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Pest Reaction, Yield, and Economic Return of Peanut Cropping Systems in the North Carolina Coastal Plain

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Abstract
Research was conducted in North Carolina from 2001-2006 to determine disease and nematode development, yield, and estimated economic return in rotation systems including corn (*Zea mays* L.), cotton (*Gossypium hirsutum* L.), peanut (*Arachis hypogaea* L.), and soybean [*Glycine max* (L.) Merr.]. Specific rotations included three cycles of corn-peanut and cotton-peanut and two cycles of corn-corn-peanut, cotton-corn-peanut, cotton-cotton-peanut, soybean-corn-peanut, and soybean-cotton-peanut. Additional rotations included corn-corn-corn-corn-corn-peanut and continuous peanut. In the final year of the experiment, the cultivars Gregory and NC 12C were planted either without or following fumigation with metam sodium 2 weeks before planting. Increasing the number of years between peanut plantings increased yield of peanut in the final year of the experiment when peanut was not fumigated. Fumigating with metam sodium or planting the cultivar NC 12C, a cultivar with resistance to Cylindrocladium black rot (caused by *Cylindrocladium parasiticum*) (CBR), compensated for shorter rotations between peanut plantings. Although peanut yield was higher when rotation length was increased, the highest cumulative net returns over the duration of the experiment often were noted when peanut was included two or more times during the duration of the experiment compared with peanut planted only at the end of the experiment.

Introduction
Corn, cotton, peanut, and soybean are commonly grown in the coastal plain of North Carolina. Economic value of these crops varies considerably and influences producers' decisions on crop selection (21). Crop rotation can have a dramatic impact on development of pests and subsequent crop yield. However, economic return over years is associated with income generated by each crop in the rotation and not necessarily the rotation that is most biologically advantageous (21). Growers must balance the benefits of rotating lower value crops that are effective in reducing pest and pathogen populations with the desire to plant higher value crops in shorter rotations in an effort to optimize

economic return over the length of the cropping system. For example, Lamb et al. (13) reported that irrigated peanut is often grown under shorter rotations than nonirrigated peanut because of high capital investment in peanut production compared with most other agronomic crops.

Producers, extension publications, and peer-reviewed publications often mention that crop rotation is the most important component of pest management strategies for profitable peanut production (14,19,20,23,25). Benefits of increasing the number of non-legume crops between peanut plantings have been well documented (12,17,18,21). Conversely, planting soybean in rotation with peanut often results in lower peanut yield compared with corn or cotton because of increased damage by plant parasitic nematodes and diseases, especially Cylindrocladium black rot (CBR) caused by *Cylindrocladium parasiticum* (1,12,17,22). Cultivar also can have a major impact on yield and subsequent economic return of peanut because of differences in disease resistance (12,15,16). Virginia market type peanut cultivars offer a wide range of agronomic and disease resistance characteristics (10,20).

Historically, use of fumigants and other pesticides helped maintain profits even when CBR susceptible cultivars were planted in short rotations (2,12,16). However, under new Federal farm legislation, the price of Virginia market type peanut has dropped by about one-third since 2002. Current prices range from $400 to $500/US ton when contracted for domestic consumption (5), with a guaranteed loan rate value of approximately $355/ton (5). Thus, the gap between contract prices for peanut relative to prices for corn, cotton, and soybean has narrowed from the historic standard. Defining interactions among cultivar selection and cropping sequence is important in developing appropriate pest management strategies and in helping producers compare and contrast cropping systems they could implement.

The objectives of this project were to: (i) evaluate the profitability of nine cropping systems that included corn, cotton, peanut, and soybean over a 6-year cycle; (ii) determine long-term impacts of these cropping systems on incidence of CBR and populations of plant parasitic nematodes in soil; and (iii) determine interactions of cultivar selection and fumigation with metam sodium with respect to incidence of CBR, nematode populations, and peanut yield.

