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Influence Of Crop Rotation On The Severity Of Diseases As Well As Populations Of Root-Knot Nematode On The Yield Of Corn, Cotton, And Peanut In Southwest Alabama

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Introduction

Crop rotation is considered the most effective management strategy for avoiding damaging outbreaks of soil borne diseases and nematodes in cotton and peanut, as well as, costly pesticide inputs required for their control (1,2,4,5,8,9). Peanut cropping frequency has also been shown to have an impact on the severity of early and late leaf spot (2,6). The objectives of this study are to 1) assess the impact of corn cropping frequency on the severity of diseases of peanut, as well as on populations of the southern and peanut root-knot nematodes on corn, cotton, and peanut; and 2) define the agronomic value of corn as a rotation partner with cotton and peanut.

Production Methods

From 1998 until 2002, the cropping sequence for the test area was cotton – cotton – peanut – cotton – peanut. Prior to planting, the site, which is a Malbis fine sandy loam (OM<1%), was prepared for planting with a moldboard plow and a disk harrow/field cultivator. A randomized complete block with four replications of each rotation pattern was used. Individual plots consisted of eight 30-ft rows spaced 3.2 ft apart. The plots were not irrigated. A broadcast applications of 279 lb/A of 7-21-21-10S-0.5B, 250 lb/A of 15-15-15-10S-3Z, and 280 lb/A of 7-21-21-10S-0.5B analysis fertilizer were made on 26 March 2003, 9 March 2004, and 7 March, respectively, and incorporated. While Pioneer 33R25 corn was planted on 1 April 2003, DKC 69-72 was planted on 18 March 2004 and 11 April 2005. Corn was topdressed with approximately 325 lb/A of ammonium nitrate on 28 April 2003 and 2004, and on 10 May 2005. Corn plots were combined on 5 August 2003, 4 August 2004, and 18 August 2005.

The cotton cultivar DPL 458 BR, which was planted on 13 May 2003 and 2004, was followed by Fibermax 960 BR on 12 May 2005. In all three years, Temik 15G at 6.7 lb/A was applied in-furrow for thrips control. A lay-by application of N-Sol (32% nitrogen) at a rate of 75 to 88 pounds of actual nitrogen/A was made to the cotton approximately 50 to 60 days after planting (DAP). While Pix was used as a growth regulator in 2003 and 2004, Pentia was applied to cotton in 2005. Timely application(s) of a defoliant and boll opener were made to the cotton approximately 1 to 2 weeks prior to harvest. Cotton was picked on 16 October 2003 and 30 September 2005. In 2004, the cotton was heavily damaged by Hurricane Ivan and was not harvested for yield.

Peanut cv Carver was planted on 13 April 2003 and 2004, and 12 May 2005 at a rate of 6 seed per foot of row. Bravo Ultrex at 1.4 lb/A or Bravo Weather Stik at 1.5 pt/A was applied on a 14-day calendar schedule with a CO_2-pressurized sprayer with three TX-8 nozzles per row in approximately 10 gallons of water/A. Applications were made on 26 June, 10 July, 22 July, 5 August, 18 August, 2 September, and 12 September 2003; 22 June, 7 July, 13 July, 29 July, 4 August, 13 August, 26 August, and 8 September 2004; and 22 June, 5 July, 20 July, 3 August, 17 August, 1 September, and 13 September 2005. Peanuts were inverted on 18 September 2003, 28 September 2004, and 4 October 2005. Yields are reported at 10% moisture.

In 2003, Prowl at 3 pt/A was broadcast for pre-emergent weed control on the corn, cotton and peanut plots. Post-plant applications of 2 qt/A Atrazine were made to corn on 13 May 2003 and 7 May 2004. Cotton plots were treated post-emergent with 24 fl oz/A of Roundup Ultra-Max in 2003, 2 pt/A of Roundup Weathermax + 2 pt/A Prowl on 14 May 2004, and 24 fl oz/A of Roundup Originalmax on 20 May 2005. In 2003, additonal post-plant herbicide applications on cotton included 1.2 oz/A Staple + 1 qt/A DSMA + 1 qt/100 gal Activate adjuvant on 9 June and 42 fl oz/A MSMA 6 + 1.5 pt/A Prometryne on 26 June. For 2004, the only additional post-plant herbicide treatment applied to cotton was 1 oz/A Staple on 8 June. Other than Roundup Originalmax, no additional post-plant herbicide treatments were applied to cotton.

