# POPULATION DYNAMICS OF SOUTHERN ROOT-KNOT, COLUMBIA LANCE AND RING NEAMTODES IN A COTTON-COTTON-PEANUT ROTATION IN SOUTH CAROLINA

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## Abstract

Nematode population densities were recorded following the 2017 and 2018 growing seasons in 53 fields that comprised a 645-hectare farm in Bamberg County, South Carolina. Soil textures for all 53 fields were either loamy sands or sandy loams. All fields were included in a repeated three-year rotation of cotton/cotton/peanut. This rotation was initiated to reduce yield losses due to Southern root-knot nematodes (SRK; *Meloidogyne incognita*) on cotton and prevent yield losses due to ring nematodes (*Criconemella* spp.) on peanut.

SRK populations were greatly reduced following one year of peanuts, however, one year of cotton after peanut was enough time to see a rebound in SRK populations. In one group of 12 fields, SRK were not detected in the Fall of 2017 following one year of peanut. In these same 12 fields following cotton in the Fall of 2018 SRK had rebounded to an average of 78/100 $cm^3$ soil. A second group of 16 fields planted to peanut in 2018 followed 2 years of cotton. In the Fall of 2017 these fields averaged 177 SRK/100 $cm^3$ soil. After 1 year of peanut in 2018, SRK could not be detected in the Fall samples. The damage threshold for SRK on cotton is 75/100 $cm^3$ soil. Therefore, one year of peanut reduced levels of SRK to the point where use of a nematicide was not warranted.

Populations of SRK were also significantly reduced by planting an SRK-resistant cotton variety. Deltapine 1747NR B2XF, an SRK-resistant variety, was very effective in reducing SRK densities. In one group of 9 fields DP 1747NR B2XF was planted as a second year of cotton after one year of a susceptible cotton that followed a year of peanuts. After the 1st year of cotton, 2017, SRK populations averaged 236 SRK/100 $cm^3$ soil. All 9 fields exceeded the damage threshold of 75 SRK/100 $cm^3$ soil. After the next year (2018) planted to the SRK-resistant variety, the fields averaged only 109 SRK/100 $cm^3$ soil. Only 67% of the fields exceeded the damage threshold. In a second group of 5 fields, when the resistant variety was planted after 2 years of a susceptible variety, the levels of SRK dropped from 94 to 30/100 $cm^3$ of soil and the percentage of fields above threshold dropped from 80% to 20%. The highest populations of SRK observed were after three continuous years of cotton with SRK levels reaching 632 per 100 $cm^3$ soil.

Cotton was very effective in reducing ring nematode population levels. In a group of 12 fields populations of ring nematode averaged 374/100 $cm^3$ soil after one year of peanut, 2017. After one year of cotton in 2018 ring nematode populations had dropped to just 58/100 $cm^3$ of soil. Conversely, in a group of 16 fields after 2 years of cotton only 28 ring nematodes/per 100 $cm^3$ soil were present but following one year of peanut in 2018 the levels climbed to 136/100 $cm^3$ of soil.

Levels of Columbia lance, lesion and stubby root nematodes were relatively low in these fields. Columbia lance nematode approached threshold levels only after three consecutive years of cotton. Mean recovery of lesion nematodes was less than 22/100 $cm^3$ soil in each of the 7 rotations. Reproduction did not show a response to cropping with cotton versus peanut. Mean recovery of stubby root nematode was also very low in the 7 rotation schemes, with a maximum of 22/100 $cm^3$ of soil.

This rotation was highly effective in reducing levels of SRK and ring nematodes and associated yield losses for subsequent cotton and peanut crops.

## Introduction

Plant-parasitic nematodes are some of the most important yield limiting factors in cotton production in the Southeastern United States (Koenning et al., 2004). Each year they cause more than an average of 5% yield loss across the U.S. Cotton Belt (Lawrence et al., 2020). The major nematode pests of cotton in South Carolina include the Southern root-knot (*Meloidogyne incognita* - SRK), reniform (*Rotylenchulus reniformis* - RN) and Columbia lance (*Hoplolaimus columbus* - CLN) nematodes (Martin et al., 1994). Crop rotation options are limited to control these

three species. Soybean is a host for all three species, and corn and grain sorghum are hosts for SRK and CLN. So, those three crops are not suitable for a rotation aimed at controlling yield losses due to nematodes. However, peanut is not a host for any of the three species. Since cotton is not a host for Peanut root-knot nematode (*Meloidogyne arenaria* - PRK), the major nematode pathogen of peanut, a cotton/peanut rotation seems to offer a very effective rotation system to reduce nematode damage on both crops.

