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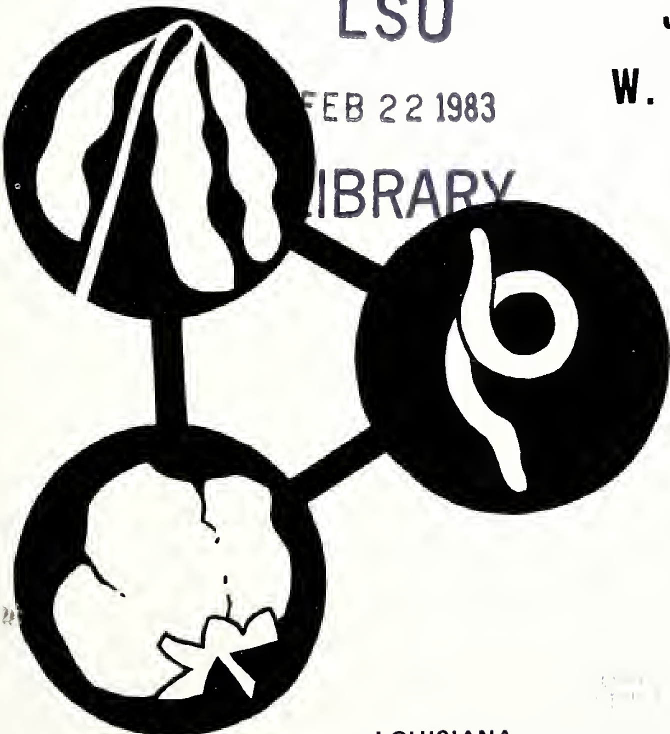

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Cotton-Soybean Rotation for Reniform Nematode Control

C. Williams[1], D. F. Gilman[2], J. E. Jones[3], and W. Birchfield[4]

Reniform nematodes have been reported in Avoyelles, Rapides, St. Landry, Orleans, Grant, East Baton Rouge, Morehouse, Richland, and several other parishes in Louisiana. Once a field is infested with this nematode, no known method will eliminate them. Populations can build to damaging proportions if susceptible cultivars are grown continuously in infested fields. Plant symptoms are not readily noticeable, and the nematode cannot be seen with the naked eye. Since reniform nematodes are quite resistant to soil drying (*4*)[5], they may be easily spread from field to field on farm equipment. Partial control can be obtained through proper use of nematicides, resistant cultivars and crop rotation. All commercially available cotton cultivars and most soybean cultivars are susceptible to this nematode. Resistant soybean cultivars commercially available to Louisiana producers are Forrest, Bedford, Pickett 71, and Centennial.

The objective of this study was to evaluate the effectiveness of cropping sequences, involving a reniform-resistant soybean cultivar in rotation with susceptible cotton and soybean cultivars, on degree of nematode control compared with continuous cropping of these cultivars with and without a nematicide.

Literature Review

The reniform nematode, *Rotylenchulus reniformis* Linford and Oliviera, was first reported as a plant parasite in 1940 (*11*). According to Linford and Oliviera, this nematode was probably observed by Hagan and Yap on cowpeas in 1931, but it was not investigated until 1936 (*11*). The common name "reniform nematode" was proposed to describe the usual kidney shape of the adult female.

The reniform nematode has a very wide host range, including the agronomically important families Graminae, Leguminosae, Malvaceae, and Solanaceae (*9, 19*). Only females are parasitic. Infective young females imbed themselves partially, sometimes entirely, in the root cortex of the cowpea (*11*). Birchfield (*1*) found that the young females initiated

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[5]Italic numbers in parenthesis refer to Literature Cited, page 21.

damage in cotton (*Gossypium hirsutum* L.) by extending the anterior portion of their bodies through the epidermis and cortical parenchyma to feed in phloem tissue. Young females began egg production 8-9 days after infection and completed their life in 17-23 days. Rebois (*14*) found that the life cycle was completed within 19 days on Lee and Hood soybeans [*Glycine max* L. (Merr)].

Reniform nematode populations can increase greatly during the growing season. Jones et al. (*9*) made nematode counts at intervals from May 20 until August 25 and found that nematode numbers increased from 1,019 to 49,120 per 500 cm^3 of soil in non-fumigated plots. Rebois (*15*) found reniform nematode infectivity on soybeans greatest when soil water content was maintained just below field capacity. Temperature affected nematode development and population growth rate (*14*). Rebois (*14*) reported that fecundity was highest on soybean roots maintained at 29.5°C.

The reniform nematode was first identified on cotton by G. Steiner, according to Smith (*18*). Neal (*12*) reported that a high incidence of fusarium wilt (*Fusarium oxysporium f. vasinfectum*, Atk., S. and H.) in a susceptible cotton variety was induced by reniform nematode infection. Smith and Taylor (*19*) observed a pronounced reniform nematode infection on roots of cotton and cowpeas in a fusarium wilt nursery at Baton Rouge. Khadr et al. (*10*) studied the reaction of 16 Egyptian cotton cultivars (*Gossypium barbadense* L.) to reniform nematode and fusarium wilt. They found that the reniform nematode increased wilt severity in highly and moderately susceptible cultivars and induced infection in wilt resistant cultivars. Jones et al. (*9*) reported that the nematode reproduced abundantly and caused a reduction in lint yield, a delay in maturity, a reduction in boil size, and in some years, a reduction in lint percent. Seed size, fiber length, fiber strength, and fiber fineness were not affected. Birchfield and Jones (*3*) attributed a yield reduction in cotton on 2,000-5,000 acres in Rapides and Avoyelles parishes in Louisiana to reniform nematode.

