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USING SOIL ELECTRICAL CONDUCTIVITY TO DENOTE POTENTIAL NEMATODE MANAGEMENT ZONES

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Abstract

A study was initiated at the LSU AgCenter Northeast Research Station, located at St. Joseph, LA, to develop potential applications for the site-specific management of plant parasitic nematodes. Analysis of soil samples obtained in 2001 and 2002 from a 78.7 acre production field with a known history of natural infestation of root knot nematodes (*Meloidogyne incognita*) showed a strong negative relationship between nematode populations and soil clay content; as clay content increased, root knot nematode population of decreased. Bulk soil electrical conductivity (SEC), mapped with a Veris® 3100 Soil EC Mapping System, was highly correlated (r = 0.94) with soil clay content. Using SEC as a surrogate for soil texture in developing site-specific prescriptions for the application of nematicides to only those areas of production fields with soil textures having the highest probability of supporting damaging levels of root knot nematodes may be feasible.

Introduction

Plant-parasitic nematodes such as root knot (*Meloidogyne incognita*) and reniform (*Rotylenchulus reniformis*) are a major factor limiting cotton production in the United States, costing producers millions of dollars annually. Current management strategies used to reduce losses due to nematode infestations include crop rotation and/or nematicide application. Applications of nematicide are generally made uniformly across problem fields. Nematode populations are usually clumped and not uniformly distributed throughout problem fields; therefore the field-wide uniform application of nematicides can result in application to areas where either no nematodes are present, or populations are below economic threshold levels. The result is potentially adverse both economically and environmentally.

Advances in the application of geo-spatial technologies in production agriculture, or Precision Agriculture, have given agricultural producers the capability of prescription application of agricultural inputs, including nematicides, to only portions of production fields that require treatment. In theory, prescription applications have the potential to reduce the amount of pesticide applied, with favorable results both to the environment and financially to the producer. Unfortunately, costs associated with collecting data necessary to develop variable rate prescriptions can offset potential pesticide savings. Costs for labor, time, and laboratory assays related to intensive spatial g or grid sampling to determine nematode population densities would typically be prohibitive. Alternative methods to accurately determine those areas of production fields in which plant parasitic nematodes have the potential to adversely affect crop yields are needed.

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 sandy loams to 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 (*Hoploaimus 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 the reniform nematode reproduced best in loamy sand with a silt plus 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.

Electrical conductivity (EC) measurements of soil have long been used to identify contrasting soil properties for environmental and geological purposes. Recently, researchers have used bulk soil EC (SEC) to measure or estimate many chemical and physical properties of non-saline soils, such as clay content (Williams and Hoey, 1987), CEC, exchangeable Ca and Mg (McBride et al., 1990), and depth to claypans (Doolittle et al., 1994). Texture, Ca, Mg, K, and CEC on soils of the Mississippi Delta have been estimated with SEC (Kitchen et al., 2000).

Commercial devices are now available to rapidly and economically measure and map SEC across agricultural fields. The Veris® 3100 Soil EC Mapping System (Veris Technologies, Salina, Kansas) measures SEC with a system of coulters that are in direct contact with the soil. The EM38 (Geonics, Limited, Mississauga, Ontario, Canada) induces a current into the soil with one coil and determines conductivity by measuring the resulting secondary current with another coil. Both sensors have been demonstrated to give similar results (Suddeth et al., 1999). This technology allows for rapid, detailed, and costeffective spatial mapping of agricultural fields, and may prove to be useful as a surrogate for soil texture in developing applications for site-specific nematode management. The objectives of this study were: 1) Determine the relationship between population densities of plant parasitic nematodes and soil texture in the Mississippi River alluvial soil area of northeast Louisiana. 2) Determine the relationship between bulk soil electrical conductivity and soil texture in the Mississippi River alluvial soil area of northeast Louisiana. 3) Determine the potential for using bulk soil electrical conductivity as a basis for developing nematode management zones.

