VALUE OF ROTATIONAL CROPS FOR PROFIT INCREASE AND RENIFORM NEMATODE SUPPRESSION WITH AND WITHOUT A NEMATICIDE IN ALABAMA

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Abstract

Crop rotation with cotton is often utilized for the suppression of the reniform nematode (*Rotylenchulus reniformis*) in the southeastern United States. A study was conducted from 2006 – 2009 to evaluate the economic benefit and reniform nematode suppression of single and multiple year rotations of corn, soybeans, and peanuts with cotton, with and without Telone II. All rotations resulted in initial reniform nematode population reductions ($P \leq 0.10$) compared with continuous cotton. Reduction ($P \leq 0.10$) of final reniform populations was achieved by cotton following two years of corn, one and two years of peanuts, and two years of soybeans without Telone II. Cotton following two years of soybeans was the only rotation to reduce final populations ($P \leq 0.10$) with Telone II. While no rotation produced significantly ($P \leq 0.10$) higher yields with or without Telone II, all rotations with the exception of one year of soybean produced numerically higher yields. Cotton following one year of corn, peanuts or soybeans without Telone II yielded 16%, 26%, and 17% higher than continuous cotton. One year of corn or peanuts with Telone II yielded 2% and 4% higher than continuous cotton. Cotton following two years of corn, peanuts or soybeans yielded higher than continuous cotton by 34%, 46%, and 40% without Telone II, and 14%, 19%, and 13% with Telone II, respectively. All rotations resulted in a net profit over variable costs compared to continuous cotton both with and without a nematicide. The three year rotations of corn and soybeans followed by cotton produced the largest increase in net profit over variable costs, both with and without a nematicide. The use of the correct crop rotation for the suppression of the reniform nematode can have a positive impact on cotton yields, even without the use of a nematicide.

Introduction

The reniform nematode, (*Rotylenchulus reniformis*), is the most economically damaging cotton pest in Alabama. Yield losses of greater than 7% have been recorded throughout the past decade (Blasingame et al., 2009) equaling more than 16 million dollars annually. Rotation to non-host crops such as corn and peanuts, as well as resistant cultivars of soybean, has been reported to lower reniform nematode populations and increase cotton yields in subsequent growing seasons (Davis et al., 2003; Gazaway et al., 2000; Stetina, et al., 2007; Westphal and Scott, 2005). However crop rotation, while increasing cotton yields over monoculture cotton, may not increase overall profits. Cotton profits per acre are consistently higher compared to peanuts, soybeans, or corn (USDA-NASS) and the loss of profit per acre could outweigh the benefits of reniform nematode suppression. The use of 1, 3-dichloropropene (Telone II®) has been shown to effectively reduce reniform nematode populations in cotton (Koenning et al., 2007; Rich and Kinloch, 2000) while increasing cotton yields. The goal of this study is to determine the overall economic benefit of one, two, and three year rotations of cotton, corn, soybeans, and peanuts compared to continuous cotton, with and without the nematicide Telone II.

Materials and Methods

Field Trial:
A trial to determine the economic benefits of crop rotation with and without a nematicide was established in 2005 in Escambia County, AL. The soil type of the field was a Ruston very fine sandy loam (sand-silt-clay 59-33-08, OM 0.9%, pH 6.1) with a long history of reniform nematode infestation. Treatments were established as continuous cotton, or one, two, or three year rotations of corn, soybeans, or peanuts with and without the nematicide 1, 3-dichloropropene (Telone II). The rotation/nematicide treatments are summarized in Table 1. The field trial was a split-plot design with nematicides as the primary factor and the rotational crops as the secondary factor, with four

replicates. All plots were 8 rows wide and 12.19 m long. Cotton plots were split into 2, 4-row subplots with one subplot selected at random and treated with Telone II. All plots were planted in winter with a rye cover crop which was cut the following spring, plowed, and disked 6 weeks prior to summer crop planting. Telone II was injected 18 inches deep at a rate of 3 gal/acre into raised seedbeds designated nematicide plots three weeks before planting. Cotton seed (*cv.* DPL-555BGRR) was treated with thiamethoxam (Cruiser®) for early season insect control. Peanut (*cv.* AP3), soybean (*cv.* DP5634RR), and corn (*cv.* Pioneer 33M53RR) were planted in the rotation crops.

