# Crop Rotation Effects on Nematode Populations

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## ABSTRACT

**Crop rotations are an effective method of improving yields. One benefit of alternating crops within a field is nematode suppression. In Louisiana, many fields are infested with root-knot [*Meloidogyne incognita (Koifoid and White*)], reniform [*Rotylenchus reniformis* (Linford and Oliveira), and soybean cyst (*Heterodera glycines* Ichinohe) nematodes. Nematodes can cause plants to be less thrifty and hypersensitive to stress, resulting in yield decline. Nematodes can be controlled for a limited duration with chemicals that can be expensive and highly toxic. Host plant resistance is another alternative to controlling nematode populations; however, this option is often limited by the lack of high-yielding, resistant cultivars available to producers. Most studies involving nematode control with crop rotation have been for less than five years and can not account for alterations in soil properties caused by long-term crop sequences, which may affect nematode population dynamics. The objective of this study was to compare the effectiveness of cropping sequences involving cotton (*Gossypium hirsutum* L.), corn (*Zea mays* L.), soybean (*Glycine max* (L.) Merr.), grain sorghum [Sorghum bicolor (L.) Moench], and wheat (*Triticum aestivum* L.) for control of nematode populations. Cropping sequences established in 1982 were evaluated for nematode population densities. The test site was managed with conventional tillage and practices recommended by LSU. Five sampling dates during 1999-2002 were taken from 6-in cores and assayed for nematode infestation. Data indicated grain sorghum was the best alternative as a non-host crop in fields with mixed reniform and root-knot populations. Corn was a good non-host for reniform nematodes but proved to be a host plant for root-knot nematodes. Winter and spring weed species may also contribute to boosting root-knot nematode populations that were previously suppressed by non-host crops.**

## KEYWORDS

Root-knot nematode, reniform nematode, soybean cyst nematode, cropping systems, crop rotation

## INTRODUCTION

Alluvial soils of the lower Mississippi Delta region in Louisiana are often infested with root-knot (RKN), reniform (REN), and soybean cyst (SCN) nematodes. Infected crops generally are slightly stunted and may show signs of potassium deficiency (Shepherd *et al*., 1988b; Blasingame, 1994). If growing conditions for the crop are less than ideal, nematode infestation may exacerbate plant stress.

Economic losses attributed to nematodes can be immense. In Louisiana, an estimated 87,000 bales of cotton were lost in 2000 because of nematode damage (Blasingame, 2001). Nationwide in the same year, nematodes cost cotton producers nearly 800,000 bales. The range of REN infestation appears to be worsening in Louisiana. Overstreet and McGawley (2000) reported that in two of the leading cotton producing parishes, Richland and Franklin, the incidence of samples with REN had increased by nearly twenty-fold over the last twenty years.

Control of nematodes is difficult and expensive. Chemical control has been somewhat successful with the use of Temik™ (aldicarb) and Telone II™ (Gazaway *et al*., 2001; Lorenz *et al*., 2001; Overstreet *et al*., 2001). Unfortunately, these chemicals can be expensive, highly toxic, and provide only short-term nematode suppression.

An alternative method of controlling nematode populations has been the use of host plant resistance. Several soybean lines exist with excellent SCN and REN resistance (Robbins *et al*., 2000; Long and Todd, 2001). Varying levels of resistance to RKN has also been identified in soybean germplasm (Luzzi *et al*., 1994). Several experimental cotton genotypes have been developed with resistance to RKN (Shepherd, 1974; Shepherd *et al*., 1988a). In 1991, cotton cultivar 'LA 887' was released and possessed partial resistance to root-knot nematodes (Jones *et al*., 1991). Cotton cultivar 'Acala NemX', released in 1995, was the first commercial cultivar with complete resistance to RKN (Oakley, 1998). Unfortunately, few commercial cotton breeding companies dedicate resources for development of RKN resistant cultivars, which leaves producers with

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limited options for fields infested with the nematodes. Little progress has been made in developing REN resistant cotton cultivars.