Yield increases in cotton from soil fumigation has varied with both variety and year. Jones et al. (*9*) obtained a 38 percent increase in lint yield in 1954, a 1.5 percent increase in 1955, and a 37.8 percent increase in 1956 from fumigation. Yield increases were greatest for cultivars highly susceptible to wilt. A 73 percent increase in lint yield resulted from fumigation for one cultivar.

Several workers have reported that reniform nematode parasitized soybeans (*2, 6, 7, 13, 17*). Williams and Birchfield (*20*) found that the pathogen caused root decay, unthrifty growth, and up to 10 percent yield reduction in susceptible soybean cultivars grown in Louisiana. In a greenhouse test, Rebois and Johnson (*16*) found that seed phosphorus decreased and potassium increased at low inoculum levels, but little change was noted in nitrogen content of the seed. Rebois et al. (*17*) reported that all soybean cultivars which were resistant to the reniform nematode also were resistant to the cyst nematode. They postulated a common source of resistance to both nematodes. Birchfield et al. (*5*) later showed that all cultivars resistant to the reniform nematode were not necessarily resistant to the soybean cyst nematode. Fontenot (*8*) studied the inheritance of resistance to the reniform nematode in the soybean cross, Forrest X Ransom. He found that susceptibility was dominant to resistance and that a small number of genes appeared to control resistance.

The reniform nematode apparently cannot reproduce on resistant soybean cultivars. Rebois et al. (*17*) did not find mature females or egg masses attached to roots of resistant cultivars. Resistant cultivars were penetrated by infective females, but the females soon died (*8*). The resistant cultivars Pickett and Dyer reduced a reniform nematode population from 10,000 to 500 per 500 cm^3 of soil over a 2.5 month period (*17*). Soybean cultivars varied in yield response and tolerance at low reniform nematode populations in greenhouse studies; however, at high initial populations (25,000 nemas per 3.8 liters soil) yield was consistently lower for both resistant and susceptible cultivars (*16*). Williams and Birchfield (*20*) found significantly lower reniform nematode populations in plots of resistant Pickett and Pickett 71 soybeans compared with plots of reniform susceptible cultivars. Soil fumigation reduced the reniform nematode population only slightly in Pickett and Pickett 71 soybean plots in comparison to plots where susceptible cultivars were grown. The susceptible cultivars did not yield as well with soil fumigation as resistant cultivars yielded without soil fumigation.

Procedure

Deltapine 45A cotton and Lee 68 and Pickett 71 soybeans were used in the study. Deltapine 45A is susceptible to the reniform nematode. Lee 68 (replaced by Lee 74) and Pickett 71 soybeans are grown commercially in Louisiana and are similar in morphology, disease resistance, and adaptability. However, Pickett 71 is resistant to the reniform nematode and races 1 and 3 of the soybean cyst nematode, whereas, Lee 68 is susceptible to both organisms.

The test was conducted at the Perkins Road Agronomy Farm in Baton Rouge for five years from 1972 through 1976. The soil, Olivier silt loam (Aquic Fragiudalf), was heavily and fairly uniformly infested with the reniform nematode. The field had been cropped continuously with cotton for several years prior to 1971. A reniform nematode susceptible soybean cultivar was grown on the entire test site in 1971 in an effort to improve on uniformity of nematode infestation prior to the initiation of the experiment.

Land preparation consisted of disking and bedding in the fall or early winter. In the spring, fertilizer was applied in row middles, old beds were disked, and new beds were formed over the fertilized areas. Before planting, 8.6 pounds per acre of DBCP, (1, 2-dibromo-3-chloropropane) (EC) was injected with 16 gallons of water into the center of the bed of the

Table 1.—Fertilizer date and rate, fumigation date, and planting date of a cotton-soybean rotation study conducted in reniform nematode infested Olivier silt loam, Baton Rouge.

Year	Date fertilizer applied[1]	Fertilization rote, lbs/ocre	Soil fumigation date.	Plonting dote
197 2[2]	April 21 June 14	0-80-80 60-0-0	April 21 Moy 16	May 5 May 17, 26
1973[3]	April 12	126-60-60	Moy 10	May 16
1974	April 9 July 2	0-60-60 60-0-0	Moy 14	Moy 17
1975	Moy 7 July 22	40-80-80 25-0-0	Moy 19	Moy 27
1976	Moy July 30	0-60-60 60-0-0	June 4	June 4

[1]Applied nitrogen to cottan by side dressing.

[2]Received 5. 2 inches af roinfall on Moy 7. Fumigated plats agoin and replonted cotton ond saybean plats on May 17. The soybean plats were agoin replanted an Moy 26.

[3]Plots were unintentionally over-fertilized with nitrogen in 1973.

appropriate plots to a depth of about 8 inches. The injection knife was passed through all plots. The beds were reformed and knocked down to a height of about four inches immediately before planting. Ferilizer, fumigation, and planting dates are shown in Table 1.

Plots consisted of four rows, 40 inches wide and 50 feet long. Treatments were arranged in a randomized complete block design with six replications. Cotton was planted in excess and later thinned to four plants per foot of row.

The nematode population was monitored in 3 of 5 years at planting, and annually in August and late September or early October by taking a minimum of 10 soil cores from the center two rows of each plot. The samples were taken at a depth of 8 inches on the side of the row about 4 inches from the drill. Nematode counts were made using a technique previously described by Birchfield et al (*5*).

Weed control was maintained by using the preplant incorporated herbicide Treflan, cultivation, and hand hoeing. A 4- to 5-day spray schedule was used from bloom to mid-September for insect control in cotton. Soybeans were sprayed as needed for insect control.

