Applied Soil Ecology 95 (2015) 107–114

Contents lists available at ScienceDirect

Applied Soil Ecology

journal homepage: www.elsevier.com/locate/apsoil

Population dynamics and spatial distribution of Columbia lance nematode in cotton

Claudia M. Holguin[a], John D. Mueller[b], Ahmad Khalilian[b], Paula Agudelo[a,*]

[a] School of Agricultural, Forest, and Environmental Sciences, Clemson University, Clemson, SC 29634 USA
[b] Edisto Research and Education Center, Clemson University, Blackville, SC 29817, USA

ARTICLE INFO

Article history:
Received 24 November 2014
Received in revised form 1 June 2015
Accepted 7 June 2015
Available online 4 July 2015

Keywords:
Lance nematode
Reniform nematode
Spatial distribution
Soil texture
Crop rotation

ABSTRACT

Hoplolaimus columbus, Columbia lance nematode (CLN), can cause severe stunting and considerable yield losses in cotton. A three-year field study was conducted in South Carolina with the purpose of examining the population dynamics and spatial distribution patterns of CLN as influenced by soil texture, the presence of *Rotylenchulus reniformis*, reniform nematode (RN), and a cotton–corn–soybean rotation scheme. Four plots with different soil textures inferred by soil electrical conductivity were sampled at plant and at harvest for each crop. Population densities of CLN were aggregated and the host plant did not affect the pattern of spatial distribution. Columbia lance nematode and RN were found in spatially distinct areas in the field influenced by differences in soil texture. Columbia lance nematode was mainly found in areas with high sand content (above 75%) and RN in areas with 60–65% sand content. Therefore, depending on the sand content, whenever there are concomitant infestations of CLN and RN in a field, only one species is likely to be the key pest. Knowledge of the distribution patterns of CLN is essential for selecting sampling strategies and for site-specific management.

1. Introduction

Hoplolaimus columbus, Columbia lance nematode (CLN), can cause severe stunting and considerable yield losses in cotton (*Gossypium hirsutum*) (Lewis and Fassuliotis, 1982; Noe, 1993; Koenning et al., 2003, 2004). Lance nematodes are migratory endo- and ectoparasites that cause necrotic lesions in cotton roots. The most substantial damage occurs when plants are infected early in the growing season and the tips of tap and secondary roots are damaged (Lewis et al., 1976; Mueller and Sullivan, 1988). Damage thresholds are reported to be approximately 75 CLN per 100 cm^3 of soil, and yield losses normally range from 10% to 25%, but can surpass 50% (Koenning et al., 2004; Mueller et al., 2010).

In South Carolina, CLN, root-knot nematode (RKN) *Meloidogyne incognita*, and reniform nematode (RN) *Rotylenchulus reniformis* are the three main plant-pathogenic nematode species causing yield losses in cotton production (Lewis and Smith, 1976; Lewis and Fassuliotis, 1982; Martin et al., 1994). A survey of cotton-growing counties in the state (Martin et al., 1994) showed that these three species are present in approximately 60% of the cotton acreage in South Carolina and exceed damage thresholds in nearly 50% of that area. Unlike RKN and RN, which are widely distributed across the cotton-growing states in the southeastern United States, CLN has a more limited distribution and is only reported infecting cotton plants in North Carolina, South Carolina, and Georgia (Gazaway, 1994; Koenning et al., 1999).

The relationship between CLN and RKN on cotton has been studied in the field (Bird et al., 1974) and in the greenhouse (Kraus-Schmidt and Lewis, 1981). Populations of RKN can be suppressed in the presence of CLN to the extent that CLN can replace RKN as the predominant plant-pathogenic species (Bird et al., 1974; Kraus-Schmidt and Lewis, 1981). Distribution of these two nematode species in the field is influenced by soil texture. The occurrence of higher population densities of RKN and more severe crop damage in coarser textured soils was documented by Koenning et al. (2004). Reproduction of RKN is greater in soils ranging in sand content from 72% to 91% (Prot and Van Gundy, 1981). Likewise, population densities of CLN are positively correlated to sand content in fields where the sand content ranges from 81% to 90%, and the species is reported to be rare in soils with less than 70% sand (Khalilian et al., 2001).

The relationship between CLN and RN in cotton fields has not been studied, but the two species appear to have different soil texture associations. In a previous field study, Holguin et al. (2015) reported strong correlations between RN densities and percent sand and silt, showing that RN densities peak when sand content is around 60–65% and decline when sand content increases

---

* Corresponding author. Tel.: +1 518646565741.
E-mail address: pagudel@clemson.edu (P. Agudelo).