A third alternative to suppressing nematodes is the practice of crop rotation. Studies indicate that excellent control of soybean cyst nematode can be achieved by rotating SCN resistant soybean cultivars with corn (Howard *et al*., 1998; Long and Todd, 2001; Chen *et al*., 2001). Crop damage from RKN and REN can be mitigated by rotating to a non-host crop for at least one year (Goodell and Eckert, 1998; Overstreet, 1998; Mueller, 1999; Gazaway *et al*., 2000). After a season of growing a susceptible crop host, nematode levels will again be restored to pre-rotation levels. Winter cover crops supposedly have little effect on spring populations of REN (Overstreet *et al*., 2001; Gazaway *et al*., 2000).

Most crop rotation studies that monitored nematode populations have been for less than five years. It is not known how cropping sequences continued for a longer period of time will affect nematode populations in the lower Mississippi Delta.

## METHODS AND MATERIALS

Fourteen cropping sequences including cotton (CT), corn (CN), grain sorghum (GS), soybean (SY), and wheat (WT) have been evaluated at the LSU AgCenter's Northeast Research Station near St. Joseph, LA. The study was initiated in 1982 on Commerce silt loam (fine-silty, mixed, nonacid, thermic Aeric Fluvaquent). Experimental design was a randomized complete block with four replications. Plot size was 16-rows (40-in. centers) X 50 ft. All plots are managed with conventional tillage practices and were not irrigated. During the winter and spring, native weed species were allowed to grow unchecked. All cultivars have been the most recent to be recommended by LSU for commercial production in Louisiana.

Soil was sampled Sept. 1999, Sept. 2000, Sept. 2001, Dec. 2001, and April 2002. Ten cores at 6-in. depths were taken from each plot. Samples were then sent to the LSU Plant Pathology Department in Baton Rouge, LA, for nematode assessment. Nematode populations are reported as nematodes per 500 $cm^3$ soil. Nematode data were analyzed using the GLM procedures of SAS (1989). Fisher's protected LSD at a significance level of 0.05 was used to separate means.

## RESULTS AND DISCUSSION

The most common nematode species found was RKN (Table 1). Cotton, corn, and to a lesser extent soybean and wheat were susceptible to RKN. Grain sorghum did not support RKN populations at a detectable level and appears to be the most promising rotation choice for suppression. Grain sorghum consistently eliminated RKN from areas previously planted to cotton and soybean. After a year back to cotton or soybean, RKN populations were restored to the pre-rotation level. These results are similar to scenarios associated with REN and crop rotation (Overstreet, 1998; Gazaway, 1999; Mueller, 1999). The spring 2002 sampling from the CT-GS-SY cropping scheme, in which grain sorghum was planted in 2001, indicated the presence of