Experiments with Peanut Cropping Systems in North Carolina

The experiment was conducted in North Carolina from 2001-2006 at the Peanut Belt Research Station located near Lewiston-Woodville and was a continuation of cropping systems experiments established in 1997 (12). Soil was a Norfolk sandy loam (fine-loamy, siliceous, thermic Aquic Paleudalts) with pH ranging from 5.9 to 6.2 over the duration of the experiment and 1.9% organic matter. Plot size was 12 rows (36-inch spacing for all crops) by 50 ft. A wheat (*Triticum aestivum* L.) cover crop (cultivar unknown) was established during the fall of each year by disking and seeding wheat with a drill in rows spaced 24 cm apart. The cover crop was terminated by application of glyphosate [*N*-(phosphonomethyl)glycine] at 0.75 lb acid equivalent/acre 4 weeks before planting each crop. Conventional tillage included disking twice, field cultivating, and ripper bedding within one week prior to planting.

Crop rotations, cultivars, and production and pest management practices. Specific rotations included three cycles of corn-peanut and cotton-peanut and two cycles of corn-corn-peanut, cotton-corn-peanut, cotton-cotton-peanut, soybean-corn-peanut, and soybean-cotton-peanut. Additional rotations included corn-corn-corn-corn-corn-peanut and continuous peanut (Table 1). Corn hybrids included Pioneer 3223 (2001), Dekalb 697 (2002-2004), and Dekalb 6971 RR (2005). Cotton cultivars were Suregrow 747 (2001), Suregrow 105 (2002), Deltapine 751 (2003), Fiber Max 959 (2004), and Deltapine 424 BGRR (2005). The soybean cultivar in 2001 and 2004 was P95B33 (nematode susceptible). The peanut cultivar NC 12C (8) was the only cultivar planted from 2001-2005. In 2006, the cultivar Gregory (9) was planted in four of the 12 rows. The cultivar NC 12C was planted in the eight remaining rows. The cultivar Gregory is susceptible to most peanut diseases including CBR (9,20). The cultivar NC 12C has moderate resistance to CBR (8,20). Two weeks prior to planting during 2006 only, four contiguous rows in each plot (two rows per cultivar) were fumigated with metam sodium concurrently with ripping and bedding the field. Metam sodium at 12 gal/acre (Vapam, 42% metam sodium) was injected 12 inches below seed placement. Liquid metam is rapidly converted to gas and moves through the soil profile to kill microsclerotia of *C. parasiticum* (2,16) and some plant parasitic nematodes (16,22). Cultivar and fumigation treatments were stripped through the field and were not randomized among replications. For example, fumigation was performed on the same four rows of each plot regardless of rotation or replication. Production and pest management practices for peanut and other crops were held constant regardless of cropping system and were standard practices for the region (4,11,20). Fungicides were applied bi-weekly to peanut during each year beginning in early July through mid September to control early leaf spot (*Cercospora arachidicola* Hori), late leaf spot (*Cercosporidium personatum* (Berk. & M.A. Curtis), web blotch (*Phoma arachidicola* Marasas et al.), and southern stem rot (*Sclerotium rolfsii*) (20).

Table 1. Crop rotations including corn, cotton, peanut, and soybean from 2001-2006 at Lewiston-Woodville, NC.

Rotation sequence	2001	2002	2003	2004	2005	2006
A	corn	Peanut	corn	peanut	corn	peanut
B	cotton	peanut	cotton	peanut	cotton	peanut
C	corn	corn	peanut	corn	corn	peanut
D	cotton	cotton	peanut	cotton	cotton	peanut
E	soybean	corn	peanut	soybean	corn	peanut
F	soybean	cotton	peanut	soybean	cotton	peanut
G	cotton	corn	peanut	cotton	corn	peanut
H	peanut	peanut	peanut	peanut	peanut	peanut
I	corn	corn	corn	corn	corn	peanut

Experimental design and data collected. The experimental design from 2001-2005 was a randomized complete block with cropping systems replicated four times. Subplots in 2006 consisted of combinations of the non-randomized cultivar and fumigant treatments. In all years, the experimental unit consisted of two rows by 50 feet. Yield was determined for all crops during each year at optimum crop maturity under appropriate environmental and edaphic conditions. Rainfall data in each year from April through September are presented in Table 2.

