2007 Project Report for the Cotton Commission

Title: Influence of cropping sequence on root knot nematodes pests and diseases

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Objectives: 1) Assess the impact of corn cropping frequency on the severity of diseases in peanut, as well as on populations of the southern root-knot nematode on corn, cotton, and peanut; 2) define the yield benefits of cotton as a rotation partner with peanut and corn at the Plant Breeding Unit, Tallassee and the Gulf Coast Research and Extension Center, Fairhope, AL for 2007.

Production Methods for the Plant Breeding Unit (PBU)

General: Prior to 2003, the cropping history of the study site was cotton in 2002, sweet corn in 2001, and either lupine or vetch in 2000. The cotton root-knot nematode (*Meloidogyne incognita* race 3) and the causal fungus of Fusarium Wilt of cotton (*Fusarium oxysporum*) as well as the causal fungus of white mold (*Sclerotium rolfsii*) were established before the start of this study.

The study site was disked and chiseled on February 19, 2007. On March 20, 67 pounds per acre of 0-0-60 (murate of potash) fertilizer was broadcast and incorporated with a disk harrow. A second broadcast application of 0-0-60 was made on July 12. A hose-tow irrigation system was used to apply 0.9, 0.7, 1.0, 0.8, 1.0, 0.7, 1.0, and 1.3 acre inches of water on May 10, May 24, June 8, June 21, June 28, July 25, August 18, and August 27, respectively. Individual plots of corn, cotton, and peanut consisted of eight rows that were 30 feet in length. The experimental design was a randomized complete block with four replications.

Corn: Plots being planted to corn received a broadcast application of 176 pounds per acre of 34-0-0 analysis fertilizer on March 20, leveled with a field cultivator, and then planted to Pioneer 31G66 corn on 30-inch centers. A layby application of 288 pounds per acre of 33-0-0 was made to corn on May 3. An early post application of a tank mixture of Dual Magnum II at 12 fluid ounces per acre + Atrazine at 1.75 quart per acre was broadcast on March 21 to control weeds in corn. Corn plots were combined on 14 August.

Cotton: On May 14, 88 pounds per acre of 34-0-0 analysis fertilizer was incorporated with a leveling disk harrow into the plots scheduled to be planted to DPL 555 cotton on 3-foot centers later that day. Thrips and damping-off control on cotton was provided in-furrow applications of Temik 15G at 6.5 pounds per acre and Terraclor Super X at 8.0 pounds per acre. Pre-emergent weed control was provided by an application of Pendant at 1 quart per acre. Post-emergent weed control was obtained with applications of Roundup at 1 quart per acre on June 12 and July 17. Cotton plots were hand weeded or hoed as needed during the growing season. An application of Finish at 1.5 pints per acre to cotton on September 21 was followed by an application of Def-6 at 1.5 pints per acre plus Ginstar at 8 fluid ounces per acre on September 25. Cotton plots were picked on October 1.

Peanut: On May 14, plots planted to peanut were prepared for planting with a leveling disk harrow. The peanut cultivar ‘Georgia Green’ was planted in single rows on 3-foot centers on May 15 with Temik 15G at 6.5 pounds per acre applied in-furrow. Weed control was obtained

with an pre-emergent application of Pendant at 1 quart per acre + Dual Magnum II at 1.5 pints per acre on May 16. On 12 July, Poast at 1.0 pint per acre was broadcast over the peanuts for post-emergent grass control. Peanut plots were hand weeded or hoed as needed during the growing season. Leaf spot control on peanut was maintained with applications of Echo 720 at 30 fluid ounces per acre on June 25, July 12, July 27, 8 August, 22 August, September 6, and September 21. An application of Moncut 70DF at 2.9 pounds per acre was made on July 12 to four of eight rows of each peanut plot. The peanuts were inverted on October 5 and picked on October 11.