Materials and Methods

Research was conducted in a 78.7 acre field in the Mississippi River alluvial soil area of northeast Louisiana located on the LSU AgCenter Northeast Research Station at St. Joseph, Louisiana. The field has a long history of natural infestation with root knot nematode as well as a natural variability in soil texture. The field was sampled in 2001and 2002 using a DGPS system to collect samples based on a 1 acre grid with a systematic square (grid center) design. Each sample was composed of 12-14 soil cores obtained at a depth of 6-7 inches. Nematodes were extracted from the samples using a combination of wet sieving and centrifugal sugar flotation (Jenkins, 1964). Nematodes were identified to species microscopically based on morphology, and population densities calculated using dilution techniques. A portion of each sample obtained in 2001 was also analyzed for particle size using the hydrometer method. In 2003 the field was again sampled, but the sampling procedure was modified to use a stratified random design, using SEC zones as strata. Samples obtained in 2003 were assayed for nematodes, but particle size analysis was not performed.

In the spring of 2002, the field was mapped for SEC utilizing a Veris® 3100 Soil EC Mapping System (Figure 1). This unit consists of six coulters, two of which introduce an electrical potential into the soil. The remaining four coulters are spaced to measure SEC over two approximate depths, 0-12" (SEC_1) and 0-36" (SEC_3) (Figure 2). SEC was recorded at 1 second intervals on a transect width of approximately 35 ft., and geo-referenced using a DGPS receiver. SEC data was recorded as milliSiemens per meter. The SEC data was processed utilizing SSToolbox, an agriculturally oriented GIS operating in ArcView 3.x, and utilizing Surfer for interpolation. The original shallow (SEC_1) point data was interpolated to a 20ft x 20 ft grid cell format using Kriging, and was classified into 10 zones using unsupervised natural breaks. The SEC value at each soil sample site was determined, and this value was incorporated into the attribute data for each sample site for analysis.

Results

The population of root knot nematodes ranged from a low of 0 to a high of 2560 in 2001 and 2002 (Figure 3). Soil clay content ranged from 6.6% to 45.7%. Root knot nematodes populations tended to decrease as clay content increased, although the exact relationship of clay content and nematode populations is unknown at this time (Figure 3). If a population of 250 root knot nematodes per cm^3 of soil is assumed to be a damaging population, then data in Figure 3 indicates that damaging levels were rarely observed when clay content exceeded 18% in 2001 and 2002.

SEC ranged from 4.8 to 71.7 milliSiemens per meter (mS/m) (Figure 5). Clay content was positively related to SEC with a strong correlation ($r = 0.94$), indicating that clay content could be accurately predicted with SEC (Figure 4). The map in Figure 5 indicates the spatial variation in shallow SEC (SEC_1), and the clay content, across the field. Darker shaded areas denote increased SEC and clay content. Samples from 2003 were grouped into 10 SEC zones (Figure 6). Damaging levels (>250 nematodes per cm^3 of soil) of nematodes were only observed in SEC zones that contained 15 or less per cent clay content.

Although the exact relationship of clay content and nematode populations is not known, these data suggest that there is a threshold between 15 and 20% clay content beyond which nematode populations rarely occur at damaging levels. These data also indicate that SEC could be practically used in the field to predict clay content and zones having the highest probability of supporting damaging levels of root knot nematodes. However, as nematodes do not occur in all sandy soils, groundtruthing with nematode assays is still a critical component of any nematode management program. Further research should define the relationship between clay content and nematode populations in problem fields. With that relationship established, prescription applications of nematicides may be possible and advantageous.

Disclaimer

The interpretation of data presented may change with additional experimentation. Information is not to be construed as a recommendation for use or as an endorsement of a specific product by the LSU AgCenter.

Acknowledgments

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Figure 1. Veris® 3100 Soil EC Mapping System.

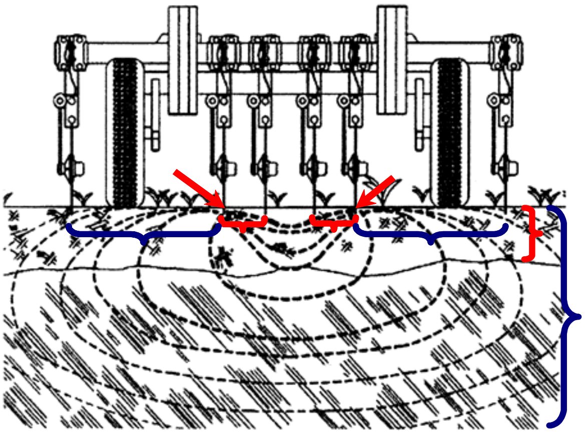

Figure 2. Schematic of Veris® Dual-Depth Array.