Table 2. Monthly rainfall from April through September at Lewiston-Woodville during 2001-2006 and 100-year average.

	Rainfall (inches)						
Month	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**100-year avg.**
April	1.88	1.76	6.25	1.93	2.88	4.04	6.99
May	2.01	1.74	5.70	4.08	4.57	4.90	6.60
June	10.33	2.57	4.45	4.86	2.18	8.91	5.33
July	4.30	4.02	6.41	5.63	4.84	7.99	6.94
August	3.10	5.02	4.62	11.20	3.28	3.38	5.12
September	2.64	4.40	8.81	3.25	1.93	7.36	8.93
Total	24.26	19.51	36.24	30.95	19.68	36.58	39.91

Within 2 weeks of harvest during 2006, a visual estimate of plant condition was recorded for each subplot on a scale of 0 to 100% where 0 = no disease symptoms and 100 = the entire plot was expressing typical CBR symptoms of wilting, yellowing, or plant death. The predominant disease in this field was CBR, and few plants expressed symptoms characteristic of tomato spotted wilt or other diseases of peanut (20). In each plot, 15 soil cores were collected from a depth of 4 inches on each bed and pooled from the two rows planted with NC 12C, either with or without fumigation, within 2 weeks prior to digging. Populations of plant parasitic nematodes in 500 cm^3 soil were assayed by the North Carolina Department of Agriculture and Consumer Service and data were transformed to the log of nematode population prior to analysis.

Net return during each year for each crop was calculated from crop prices, excluding loan deficiency payment (LDP), less production and pest management practices. Net returns reflect return to overhead, risk, and management after fixed and variable costs were considered. Returns were based on corn prices set at $2.50 and $4.00/bu at 12% moisture, and soybean prices set at $6.00/bu at 13% moisture. Peanut price was set at $350, $400, $450, and $500/ton farmer stock peanut at 8% moisture. Production costs were estimated as $278/acre for corn (R. E. Heiniger, 2007, North Carolina State University, *personal communication*), $515/acre for cotton (6), $726/acre for peanut (7), and $150/acre for soybean (E. J. Dunphy, 2007, North Carolina State University, *personal communication*). Net return over the six years, referred to as cumulative net return, included data for NC 12C without fumigation.

Data for crop yield within each year, cumulative net return over the 6 years of the experiment for each rotation, plant condition rating, and the log of soil nematode population were subjected to analysis of variance for each cultivar and fumigation combination. Means were separated using Fisher's Protected LSD at $P \leq 0.05$. Additionally, data within a cropping system during 2006 for fumigated versus non-fumigated treatment were compared using a t-test at $P \leq 0.05$.

Peanut Yield in 2006

In 2006, yield of the peanut cultivar NC 12C following five years of corn and two cycles of corn-corn-peanut or cotton-corn-peanut was similar when fumigation was not included (Table 3). Peanut yield also was similar but somewhat reduced when peanut plantings were separated with corn-corn, cotton-cotton, and soybean-cotton. Among rotation treatments, peanut yields were lowest in 2006 when peanut planting was separated by one year of corn or cotton, two years of cotton, soybean-corn, or soybean-cotton. However, peanut in all rotations with at least one year separating peanut plantings exceeded yield of continuous peanut. When fumigation was included with NC 12C, fewer differences in yield were noted among cropping systems (Table 3). Peanut yield following five years of corn was similar to several cropping systems with only two crops separating peanut plantings (corn-corn, cotton-cotton, cotton-corn, soybean-corn, soybean-cotton). Yield after one year of cotton or corn was greater than continuous peanut but less than yield after two or five years of corn between peanut.