Table 1. Rotation /nematicide treatment schedule

TRT #	TREATMENT	Treatment	2005	2006	2007	2008	2009	2010
1	Corn 1 Year	Nematicide	cotton	corn	cotton	corn	cotton	corn
2	Corn 1 Year	No Nematicide	cotton	corn	cotton	corn	cotton	corn
3	Peanut 1 Year	Nematicide	cotton	peanut	cotton	peanut	cotton	peanut
4	Peanut 1 Year	No Nematicide	cotton	peanut	cotton	peanut	cotton	peanut
5	Soybean 1 Year	Nematicide	cotton	soybean	cotton	soybean	cotton	soybean
6	Soybean 1 Year	No Nematicide	cotton	soybean	cotton	soybean	cotton	soybean
7	Corn 2 Year	Nematicide	corn	corn	cotton	corn	corn	cotton
8	Corn 2 Year	No Nematicide	corn	corn	cotton	corn	corn	cotton
9	Peanut 2 Year	Nematicide	peanut	peanut	cotton	peanut	peanut	cotton
10	Peanut 2 Year	No Nematicide	peanut	peanut	cotton	peanut	peanut	cotton
11	Soybean 2 Year	Nematicide	soybean	soybean	cotton	soybean	soybean	cotton
12	Soybean 2 Year	No Nematicide	soybean	soybean	cotton	soybean	soybean	cotton
13	Continuous Cotton	Nematicide	cotton	cotton	cotton	cotton	cotton	cotton
14	Continuous Cotton	No Nematicide	cotton	cotton	cotton	cotton	cotton	cotton
15	Corn 1 Year	Nematicide	corn	cotton	corn	cotton	corn	cotton
16	Corn 1 Year	No Nematicide	corn	cotton	corn	cotton	corn	cotton
17	Peanut 1 Year	Nematicide	peanut	cotton	peanut	cotton	peanut	cotton
18	Peanut 1 Year	No Nematicide	peanut	cotton	peanut	cotton	peanut	cotton
19	Soybean 1 Year	Nematicide	soybean	cotton	soybean	cotton	soybean	cotton
20	Soybean 1 Year	No Nematicide	soybean	cotton	soybean	cotton	soybean	cotton
21	Corn 2 Year	Nematicide	cotton	corn	corn	cotton	corn	corn
22	Corn 2 Year	No Nematicide	cotton	corn	corn	cotton	corn	corn
23	Peanut 2 Year	Nematicide	cotton	peanut	peanut	cotton	peanut	peanut
24	Peanut 2 Year	No Nematicide	cotton	peanut	peanut	cotton	peanut	peanut
25	Soybean 2 Year	Nematicide	cotton	soybean	soybean	cotton	soybean	soybean
26	Soybean 2 Year	No Nematicide	cotton	soybean	soybean	cotton	soybean	soybean
27	Corn 3 Year	Nematicide	cotton	corn	corn	corn	cotton	corn
28	Corn 3 Year	No Nematicide	cotton	corn	corn	corn	cotton	corn
29	Peanut 3 Year	Nematicide	cotton	peanut	peanut	peanut	cotton	peanut
30	Peanut 3 Year	No Nematicide	cotton	peanut	peanut	peanut	cotton	peanut
31	Soybean 3 Year	Nematicide	cotton	soybean	soybean	soybean	cotton	soybean
32	Soybean 3 Year	No Nematicide	cotton	soybean	soybean	soybean	cotton	soybean

Data Collection and Analysis

Nematode samples were collected at planting and at harvest in all rotation plots. Multiple core samples, 1 inch diameter by 6 inches deep, were collected from the center two rows of each plot in a systematic zigzag pattern. Samples were placed into plastic bags and transported back to Auburn University within an insulated ice chest. The soil was then thoroughly mixed and a 150cm^3 was removed for extraction. Nematodes were extracted by combined gravity screening and sucrose centrifugation (specific gravity = 1.13) and enumerated with an inverted microscope. Cotton yields were harvested with a mechanical plot cotton picker from the two center rows of each plot. Nematode populations and cotton yields were analyzed using the GLIMMIX procedure of SAS (SAS Institute, Cary, NC). Least squares means of treatments were compared using Dunnett's method and were considered significant where $P \leq 0.10$. Commodity prices, average commodity yields per acre and average variable cost per acre for Escambia County, AL were obtained from the USDA-NASS data base and the Alabama Cooperative Extension System (Table

2). Average profits per year for each commodity were normalized by comparison to cotton yields by the formula [(Average real cotton profit per acre/county average cotton profit per acre) * county average commodity profit per acre].

