Figure 4 illustrates this same field divided into four different $EC_{a\text{-}dp}$ designations including 3, 4, 5, or 6 zones. This illustrates the changes that will occur depending on how soil zones are divided. The number of zones usually ranges from 3-7 with an average of 4-5. In this example, the lightest zone in the field gets smaller as the number of soil zones increases. The number of zones may also be important in determining exactly where nematode damage is occurring in a field.

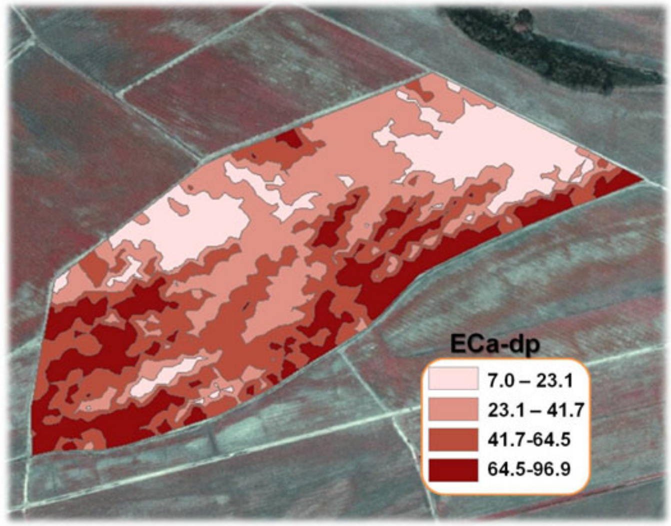

Figure 1. An example of a typical cotton field in the Mississippi alluvial soil that has been divided into four zones based on ECa-dp reading obtained from a Veris 3100 Soil EC Mapping System.

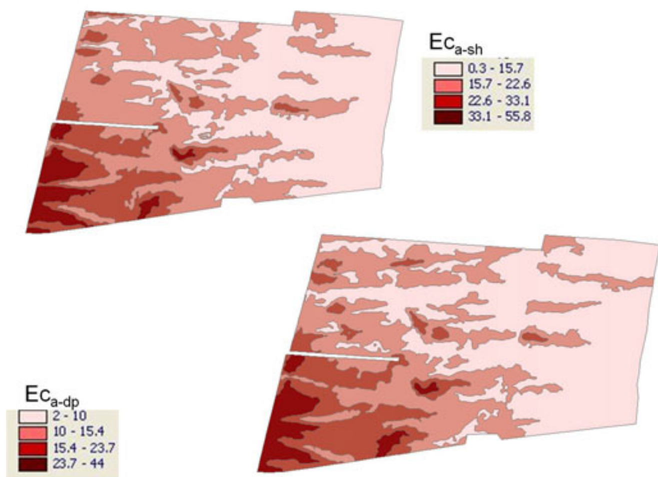

Figure 2. A field showing little differences between the $EC_{a\text{-}sh}$ and $EC_{a\text{-}dp}$ reading based on Veris data.

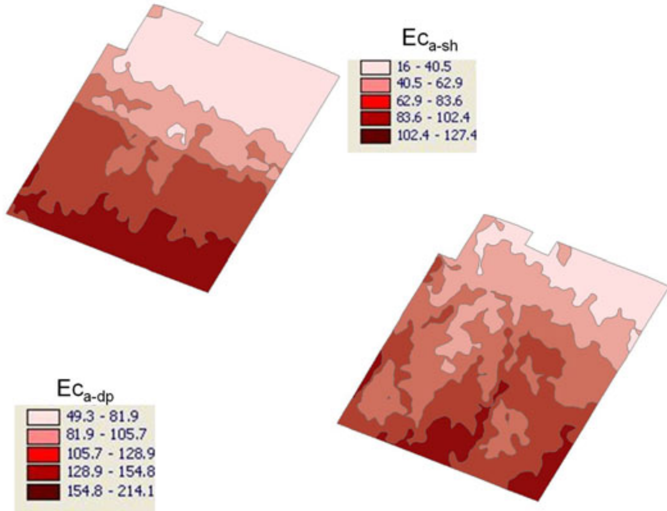

Figure 3. A field showing considerable variability between $EC_{a\text{-}sh}$ and $EC_{a\text{-}dp}$ reading based on Veris data.