Table 3. Pod yield of the CBR-resistant cultivar NC 12C and the CBR-susceptible cultivar Gregory planted with and without fumigation during 2006.

Rotation sequence	Cropping systems, 2001-2006	**Cultivar**			
		NC 12C		**Gregory**	
		Metam sodium (gal/acre)			
		0	**12**	**0**	**12**
		Peanut yield (lb/acre)			
A	corn-peanut (3 cycles)	4,180 c	4,370 bc	4,350 cd	4,400 b
B	cotton-peanut (3 cycles)	4,200 c	3,980 c	4,100 cde	4,190 b
C	corn-corn-peanut (2 cycles)	4,850 ab	4,850 ab	5,030 b	4,840 b
D	cotton-cotton-peanut (2 cycles)	4,730 bc	4,620 ab	4,570 bc	4,370 b
E	soybean-corn-peanut (2 cycles)	4,130 c	4,550 abc	3,800 de	4,340 b
F	soybean-cotton-peanut (2 cycles)	4,330 bc	4,500 bc	3,560 e	4,480 b*
G	cotton-corn-peanut (2 cycles)	4,930 ab	4,710 ab	4,760 bc	4,480 b
H	continuous peanut	3,040 d	2,900 d	2,600 f	2,720 c
I	corn-corn-corn-corn-corn-peanut	5,540 a	5,130 a	5,920 a	5,980 a
F statistic		11.06	10.57	17.14	5.07
P > F		<0.0001	<0.0001	<0.0001	0.0009

Means within a cultivar and fumigation treatment followed by the same letter are not significantly different at $P \leq 0.05$ according to Fisher's Protected LSD test.
* = significant at $P \leq 0.05$ using a t-test when comparing fumigation treatments within a cropping system and cultivar.

Considerable differences were noted among cropping systems when the cultivar Gregory was planted without previous fumigation with metam sodium (Table 3). Yield of peanut following five years of corn exceeded yield in all other cropping systems. When soil was not fumigated, increasing the number of years of corn or cotton between plantings of Gregory resulted in higher yields, whereas yields of Gregory in soybean-cotton-peanut or soybean-corn-peanut rotations were less than or equal to yields after a single year of cotton or corn. When the cultivar Gregory was planted following fumigation, there was no difference in yield among cropping systems with at least one year of a crop other than peanut planted between peanut plantings (Table 3). Within cropping systems, fumigation had little impact on yield, except in the case of soybean-cotton-peanut, where yields were significantly higher in fumigated than in nonfumigated plots (Table 3). Results from this experiment are consistent with previous research demonstrating that increasing the number of nonleguminous crops between peanut plantings often increases peanut yield (12,17,21). In contrast, corn and cotton are often grown in successive years with no adverse affect on yield (12).

Nematode Population and Plant Condition Rating

Root knot nematode populations in soil differed among cropping systems when fumigation was not included (Table 4). The highest population of root knot nematode was noted when one year of corn-separated peanut or when peanut was planted each year. The lowest population was noted when five years of corn-separated peanut or when the rotation consisted of soybean and cotton.

In contrast, when fumigation was included there were no differences in nematode populations even though considerable variation was noted among cropping systems. However, there was no difference in root knot nematode population when comparing fumigation treatments within a cropping system (Table 4). Populations of root knot nematode can build up rapidly in cropping systems that include corn, peanut, or soybean in short rotations (1,3,22), thus explaining the lower yields of peanut planted in rotation with corn or cotton, soybean-corn-peanut, or soybean-cotton-peanut compared with corn-corn-peanut, cotton-cotton-peanut, or cotton-corn-peanut cropping systems. Soybean is a host to *C. parasiticum* and several species of plant parasitic nematodes that also attack peanut.

Table 4. Root knot nematode population in soil during 2006 for nine cropping systems from 2001-2006 following fumigation with metam sodium for the CBR-resistant cultivar NC 12C.