http://dx.doi.org/10.1016/j.apsoil.2015.06.004
0929-1393/

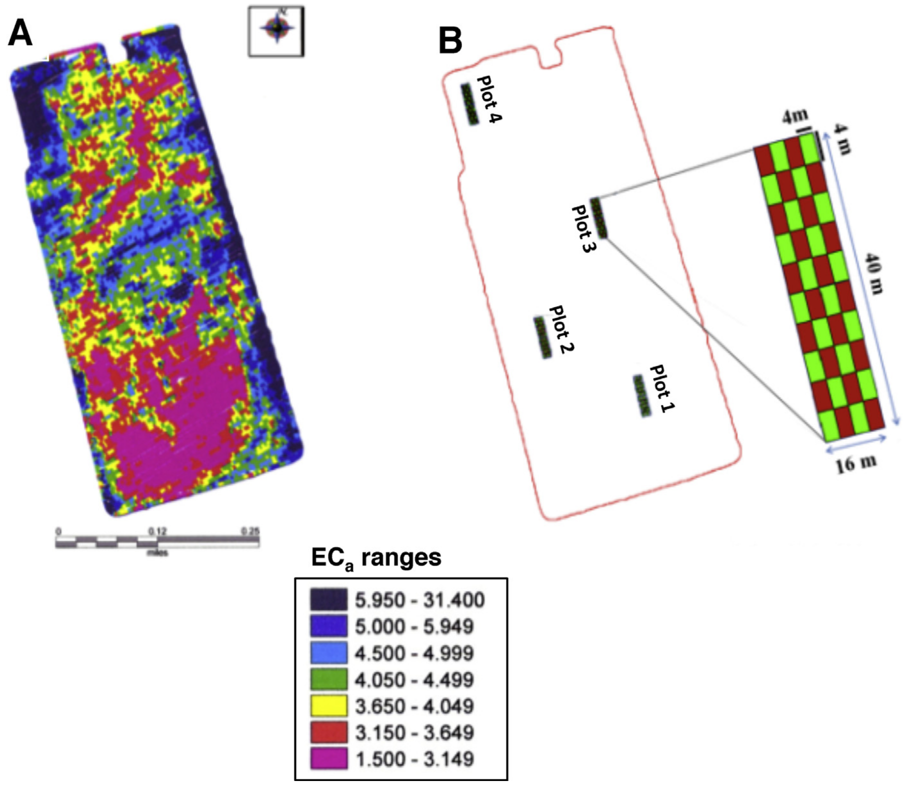

Fig. 1. Sampling design. Electrical conductivity (EC_a) map of readings taken before planting (April 2011). (A) Map showing seven EC_a zones. Each color represents different EC_a ranges. (B) Four plots selected for sampling and each plot divided into 40 (4 m × 4 m) subplots. Eighty total samples taken per date (40/2 * 4 = 80).

above 65%. However, cotton has been shown to be an excellent host for both species (Noe, 1993) and several authors have reported an increase in distribution of these nematodes in cotton-growing regions (Bird et al., 1974; Martin et al., 1994; Koenning et al., 2003). Lewis and Smith (1976) suggest that the high incidence of CLN in South Carolina may be due to continuous cropping with susceptible hosts, such as cotton, corn (*Zea mays*), and soybean (*Glycine max*), and they indicate that continuous cotton may sustain higher densities of CLN than rotations with soybean and corn. The population dynamics and distribution patterns of CLN and RN in cotton fields infested with both species can be especially relevant when considering crop rotation as a management practice (Davis et al., 2000). For example, rotation with corn or RN-resistant soybean, both suitable hosts for CLN, is a commonly prescribed management practice for RN on cotton (Davis et al., 2003; Koenning et al., 2003).

Distribution of CLN within a field is usually in scattered patches determined by soil texture due to the strong positive correlation between CLN population densities and sand content (Khalilian et al., 2001; Koenning et al., 2004). Consequently, the application of nematicides uniformly over the entire field for the control of CLN can be both costly and environmentally questionable (Mueller et al., 2010). Site-specific application of nematicides has been proposed for management of nematodes in cotton fields (Davis et al., 2013; Mueller et al., 2010), so that application of nematicides is restricted to target areas in the field where the nematodes are above threshold (Khalilian et al., 2001; Mueller et al., 2010). By using a soil electrical conductivity meter, the soil texture can be inferred and the distribution of CLN can be predicted (Khalilian et al., 2001; Ortiz et al., 2010; Mueller et al., 2010; Davis et al., 2013). However, soil texture is not the only driver of CLN distribution in the field, and the effective use of site-specific management requires knowledge of the spatial distribution patterns of the nematode species within individual fields (Park et al., 2007; Mueller et al., 2001). The objective of this three-year study was to determine population dynamics and spatial distribution patterns of CLN as influenced by soil texture and the presence of RN, under a cotton–corn–soybean rotation scheme.

2. Materials and methods

Population densities of CLN and RN were monitored over three growing seasons (spring 2011 to winter 2013) in a 36.4 ha irrigated commercial field near Bishopville, South Carolina (80.648° W, 33.736° N). The field was planted with cotton ‘Deltapine 1050’ in 2011, followed by corn ‘Pioneer 1690’ in 2012, and soybean ‘Asgrow 7231’ in 2013.

2.1. Plot selection and sample collection

Prior to this study (April 2011), the soil electrical conductivity (EC_a) was measured in the field with a sensor cart (Veris 3100 from Veris Technologies, Salina, KS, USA) to map the soil EC_a and identify management zones in the field with predictable soil texture similarities (Mueller et al., 2010). Using Global Positioning System (GPS) technology and mapping sensors, each point in the field where the EC_a value was taken was geo-referenced to create a map. The generated map was divided into seven sections according to shallow EC_a (0–30 cm) value ranges (Fig. 1a). For nematode sampling, four zones of the field were selected to represent different EC_a readings and corresponding inferred textures. In each of these four zones, a plot of 40 m × 16 m was divided into 40 subplots of 4 m × 4 m (Fig. 1b). Soil samples were collected from 20 subplots in each plot at planting (May 2011 and August 2013) and after harvest (December 2011 and December 2013). In September 2012, soil samples were collected only after corn harvest. Each soil sample consisted of four subsamples of 200 cc taken from within a one-square-meter area