Fourteen cropping sequences were established (Table 2).

Cotton

Yields were determined by mechanically harvesting the two center rows of each plot and are reported in pounds of lint per acre. Fiber properties were determined from a 50-boll sample hand picked from each treatment prior to first harvest. The samples were ginned on a laboratory saw gin and lint percent was computed. The following fiber properties were measured by the LSU Cotton Fiber Laboratory.

Micronaire—the fineness of the sample taken from ginned lint measured by the Fibronaire and expressed in standard micronaire units.

Span length—fiber length was measured on a Digital Fibrograph. The 2.5 percent span length is the length, in inches, on the test specimen spanned by 2.5 percent of the fibers scanned at the initial starting point. It closely approximated classer's staple. The 50 percent span length is the length, in inches, on the test specimen spanned by 50 percent of the fibers scanned at the initial starting point.

Fiber strength is the strength of a bundle of fibers measured on the Pressley Strength Tester, with the jaws holding the fiber bundle separated by an ⅛-inch spacer and expressed in grams-force per tex.

Table 2.—Cropping sequence by years of Deltapine 45A cotton and Lee 68 and Pickett 71 soybeans grown in reniform nematode infested Olivier silt loam, Baton Rouge.

1972	1973	1974	1975	1976
C[1]	C	C	C	C
C-F	C-F	C-F	C-F	C-F
L	L	L	L	L
L-F	L-F	L-F	L-F	L-F
P	P	P	P	P
P-F	P-F	P-F	P-F	P-F
C	L	C	P	C-F
C	P	C	P	C
L	C	L	L	C
P	C	P	P	C
P	P	C	C	L
P	P	L	C	L
L	P	L	L	C-F
P	L	P	P	L

[1]C = Deltapine 45A cotton, L = Lee 68 saybeans, P = Pickett 71 soybeans, and F = soil fumigated with 8.6 pounds per acre af DBCP.

Soybeans

Yields were determined from weight of seed harvested from the two center rows of each plot with a commercial combine. Yields are reported as bushels per acre of cleaned seed adjusted to 13 percent moisture.

Plant height was determined as the average length of mature plants from the ground to the top.

Lodging was recorded on a scale of 1 to 5 according to the following criteria:

1—almost all plants erect
2—either all plants leaning slightly, or a few plants down

3—either all plants leaning moderately, or 25 to 50 percent of the plants down
4—either all plants leaning considerately, or 50 to 80 percent of the plants down
5—all plants down

Percent protein and percent oil were determined from a composite of three replicates of 30 grams of seed from each treatment. Protein content was determined by the Kjeldahl procedure and oil content was determined by Nuclear Magnetic Resonance spectroscopy at the U.S. Regional Soybean Laboratory, Urbana, Illinois.

Statistical Analysis

Data from each year were analyzed separately and in a combined analysis across years. Treatment means were separated using Tukey's Honestly Significant Difference Test.

Results

Effects of Cropping Sequence and Soil Fumigation on Nematode Populations

Initial reniform nematode populations were 1,200 nemas per 500 cm^3 of soil in the non-fumigated plots and 200 nemas per 500 cm^3 of soil in the fumigated plots (Table 3). Soil fumigation and cultivar resistance produced significant shifts in reniform nematode population levels at planting by the second year. Plots where 2 years of continuous cotton (11,140) and continuous Lee 68 soybeans (7,070) were grown without soil fumigation had significantly higher early season nematode numbers than fumigated plots (1,080 and 1,990, respectively) or plots where Pickett 71 soybeans were grown for one (avg. 705) or two (avg. 320) years. Nematode populations at planting in 1974 were lower in non-fumigated Pickett 71 plots than in fumigated Lee 68 soybean and fumigated cotton plots, although differences were not statistically significant.

Reniform nematode populations were considerably higher at planting in 1973 plots where Lee 68 soybeans or cotton had been grown in 1972 compared with plots containing Pickett 71 soybeans in 1972 (Table 3). Similarly, fewer reniform nematodes were present at planting in 1974 plots where Pickett 71 soybeans were grown in either 1973 or in both 1972 and 1973 than in plots where cotton or Lee 68 soybeans had been grown the previous year. Reniform nematode numbers were essentially equal at planting in fumigated and in non-fumigated plots where Pickett 71 soybeans were grown the previous year. Nematode population levels at planting in 1974 were similar in plots where cotton followed Lee 68 or Pickett 71

Table 3.—Infestation levels of reniform nematodes in soil at planting by years as affected by cropping sequences and fumigation treatment.

Cropping sequence[1]			Lorvae/500 cm^3		
1972	1973	1974	1972[2]	1973	1974
C	C	C	1, 200	910	11,140
C-F	C-F	C-F	200	570	1,080
L	L	L	1, 200	940	7,070
L-F	L-F	L-F	200	210	1,990
P	P	P	1, 200	140	240
P-F	P-F	P-F	200	30	230
C	L	C	1, 200	910	4,000
C	P	C	1, 200	820	680
L	C	L	1, 200	490	8,590
P	C	P	1, 200	120	8,360
P	P	C	1, 200	50	470
P	P	L	1, 200	140	250
L	P	L	1, 200	610	730
P	L	P	1, 200	40	830
H.S.D.$_{.05}$			850	430	7,540

[1]C = Deltopine 45A, L = Lee 68 soybeans, P = Pickett 71 soybeans ond F = soil fumigoted with 8.6 pounds per ocre of DBCP.
[2]Composited soil from plots with some treatment for nemotode onolyses.

soybeans (8,590 vs. 8,360). This was slightly higher than where Lee 68 soybeans had been grown for 2 years (7,070), considerably higher than where Lee 68 soybeans followed cotton (4,000), but lower than where cotton had been grown for 2 years (11,140).