Table 2. Average commodity yields, prices, and profit per acre for Escambia County, AL

Escambia County, AL				
Commodity	Predicted Yield/acre	Average Price	Variable Costs	Net Return / Variable Costs
Cotton	1,200 lbs	$0.52	$580	$44
Peanut	4,200 lbs	$0.18	$587	$169
Soybean	55 bu	$7.86	$272	$160
Corn	170 bu	$3.81	$492	$156

Results and Discussion

Reniform nematode populations at plant averaged 1,165 per 150cm^3 of soil for the continuous cotton treatment without nematicide throughout the trial. All treatments significantly reduced initial reniform populations compared to continuous cotton, with the exception of the 3 year peanut and 3 year soybean treatments (Figure 1). All treatments with the exception of the three year soybean treatment significantly lowered reniform nematode populations at plant compared to the continuous cotton treatment with a nematicide, which averaged 901 per 150cm^3 of soil (Figure 2).

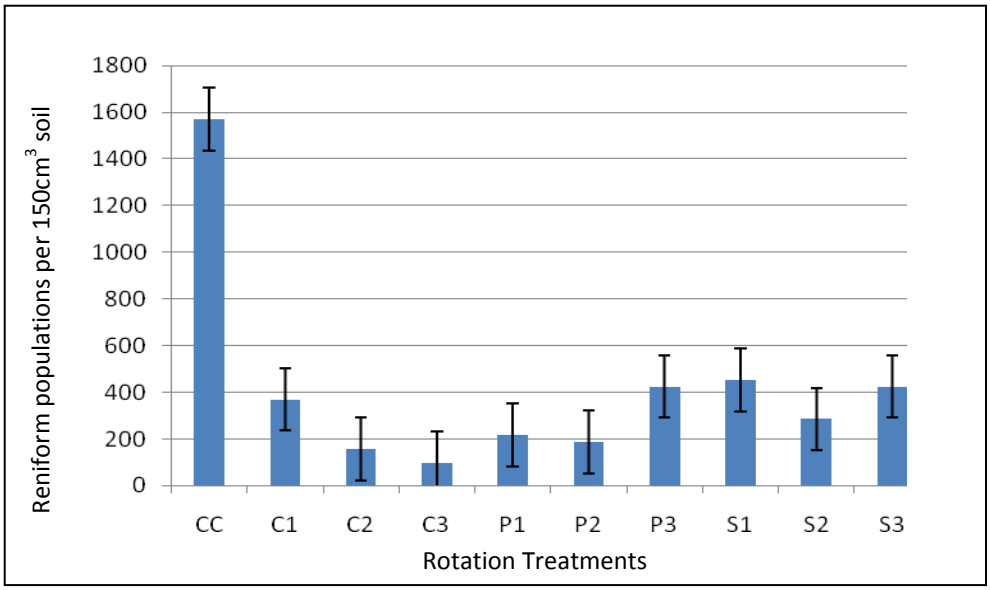

Figure 1. Average reniform nematode populations per 150cm^3 soil at plant for treatments (C1= Corn 1 year, C2= Corn 2 year, C3= Corn 3 year, P1= Peanut 1 Year, P2= Peanut 2 year, P3=Peanut 3 year, S1 = Soybean 1 year, S2= Soybean 2 year, S3= Soybean 3 year) compared to continuous cotton (CC) without Telone II.