Disease and Nematode Assessment

Severity of early and late leaf spot was rated using the Florida 1 to 10 peanut leaf spot scoring system, where 1 = no disease, 2 = very few leaf spots in canopy, 3 = some leaf spots in lower and upper canopy, 4 = some leaf spotting with light defoliation (≤10%), 5 = leaf spotting noticeable in upper canopy with some defoliation (≤25%), 6 = leaf spots numerous with significant defoliation (≤50%), 7 = leaf spots numerous with heavy defoliation (≤75%), 8 = numerous leaf spots on few remaining leaves with severe defoliation (≤90%), 9 = very few remaining leaves covered with leaf spots and severe defoliation (≤95%), and 10 = plants defoliated or dead, on 18 September 2003, 2004, and 2005. Rust severity was rated using the ICRISAT 1-9 rust rating scale where 1 = no disease to 9 = 80 to 100% of the leaves withered. White mold [southern stem rot] hit counts, where 1 hit equals ≤1 foot of consecutive white mold-damaged plants per row, were made immediately after plot inversion on 18 September 2003, 28 September 2004, and 4 October 2005. Incidence of tomato spotted wilt virus (TSWV) in peanut was assessed the week before plots inversion by counting the number of TSWV hits where 1 hit equals ≤ 1 foot of consecutive diseased plants per row. Approximately 20 cores from each plot were taken with a 1 inch sampling tube and bulked. Nematodes were separated from a 1-pint soil sample using the sugar flotation method. Root knot nematodes are reported in the tables as the number of juveniles (J2) per 100 cc soil.

Results

2003 – Monthly rainfall totals for April, September, and October were slightly below historical average, average for March, May and August, and excessive in June and July. No extended periods of hot, dry weather, which could suppress crop yields, occurred during the 2003 summer production season.

On peanut, late leaf spot, which was more common than early leaf spot, caused 25% to 50% premature defoliation (Table 1). As expected in the first year of this study, no significant differences in leaf spot severity were noted between crop sequences. Rust severity, which was very low, was similar for all peanut cropping sequences (Table 1). Incidence of TSWV and white mold did vary significantly among peanut cropping sequences (Table 2). Overall TSWV incidence, which was rated as light to moderate, probably caused little yield loss. In contrast, white mold may be responsible for some of the significant differences in yield that were noted between peanut treatments (Table 2 and 3). Root knot nematode counts were very low in all peanut plots (Table 3).

Despite the absence of notable diseases or sizable populations of damaging nematode pests, significant differences in yield were found between the cotton rotations (Table 4). Unlike peanut and cotton yields, root knot nematode counts and corn yields were similar across all treatments (Table 5). Noticeable symptoms of southern corn leaf blight, northern corn leaf blight, or other corn diseases were not observed.

2004 – During the production season, temperatures were near normal and monthly rainfall totals were at or above normal. Due to heavy wind and rain damage during Hurricane Ivan in mid-September, the cotton plots were abandoned.

Early and late leaf spot severity was significantly reduced when peanut followed cotton compared with two of the three peanut-peanut crop patterns (Table 1). Also, the corn-peanut pattern had a lower early and late leaf spot rating than one of the three peanut-peanut rotation patterns. Crop sequence had no significant impact on the severity of rust, incidence of TSWV, and surprisingly the incidence of white mold in peanut (Table 1 and 2). Numbers of root knot nematode juveniles, which were similar across all peanut cropping sequences, remained very low for the second consecutive year (Table 3).

Peanut yield was related to peanut cropping frequency (Table 3). Highest pod yields were recorded for peanut cropped behind corn. Yield for the peanut-cotton sequence was intermediate to that recorded for the corn-peanut rotation, as well as the peanut-peanut rotations.