Mid-season nematode populations fluctuated greatly from year to year in both cotton and Lee 68 soybean plots, irrespective of fumigation, but they were fairly consistent within treatments involving Pickett 71 soybeans (Table 4). The 5-year average mid-season nematode population was reduced significantly by soil fumigation in both cotton (from 11,530 to 3,470 per 500 cm^3 soil) and Lee 68 soybeans (9,820 to 1,460 per 500 cm^3 soil). Soil fumigation was effective in reducing the mid-summer nematode population in all 5 years of the test for the two susceptible hosts, but it had little effect on nematode population where the resistant soybean cultivar Pickett 71 was grown (260 vs. 130). Both susceptible hosts supported significantly more reniform nematodes than the resistant host at mid-summer. In fact, the reniform nematode population was higher at mid-season in fumigated plots of cotton and Lee 68 soybean than in non-fumigated Pickett 71 soybean plots in all years except 1972.

Cotton following 1 year of Lee 68 or Pickett 71 soybeans had a much higher mid-season nematode population than when Lee 68 followed cotton or Pickett 71 soybeans (Table 4). Regardless of the preceeding crop, Pickett 71 supported significantly fewer reniform larvae than Lee 68 or cotton, and was particularly effective in reducing the mid-season population of this nematode when grown for 2 or more successive years. In fact,

Table 4.—Infestation levels of reniform nematodes in soil at mid-season by years as affected by cropping sequences and fumigation treatment.

Cropping sequence[1]					Larvae/500 cm³				
1972	1973	1974	1975	1976	1972[2]	1973	1974	1975	1976
C	C	C	C	C	6,570	20,510	13,160	14,990	2,430
C-F	C-F	C-F	C-F	C-F	100	4,310	9,590	3,230	100
L	L	L	L	L	6,060	15,350	9,110	16,140	2,470
L-F	L-F	L-F	L-F	L-F	270	1,710	3,450	1,720	130
P	P	P	P	P	390	390	340	150	50
P-F	P-F	P-F	P-F	P-F	40	80	440	80	20
C	L	C	P	C-F	6,570	11,990	10,420	1,790	100
C	P	C	P	C	6,570	770	11,580	2,820	5,740
L	C	L	L	C	6,060	23,890	5,150	23,000	5,210
P	C	P	P	C	390	25,980	1,130	800	1,650
P	P	C	C	L	390	330	9,390	23,850	3,230
P	P	L	C	L	390	240	1,410	8,810	2,630
L	P	L	L	C-F	6,060	460	2,310	9,900	140
P	L	P	P	L	390	10,190	530	200	220
H.S.D.$_{.05}$					3,640	9,320	11,800	20,220	4,400

[1] C = Deltapine 45A cotton, L = Lee 68 saybeans, P = Pickett 71 soybeons, and F = soil fumigoted with 8.6 pounds per acre of DBCP.

[2] Composited soil from plots with some treotment for nemotode analyses.

non-fumigated cotton following 2 years of Pickett 71 had a similar reniform nematode population at mid-season as continuous cotton with soil fumigation. Likewise, non-fumigated Lee 68 following two years of Pickett 71 supported a similar mid-season nematode population as continuous Lee 68 with soil fumigation.

Nematode populations at harvest were extremely high when cotton and Lee 68 soybeans were grown continuously without fumigation (Table 5). Continuous Pickett 71 supported significantly lower reniform nematode populations than continuous cotton or Lee 68 soybeans. Fumigation significantly reduced nematode population levels at harvest in cotton and Lee 68 plots, but it had little effect where Pickett 71 was grown continuously. Although fumigation significantly reduced reniform nematode populations at harvest in cotton (10,410 vs. 4,340) and Lee 68 plots (6,800 vs. 2,160) as an average across years, there were fewer nematodes in non-fumigated Pickett 71 plots (340) than continuous cotton or Lee 68 plots with fumigation.

Cropping rotations involving cotton and Lee 68 soybeans in the current year tended to develop high reniform nematode populations at harvest (Table 5). Reniform nematode numbers were greatly reduced early in the growing season when Pickett 71 was the previous crop; however, population levels increased by harvest time when a susceptible host was grown. Two consecutive years of Pickett 71 further reduced the reniform population at harvest over that of 1 year of Pickett 71; however, nematode numbers increased to very high levels by crop maturity when a susceptible host was subsequently grown.

Table 5.—Infestation levels of reniform nematodes in soil at harvest by years as affected by cropping sequences and fumigation.

Cropping sequence[1]					Larvae/500 cm^3				
1972	1973	1974	1975	1976	1972[2]	1973	1974	1975	1976
C	C	C	C	C	13,150	17,240	12,210	2,160	7,290
C-F	C-F	C-F	C-F	C-F	630	9,990	9,360	1,000	700
L	L	L	L	L	10,720	8,790	8,130	2,010	4,370
L-F	L-F	L-F	L-F	L-F	130	3,130	6,510	760	290
P	P	P	P	P	550	480	450	70	160
P-F	P-F	P-F	P-F	P-F	350	160	230	30	80
C	L	C	P	C-F	13,150	9,650	13,330	160	590
C	P	C	P	C	13,150	870	9,910	700	4,200
L	C	L	L	C	10,720	18,570	12,290	2,150	3,970
P	C	P	P	C	550	12,860	850	100	3,530
P	P	C	C	L	550	370	13,160	3,020	2,820
P	P	L	C	L	550	270	4,660	2,680	2,600
L	P	L	L	C-F	10,720	380	5,180	1,470	1,750
P	L	P	P	L	550	8,070	1,020	150	1,910
$H.S.D._{.05}$					7,460	9,910	9,060	2,210	3,720

[1]C = Deltapine 45A cotton, L = Lee 68 soybeans, P = Pickett 71 soybeans, and F = soil fumigated with 8.6 pounds per acre of DBCP.
[2]Composited soil fram plots with same treatment for nematode anolyses.