Rotation sequence	**Cropping systems, 2001-2006**	**Metam sodium** (gal/acre) 0	12
		Nematode population in soil (no./500 cm³)	
A	corn-peanut (3 cycles)	7.6 a	5.1 a
B	cotton-peanut (3 cycles)	1.9 bc	4.7 a
C	corn-corn-peanut (2 cycles)	2.6 bc	3.3 a
D	cotton-cotton-peanut (2 cycles)	2.5 bc	1.0 a
E	soybean-corn-peanut (2 cycles)	4.5 ab	1.8 a
F	soybean-cotton-peanut (2 cycles)	0.0 c	1.5 a
G	cotton-corn-peanut (2 cycles)	1.2 bc	1.0 a
H	continuous peanut	7.1 a	4.0 a
I	corn-corn-corn-corn-corn-peanut	0.6 c	0.9 a
F statistic		11.9	1.21
P > F		<0.0001	0.3344

Means within a fumigation treatment followed by the same letter are not significantly different at $P \leq 0.05$ according to Fisher's Protected LSD test. Data were transformed to a log scale. * = significant at $P \leq 0.05$ using a t-test when comparing fumigation treatments within a cropping system.

Differences in incidence of diseased plants were noted when comparing cropping systems when the cultivar Gregory was planted without previous fumigation (Table 5). More disease was observed when peanut was planted in rotation with soybean-corn than all other cropping systems, including continuous peanut. Disease was moderate when peanut was planted in a one year rotation with corn, when peanut was planted continuously, and when two crops separated peanut including soybean-cotton or cotton-corn. The lowest level of disease was noted when only one year of cotton-separated peanut, when two years of corn or cotton-separated peanut, or when five years of corn-separated peanut. In contrast, there was no difference in disease when the cultivar Gregory followed fumigation or when the cultivar NC 12C was planted with or without fumigation (Table 5). These results are consistent with previous experiments demonstrating less CBR, the primary disease in our experiment, when a CBR-resistant cultivar (NC 12C) is planted or when a CBR-susceptible cultivar (Gregory) is planted following previous fumigation (20). Final levels of disease symptoms (yellowing, wilting, and death) on nonfumigated Gregory were higher in the soybean-corn-peanut rotation than in continuous peanut. Disease levels in continuous peanut also were not significantly different than in many other rotations. It is possible that a build-up of antagonistic microorganisms occurred over the six years of this test, resulting in the development of a disease suppressive soil (24). Rotation crop affects inoculum efficiency, the ability of *C. parasiticum* to infect root systems of viable hosts, although reduced efficiency previously was observed in soybean-peanut rotations rather than continuous peanut (3,22). Depressed yields in continuous peanut could be attributed to increases in nematode populations (Table 5) and/or build up of other pathogens such as southern stem rot leaf spot fungi even though fungicide programs were included to control these diseases. However, prior to digging peanut each year, little to no defoliation of the peanut canopy was noted and southern stem rot was not apparent.

Table 5. Plant condition rating for peanut in 2006 from nine cropping systems from 2001-2006 following fumigation with metam sodium for the CBR-resistant cultivar NC 12C and the CBR-susceptible cultivar Gregory.

		Cultivar			
		Gregory		NC 12C	
		Metam sodium (gal/acre)			
		0	12	0	12
Rotation sequence	Cropping systems, 2001-2006	Plant condition rating (%)			
A	corn-peanut (3 cycles)	5 bc	1 a	4 a	1 a
B	cotton-peanut (3 cycles)	3 c	1 a	3 a	1 a
C	corn-corn-peanut (2 cycles)	1 c	0 a	6 a	2 a
D	cotton-cotton-peanut (2 cycles)	1 c	1 a	4 a	1 a
E	soybean-corn-peanut (2 cycles)	23 a	8 a *	10 a	1 a *
F	soybean-cotton-peanut (2 cycles)	12 b	3 a	5 a	0 a
G	cotton-corn-peanut (2 cycles)	4 bc	2 a	4 a	1 a
H	continuous peanut	6 bc	1 a	2 a	6 a
I	corn-corn-corn-corn-corn-peanut	1 c	2 a	4 a	2 a
F statistic		6.57	2.13	1.12	1.46
P > F		<0.0001	0.0724	0.3851	0.2223