**Table 1.** Cropping sequence effect on root-knot nematode (500 $cm^3$ of soil).

| Crop | Fall 1999 | | Fall 2000 | | Fall 2001 | | Winter 2001 | | Spring 2002 | |
|---|---|---|---|---|---|---|---|---|---|---|
| Scheme | Crop | RKN | Crop | RKN | Crop | RKN | Crop | RKN | Crop | RKN |
| CT | *CT* | 3840 | *CT* | 560 | *CT* | 950 | *CT* | 160 | *CT* | 295 |
| SY | *SY* | 0 | *SY* | 420 | *SY* | 40 | *SY* | 0 | *SY* | 325 |
| CN | *CN* | 160 | *CN* | 747 | *CN* | 120 | *CN* | 40 | *CN* | 80 |
| GS | *GS* | 0 | *GS* | 0 | *GS* | 0 | *GS* | 0 | *GS* | 0 |
| CN-CT | *CT* | 1813 | *CN* | 300 | *CT* | 960 | *CT* | 200 | *CT* | 40 |
| CN-SY | *SY* | 27 | *CN* | 107 | *SY* | 650 | *SY* | 160 | *SY* | 1200 |
| CT-SY | *SY* | 373 | *CT* | 27 | *SY* | 75 | *SY* | 35 | *SY* | 80 |
| GS-CT | *CT* | 3840 | *GS* | 0 | *CT* | 560 | *CT* | 0 | *CT* | 920 |
| GS-SY | *SY* | 107 | *GS* | 0 | *SY* | 0 | *SY* | 0 | *SY* | 40 |
| CT-CN-SY | *SY* | 27 | *CT* | 0 | *CN* | 835 | *CN* | 80 | *CN* | 280 |
| CT-GS-SY | *SY* | 93 | *CT* | 427 | *GS* | 0 | *GS* | 0 | *GS* | 80 |
| CT-CT-SY | *SY* | 40 | *CT* | 0 | *CT* | 240 | *CT* | 80 | *CT* | 0 |
| CT-CT-CN | *CN* | 3840 | *CT* | 0 | *CT* | 960 | *CT* | 40 | *CT* | 220 |
| SY-WT | *SY* | 0 | *SY* | 13 | *SY* | 120 | *WT* | 40 | *WT* | 80 |
| **Mean** | | 1011 | | 186 | | 394 | | 60 | | 260 |
| **LSD$_{(0.05)}$** | | n.s. | | n.s. | | n.s. | | n.s. | | n.s. |

**Table 2.** Cropping sequence effect on reniform nematode (500 $cm^3$ of soil).

| Crop Scheme | Fall 1999 | | Fall 2000 | | Fall 2001 | | Winter 2001 | | Spring 2002 | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Crop | REN | Crop | REN | Crop | REN | Crop | REN | Crop | REN |
| CT | *CT* | 0 | *CT* | 3733 | *CT* | 1600 | *CT* | 2840 | *CT* | 3610 |
| SY | *SY* | 0 | *SY* | 0 | *SY* | 0 | *SY* | 0 | *SY* | 40 |
| CN | *CN* | 0 | *CN* | 0 | *CN* | 0 | *CN* | 0 | *CN* | 0 |
| GS | *GS* | 0 | *GS* | 0 | *GS* | 0 | *GS* | 0 | *GS* | 0 |
| CN-CT | *CT* | 0 | *CN* | 0 | *CT* | 0 | *CT* | 250 | *CT* | 640 |
| CN-SY | *SY* | 0 | *CN* | 0 | *SY* | 0 | *SY* | 0 | *SY* | 0 |
| CT-SY | *SY* | 0 | *CT* | 0 | *SY* | 5080 | *SY* | 1680 | *SY* | 80 |
| GS-CT | *CT* | 0 | *GS* | 0 | *CT* | 0 | *CT* | 0 | *CT* | 0 |
| GS-SY | *SY* | 0 | *GS* | 0 | *SY* | 0 | *SY* | 0 | *SY* | 0 |
| CT-CN-SY | *SY* | 0 | *CT* | 0 | *CN* | 0 | *CN* | 0 | *CN* | 0 |
| CT-GS-SY | *SY* | 0 | *CT* | 0 | *GS* | 0 | *GS* | 0 | *GS* | 0 |
| CT-CT-SY | *SY* | 0 | *CT* | 0 | *CT* | 0 | *CT* | 0 | *CT* | 0 |
| CT-CT-CN | *CN* | 0 | *CT* | 0 | *CT* | 0 | *CT* | 40 | *CT* | 0 |
| SY-WT | *SY* | 0 | *SY* | 6613 | *SY* | 0 | *WT* | 0 | *WT* | 0 |
| **Mean** | | 0 | | 739 | | 477 | | 344 | | 312 |
| **$LSD_{(0.05)}$** | | n.s. | | n.s. | | n.s. | | n.s. | | n.s. |