Large, mostly positive, changes occurred in reniform nematode population between planting and mid-season (Table 6). Population levels increased more in continuous cotton and continuous Lee 68 plots without soil fumigation than in plots with soil fumigation. Pickett 71 drastically reduced the initial nematode population but had little further effect on the population level. In the cropping sequences, all decreases in reniform population from planting until mid-season were in Pickett 71 plots, except for Lee 68 following cotton in 1974. Population increases were generally greater in plots containing cotton than in plots containing Lee 68 soybeans.

Nematode population shifts from planting to harvest were large in continuous cotton and Lee 68 plots irrespective of fumigation treatment, but they were small in continuous Pickett 71 plots (Table 7). Likewise, there were increases in population density from spring until fall in all treatments containing cotton or susceptible soybeans, except for fumigated Lee 68 in 1972. In 1974, cotton following 2 years of resistant soybeans had a significantly greater population change from planting until harvest than all other crop sequences involving Pickett 71 soybeans. The only large decrease in nematode population occurred in 1974 in the rotation Pickett 71-Deltapine 45A-Pickett 71, when 7,510 fewer nematodes were present at harvest than at planting.

The reniform nematode population change from mid-season until harvest for the various treatments varied greatly among years (Table 8). Continuous cropping treatments of susceptible hosts tended to have fewer nematodes at harvest than at mid-season, while the continuously cropped

Table 6.—Effect of cropping sequence and soil fumigation on the change in reniform nematode population from planting until mid-season.

Cropping sequence[1]			Population change		
1972	1973	1974	1972[2]	1973	1974
			---------- Nematodes per 500 cm^3 of soil ----------		
C	C	C	5,370	19,600	2,020
C-F	C-F	C-F	− 100	3,740	8,510
L	L	L	4,860	14,410	2,040
L-F	L-F	L-F	70	1,500	1,460
P	P	P	− 810	250	100
P-F	P-F	P-F	− 160	50	210
C	L	C	5,370	11,080	6,410
C	P	C	5,370	− 40	10,900
L	C	L	4,860	23,400	− 3,440
P	C	P	− 810	25,870	− 7,230
P	P	C	− 810	280	8,910
P	P	L	− 810	100	1,160
L	P	L	4,860	− 110	1,570
P	L	P	− 810	10,150	− 290
H.S.D.$_{.05}$			3,660	9,280	13,000

[1]C = Deltopine 45A cotton, L = Lee 68 soybeans, P = Pickett 71 soybeans, and F = soil fumigated with 8.6 pounds per acre of DBCP.

[2]Composited soil from plots with same treatment for nematode analyses.

Table 7.—Effect of cropping sequence and soil fumigation on the change in reniform nematode population from planting until harvest.

Cropping sequence[1]			Population change		
1972	1973	1974	1972[2]	1973	1974
			---------- Nematodes per 500 cm^3 of soil ----------		
C	C	C	11,950	16,330	1,070
C-F	C-F	C-F	430	9,420	8,280
L	L	L	9,520	7,840	1,060
L-F	L-F	L-F	− 70	2,920	4,520
P	P	P	− 650	340	210
P-F	P-F	P-F	150	130	10
C	L	C	11,950	8,740	9,330
C	P	C	11,950	50	9,230
L	C	L	9,520	18,080	4,700
P	C	P	− 650	12,740	− 7,510
P	P	C	− 650	320	12,690
P	P	L	− 650	130	4,410
L	P	L	9,520	− 230	4,450
P	L	P	− 650	8,030	190
H.S.D.$_{.05}$			7,460	9,850	10,580

[1]C = Deltopine 45A cotton, L = Lee 68 soybeans, P = Pickett 71 soybeans, and F = soil fumigated with 8.6 pounds per acre of DBCP.

[2]Composited soil from plots with same treatment for nematode analyses.

Pickett 71 tended to support small increases during this period. Significant shifts in nematode density between mid-season and harvest occurred among the various rotations during all years except 1974. Population changes from August to October appeared to be influenced more by environmental changes than cropping sequence.

Effect of Cropping Sequence and Soil Fumigation on Yield and Quality Measurements

Cotton

Fumigation increased lint yield of continuously grown cotton during 3 of the 5 years (Table 9). When averaged across years, fumigation increased lint yield from 581 to 694 pounds per acre, a highly significant difference of 113 pounds. The largest yield response to fumigation occurred in 1975 when lint yield was increased 66 percent or 383 pounds per acre over the non-treated check.

Crop rotation had no effect on lint yield in 1973 when yields were extremely low; all rotations produced similar or higher yields than continuous cotton during all other years of the study (Table 9). Lint yields were similar when non-fumigated cotton followed cotton or Lee 68 soybeans. But yields were higher when cotton followed 1 year of Pickett 71 compared with non-fumigated continuous cotton; they were appreciably higher when cotton followed 2 years of Pickett 71 compared with non-fumigated continuous cotton. In fact, cotton following 2 years of Pickett 71 had lint yields slightly higher than continuous cotton with fumigation. Cotton following 2 years of Pickett 71 yielded 839 pounds of lint per acre in 1976, which was 56 percent or 300 pounds per acre more than continuous cotton without fumigation and 7 percent or 55 pounds of lint per acre more than continuous cotton with soil fumigation. Cotton, in an alternate year rotation with Pickett 71, was significantly higher yielding (36 percent) in 1976 than continuous cotton without soil fumigation. Furthermore, there was a significant response to fumigation in 1976 when cotton followed cotton or Lee 68 soybeans but not when cotton followed Pickett 71. This is further evidence that 1 year of Pickett 71 had a measurable effect in suppressing this nematode.