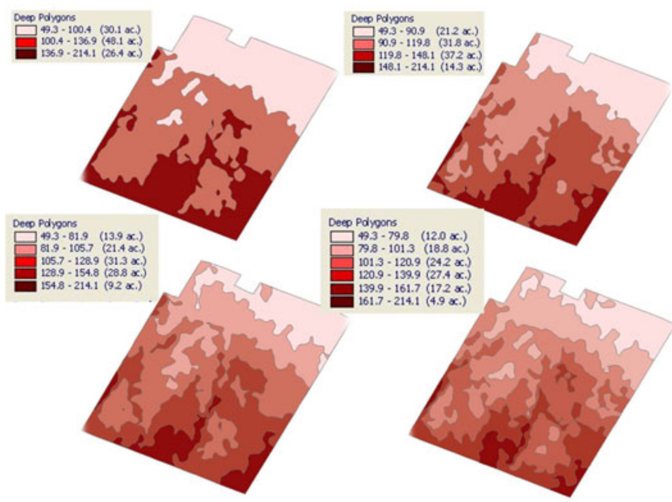

Figure 4. Showing the difference in soil zones based on dividing the field into 3, 4, 5, or 6 categories depending upon natural breaks in the $EC_{a\text{-}dp}$ reading.

Four different fields are illustrated in Figure 5 that show the various ranges of ECa that have been found in some fields where nematicide trials have been conducted in the past. The upper two fields had only Southern root-knot nematode present while the lower two fields had both reniform and Southern root-knot nematodes. These fields were divided into either 3, 4, or 5 zones. The $EC_{a\text{-}dp}$ readings ranged from 4-150 in these four fields illustrating the extent of soil variability that can be found in Louisiana fields. Each of these fields had at least 4 verification strips to measure the differences in yield that occurred between zones. Figure 6 shows the areas in the field that responded to the application of a nematicide (in green). The red areas are the zones that failed to show a significant yield response (80 pounds of lint over the untreated) and would not need the use of a nematicide. Every field showed at least 2 or more zones that responded positively to the application of Telone. The two fields with reniform nematode did show significant increase in higher zones that fields where only the Southern root-knot nematode were present.

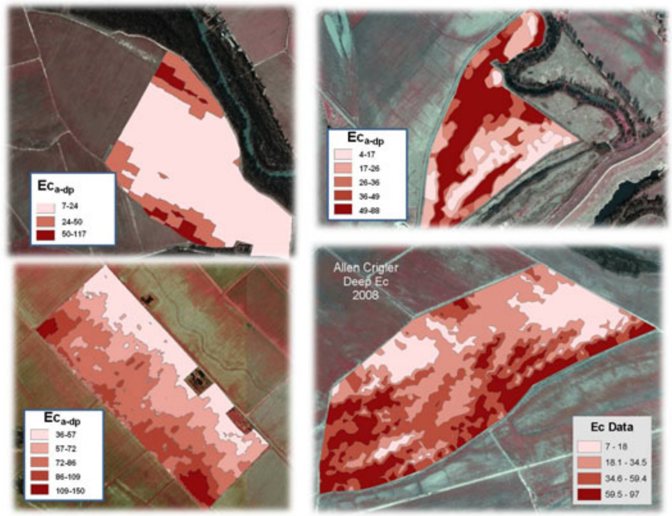

Figure 5. Examples of ECa-dp reading from four fields where nematicide trials were conducted using verification strips of Telone.

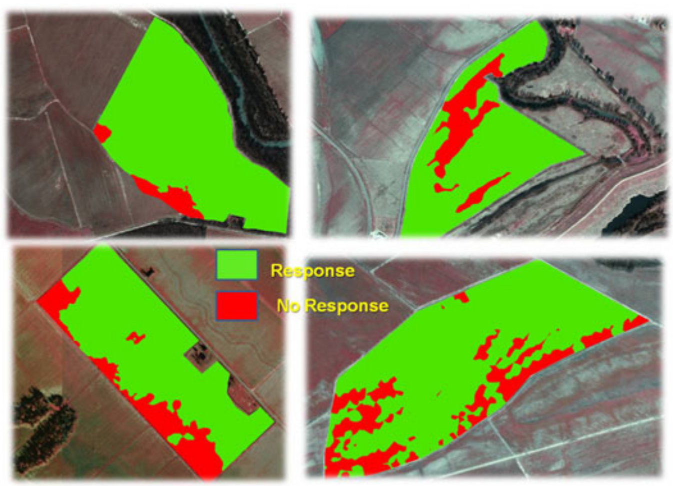

Figure 6. The areas of the four nematicide trials that responded positively to the application of Telone (greater than 80 pounds of lint/a) colored in green and areas in red showing no response.