Production Methods for the Gulf Coast Research and Extension Center (GCREC)

On March 5, 206 pounds per acre of 9-19-19 analysis fertilizer amended with 10 pounds per acre of sulfur and 3 pounds per acre of zinc as well as 2 pints per acre of Prowl herbicide were broadcast and lightly incorporated. The entire study area was ripped and bedded on March 6. Roundup Weathermax at 22 fluid ounces per acre was broadcast over the areas to be planted to cotton and peanut as well as the established corn plots on April 16 and May 3. The experimental design is a randomized complete block with four replications. Plots for individual rotation sequences consisted of eight rows on 38-inch centers that were 30 feet in length.

Corn: On March 20, 'DKC 69-72' corn was planted. On May 8, 382 pounds per acre of a mixture of ammonium sulfate and urea as well as a post-directed application of Roundup Weathermax at 22 fluid ounces per acre plus Atrazine at 2 quarts per acre was broadcast over the corn. The occurrence of diseases in corn was assessed on July 18. Corn plots were harvested on September 4.

Cotton: The cotton variety DP555BR was planted on May 10. Thrips control was provided by an in-furrow application of 6.5 pounds per acre of Temik 15G. An application of Roundup Weathermax at 22 fluid ounces per acre to cotton on May 29 was followed by an application Caparol at 1.5 pints per acre + MSMA at 2 pints per acre + LI700 at 2 quarts per 100 gallons of spray volume applied post-direct on June 26. Escape weeds were pulled by hand. The plant growth regulator Stance at 2 fluid ounces per acre was applied to cotton alone or tank-mixed with the herbicide Evoke at 0.15 ounces per acre on June 26, July 10, and July 19. Cotton was prepared for harvest with an application of Harvade 5F at 8 fluid ounces per acre + Dropp 50W at 2 ounces per acre + Super Boll at 1 pint per acre + Crop Oil at 1 quart per 100 gallons of spray volume on September 17 and an application of Aim 2EC at 1.5 fluid ounces per acre on September 28. Cotton plots were picked on October 4.

Peanut: The peanut cultivar GA03L was planted on May 23 with 6.5 pounds per acre of Temik 15G placed in-furrow for thrips control. Weed control on peanut was obtained with an application of Gramoxone Inteon at 8 fluid ounces per acre + Storm 4L at 1 pint per acre + Butoxone 175 at 1 pint per acre on June 8 followed by an application of Cadre 70DG at 2 ounces per acre + Strongarm 84WDG at 0.225 ounces per acre + LI700 at 2 quarts per 100 gallons of spray volume on June 26. Full canopy sprays of Bravo Weather Stik 6F at 1.5 pints per acre were made for leaf spot and rust control using an All Terrain Vehicle-mounted boom sprayer with 3 TX-8 nozzles per row at 10 gal/A spray volume at 45 psi on June 26, July 10, July 25, August 9, August 23, and September 6. Peanut plots were combined October 8.

Disease and Nematode Assessment: Early leaf spot severity was rated using the Florida 1 to 10 peanut leaf spot scoring system on September 19 at the PBU and October 3 at GCREC. White mold hit counts, where 1 hit is defined as $\leq$ 1 foot of consecutive white mold damaged plants per row, were made on October 3 at GCREC and October 5 at PBU. Incidence of tomato spotted wilt virus (TSWV) in peanut was assessed on September 7 at PBU and September 16 at GCREC by

counting the number of TSWV hits where 1 hit is defined as $\leq$ 1 foot of consecutive TSWV-damaged plants per row. Soil samples for a nematode assay, which were taken on twice during the production season, will be processed using the sugar flotation method.

Results

Plant Breeding Unit

Results: In 2007, cropping sequence had a significant impact on the leaf spot and white mold but not on TSWV in peanut (Table 1). Early leaf spot ratings were lower where peanut but not cotton followed one year of corn than after one or more years of peanut. When compared with peanut cropped behind one year of corn, white mold damage was higher for the corn-peanut-peanut rotation sequence.

Table 1. Impact of crop rotation on the level of damage attributed to diseases and nematodes of peanut at the PBU in 2007.