Cropping sequence affected lint percent in only 2 years, 1972 and 1975 (Table 10). The effects were, for the most part, small and inconsistent.

Significant differences among treatments occurred for micronaire in 1974 and 1976 (Table 11). In 1974, Deltapine 45A produced lint with significantly lower micronaire values when following 1 and 2 years of Pickett 71 than when following Lee 68 or cotton, irrespective of fumigation treatment. In 1976, the micronaire value of fumigated continuous cotton

Table 8.—Effect of cropping sequences and soil fumigation on the change in reniform nematode population from mid-season until harvest.

Cropping sequence[1]					Population change				
1972	1973	1974	1975	1976	1972[2]	1973	1974	1975	1976
					Nematodes per 500 cm^3 of soil				
C	C	C	C	C	6,580	−3,270	−940	−12,830	−4,860
C-F	C-F	C-F	C-F	C-F	530	5,670	−230	−2,230	600
L	L	L	L	L	4,670	−6,570	−980	−14,130	1,900
L-F	L-F	L-F	L-F	L-F	−140	1,420	3,060	−970	160
P	P	P	P	P	160	100	110	−80	110
P-F	P-F	P-F	P-F	P-F	300	80	−210	−50	60
C	L	C	P	C-F	6,580	−2,340	2,920	−1,640	490
C	P	C	P	C	6,580	100	−1,680	−2,120	−1,540
L	C	L	L	C	4,670	−5,320	8,150	−20,850	−1,240
P	C	P	P	C	160	−13,130	−280	−970	−1,880
P	P	C	C	L	160	30	3,770	−20,830	−410
P	P	L	C	L	160	30	3,250	−6,120	−30
L	P	L	L	C-F	4,670	−90	2,880	−8,440	1,610
P	L	P	P	L	160	−2,120	490	−50	1,690
H.S.D.$_{.05}$					7,770	12,830	ns	15,780	5,630

[1]C = Deltapine 45A cotton, L = Lee 68 soybeans, P = Pickett 71 soybeans, and F = soil fumigated with 8.6 pounds per acre of DBCP.

[2]Composited soil from plots with same treatment for nematode analyses.

Table 9.—Cropping sequence effects on yield of Deltapine 45A cotton grown in reniform nematode infested soil.

Crop sequence[1]					Lint yield (lbs/acre)				
1972	1973	1974	1975	1976	1972	1973	1974	1975	1976
C	C	C	C	C	732	382	675	579	539
C-F	C-F	C-F	C-F	C-F	610	370	742	962	784
C	L	C	P	C-F	714	-	698	-	724
C	P	C	P	C	651	-	702	-	732
L	C	L	L	C	-	372	-	-	549
P	C	P	P	C	-	342	-	-	839
P	P	C	C	L	-	-	770	659	-
P	P	L	C	L	-	-	-	685	-
L	P	L	L	C-F	-	-	-	-	721
H.S.D.$_{.05}$					ns	ns	84	221	191

[1]C = Deltapine 45A cotton, L = Lee 68 soybeans, P = Pickett 71 soybeans, and F = soil fumigated with 8.6 pounds per acre of DBCP.

was not significantly different from that of continuous non-fumigated cotton or non-fumigated cotton following Lee 68 soybeans. However, these cropping sequences produced lint with generally higher micronaire values than when cotton followed Pickett 71 or when fumigated cotton followed Lee 68. This is interpreted to be the result of a combined response to nematode control and nitrogen accumulation resulting from soybean plant residue.

None of the cropping sequences had a significant effect on fiber length or fiber strength measurements.

Soybeans

Fumigation increased yield of continuous Lee 68 by an average of 2.5 bushels per acre (8 percent) but had no effect on continuous Pickett 71 soybean yield when averaged across years. Yield increases from fumigation were obtained during each year for Lee 68. Nevertheless, yields were consistently higher for non-fumigated Pickett 71 than for fumigated Lee 68 (Table 12). In the crop rotations, yields were somewhat higher for Lee 68 when following Pickett 71 than when following either Lee 68 or cotton, and in some cases, yields were significantly higher when following 2 years of Pickett 71 than when grown continuously without fumigation. In fact, Lee 68 produced 10 and 12 percent higher yields in 1974 and 1976, respectively, when following 2 years of Pickett 71 compared with continuous Lee 68 with soil fumigation, but in neither year was the difference significant.

Table 10.—Cropping sequence effects on lint percentage of Deltapine 45A cotton grown in reniform nematode infested soil.

Crop sequence[1]					Lint percent				
1972	1973	1974	1975	1976	1972	1973	1974	1975	1976
C	C	C	C	C	41.5	38.8	38.5	38.2	38.5
C-F	C-F	C-F	C-F	C-F	40.7	38.9	38.8	39.3	39.4
C	L	C	P	C-F	41.5	-	38.9	-	38.4
C	P	C	P	C	41.5	-	38.6	-	38.8
L	C	L	L	C	-	38.7	-	-	38.1
P	C	P	P	C	-	38.5	-	-	39.1
P	P	C	C	L	-	-	38.9	38.7	-
P	P	L	C	L	-	-	-	40.0	-
L	P	L	L	C-F	-	-	-	-	38.4
H.S.D.$_{.05}$					0.8	ns	ns	1.0	ns

[1]C = Deltapine 45A cotton, L = Lee 68 soybeans, P = Pickett 71 soybeans, and F = soil fumigated with 8.6 pounds per acre of DBCP.