There are some questions concerning the utilization of a cotton/cotton/peanut rotation to minimize yield losses due to nematodes on both crops. These questions are: How long does it take SRK, CLN and RN populations to rebound after a year of peanuts? Will populations of secondary pathogens like lesion (*Pratylenchus* spp.), ring (*Mesocriconema* spp.) or stubby root (*Paratrichodorus* spp.) nematodes which go to both cotton and peanuts, increase? How will the use of recently released root-knot nematode resistant cotton varieties affect the population dynamics of SRK in a cotton/cotton/peanut rotation?

## Materials & Methods

### Nematode Sampling

Nematode samples were collected in the Falls of 2017 and 2018 from all the fields being utilized by a cotton/peanut producer on their farm in Bamberg County, South Carolina. Samples were collected within 30 days of the harvest of each field. Samples consisted of 12 to 15 cores per field. Cores were 2.54-cm in diameter and taken approximately 20-cm deep. All cores from a single field were blended together and approximately 400 $cm^3$ were placed in a waterproof paper bag. Samples were shipped via commercial carrier to the Clemson University Nematode Assay Laboratory. At the Clemson University Nematode Assay Laboratory all vermiform nematodes were extracted from a representative soil sample using a combination of "wet sieving" and "differential centrifugal flotation" (Jenkins, 1964) and identified to genus using nematode morphology.

Fields were typical of the Coastal Plain Soils of South Carolina, primarily loamy sands with less than 0.5% organic matter. The top 15 to 25 cm are 80% to 95% coarse textured sands. The layer below this contains less sand and more clay. Fifty-three fields were divided into 7 rotations based on cropping histories beginning in 2015 (Table 1).

Table 1. Rotations schemes utilizing 53 fields on a Bamberg County, South Carolina cotton/peanut farm.

| Rotation # | 2015 | 2016 | 2017 | 2018 | # fields |
|---|---|---|---|---|---|
| 1 | Cotton | Cotton | Cotton | Peanut | 2 |
| 2 | Cotton | Cotton | Peanut | Cotton Resistant | 12 |
| 3 | Cotton | Peanut | Cotton | Cotton | 9 |
| 4 | Cotton | Peanut | Cotton | Cotton Resistant | 5 |
| 5 | Peanut | Cotton | Cotton | Cotton | 5 |
| 6 | Peanut | Cotton | Cotton | Cotton | 4 |
| 7 | Peanut | Cotton | Cotton | Peanut | 16 |
| **Total** | 28 Cotton 25 Peanut | 39 Cotton 14 Peanut | 41 Cotton 12 Peanut | 35 Cotton 18 Peanut | 53 |

Unless marked "Resistant" all cotton varieties were susceptible to Southern root-knot nematode.

## Results and Discussion

### Southern Root-Knot Nematode

Rotations 1, 2, and 7 show high levels of SRK after just one or two years of cotton and significant reductions in SRK following peanut (Table 2). Rotations 3 and 5 show high levels of SRK after susceptible cotton in 2017 but that following resistant cotton variety in 2018 SRK levels dropped significantly. In both rotations SRK levels following

the resistant variety were less than half that of the susceptible variety and the percentage of fields above the damage threshold for SRK dropped considerably. Insertion of an SRK-resistant variety as the second year of cotton provided enough suppression of SRK to possibly allow a third year of cotton without a nematicide. Rotations 1, 2, and 7 show that SRK levels following 1 growing season of peanut were significantly reduced compared to a year of susceptible cotton.

One year of peanuts was enough to reduce densities of SRK in a field to below the damage threshold. Planting an SRK resistant cultivar reduced SRK levels at harvest to similar levels. However, after just one year of an SRK-susceptible cultivar, levels of SRK J2's in soil were greater than the known damage thresholds. These reductions after one year of peanut or a resistant cultivar were generally sufficient to allow a grower to produce an above average cotton crop without the use of a high rate of a nematicide.

A cotton/cotton/peanut rotation provided excellent suppression of SRK and possibly prevented the buildup of Peanut root-knot nematodes. No PRK nematodes were ever observed on this farm.