Means within a cultivar and fumigation treatment followed by the same letter are not significantly different at $P \leq 0.05$ according to Fisher's Protected LSD test. Plant condition was determined on a scale of 0 to 100% where 0 = no visible expression of disease and 100 = the entire canopy was expressing disease symptoms associated with CBR. * = significant at $P \leq 0.05$ using a t-test when comparing fumigation treatments within a cropping system and cultivar.

Variation in Crop Yield from 2001-2005

Variation in crop yield was noted when comparing across years (Tables 6 and 7). Although a direct comparison of yields from year to year is difficult due to possible rotation effects, some explanation is in order. For example, cotton and peanut yields were substantially lower during 2002 compared with other years. Yield during 2001, 2003, and 2004 for corn ranged from 122 to 185 bu/acre while corn yield during 2005 ranged from 68 to 99 bu/acre (Table 6). Cotton yield exceeded 1,030 lb/acre during 2001 and 2004 but was somewhat lower during 2003 and 2005 (640 to 910 lb/acre, Table 6). Lower yield, especially during 2002, was most likely a reflection of limited rainfall (Table 2). However, rainfall during 2005 from April through September was similar to that of 2002 (Table 2). Differences in yield across years were affected by interactions of rainfall, rotation, and other environmental and management factors.

Table 6. Corn and cotton yield for each rotation from 2001-2005.

Rotation sequence	Cropping system, 2001-2006	Crop yield (per acre)									
		2001		2002		2003		2004		2005	
		corn (bu)	cotton (lb)	corn (bu)	cotton (lb)	corn (bu)	cotton (lb)	corn (bu)	cotton (lb)	corn (bu)	cotton (lb)
A	corn-peanut (3 cycles)	136	—	—	—	132	—	—	—	94	—
B	cotton-peanut (3 cycles)	—	1,030	—	—	—	840	—	—	—	640
C	corn-corn-peanut (2 cycles)	122	—	19	—	—	—	182	—	67	—
D	cotton-cotton-peanut (2 cycles)	—	1,240	—	210	—	—	—	1,290	—	910
E	soybean-corn-peanut (2 cycles)	—	—	28	—	—	—	—	—	99	—
F	soybean-cotton-peanut (2 cycles)	—	—	—	210	—	—	—	—	—	800
G	cotton-corn-peanut (2 cycles)	—	1,160	25	—	—	—	—	1,300	86	—
H	continuous peanut	—	—	—	—	—	—	—	—	—	—
I	corn-corn-corn-corn-corn-peanut	130	—	35	—	132	—	185	—	64	—
F statistic		1.23	1.61	1.23	0.35	0.16	—	0.82	0.01	2.64	2.13
P > F		0.3563	0.2756	0.3539	0.5952	0.7186	—	0.8202	0.9843	0.0859	0.1995

Bushels per acre based on a mass of 56 lbs/bushel corn.

Table 7. Crop yield for each year in nine cropping systems from 2001-2005.