Soil fumigation had no effect on soybean seed oil or protein content. However, Lee 68 had a significantly higher protein content than Pickett 71.

Small but significant differences were observed among cropping sequences for mature plant height (Table 13). Non-fumigated Lee 68 plants were shorter than fumigated Lee 68 plants during each year of the test, and they were significantly shorter than fumigated Lee 68 plants when averaged across years. The only significant differences in plant height among rotations occurred in 1974 when Pickett 71 followed Lee 68. These plants were significantly shorter than Pickett 71 plants grown continuously with fumigation.

Table 11.—Cropping sequence effects on micronaire of Deltapine 45A cotton grown in reniform nematode infested soil.

Crap sequence[1]					Micranaire (value)				
1972	1973	1974	1975	1976	1972	1973	1974	1975	1976
C	C	C	C	C	5.3	4.5	4.6	4.8	4.9
C-F	C-F	C-F	C-F	C-F	5.5	4.5	4.6	4.9	4.[illegible]
C	L	C	P	C-F	5.4	-	4.5	-	4.7
C	P	C	P	C	5.4	-	4.3	-	4.4
L	C	L	L	C	-	4.5	-	-	4.9
P	C	P	P	C	-	4.3	-	-	4.6
P	P	C	C	L	-	-	4.3	4.9	-
P	P	L	C	L	-	-	-	5.0	-
L	P	L	L	C-F	-	-	-	-	4.6
$H.S.D._{.05}$					ns	ns	0.2	ns	0.3

[1]C = Deltapine 45A cattan, L = Lee 68 saybeans, P = Pickett 71 saybeans, and F = sail fumigated with 8.6 paunds per acre af DBCP.

Table 12.—Cropping sequence effects on yield of Lee 68 and Pickett 71 soybeans grown in reniform nematode infested soil.

Crap sequence[1]					Yield (bushels/acre)				
1972	1973	1974	1975	1976	1972	1973	1974	1975	1976
L	L	L	L	L	31.9	29.8	32.2	34.4	34.4
L-F	L-F	L-F	L-F	L-F	33.4	33.3	33.9	35.9	39.8
P	P	P	P	P	38.3	34.8	35.7	41.4	45.6
P-F	P-F	P-F	P-F	P-F	38.0	28.8	37.3	41.4	47.4
C	L	C	P	C-F	-	28.8	-	39.2	-
C	P	C	P	C	-	35.3	-	42.4	-
L	C	L	L	C	35.8	-	35.1	34.4	-
P	C	P	P	C	36.4	-	32.6	41.6	-
P	P	C	C	L	38.4	39.2	-	-	37.8
P	P	L	C	L	40.7	36.3	37.2	-	40.6
L	P	L	L	C-F	33.0	35.0	34.8	34.6	-
P	L	P	P	L	36.7	30.5	31.3	42.5	44.4
$H.S.D._{.05}$					8.5	8.9	ns	7.9	7.0

[1]C = Deltapine 45A cattan, L = Lee 68 saybeans, P = Pickett 71 saybeans, and F = sail fumigated with 8.6 paunds per acre af DBCP.

Pickett 71 set pods significantly closer to the ground when following cotton than when grown continuously with fumigation in 1974, and Lee 68 set pods closer to the ground when following 2 years of cotton than when following 2 years of Pickett 71 in 1976 (Table 14). Fumigation had no effect on lower pod height of Lee 68 or Pickett 71 when grown continuously.

None of the cropping sequences had a significant effect on lodging or seed quality.

Table 13.—Cropping sequence effects on plant height of Lee 68 and Pickett 71 soybeans grown in reniform nematode infested soil.

Crop sequence[1]					Plant height (inches)		
1972	1973	1974	1975	1976	1974	1975	1976
L	L	L	L	L	26.0	35.8	33.8
L-F	L-F	L-F	L-F	L-F	28.3	36.5	37.7
P	P	P	P	P	26.8	38.5	37.7
P-F	P-F	P-F	P-F	P-F	27.2	36.8	36.5
C	L	C	P	C-F	-	35.8	-
C	P	C	P	C	-	35.5	-
L	C	L	L	C	25.5	33.2	-
P	C	P	P	C	26.2	38.2	-
P	P	C	C	L	-	-	35.0
P	P	L	C	L	37.3	-	34.7
L	P	L	L	C-F	30.0	35.8	-
P	L	P	P	L	23.2	36.5	38.1
H.S.D..05					3.9	ns	ns

[1]C = Deltapine 45A cotton, L = Lee 68 soybeons, P = Pickett 71 saybeons, and F = soil fumigoted with 8.6 pounds per acre of DBCP.

Table 14.—Cropping sequence effects on lower pod height of Lee 68 and Pickett 71 soybeans grown in reniform nematode infested soil.

Crop sequence[1]					Height of lower pod (inches)		
1972	1973	1974	1975	1976	1974	1975	1976
L	L	L	L	L	5.0	4.5	5.0
L-F	L-F	L-F	L-F	L-F	5.2	4.2	4.8
P	P	P	P	P	5.7	4.5	5.8
P-F	P-F	P-F	P-F	P-F	5.2	4.8	4.7
C	L	C	P	C-F	-	4.8	-
C	P	C	P	C	-	4.5	-
L	C	L	L	C	5.5	4.5	-
P	C	P	P	C	4.5	4.2	-
P	P	C	C	L	-	-	4.3
P	P	L	C	L	5.2	-	4.8
L	P	L	L	C-F	5.5	4.2	-
P	L	P	P	L	5.0	4.2	5.7
H.S.D..05					1.1	ns	1.2

[1]C = Deltapine 45A cotton, L = Lee 68 soybeons, P = Pickett 71 soybeans, and F = soil fumigoted with 8.6 pounds per acre of DBCP.