Crop Sequence					Root		ELS	White
2003	2004	2005	2006	2007	Knot	TSWV[z]	Rating[y]	mold[z]
Pnut	Pnut	Pnut	Pnut	Pnut	NA[x]	3.5 a[w]	5.0 a	16.5 ab
Pnut	Corn	Pnut	Corn	Pnut	NA	3.8 a	4.0 b	11.3 b
Pnut	Pnut	Corn	Pnut	Pnut	NA	3.3 a	4.9 a	24.5 a
Pnut	Pnut	Cotton	Pnut	Pnut	NA	3.0 a	5.0 a	21.5 ab
Pnut	Cotton	Pnut	Cotton	Pnut	NA	4.5 a	4.5 ab	17.8 ab

[z]TSWV and white mold incidence is expressed as number of hits per 60 foot of row.
[y]Early leaf spot (ELS) was rated on September 19 using the Florida 1 to 10 scoring system.
[x]NA = nematode soil samples have not been processed.
[w]Means in each column followed by the same letter are not significantly different according to Fisher's least significant difference (LSD) test (P=0.05).

When averaged across all cropping sequences, a single application of 2.0 pounds per acre of Moncut 70DF gave approximately 76% control of white mold (Table 2). Despite 79% white mold control with Moncut 70DF, the smallest increase in pod yield of 166 pounds per acre was seen in the plots maintained in continuous peanut production. Otherwise, yield gains with Moncut 70DF for the remaining cropping sequences ranged from 510 to 1218 pounds per acre.

Table 2. Impact of Moncut 70DF on white mold and peanut yield response at PBU in 2007.

Crop Sequence					White mold[z]		Yield lb/A		Yield Gain
2003	2004	2005	2006	2007	NT[y]	FT[x]	NT	FT	lb/A
Pnut	Pnut	Pnut	Pnut	Pnut	16.5 ab[w]	3.5 a	3416 bc	3582 b	166
Pnut	Corn	Pnut	Corn	Pnut	11.3 b	7.5 a	4197 ab	5415 a	1218
Pnut	Pnut	Corn	Pnut	Pnut	24.5 a	5.5 a	3085 c	4018 b	933
Pnut	Pnut	Cttn	Pnut	Pnut	21.5 ab	2.8 a	3005 c	3515 b	510
Pnut	Cttn	Pnut	Cttn	Pnut	17.8 ab	2.8 a	4543 a	5503 a	960

[z]White mold damage is expressed as number of hits per 60 foot of row.
[y]NT = peanuts not treated with 2.9 pounds per acre of Moncut 70DF.
[x]FT = peanuts treated with 2.9 pounds per acre of Moncut 70DF.
[w]Means in each column followed by the same letter are not significantly different according to Fisher's least significant difference (LSD) test (P=0.05).

Cotton root knot larvae counts were higher in the plots maintained in continuous corn than for the corn-peanut-corn rotation, while the counts for the remaining corn cropping sequences were intermediate (Table 3).

Table 3. Impact of crop rotation on the populations of the cotton root knot nematode on corn, cotton, and peanut at PBU in 2007.

Crop Sequence					2007 Cotton root knot juvenile (J2) counts		
2003	2004	2005	2006	2007	Cotton	Corn	Peanut
Corn	Corn	Corn	Corn	Corn	--	313 a*	--
Corn	Peanut	Corn	Peanut	Corn	--	108 b	--
Corn	Corn	Peanut	Corn	Corn	--	210 ab	--
Corn	Corn	Corn	Peanut	Corn	--	155 ab	--
Peanut	Peanut	Peanut	Peanut	Peanut	--	--	NA
Peanut	Corn	Peanut	Corn	Peanut	--	--	NA
Peanut	Peanut	Corn	Peanut	Peanut	--	--	NA
Cotton	Cotton	Cotton	Cotton	Cotton	NA**	--	--
Peanut	Peanut	Cotton	Peanut	Peanut	--	--	NA
Cotton	Peanut	Cotton	Peanut	Cotton	NA	--	--
Peanut	Cotton	Peanut	Cotton	Peanut	--	--	
Peanut	Cotton	Cotton	Peanut	Cotton	NA	--	--
Cotton	Cotton	Peanut	Cotton	Cotton	NA	--	--
Cotton	Cotton	Cotton	Peanut	Cotton	NA	--	--
Cotton	Corn	Cotton	Corn	Cotton	NA	--	--
Cotton	Corn	Corn	Cotton	Corn	NA	291 ab	--
Cotton	Corn	Corn	Corn	Cotton	NA	--	--
Cotton	Cotton	Corn	Cotton	Cotton	NA	--	--
Cotton	Cotton	Cotton	Corn	Cotton	NA	--	--

*Means in each column followed by the same letter are not significantly different according to Fisher's least significant difference (LSD) test (P=0.05).
**NA = nematode soil samples not yet processed.