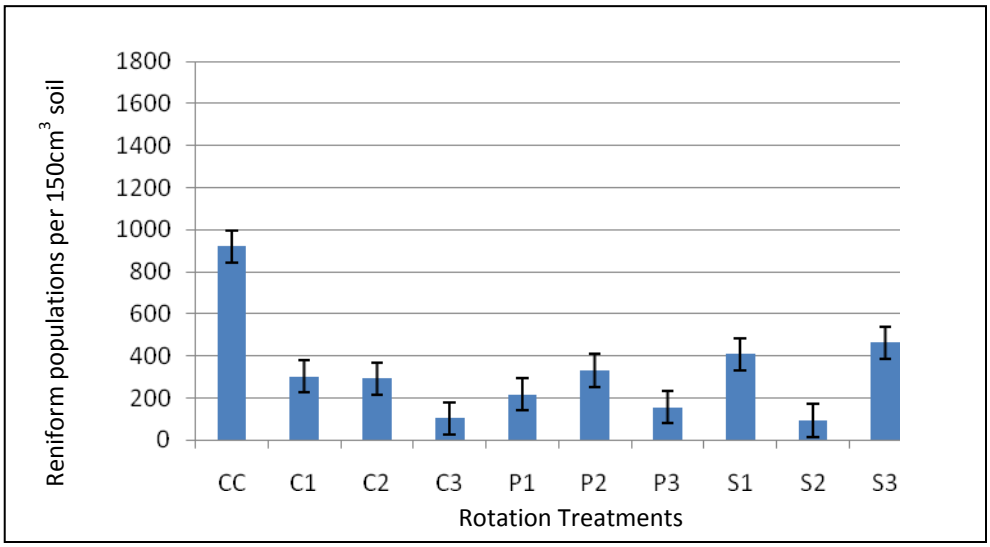

Figure 2. Average reniform nematode populations per 150cm^3 soil at plant for treatments (C1= Corn 1 year, C2= Corn 2 year, C3= Corn 3 year, P1= Peanut 1 Year, P2= Peanut 2 year, P3=Peanut 3 year, S1 = Soybean 1 year, S2= Soybean 2 year, S3= Soybean 3 year) compared to continuous cotton (CC) with Telone II.

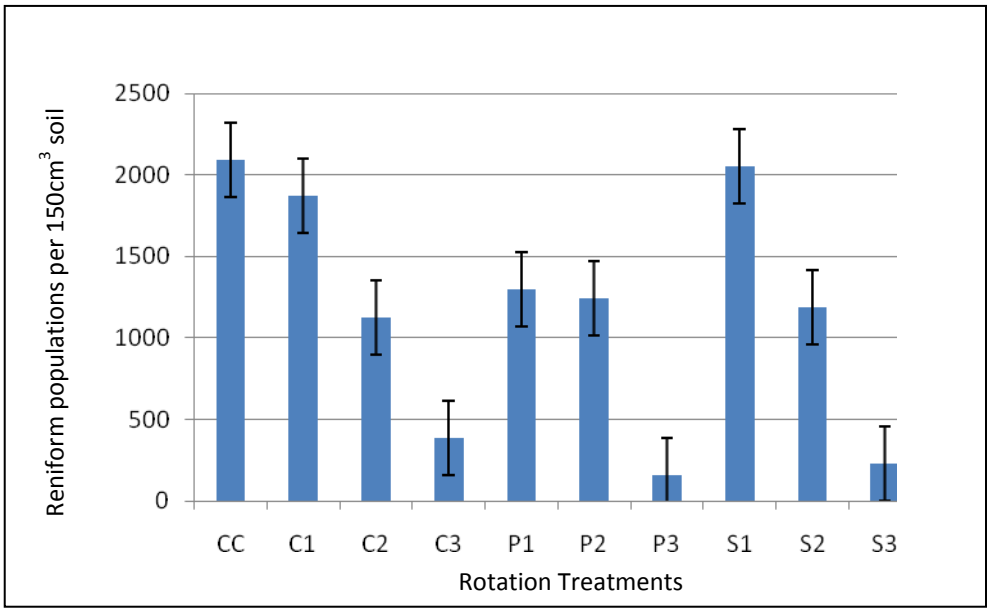

Figure 3. Average reniform nematode populations per 150cm^3 soil at harvest for treatments (C1= Corn 1 year, C2= Corn 2 year, C3= Corn 3 year, P1= Peanut 1 Year, P2= Peanut 2 year, P3=Peanut 3 year, S1 = Soybean 1 year, S2= Soybean 2 year, S3= Soybean 3 year) compared to continuous cotton (CC) without Telone II.

Reniform nematode populations at harvest were significantly lower for the 3 year corn, 3 year peanut, and 3 year soybean treatments compared to the continuous cotton without nematicide treatment, which averaged 2,182 per 150cm^3 of soil (Figure 3). Reniform nematode populations at harvest for the continuous cotton treatment with a nematicide averaged 1,423 per 150cm^3 of soil (Figure 4). The 3 year peanut and 3 year soybean treatments produced significantly lower populations at harvest compared to the continuous cotton treatment with a nematicide. Cotton lint yields were significantly increased following all rotations both with and without nematicide, with the exception of cotton following one year of corn and soybeans (Figures 5 and 6). All cotton yields increased with the number of years of rotation, with the exception of cotton following 3 years of peanuts with a nematicide. With a nematicide,

cotton lint yields were significantly increased by two and three year rotations of corn and peanuts, and the three year rotation of soybeans compared to all other rotations. A one year rotation of peanuts significantly increased cotton yields compared to the one year rotation of soybeans, while the two year rotations of corn and peanuts resulted in significantly higher lint yields than the two year rotation of soybeans. Without a nematicide, the three year rotation to corn produced significantly higher yields compared to one and two year rotations of corn, but was similar to the two and three year rotations of peanuts and soybeans. The two year rotation of corn produced significantly higher yields compared to one year rotations of corn and soybeans but produced similar yields compared to the one year rotation of peanuts.