Discussion

Growing conditions varied considerably during the test period. Acceptable stands were obtained each year although the test had to be replanted in 1972 due to excessive rainfall immediately after planting. Soybean stands also were reduced on the fumigated plots in 1972, and plant growth was subnormal the entire year. Rainy weather in late August and early September in 1973 prevented timely applications of insecticide on the cotton. This resulted in a reduction in the top crop of bolls on all plots. Minor damage resulted from hurricane Carmen, September 9, 1974.

In 1975, excessive rainfall occurred in June, July, and August. Water remained on some plots for several days, resulting in stunted growth and minor weed problems. Therefore, two replications were not harvested for yield measurements. Ideal growing conditions occurred in 1976. Relatively drier soils may explain the low reniform nematode count at midseason in 1976 compared with other years. The average number of reniform nematodes was lower at harvest in 1976 than in all years except 1972.

A small number of reniform nematodes remained in the soil in continuous Pickett 71 soybean plots. Since reniform nematodes cannot reproduce on this cultivar (*17*), it is assumed that the nematodes reproduced on escaped weeds or were moved during tillage operations or by surface flooding. Reniform nematode numbers tended to decrease slightly in the resistant soybean plots during the test period and showed no tendency for new nematode biotypes or races to arise during this short period.

A resistant variety such as Pickett 71 reduces the nematodes population throughout the rooting zone; whereas, a fumigant reduces nematode numbers in a rather narrow band within the row. In mid-October of 1972, soil samples were taken 15 inches from the drill. Soil from Lee 68 plots had about 10 times more reniform nematodes than soil from Pickett 71 plots.

Conclusion

Since it was known that reniform nematodes could not reproduce on resistant soybean cultivars, it was theorized that certain rotation sequences involving resistant soybeans and susceptible hosts might eliminate the need for chemical control of this nematode. Data from this study did in fact demonstrate that growing a resistant soybean cultivar for 2 consecutive years would eliminate the need for fumigation for reniform nematode control when growing cotton or a susceptible soybean cultivar in the following year. Therefore, if a producer wanted to grow cotton or a susceptible soybean cultivar on a field infested with reniform nematodes he could eliminate the expense of fumigation for nematode control by following a rotation of 2 years of resistant soybeans and 1 year of cotton or susceptible soybeans. Although this study involved Pickett 71 as the reniform nematodes resistant soybean cultivar, it is assumed that other reniform-resistant soybean cultivars such as Forrest, Centennial, or Bedford would be equally as effective as Pickett 71 in suppressing populations of this nematode.

Summary

A 5-year rotation study, involving reniform nematode susceptible cotton and Lee 68 soybeans and reniform nematode resistant Pickett 71 soybeans, was conducted in reniform nematode infested Olivier silt loam soil at Baton Rouge. Treatments included 14 cropping sequences to permit the comparison of soil fumigation with selected cotton-soybean rotations on yields, quality factors, selected plant characters, and reniform nematode population changes.

A summary of the findings is listed below:

1. Soil fumigation with DBCP was effective in reducing reniform nematode numbers in soil of Deltapine 45A and Lee 68 plots at planting, mid-season, and harvest.
2. Deltapine 45A was a more suitable reniform nematode host than Lee 68.
3. Reniform nematode numbers remained low throughout the season in soil of continuously cropped Pickett 71, and fumigation reduced total numbers only slightly.
4. Pickett 71 following either crop was effective in greatly reducing the reniform population by mid-season and only 1 year of Pickett 71 reduced the reniform nematode population for the succeeding crop to a level at or below that obtained by soil fumigation. However, reniform nematode densities in plots of Deltapine 45A following 1 year of Pickett 71 increased by mid-season to the level present in plots of continuous cotton following Lee 68.
5. Soil in plots of Deltapine 45A and Lee 68 following 2 years of Pickett 71 had approximately the same reniform nematode populations at mid-season as when cropped continuously with fumigation.
6. One year of Pickett 71 was no better than 1 year of Lee 68 in reducing the reniform nematode population in Deltapine 45A at mid-season. However, 2 years of Pickett 71 was more effective than 2 years of Lee 68 in restricting the mid-season reniform nematode population in Deltapine 45A.
7. Soil fumigation significantly increased Deltapine 45A yields when averaged across years.
8. Deltapine 45A following 2 years of Pickett 71 yielded significantly more than continuous non-fumigated Deltapine 45A and slightly more than fumigated Deltapine 45A.
9. Cropping sequence and fumigation had little effect on lint percentage, micronaire, tensil strength, 2.5 percent span length, or 50 percent span length.
10. Fumigation increased yield of Lee 68 soybeans as an average of years, but had no effect on Pickett 71 yield.
11. Lee 68 following 2 years of Pickett 71 yielded significantly higher than Lee 68 grown continuously without fumigation, and slightly

more than Lee 68 grown continuously with fumigation.

12. Soil fumigation slightly increased mature plant height and lower pod height of Lee 68 but had no effect on Pickett 71 soybeans.
13. Cropping sequence and fumigation had little or no effect on seed protein content, oil content, lodging, seed quality, or seed size of the two soybean cultivars.

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