Table 2. Mean recovery of Southern root-knot nematodes (SRK) per 100 $cm^3$ soil in the Falls of 2017 and 2018 from 53 fields in 7 rotation sequences utilizing cotton and peanut on a Bamberg County, South Carolina farm.

| Rotation # | 2015 | 2016 | 2017 | 2018 | SRK/100 $cm^3$ soil Fall 17 | SRK/100 $cm^3$ soil Fall 18 |
|---|---|---|---|---|---|---|
| 1 | Cotton | Cotton | Cotton | Peanut | 255 | 10 |
| 2 | Cotton | Cotton | Peanut | Cotton | 0 | 78 |
| 3 | Cotton | Peanut | Cotton | Resistant Cotton | 236 | 109 |
| 4 | Cotton | Peanut | Cotton | Cotton | 4 | 0 |
| 5 | Peanut | Cotton | Cotton | Resistant Cotton | 94 | 30 |
| 6 | Peanut | Cotton | Cotton | Cotton | 23 | 632 |
| 7 | Peanut | Cotton | Cotton | Peanut | 177 | 0 |

Unless marked "Resistant" all cotton varieties were susceptible to Southern root-knot nematode.

**Columbia Lance Nematode**

Levels of CLN were relatively low in all fields across rotations (Table 3). Mean recovery of CLN within a rotation approached the damage threshold of 100 per 100 $cm^3$ soil (Dickerson et al., 2000) only when a rotation included three consecutive years of cotton (rotations 5 & 6). One year of cropping to peanut resulted in very low levels of CLN as shown in rotations 1, 2, and 7.

**Ring Nematode**

In general recovery of ring nematodes was highest following one year of peanut, as seen in rotations 1, 2, and 7 (Table 4). Recovery of ring nematodes decreased when fields were planted to cotton following peanut, as in rotation 2, and continued to drop after a second year of either resistant or susceptible cotton. Only in rotation 5 did constant culture with cotton maintain a ring nematode population level close to the damage threshold of 50 per 100 $cm^3$ soil.

Table 3. Mean recovery of Columbia lance nematodes (CLN) per 100 $cm^3$ soil in the Falls of 2017 and 2018 from 53 fields in 7 rotation sequences utilizing cotton and peanut on a Bamberg County, South Carolina farm.

| Rotation # | 2015 | 2016 | 2017 | 2018 | CLN/100 $cm^3$ soil Fall 17 | CLN/100 $cm^3$ soil Fall 18 |
|---|---|---|---|---|---|---|
| 1 | Cotton | Cotton | Cotton | Peanut | 0 | 0 |
| 2 | Cotton | Cotton | Peanut | Cotton | 0 | 5 |
| 3 | Cotton | Peanut | Cotton | Resistant Cotton | 3 | 8 |
| 4 | Cotton | Peanut | Cotton | Cotton | 2 | 10 |
| 5 | Peanut | Cotton | Cotton | Resistant Cotton | 12 | 50 |
| 6 | Peanut | Cotton | Cotton | Cotton | 18 | 93 |
| 7 | Peanut | Cotton | Cotton | Peanut | 9 | 1 |

Unless marked "Resistant" all cotton varieties were susceptible to Southern root-knot nematode.

Table 4. Mean recovery of ring nematodes per 100 $cm^3$ soil in the Falls of 2017 and 2018 from 53 fields in 7 rotation sequences utilizing cotton and peanut on a Bamberg County, South Carolina farm.

| Rotation # | 2015 | 2016 | 2017 | 2018 | Ring/100 $cm^3$ soil Fall 17 | Ring/100 $cm^3$ soil Fall 18 |
|---|---|---|---|---|---|---|
| 1 | Cotton | Cotton | Cotton | Peanut | 0 | 45 |
| 2 | Cotton | Cotton | Peanut | Cotton | 374 | 58 |
| 3 | Cotton | Peanut | Cotton | Resistant Cotton | 17 | 9 |
| 4 | Cotton | Peanut | Cotton | Cotton | 100 | 12 |
| 5 | Peanut | Cotton | Cotton | Resistant Cotton | 54 | 42 |
| 6 | Peanut | Cotton | Cotton | Cotton | 12 | 15 |
| 7 | Peanut | Cotton | Cotton | Peanut | 28 | 136 |

Unless marked "Resistant" all cotton varieties were susceptible to Southern root-knot nematode.

**Lesion Nematodes**

Although both cotton and peanut are hosts for lesion nematodes, recovery of lesion nematodes was relatively low throughout the study (Table 5). The highest observed level was 22 lesion nematodes per 100 $cm^3$ soil in rotation 5 which included 3 consecutive years of cotton. This level is well below the damage thresholds of 100/100 $cm^3$ on cotton and but is close to the threshold of 25/100 $cm^3$ on peanut.