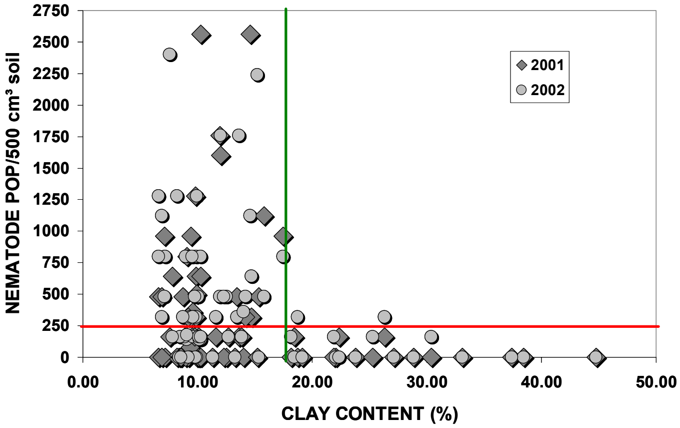

Figure 3. Effects of clay content on root knot nematode population for 2001 and 2002.

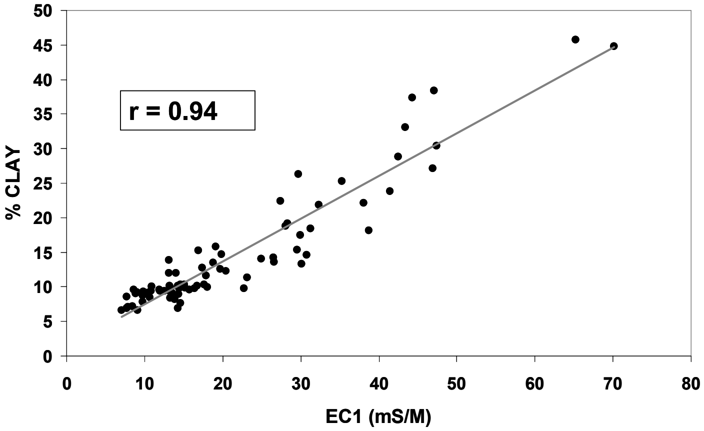

Figure 4. Relationship of soil electrical conductivity and soil clay content.

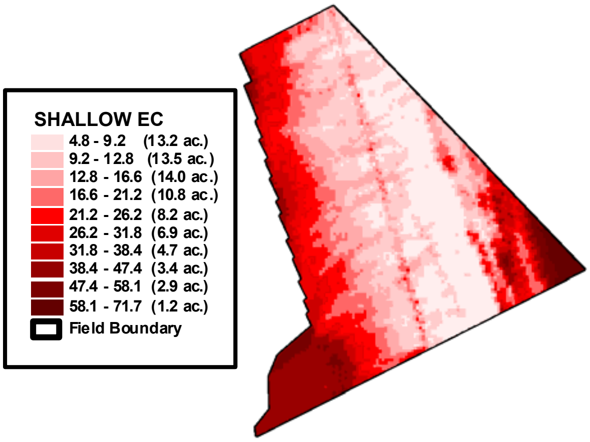

Figure 5. Map of test field illustrating the spatial variability of soil electrical conductivity.

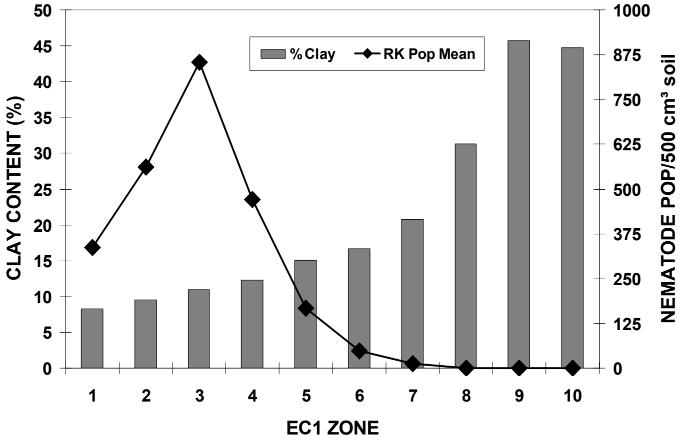

Figure 6. Mean 2003 root knot population and clay content means by EC zones.