Cropping sequence had a significant impact on the yield of cotton, corn, and peanut (Table 4). Highest cotton yields were noted where this crop followed peanut in 2006 as well as in the cotton-corn-cotton rotation pattern. As the frequency of corn or peanut in rotation with cotton declined, cotton yields fell significantly. Lowest cotton yields were noted for continuous cotton plot or where corn was rotated with cotton once over the five-year study period. Corn yield was higher by nearly 30 bu/A for the corn-peanut-corn and peanut-corn-corn rotations than where corn followed cotton or four consecutive years of corn. Peanut cropped behind one year of cotton or corn had equally high yields. When compared with the latter cropping patterns, a sizable yield decline was seen were peanut followed either corn or cotton in 2005 and then peanut in 2006. In the plots planted to peanut for five consecutive years, pod yields were similar to the corn-peanut but below those for the cotton–peanut rotation.

Table 4. Impact of cropping sequence on the yield of corn, cotton, and peanut at PBU in 2007.

Crop Sequence					2007 Yields		
					Seed Cotton	Corn	Peanut
2003	2004	2005	2006	2007	lb/A	bu/A	lb/A
Corn	Corn	Corn	Corn	Corn	--	106.8 c	--
Corn	Peanut	Corn	Peanut	Corn	--	137.3 ab	--
Corn	Corn	Peanut	Corn	Corn	--	142 a	--
Corn	Corn	Corn	Peanut	Corn	--	115.7 bc	--
Peanut	Peanut	Peanut	Peanut	Peanut	--	--	3416 bc
Peanut	Corn	Peanut	Corn	Peanut	--	--	4197 ab
Peanut	Peanut	Corn	Peanut	Peanut	--	--	3085 c
Cotton	Cotton	Cotton	Cotton	Cotton	726 f*	--	--
Peanut	Peanut	Cotton	Peanut	Peanut	--	--	3005 c
Cotton	Peanut	Cotton	Peanut	Cotton	1821 a	--	--
Peanut	Cotton	Peanut	Cotton	Peanut	--	--	4543 a
Peanut	Cotton	Cotton	Peanut	Cotton	1767 ab	--	--
Cotton	Cotton	Peanut	Cotton	Cotton	1204 bcdef	--	--
Cotton	Cotton	Cotton	Peanut	Cotton	1628 abc	--	--
Cotton	Corn	Cotton	Corn	Cotton	1470 abcd	--	--
Cotton	Corn	Corn	Cotton	Corn	--	108.1 c	--
Cotton	Corn	Corn	Corn	Cotton	1283 bcde	--	--
Cotton	Cotton	Corn	Cotton	Cotton	823 ef	--	--
Cotton	Cotton	Cotton	Corn	Cotton	1004 def	--	--

*Means in each column followed by the same letter are not significantly different according to Fisher's least significant difference (LSD) test (P=0.05).

Gulf Coast Research and Extension Center

Surprisingly, cropping frequency had a significant influence on TSWV incidence in peanut (Table 1). Fewer TSWV hits were found where peanut followed one year of cotton than one or more years of peanut. Incidence of this disease was also lower for peanut cropped behind corn compared with the cotton-peanut-peanut sequence. Late leaf spot ratings for the cotton-peanut-peanut cropping sequence were also higher than for peanut following one year of cotton but not corn. Almost no early leaf spot was noted in 2007. Cropping frequency did not have a significant impact on the incidence of white mold in peanut. Rust incidence was minimal in all peanut plots.

