Crop Rotation and Herbicide Effects on Population Densities of Plant-Parasitic Nematodes[1]

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Abstract: The influence of herbicides and mono- and multicropping sequences on population densities of nematode species common in corn, cotton, peanut, and soybean fields in the southeastern United States was studied for 4 years. Each experimental plot was sampled at monthly intervals. The application of herbicides did not significantly affect nematode population densities. *Meloidogyne incognita* and *Trichodorus christiei* increased rapidly on corn and cotton, but were suppressed by peanut and soybean. More *Pratylenchus* spp. occurred on corn and soybean than on cotton and peanut. *Criconemoides ornatus* increased rapidly on corn and peanut, but was suppressed by cotton and soybean. *Helicotylenchus dihystera* was more numerous on cotton and soybean than on corn and peanut. Numbers of *Xiphinema americanum* remained low on all crops. The peanut sequence was the most effective monocrop system for suppressing most nematode species. Multi-crop systems, corn-peanut-cotton-soybean and cotton-soybean-corn-peanut, were equally effective in suppressing nematode densities. *Key Words: Zea mays, Gossypium hirsutum, Arachis hypogaea, Glycine max.*

Limited information is available concerning field population densities of plant-parasitic nematodes present in the southeastern United States, where corn (*Zea mays* L.), cotton (*Gossypium hirsutum* L.), and peanut (*Arachis hypogaea* L.) are major crops (1, 2, 5, 8). We are unaware of any report on the effects of soybean on nematode population densities in the southeastern United States. No information is available on the effects of herbicides on population densities of plant nematodes that parasitize these crops. Our objectives were to study the effects of monocrop and multicrop rotations and herbicides vs. cultivation on densities of plant nematode species naturally occurring in the southeastern coastal plain of the United States.

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MATERIALS AND METHODS

Experimental plots were established in 1968 on Tifton sandy loam (sand 75%, silt 10%, clay 15%) naturally infested with *Meloidogyne incognita* (Kofoid & White) Chitwood, *Pratylenchus zeae*, Graham, *P. brachyurus* (Godfrey) Filip. & Sch.-Stek. (ca. 90% *P. zeae* and 10% *P. brachyurus*), *Criconemoides ornatus* Raski,

TABLE 1. Herbicides applied to crops to control grasses and weeds.

Crop	Chemical	Dosage active (kg/ha)	Method of application
Corn	1) *S*-ethyl diisobutylthiocarbamate	3.36	Injected 8 cm deep in lines 8 cm apart at planting.
	2) 2-Chloro-4-(ethylamino)-6-(isopropylamino)-*S*-treazine + (2,4-dichlorophenoxy)acetic acid + phytobland oil	0.84 + 0.28+ 18.7 liters	Postemergence spray over top of corn 8-10 cm tall.
	3) Ammonium nitrate and urea (32% N) + 3-(3,4-dichlorophenyl)-1-methoxy-1-methylurea	168 + 0.56 + 0.5%	Postemergence when corn was 38-50 cm tall. Surfactant
Cotton	1) *S*-ethyl dipropylthiocarbamate + 1, 1-dimethyl-3-(α, α, α-trifluoro-*m*-tolyl)urea	1.68 + 1.12	Injected 8 cm deep in lines 8 cm apart + 25 cm band surface spray over row at planting.
	2) Monosodium methanearsonate	2.24	Directed postemergence spray when cotton was 10-15 cm tall and again when 20-25 cm tall.
	3) 1,1-dimethyl-3-(α, α, α-trifluoro-*m*-tolyl)urea	1.12	Broadcast over top of cotton when 18-20 cm tall.
	4) Ammonium nitrate and urea (32% N) + 3-(3,4-dichlorophenyl)-1,1-dimethylurea + 0.5% surfactant	78 + 0.28	Directed postemergence spray at layby.
Peanuts	1) *N*-butyl-*N*-ethyl-α, α, α-trifluoro-2,6-dinitro-*p*-toluidine	1.4	Preplant incorporated 6-8 cm deep with power-driven rotary hoe.
	2) *S*-propyl dipropylthiocarbamate	2.24	Injected 8 cm deep in lines 8 cm apart at planting.
	3) 2,3,5-trichloro-4-pyridinol	0.56	Preemergence surface spray.
	4) 4-(2,4-dichlorophenoxy)butyric acid	0.22	Broadcast over top of peanuts when 10-15 cm tall.
Soybeans	1) *S*-propyl dipropylthiocarbamate	2.24	Injected 5 cm deep in lines 8 cm apart at planting.
	2) 3-[*p*-(*p*-chlorophenoxy)phenyl]-1,1-dimethylurea	1.12	Directed postemergence when soybeans were 15 cm tall.
	3) 2-*sec*-butyl-4,6-dinitrophenol	1.68	Directed postemergence when soybeans were 15 cm tall.
	4) 3-(3,4-dichlorophenyl)-1-methoxy-1-methylurea	0.56 + 0.5%	Directed postemergence + surfactant when soybeans were 25-30 cm tall.