Table 5. Mean recovery of lesion nematodes per 100 $cm^3$ soil in the Falls of 2017 and 2018 from 53 fields in 7 rotation sequences utilizing cotton and peanut on a Bamberg County, South Carolina farm.

| Rotation # | 2015 | 2016 | 2017 | 2018 | Lesion/100 $cm^3$ soil Fall 17 | Lesion/100 $cm^3$ soil Fall 18 |
|---|---|---|---|---|---|---|
| 1 | Cotton | Cotton | Cotton | Peanut | 10 | 15 |
| 2 | Cotton | Cotton | Peanut | Cotton | 0 | 2 |
| 3 | Cotton | Peanut | Cotton | Resistant Cotton | 11 | 11 |
| 4 | Cotton | Peanut | Cotton | Cotton | 0 | 0 |
| 5 | Peanut | Cotton | Cotton | Resistant Cotton | 22 | 6 |
| 6 | Peanut | Cotton | Cotton | Cotton | 0 | 0 |
| 7 | Peanut | Cotton | Cotton | Peanut | 4 | 18 |

Unless marked "Resistant" all cotton varieties were susceptible to Southern root-knot nematode.

**Stubby Root Nematodes**

Cotton and peanut are both hosts for stubby root nematode. However, recovery levels were quite low in the 7 rotation schemes with a maximum of 22/100 $cm^3$ of soil. This is less than one-half the damage thresholds of 40/100 $cm^3$ on cotton and 50/100 $cm^3$ on peanut.

Table 6. Mean recovery of stubby root nematodes (SRN) per 100 $cm^3$ soil in the Falls of 2017 and 2018 from 53 fields in 7 rotation sequences utilizing cotton and peanut on a Bamberg County, South Carolina farm.

| Rotation # | 2015 | 2016 | 2017 | 2018 | SRN/100 $cm^3$ soil 2017 | SRN/100 $cm^3$ soil 2018 |
|---|---|---|---|---|---|---|
| 1 | Cotton[z] | Cotton | Cotton | Peanut | 10 | 10 |
| 2 | Cotton | Cotton | Peanut | Cotton | 0 | 8 |
| 3 | Cotton | Peanut | Cotton | Resistant Cotton | 14 | 6 |
| 4 | Cotton | Peanut | Cotton | Cotton | 10 | 12 |
| 5 | Peanut | Cotton | Cotton | Resistant Cotton | 1 | 4 |
| 6 | Peanut | Cotton | Cotton | Cotton | 15 | 22 |
| 7 | Peanut | Cotton | Cotton | Peanut | 8 | 4 |

Unless marked "Resistant", all cotton varieties were susceptible to Southern root-knot nematode.

This cotton/cotton/peanut rotation appears to have been highly effective in reducing levels of damage from Southern root-knot and ring nematodes on cotton and peanut, respectively. One year of peanut reduces SRK to the levels where a producer can grow a cotton crop the first year without a nematicide. However, SRK populations rebound rapidly and to grow second year of cotton some control measure will probably be needed. The SRK-resistant variety appears to function very well in reducing SRK levels and possibly allowing a third year of cotton to be grown. Ring nematodes built up very rapidly on one year of peanut. However, little or no damage was observed on the peanut crops from any nematode species or from fungal pod rotting fungi utilizing nematode-damaged sites as enhanced infection courts. There was no evidence of Peanut root-knot nematode in any of the peanut crops in these rotations. This indicates that

including cotton in a peanut rotation may be helpful in reducing any risk of damage to the peanuts from SRK. Similarly, this rotation seemed to minimize the buildup of Columbia lance, lesion, and stubby root nematodes.

## Summary

On this farm Southern root-knot nematode was the primary nematode of concern for cotton production on this farm. Columbia lance nematode was present in some fields, but usually at less than threshold levels for cotton. Ring nematode was the primary nematode of concern on peanut. One year of peanut significantly reduced levels of SRK, in many cases to the level where a nematicide was not needed in that field in cotton immediately following peanut. However, populations of SRK rebounded rapidly in the 1st year of cotton after peanut in almost every field. A nematicide or an SRK-resistant variety were needed in the second year of cotton in most fields to ensure appropriate yields. Where SRK-resistant cotton varieties were grown they suppressed the development of SRK populations in both the first and second years after peanut to the point where SRK remained below cotton threshold levels. Populations of CLN were slow to rebound in the 1st year of cotton after peanut. In most fields CLN populations remained below threshold levels for the first year of cotton after peanut. Although cotton is a host for ring nematode, in most fields ring nematode populations remained below the peanut threshold after 1 or 2 years of cotton. However, during the year of peanut ring nematode levels increased dramatically in most cases. Utilization of a cotton/cotton/peanut rotation was very valuable in minimizing yield losses on both cotton and peanut. SRK resistant varieties provided almost as much SRK control as peanut and should also be very useful in a nematode management program.

## Disclaimer



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