Table 1. Impact of crop rotation on diseases and nematodes of peanut in 2007.

Crop Sequence					Root		LLS	White
2003	2004	2005	2006	2007	Knot	TSWV[z]	Rating[y]	mold[z]
Pnut	Pnut	Pnut	Pnut	Pnut	NA	9.5 ab [x]	5.4 ab	15.8 a
Pnut	Corn	Pnut	Corn	Pnut	NA	6.3 bc	4.4 ab	11.0 a
Pnut	Pnut	Corn	Pnut	Pnut	NA	10.0 ab	5.6 a	13.5 a
Pnut	Pnut	Cotton	Pnut	Pnut	NA	13.0 a	4.8 ab	16.0 a
Pnut	Cotton	Pnut	Cotton	Pnut	NA	4.8 c	4.3 b	7.3 a

[z]TSWV and white mold incidence is expressed as number of hits per 60 foot of row.
[y]Late leaf spot (LLS) was rated on September 19 using the Florida 1 to 10 scoring system.
[x]Means in each column followed by the same letter are not significantly different according to Fisher's least significant difference (LSD) test (P=0.05).

In contrast to peanut, damaging rotation-related disease outbreaks have not emerged in cotton or corn at the GCREC study site. Regardless of corn cropping frequency, only trace levels of common and southern rust were observed in 2007. So far, no foliar or soil-borne diseases have been noted in cotton in any study year.

Over the last few years, a sizable increase in the number of juvenile root knot nematode larvae had been seen in corn. The identity of this root knot nematode will be determined in 2008. In 2007, corn cropping frequency had a significant impact on populations of this nematode in the corn root zone. Highest larvae counts were noted in the plots maintained in continuous corn for five years while the fewest larvae were recovered on corn planted behind one year of peanut (Table 2). Intermediate larvae counts were seen where corn followed one year of cotton or corn. Root knot nematode larvae counts in the peanut and cotton plots will be available at a later date.

Seed cotton yields for DPL 555BR were exceptionally high in 2006 (Table 3). While yield for nearly all cotton rotation sequences were similar, cotton that followed peanut in 2005 and cotton in 2006 yielded significantly less than cotton cropped behind peanut. Cropping frequency is beginning to have an influence on the yield of corn. Yield for corn behind peanut in 2005 and corn in 2006 was lower compared with the same crop following either peanut or cotton in 2006. For the continuous corn rotation, yields were intermediate between those reported for the above cropping patterns. Pod yield where peanut were cropped for five consecutive years were lower compared with peanut behind one year or cotton but not corn. Yield response for peanut following peanut was similar those reported for plots in continuous peanut production and peanut behind cotton.

Table 2. Impact of crop rotation on root knot nematode populations at the GCREC in 2007.

Crop Sequence					2007 Root knot juvenile (J2) counts		
2003	2004	2005	2006	2007	Cotton	Corn	Peanut
Corn	Corn	Corn	Corn	Corn	--	295 a	--
Corn	Peanut	Corn	Peanut	Corn	--	17 b	--
Corn	Corn	Peanut	Corn	Corn	--	78 ab	--
Corn	Corn	Corn	Peanut	Corn	--	25 b	--
Peanut	Peanut	Peanut	Peanut	Peanut	--	--	NA
Peanut	Corn	Peanut	Corn	Peanut	--	--	NA
Peanut	Peanut	Corn	Peanut	Peanut	--	--	NA
Cotton	Cotton	Cotton	Cotton	Cotton	NA	--	--
Peanut	Peanut	Cotton	Peanut	Peanut	--	--	NA
Cotton	Peanut	Cotton	Peanut	Cotton	NA	--	--
Peanut	Cotton	Peanut	Cotton	Peanut	--	--	NA
Peanut	Cotton	Cotton	Peanut	Cotton	NA	--	--
Cotton	Cotton	Peanut	Cotton	Cotton	NA	--	--
Cotton	Cotton	Cotton	Peanut	Cotton	NA	--	--
Cotton	Corn	Cotton	Corn	Cotton	NA	--	--
Cotton	Corn	Corn	Cotton	Corn	NA	172 ab	--
Cotton	Corn	Corn	Corn	Cotton	NA	--	--
Cotton	Cotton	Corn	Cotton	Cotton	NA	--	--
Cotton	Cotton	Cotton	Corn	Cotton	NA	--	--

*Means in each column followed by the same letter are not significantly different according to Fisher's least significant difference (LSD) test (P=0.05).