Rotation sequence	Cropping system, 2001-2006	Crop yield (acre)						
		2001		2002	2003	2004		2005
		Peanut (lb)	Soybean (bu)	Peanut (lb)	Peanut (lb)	Peanut (lb)	Soybean (bu)	Peanut (lb)
A	corn-peanut (3 cycles)	—	—	1,360	—	4,690a	—	—
B	cotton-peanut (3 cycles)	—	—	990	—	4,690a	—	—
C	corn-corn-peanut (2 cycles)	—	—	—	5,010a	—	—	—
D	cotton-cotton-peanut (2 cycles)	—	—	—	5,310a	—	—	—
E	soybean-corn-peanut (2 cycles)	—	61	—	4,440b	—	65	—
F	soybean-cotton-peanut (2 cycles)	—	62	—	4,440b	—	76	—
G	cotton-corn-peanut (2 cycles)	—	—	—	5,160a	—	—	—
H	continuous peanut	2,850	—	1,050	3,520c	3,060b	—	2,950
I	corn-corn-corn-corn-corn-peanut	—	—	—	—	—	—	—
F statistic		—	0.03	1.09	8.14	11.9	3.89	—
P > F		—	0.8777	0.3954	0.0007	0.0082	0.1432	—

Bushels per acre based on a mass of 60 lb per bushel of soybean. Means for peanut during 2003 and 2004 followed by the same letter are not significantly different at $P \leq 0.05$ according to Fisher's Protected LSD test.

Yield of continuous planted peanut was 1,050 lb/acre in 2002 compared with yield ranging from 2,850 to 3,520 lb/acre during 2001 and 2003-2005 (Table 7). There were no differences in soybean yield regardless of previous cropping system (Tables 6 and 7). Although there was no difference in peanut yield following corn or cotton in 2002, by 2003 and 2004 peanut yield in cropping systems with one or more years between peanut plantings was higher than when peanut was planted continuously (Table 7). Peanut yield in 2003 was higher when peanut followed 2 years of corn, 2 years of cotton, or prior rotations of cotton followed by corn compared to rotations including soybean (soybean-corn-peanut or soybean-cotton-peanut) or continuous peanut. Pod yield was higher when peanut was rotated with soybean and corn or cotton compared with continuous peanut. In 2004, continuous planting of peanut resulted in lower yield than rotations including one year of corn or cotton separating peanut plantings. These results are consistent with other studies documenting that increasing the number of nonpeanut crops between peanut plantings increases peanut yield (12,17,18,21).

Cumulative Net Return

When corn price was set at $2.50/bu, cropping systems including two cycles of cotton-cotton-peanut and cotton-corn-peanut generated cumulative net returns as high or higher than all other cropping systems (Table 8). Conversely, continuous peanut generated the lowest cumulative net returns compared with all other cropping systems, regardless of peanut price. Cumulative net returns with cropping systems including 5 years of corn then peanut, corn-corn-peanut, soybean-corn-peanut, and soybean-cotton-peanut were similar regardless of peanut price. Planting peanut in rotation with only one year of corn and cotton resulted in relatively low cumulative net returns compared with cropping systems with two or more crops planted between peanut. No difference in cumulative net return was noted when comparing cropping systems with only one year of corn or cotton.

Table 8. Net return to land, risk, and management for nine cropping systems from 2001-2006 when corn price was $2.50/bu.

Rotation sequence	**Cropping systems, 2001-2006**	**Peanut contract price** ($/ton)			
		350	**400**	**450**	**500**
		Cumulative net return ($/acre)			
A	corn-peanut (3 cycles)	-294 c	43 de	220 de	478 de
B	cotton-peanut (3 cycles)	-506 c	-212 e	-33 e	204 ef
C	corn-corn-peanut (2 cycles)	103 b	443 bc	588 bcd	801 cd
D	cotton-cotton-peanut (2 cycles)	544 a	898 a	1,002 a	1,302 a
E	soybean-corn-peanut (2 cycles)	239 ab	543 abc	672 abc	889 bc
F	soybean-cotton-peanut (2 cycles)	107 b	402 cd	528 cd	738 cd
G	cotton-corn-peanut (2 cycles)	472 ab	812 ab	957 ab	1,200 ab
H	continuous peanut	-1,510 d	-932 f	-688 f	-175 f
I	corn-corn-corn-corn-corn-peanut	130 b	307 cd	382 cd	509 cde
F statistic		24.34	17.74	14.33	11.64
P > F		<0.0001	<0.0001	<0.0001	<0.0001

[x] Means within a peanut pricing structure followed by the same letter are not significantly different at $P \leq 0.05$ according to Fisher's Protected LSD test.