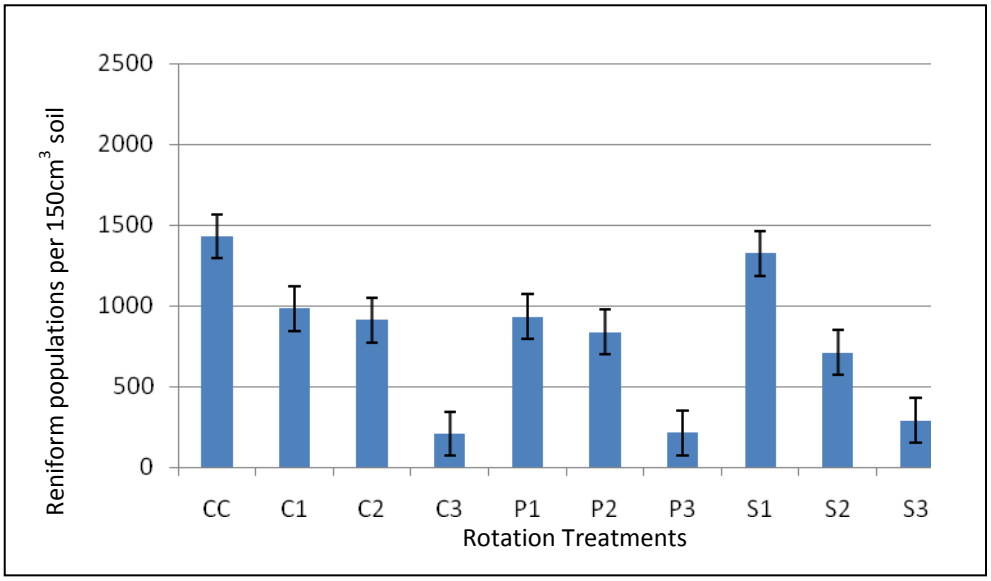

Figure 4. Average reniform nematode populations per 150cm^3 soil at harvest for treatments (C1= Corn 1 year, C2= Corn 2 year, C3= Corn 3 year, P1= Peanut 1 Year, P2= Peanut 2 year, P3=Peanut 3 year, S1 = Soybean 1 year, S2= Soybean 2 year, S3= Soybean 3 year) compared to continuous cotton (CC) with Telone II.

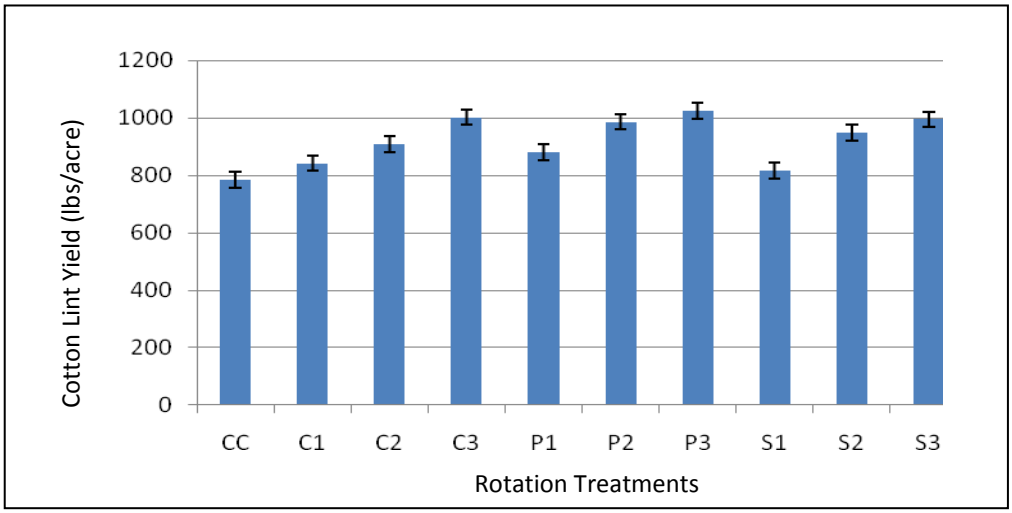

Figure 5. Average cotton lint yields (lbs/acre) for treatments (C1= Corn 1 year, C2= Corn 2 year, C3= Corn 3 year, P1= Peanut 1 Year, P2= Peanut 2 year, P3=Peanut 3 year, S1 = Soybean 1 year, S2= Soybean 2 year, S3= Soybean 3 year) compared to continuous cotton (CC) without Telone II.