Table 3. Impact of cropping sequence on the yield of corn, cotton, and peanut at GCREC in 2007.

Crop Sequence					2007 Yields		
					Seed Cotton	Corn	Peanut
2003	2004	2005	2006	2007	lb/A*	bu/A	lb/A
Corn	Corn	Corn	Corn	Corn	--	103.6 ab	--
Corn	Peanut	Corn	Peanut	Corn	--	109.5 ab	--
Corn	Corn	Peanut	Corn	Corn	--	97.3 b	--
Corn	Corn	Corn	Peanut	Corn	--	113.2 a	--
Peanut	Peanut	Peanut	Peanut	Peanut	--	--	3393 b
Peanut	Corn	Peanut	Corn	Peanut	--	--	4405 ab
Peanut	Peanut	Corn	Peanut	Peanut	--	--	3588 ab
Cotton	Cotton	Cotton	Cotton	Cotton	2518 ab*	--	--
Peanut	Peanut	Cotton	Peanut	Peanut	--	--	3945 ab
Cotton	Peanut	Cotton	Peanut	Cotton	2542 ab	--	--
Peanut	Cotton	Peanut	Cotton	Peanut	--	--	4704 a
Peanut	Cotton	Cotton	Peanut	Cotton	2841 a	--	--
Cotton	Cotton	Peanut	Cotton	Cotton	2335 b	--	--
Cotton	Cotton	Cotton	Peanut	Cotton	2450 ab	--	--
Cotton	Corn	Cotton	Corn	Cotton	2576 ab	--	--
Cotton	Corn	Corn	Cotton	Corn	--	110.5 a	--
Cotton	Corn	Corn	Corn	Cotton	2622 ab	--	--
Cotton	Cotton	Corn	Cotton	Cotton	2680 ab	--	--
Cotton	Cotton	Cotton	Corn	Cotton	2588 ab	--	--

*Means in each column followed by the same letter are not significantly different according to Fisher's least significant difference (LSD) test (P=0.05).

Summary

PBU: Cropping patterns had a significant impact on population density of cotton root knot nematode as well as on the yield of corn, cotton, and peanut. While corn is an excellent carryover host for the cotton root knot nematode, cotton yields increased the more often corn followed cotton. Peanut is a better rotation partner with cotton than corn, particularly when damaging populations of the cotton root knot nematode are present. White mold and leaf spot damage levels trended higher and yields lower with the increasing frequency of peanut production. The effectiveness of Moncut 70DF against white mold was reflected in substantially higher peanut yields for all peanut cropping patterns with the exception of continuous peanut rotation.

GCREC: After five years, cropping frequency has had a significant impact on the occurrence of diseases and yield of peanut as well as a root knot nematode and yield of corn. Increasing root knot populations may be the cause of declining corn yields. While a trend towards declining cotton yields with increasing cropping frequency of this crop is beginning to emerge, no cause for the yield decline has been found. Higher incidence of TSWV and late leaf spot, which are associated with the more frequent cropping of peanut, may be responsible for downturn in peanut yield.

Overall, Corn is an excellent bridge host for sustaining cotton root knot nematode populations between cotton crops. Reproduction rates for this nematode on corn and cotton are similar. At PBU, reduced cotton yields are linked with increasing cotton root knot larvae populations. Substantially higher yields were noted when cotton was cropped behind at least one year of

peanut and to a lesser extent corn. Due to nematode suppression and yield gains, peanut is a better rotation partner with cotton than corn in fields where the cotton root knot nematode/Fusarium Wilt complex is present. Corn and cotton are not bridge hosts for peanut root knot nematode and pod yields are higher where peanut follows one or more years of corn or cotton due reduced disease and nematode pressure.