**Table 3.** Cropping sequence effect on soybean cyst nematode (500 $cm^3$ of soil).

| Crop Scheme | Fall 1999 | | Fall 2000 | | Fall 2001 | | Winter 2001 | | Spring 2002 | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Crop | SCN | Crop | SCN | Crop | SCN | Crop | SCN | Crop | SCN |
| CT | *CT* | 0 | *CT* | 0 | *CT* | 0 | *CT* | 0 | *CT* | 0 |
| SY | *SY* | 0 | *SY* | 0 | *SY* | 15 | *SY* | 0 | *SY* | 10 |
| CN | *CN* | 0 | *CN* | 0 | *CN* | 0 | *CN* | 0 | *CN* | 0 |
| GS | *GS* | 0 | *GS* | 0 | *GS* | 0 | *GS* | 0 | *GS* | 0 |
| CN-CT | *CT* | 0 | *CN* | 0 | *CT* | 0 | *CT* | 0 | *CT* | 0 |
| CN-SY | *SY* | 0 | *CN* | 0 | *SY* | 0 | *SY* | 0 | *SY* | 0 |
| CT-SY | *SY* | 0 | *CT* | 0 | *SY* | 0 | *SY* | 0 | *SY* | 0 |
| GS-CT | *CT* | 0 | *GS* | 0 | *CT* | 0 | *CT* | 0 | *CT* | 0 |
| GS-SY | *SY* | 0 | *GS* | 0 | *SY* | 0 | *SY* | 0 | *SY* | 0 |
| CT-CN-SY | *SY* | 0 | *CT* | 0 | *CN* | 0 | *CN* | 0 | *CN* | 0 |
| CT-GS-SY | *SY* | 0 | *CT* | 0 | *GS* | 0 | *GS* | 0 | *GS* | 0 |
| CT-CT-SY | *SY* | 0 | *CT* | 0 | *CT* | 0 | *CT* | 0 | *CT* | 0 |
| CT-CT-CN | *CN* | 0 | *CT* | 0 | *CT* | 0 | *CT* | 0 | *CT* | 0 |
| SY-WT | *SY* | 0 | *SY* | 0 | *SY* | 0 | *WT* | 0 | *WT* | 0 |
| **Mean** | | 0 | | 0 | | 1 | | 0 | | 1 |
| **$LSD_{(0.05)}$** | | n.s. | | n.s. | | n.s. | | n.s. | | n.s. |

RKN. This may have been the result of RKN finding hosts among native weed species during the winter and spring.

The second most common nematode species in the study was REN (Table 2). Incidence of REN was more sporadic than RKN and may be the result of sensitivity to fluctuating conditions in the upper 6-in. soil profile (McSorley, 1998). Data suggests that cotton and soybean were excellent host species. These findings are congruent with previous research (Starr, 1998; Kinloch, 1998). Corn and grain sorghum, considered good rotation choices for REN control (Mueller, 1999; Gazaway, 2000), drove REN populations below detectable levels. REN in cotton-grain sorghum rotations were not detected and were never detected in the soybean-cotton rotation, which is contrary to expectations (Overstreet, 1998). There may have been an interaction with soil properties and REN in these cropping schemes that impaired REN fecundity (Howard *et al*., 1998; Zhao, 2000).

SCN were only detected in areas planted in continuous soybean (Table 3). The plant host range of SCN is very limited (Noe, 1998). Soybean grown in rotation with any of the other crops, including the double-cropped wheat, appeared to substantially reduce SCN.

## CONCLUSIONS

Grain sorghum appears to be the best non-host rotation option especially in fields with mixed populations of RKN and REN. Samples from plots planted to grain sorghum consistently were free from all detectable nematode infestations. Moreover, the benefit of grain sorghum in suppression of REN to cotton and soybean was slightly better than was observed from corn. SCN were invariably controlled with crop rotation.

Further investigations are needed into the dynamics of soil properties and vitality of nematode populations. In addition, weed species that are hosts to RKN and REN need to be identified and control measures devised to ensure the advantages of crop rotation are preserved for as long as possible.

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