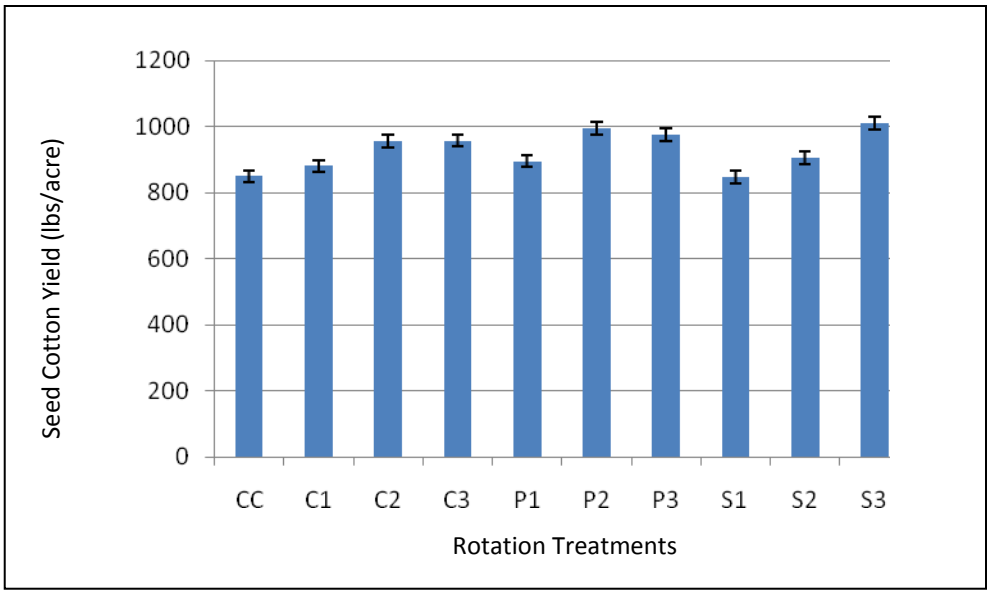

Figure 6. Average cotton yields (lbs/acre) for treatments (C1= Corn 1 year, C2= Corn 2 year, C3= Corn 3 year, P1= Peanut 1 Year, P2= Peanut 2 year, P3=Peanut 3 year, S1 = Soybean 1 year, S2= Soybean 2 year, S3= Soybean 3 year) compared to continuous cotton (CC) with Telone II.

Average net return over variable costs was significantly increased by all rotations compared to continuous cotton both with and without a nematicide (Figures 7 and 8). Without a nematicide, the three year rotations of corn and soybean increased net returns over all other rotations. A two year rotation of soybeans produced significantly higher net returns than the one and two year rotations of corn and peanuts and the one year rotation of soybeans. The three year rotation of peanuts resulted in higher net returns compared to the one and two year rotations of corn and the one year rotation of soybeans. With a nematicide, the three year rotations of corn and soybean increased net returns over all other rotations. A two year rotation of soybeans produced significantly higher net returns than the one and two year rotations of corn and the one year rotations of peanuts and soybeans. The three year rotation of peanuts resulted in higher net returns compared to the one and two year rotations of corn and peanuts and the one year rotation of soybeans. A comparison of the net return over variable costs for all rotations and continuous cotton with a nematicide compared to continuous cotton is presented in Figure 9. Net returns over variable costs increase as the number of years of rotation increase for each crop. The three year rotations of corn and soybeans both with and without a nematicide provided the largest net returns over continuous cotton. The addition of a nematicide slightly increased net returns for corn and peanuts, however it did not increase net returns for soybeans. All rotations also increased net returns compared to continuous cotton with a nematicide.