Soil texture throughout the soil profile was found to be very important in the response to the soil fumigant. Figure 7 shows the relative proportions of sands through the profile at various soil zones within the three nematicide trials. With one exception, a higher sand content through the profile resulted in a significant response (greater than 80 pounds of lint per acre). As the total amount of sand decreased to a fairly low percentage, the nematicide failed to give any response to the application of Telone. The one exception was site CN2 which turned out to have a fairly high level of sand in the 0-6 inch depth within the field but very high levels of clay in the levels beneath that layer.

Figure 8 likewise shows the response to the fumigant with clay content throughout the profile. High levels of clay through the profile usually resulted in a lack of response to the fumigant. The site G3 did have a fairly high percentage of clay but still responded to the application of the nematicide. This site had very high levels of reniform nematode which indicates that reniform nematode may cause damage even when higher amounts of clay are present.

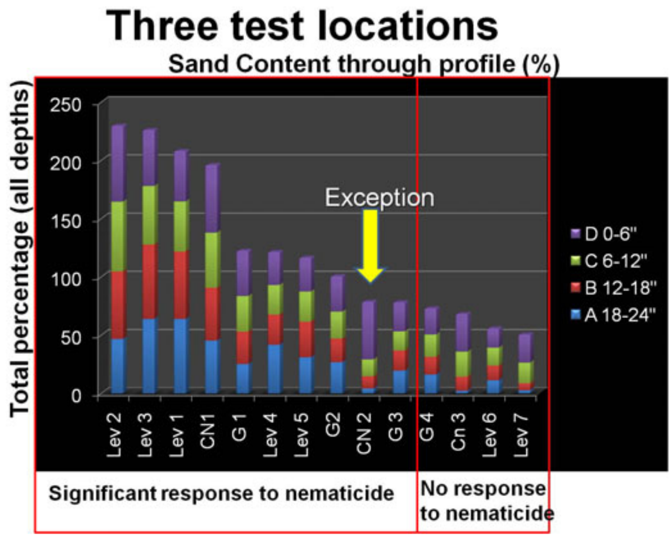

Figure 7. The total percentage of sand found within various soil zones and profile in three nematicide trials and response to the application of Telone.

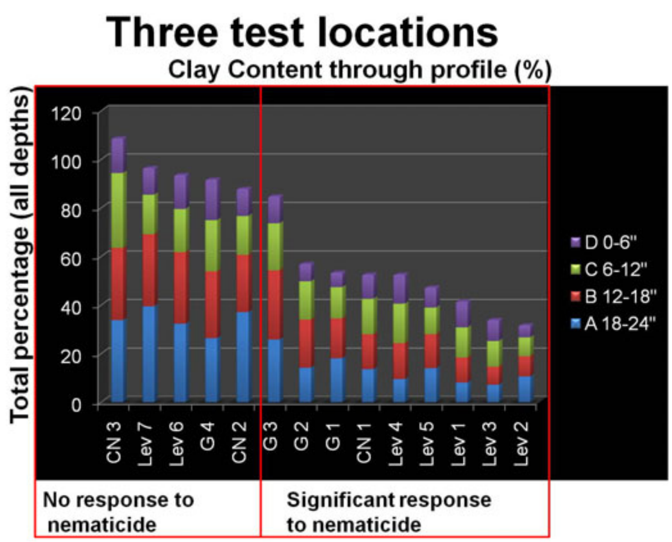

Figure 8. The response of the various soil zones to clay content throughout the profile in the three nematicide trials.

Summary

Fields within Louisiana have been shown to be highly variable in soil texture in the major areas along rivers where cotton production generally occurs. The use of EC_a information has been evaluated and determined to be a relatively effective and inexpensive method of measuring some of this variability within a field. Although EC_a data has been shown to be an acceptable method to use with nematode management zones, it was clear that it was not a standalone method. Since every field is different and EC_a is only relative within a field, some additional information is required to successfully establish nematode management zones. Verification strips can certainly pinpoint response areas to the application of a fumigant such as Telone. Other information that may need to be combined with EC_a includes nematode populations, fertility, historic yield, or producer's personal knowledge of the field.

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