Prior to Hurricane Ivan, no foliar or soil borne diseases were noted in the cotton. Counts of root knot larvae were higher for one of the cotton-cotton crop patterns compared to those plots where cotton followed corn or cotton (Table 4). Due to damage from Hurricane Ivan, the cotton plots were not harvested. Regardless of whether corn was grown for one or two consecutive years, grain yields were similar (Table 5). Cropping frequency had some impact on root knot nematode counts on corn. Lower root knot nematode counts were sometimes seen where corn was cropped after peanut or cotton compared with successive corn crops (Table 5). Despite significant differences in root-knot counts, corn yields were similar regardless of cropping frequency. Finally, incidence of foliar diseases of corn was minimal across all corn rotation patterns.

2005 - Rainfall totals for May, June, July, August, and September reached or exceeded the historical average but they were below average for April and October. Temperatures, which were below average in April and early May, were seasonal for the remainder of the production season.

Peanut cropping frequency again had a significant impact on the severity of leaf spot diseases (Table 1). Leaf spot ratings for the peanut following two years of cotton but not corn were significantly below the rating recorded for peanut cropped behind two years of peanut. Leaf spot ratings for the peanuts grown behind one or two years of cotton or corn were similar. Regardless of peanut cropping frequency, rust ratings also were similar (Table 1). While the overall incidence of TSWV in peanut was very low, significant differences were noted between peanut rotation sequences (Table 2). Incidence of this disease was lower when peanut followed one year than two years of corn. Otherwise, virus levels for the peanut in all the other cropping sequences were similar. Incidence of white mold was similar across all peanut cropping sequences (Table 2). Root knot nematode counts for peanuts are not yet available. Pod yields did not significantly differ between peanut cropping sequences (Table 3).

Cotton cropping frequency has no impact on the yield of this crop (Table 4). Appreciable numbers of root knot nematodes were noted for several corn rotation patterns in 2005 (Table 5). Significantly higher numbers of root knot larvae were found in the plots where corn was grown for three consecutive years compared to those for corn following one or two years of peanut or after cotton in 2003 and corn in 2004. Nematode numbers for corn following two years of cotton were intermediate between the peanut - corn rotation and continuous corn plots. Corn yields were similar regardless of cropping frequency.

Summary

Peanut cropping frequency often influenced the severity of both early and late leaf spot diseases in peanut. In 2004 and 2005, leaf spot ratings were often lower on peanut following one and two years, respectively, of cotton than in plots where peanut followed at least one year of peanut. Reductions in leaf spot ratings were also seen in one of two years when peanut followed one year of corn. In Southeast Alabama, Hagan *et al* (3) noted that leaf spot ratings were higher in a long-term peanut monoculture compared to peanuts cropped behind two or more years of corn, cotton, or sequences with both these crops grown in succession. Leaf spot ratings for the peanut monoculture and peanut cropped behind one year of corn or cotton were, however, similar (3). Kucharek (6) in Florida and Brenneman *et al* (2) in Georgia also noted that lengthening the interval between peanut crops up to three years reduced the incidence of early leaf spot. In contrast, peanut cropping frequency appeared to have little influence on leaf spot-induced defoliation in Alabama farm fields (1).

As expected, rust severity was not influenced by peanut cropping sequence. Unlike both leaf spot diseases, the causal fungus of rust on peanut does not overwinter in Alabama. Reportedly, conidia (uredospores) of *Puccinia arachidis* are spread from the Caribbean or Central America via upper air currents or tropical weather systems into the southeastern U.S (7). Nutter and Shokes (7) noted that neither crop rotation nor deep tillage would help prevent outbreaks of rust on peanut.

The influence of cropping frequency or sequence on the incidence of TSWV has not clearly been demonstrated. Damaging outbreaks of this disease are considered to be closely tied to cultivar selection, seed viability, suitability of soil conditions for rapid seed germination and stand establishment, and tillage practices. In this study, significant differences in TSWV incidence between crop sequences were seen in two of three years. Differences in TSWV incidence that were seen in the first year probably have more to do with variables related to stand density or soil conditions. In the long term rotation study at the Wiregrass Research and Extension Center, peanut cropping frequency has not had a consistent impact on TSWV incidence.