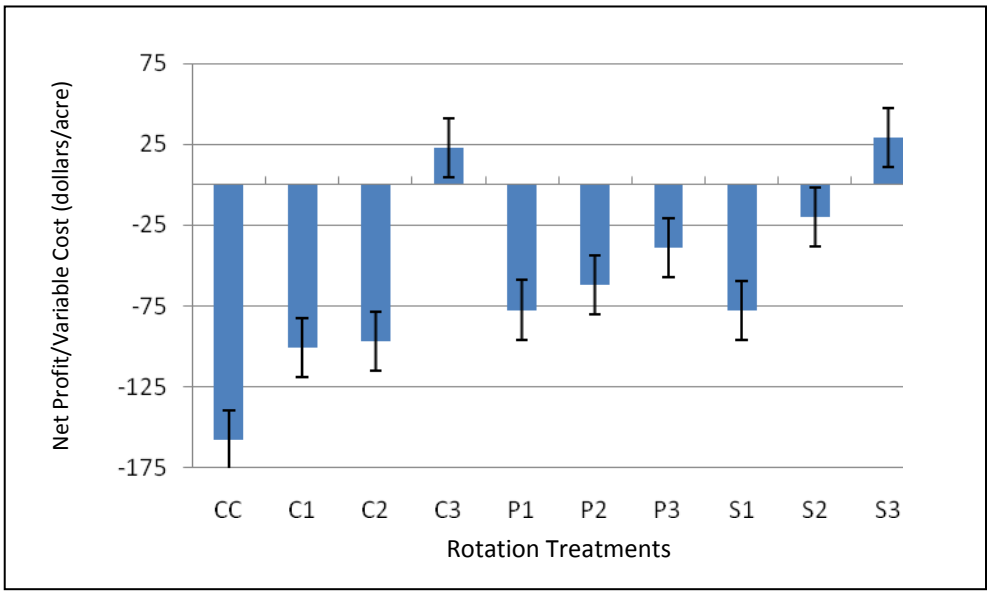

Figure 7. Average net return/variable cost (dollars/acre) for treatments (C1= Corn 1 year, C2= Corn 2 year, C3= Corn 3 year, P1= Peanut 1 Year, P2= Peanut 2 year, P3=Peanut 3 year, S1 = Soybean 1 year, S2= Soybean 2 year, S3= Soybean 3 year) compared to continuous cotton (CC) without Telone II.

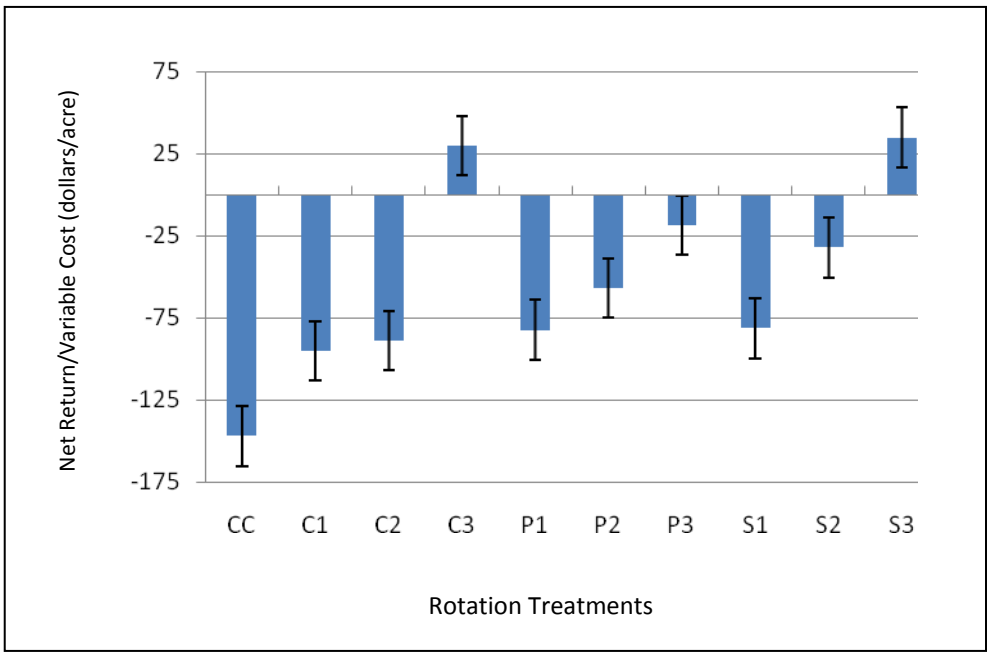

Figure 8. Average net return/variable costs (dollars/acre) for treatments (C1= Corn 1 year, C2= Corn 2 year, C3= Corn 3 year, P1= Peanut 1 Year, P2= Peanut 2 year, P3=Peanut 3 year, S1 = Soybean 1 year, S2= Soybean 2 year, S3= Soybean 3 year) compared to continuous cotton (CC) with Telone II.