Cumulative net returns of all cropping systems with at least one year of a crop other than peanut exceeded that of continuous peanut when corn price was set at $4.00/bu (Table 9). In contrast to results when corn was priced at $2.50/bu, increasing the corn price to $4.00/bu resulted in similar cumulative net returns from five years of corn then peanut or two cycles of corn-corn-peanut, cotton-cotton-peanut, and cotton-corn-peanut. When the peanut price was increased from $350 or $400/ton to $450 or $500/ton, planting peanut with only one year of corn equaled cumulative net returns of corn-corn-peanut, cotton-cotton-peanut, cotton-corn-peanut, and 5 years of corn then peanut (Table 9). No difference in cumulative net returns were noted when soybean was included with corn or cotton and one year of corn when peanut was priced at $350 or $400/ton. Results from the economic analysis demonstrate the importance of considering both biological and financial aspects of farm management when developing cropping systems. Higher prices for corn and/or peanut affected economic feasibility of these cropping systems under nonirrigated conditions in the North Carolina coastal plain.

Table 9. Net return to land, risk, and management for nine cropping systems from 2001-2006 when corn price was $4.00/bu.

Rotation sequence	**Cropping systems, 2001-2006**	**Peanut contract price** ($/ton)			
		350	**400**	**450**	**500**
		Cumulative net return ($/acre)			
A	corn-peanut (3 cycles)	255 bc	592 bc	779 ab	1,027 a
B	cotton-peanut (3 cycles)	-506 d	-212 d	-33 c	204 c
C	corn-corn-peanut (2 cycles)	662 ab	1,002 ab	1,147 a	1,360 a
D	cotton-cotton-peanut (2 cycles)	544 abc	898 ab	1,002 ab	1,302 a
E	soybean-corn-peanut (2 cycles)	430 bc	733 abc	862 ab	1,079 ab
F	soybean-cotton-peanut (2 cycles)	107 c	402 c	528 b	738 b
G	cotton-corn-peanut (2 cycles)	638 ab	978 ab	1,123 a	1,366 a
H	continuous peanut	-1,510 e	-932 e	-688 d	-175 f
I	corn-corn-corn-corn-corn-peanut	946 a	1,122 a	1,198 a	1,324 a
F statistic		23.63	17.70	14.79	11.75
P > F		<0.0001	<0.0001	<0.0001	<0.0001

Means within a peanut pricing structure followed by the same letter are not significantly different at $P \leq 0.05$ according to Fisher's Protected LSD test.

Summary

Results from this project reinforce previous research indicating that increasing the number of nonlegume crops between peanut plantings results in higher peanut yield than continuous peanut. Peanut yield was often higher when corn or cotton replaced soybean in the rotation. Although some variation was observed, less CBR and fewer root knot nematodes in soil were often observed when the number of nonpeanut crops included between peanut plantings was increased. However, the combination of soybean-corn-peanut and corn-peanut resulted in high populations of root knot nematode populations in the final year of the rotation. Fumigation with metam sodium resulted in fewer yield differences among cropping systems, less diseased plants from CBR, lower root knot nematode populations, and greater pod yield compared with nonfumigated peanut in some but not all cases. The rotation with the highest cumulative net return did not always reflect the best rotation to reduce disease caused by CBR and root knot nematodes in the final year of the experiment. Increasing the price of corn affected economic viability of those rotations including corn. When the price of corn was increased to $4.00/bu, 5 years of corn and one year of peanut provided cumulative net returns as high as all other crop rotations. Results from this experiment can be used to further contrast the biological impact of cropping systems under varying price structures for corn, cotton, peanut, and soybean in the coastal plain of North Carolina.

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