Through the first cycle of this study, the incidence of white mold in peanut was similar for all crop sequences, including those where peanut followed two years of corn or cotton. In the majority of previous studies conducted in the traditional peanut production regions of Alabama and Georgia, white mold damage was higher in a peanut monoculture compared with peanut cropped after two years of cotton (4,5,8,9), corn (3), or bahiagrass (2,8). On Alabama farms, white mold incidence was higher in fields cropped to peanut every other year compared with once every three or four years (1).

Incidence of this disease was actually higher for the recommended two year out than one year out rotation pattern. Previously, crop rotation has not been linked with TSWV incidence in peanut. Not surprisingly, leaf spot ratings were higher for continuous peanuts compared with peanut behind two years of cotton. Similar results have been noted in rotation studies at the Wiregrass Research and Extension Center. Previous studies have shown that even a one year break between peanut crops can significantly reduced the severity of early and late leaf spot in peanut.

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Table 1. Influence of peanut, cotton, and corn cropping sequence on the occurrence of leaf spot diseases and rust in 'Carver' peanut at the GCREC, 2003-2005.

Crop Sequence			Leaf Spot Rating[Z]			Rust Rating[Y]		
2003	2004	2005	2003	2004	2005	2003	2004	2005
Corn	Peanut	Corn	--[X]	4.5 bc	--	--	4.3 a	--
Corn	Corn	Peanut	--	--	3.9 ab	--	--	3.5 a
Peanut	Peanut	Peanut	5.1 a[W]	5.8 a	4.5 a	1.8 a	5.3 a	4.3 a
Peanut	Corn	Peanut	5.3 a	--	4.3 ab	2.0 a	--	4.0 a
Peanut	Peanut	Corn	5.8 a	5.3 abc	--	2.5 a	5.5 a	--
Peanut	Peanut	Cotton	5.3 a	5.5 ab	--	1.8 a	5.5 a	--
Cotton	Peanut	Cotton	--	4.3 c	--	--	5.0 a	--
Peanut	Cotton	Peanut	5.9 a	--	4.1 ab	1.8 a	--	3.8 a
Peanut	Cotton	Cotton	6.3 a	--	--	2.3 a	--	
Cotton	Cotton	Peanut	--	--	3.6 b	--	--	3.5 a

[Z]Severity of early and late leaf spot was rated using the 1 to 10 Florida leaf spot scoring system.
[Y]Severity of rust on peanut was rated using the 1-9 ICRISAT rust rating scale.
[X]-- = no data.
[W]Means in the same column that are followed by the same letter are not significant different according to Fisher's least significant difference (LSD) test (P=0.05).

Table 2. Influence of peanut, cotton, and corn cropping sequence on the incidence of TSWV and southern stem rot on 'Carver' peanut, 2003-2005.

Crop Sequence			TSWV[Z]			White Mold[Z]		
2003	2004	2005	2003	2004	2005	2003	2004	2005
Corn	Peanut	Corn	--[Y]	1.8 a	--	--	6.0 a	--
Corn	Corn	Peanut	--	--	3.5 a	--	--	10.3 a
Peanut	Peanut	Peanut	9.0 ab[X]	2.8 a	2.5 ab	4.5 a	6.5 a	8.0 a
Peanut	Corn	Peanut	5.8 b	--	1.8 b	2.8 a	--	8.5 a
Peanut	Peanut	Corn	13.3 a	3.0 a	--	2.5 a	5.0 a	--
Peanut	Peanut	Cotton	9.0 ab	2.3 a	--	5.0 a	4.8 a	--
Cotton	Peanut	Cotton	--	3.0 a	--	--	6.8 a	--
Peanut	Cotton	Peanut	5.5 b	--	2.0 ab	2.5 a	--	8.3 a
Peanut	Cotton	Cotton	8.0 ab	--	--	3.5 a	--	
Cotton	Cotton	Peanut	--	--	2.8 ab	--	--	10.8 a

[Z]Incidence of TSWV and southern stem rot is expressed as the number of disease hits or loci per 60 row ft.
[Y]-- = no data.
[X]Means in the same column that are followed by the same letter are not significant different according to Fisher's least significant difference (LSD) test (P=0.05).

Table 3. Influence of cropping sequence on root knot nematode populations and the yield of peanut.