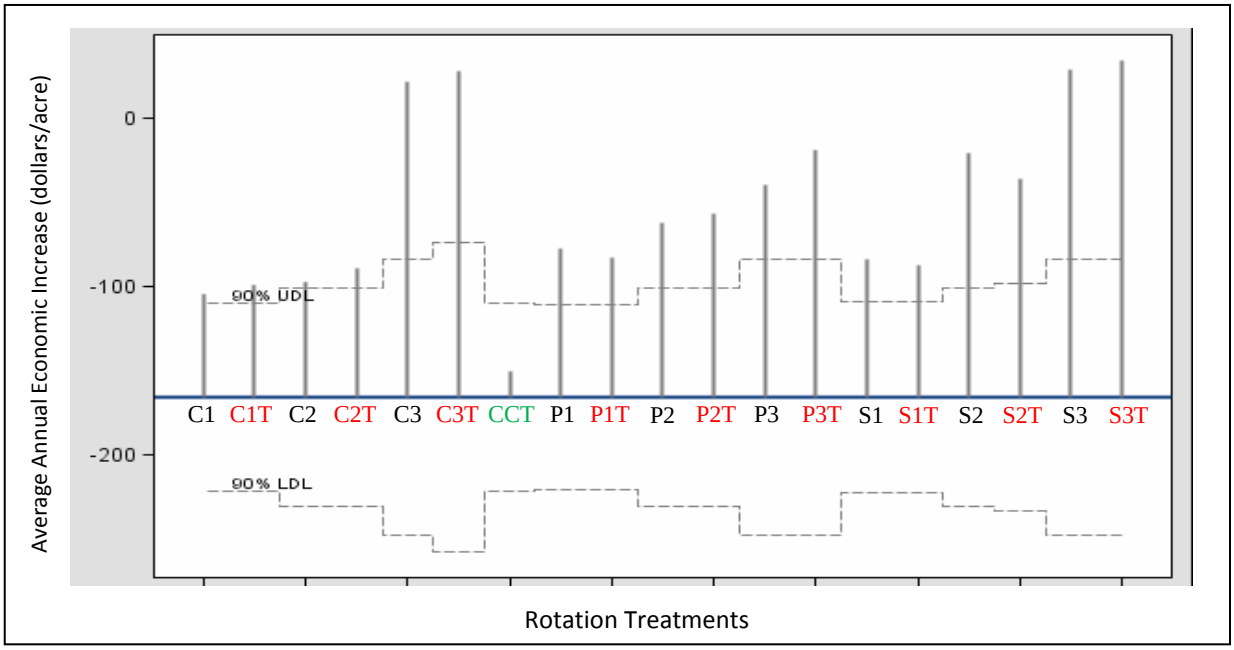

Figure 9. Average net return/variable costs (dollars/acre) for treatments (C1= Corn 1 year, C1T=Corn 1 year/nematicide, C2= Corn 2 year, C2T= Corn 2 year/nematicide, C3= Corn 3 year, C3T= Corn 3 year/nematicide, CCT= Continuous Cotton/nematicide, P1= Peanut 1 Year, P1T= Peanut 1 year/nematicide, P2= Peanut 2 year, P2T= Peanut 2 year/nematicide, P3=Peanut 3 year, P3T= Peanut 3 year/nematicide, S1 = Soybean 1 year, S1T= Soybean 1 year/nematicide, S2= Soybean 2 year, S2T= Soybean 2 year/nematicide, S3= Soybean 3 year, S3T= Soybean 3 year/nematicide) compared to continuous cotton (blue mid-line). Upper and lower confidence intervals at $P \leq 0.10$ denoted by dashed lines.

Conclusions

As was stated earlier in this paper and supported by our data, the value of reniform nematode population suppression of each of these three rotation crops, corn, peanut, and soybean is well known. Additionally, the data illustrates that the net return over variable costs is increased by all rotations over continuous cotton both with and without a nematicide. While the three year rotations of all three crops provide the greatest increases in net return, it is not necessarily practical to grow these crops, especially peanuts, for three consecutive years. The increase in disease and insect pressure would most likely negate any positive effects on yield in subsequent plantings. The increases in net return for one and two years however, can provide satisfactory results from rotation to non-host crops.

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