Crop Sequence			Root knot Counts[Z]			Peanut Yield lb/A		
2003	2004	2005	2003	2004	2005	2003	2004	2005
Corn	Peanut	Corn	--[Y]	3.5 a[X]	--	--	5058 a	--
Corn	Corn	Peanut	--	--	NA	--	--	4347 a
Peanut	Peanut	Peanut	1.0	1.5 a	NA	2534 c	4298 b	3384 a
Peanut	Corn	Peanut	5.0	--	NA	2798 abc	--	3888 a
Peanut	Peanut	Corn	1.0	3.5 a	--	2626 b	4416 ab	--
Peanut	Peanut	Cotton	0.5	2.0 a	--	2843 abc	3842 b	--
Cotton	Peanut	Cotton	--	3.0 a	--	--	4783 ab	--
Peanut	Cotton	Peanut	0.5	--	NA	3072 a	--	4347 a
Peanut	Cotton	Cotton	0.0	--	--	2980 ab	--	--
Cotton	Cotton	Peanut	--	--	NA	--	--	3934 a

[Z]Root knot populations are expressed as the number of root knot larvae (J2) in a 100 cc soil sample.
[Y]-- = no data.
[X]Means in the same column that are followed by the same letter are not significant different according to Fisher's least significant difference (LSD) test (P=0.05).

Table 4. Impact of cropping sequence on root knot nematode counts and the yield of cotton, 2003-2005.

Crop Sequence			Root knot Counts[Z]			Cotton yield lint/A		
2003	2004	2005	2003	2004	2005	2003	2004[W]	2005
Cotton	Cotton	Cotton	0 a[Y]	0 a	NA	486 abc	0	867 a
Peanut	Peanut	Cotton	--[X]	--	NA	--	--	752 a
Cotton	Peanut	Cotton	0 a	--	NA	451 bc	--	840 a
Peanut	Cotton	Peanut	--	3 a	--	--	0	--
Peanut	Cotton	Cotton	--	5 a	NA	--	0	872 a
Cotton	Cotton	Peanut	0 a	5 a	--	538 ab	0	--
Cotton	Cotton	Cotton	1 a	8 a	NA	492 a	0	720 a
Cotton	Corn	Cotton	0 a	--	NA	444 c	--	817 a
Cotton	Corn	Corn	6 a	--	--	494 abc	--	--
Cotton	Corn	Corn	0 a	--	--	492 abc	--	--
Cotton	Cotton	Corn	0 a	12 a	--	551 a	0	--
Cotton	Cotton	Cotton	0 a	0 a	NA	513 abc	0	711 a

[Z]Root knot populations are expressed as the number of root knot larvae (J2) in a 100 cc soil sample.
[Y]Means in the same column that are followed by the same letter are not significant different according to Fisher's least significant difference (LSD) test (P=0.05).
[X]-- = no data.
[W]In 2004, cotton was heavily damaged during hurricane Ivan and was not harvested for yield.

Table 5. Impact of cropping frequency on the root knot populations and yield of corn, 2003-2005.

Crop Sequence			Root knot counts			Corn yield bu/A		
2003	2004	2005	2003	2004	2005	2003	2004	2005
Corn	Corn	Corn	1.5 a	43 a	110 a	136 a	135 a	81 a
Corn	Peanut	Corn	9.0 a	--	6 b	138 a	--	76 a
Corn	Corn	Peanut	2.0 a	21 ab	--	134 a	118 a	--
Corn	Corn	Corn	4.5 a	12 ab	36 ab	132 a	121 a	75 a
Peanut	Corn	Peanut	--	1.0 b	--	--	132 a	--
Peanut	Peanut	Corn	--		7 b	--	--	85 a
Cotton	Corn	Cotton	--	2.0 b	--	--	125 a	--
Cotton	Corn	Corn	--	5.0 b	13 b		117 a	79 a
Cotton	Corn	Corn	--	7.0 b	9 b		118 a	77 a
Cotton	Cotton	Corn	--	--	37 ab			84 a

[Z]Root knot populations are expressed as the number of root knot larvae (J2) in a 100 cc soil sample.
[W]Means in the same column that are followed by the same letter are not significant different according to Fisher's least significant difference (LSD) test (P=0.05).