Helicotylenchus dihystera (Cobb) Sher, *Trichodorus christiei* Allen, and *Xiphinema americanum* Cobb. The land had been in cultivation more than 35 years, primarily with corn, peanut, and cotton.

The cropping systems consisted of duplicate 4-year monocrop plantings of (i) corn (C) 'Coker 71'; (ii) cotton (Co) 'Coker 201'; (iii) peanut (P) 'Starr'; (iv) soybean (S) [*Glycine max* (L.) Merr.] 'Hampton'; and multicrop rotations of (v) C-P-Co-S, (vi) P-Co-S-C, (vii) Co-S-C-P, and (viii) S-C-P-Co. All plots in one set of each cropping sequence were cultivated mechanically with sweeps as needed until layby (about 6 weeks after planting). Grasses and weeds were removed from corn and cotton by hand-hoeing and pulling as needed until layby. Plots in the other sets of cropping sequences were treated with herbicides (Table 1) and were not cultivated.

Fertilizer (672 kg/ha 4-12-12, N-P-K) was broadcast in the spring each year. The soil was disked and turned 20-30 cm deep with a moldboard plow. Each experimental plot consisted of five two-row (row-spacing 71 cm) beds 14.5 m long and 91 cm apart. Dates for land preparation and planting for each year are listed in Table 2. The experimental design was a randomized complete block with six replications.

Soil samples (20 cores—2.1 × 20 cm) for nematode assays, were collected monthly from the root zone, beginning May 1968 through December 1971, to provide information on seasonal and year-to-year population fluctuations. Soil samples were mixed thoroughly, and a 150-cc aliquant was processed by a centrifugal-flotation method (7) to separate nematodes from the soil.

Corn and cotton were hand harvested in August and September and peanut and soybean were mechanically harvested in August and November, respectively. Immediately after harvest, stalks were cut and the soil was disked with a disk harrow. After being disked, the soil remained undisturbed until the following spring.

The words 'significant' and 'highly significant' are used to indicate differences at 0.05 and 0.01 levels of probability, respectively. Data on nematode population densities are expressed as number of nematodes per 150 cc of soil.

RESULTS

The application of herbicides did not significantly affect nematode population densities in any cropping sequence; therefore, only data from cultivated plots are reported here. The information on weed populations is published elswhere (3).

Population densities of *M. incognita*, *Pratylenchus* spp., *C. ornatus*, *H. dihystera*, and *T. christiei* were generally uniform in the experimental area; but *X. americanum* occurred erratically, and was not uniformly distributed.

Population densities of all nematode species were influenced by different cropping systems and crops within each system. The greatest number of *M. incognita* occurred in the C-C-C-C and Co-Co-Co-Co systems (Tables 3-6). Numbers of *M. incognita* in the C-C-C-C sequence were greatest in July or August each year. The average number of larvae per 150 cc soil per month within a given year indicates that *M. incognita* increased rapidly each year on monocropped corn and cotton (Fig. 1-A, B), but not on peanut and soybean (Fig. 1-C, D). *M. incognita* did not increase to high levels on crops in the multicrop rotations.

Numbers of *Pratylenchus* spp. were generally greater on monocultured corn and soybean (Fig. 1-A, D) than on cotton and peanut (Fig. 1-B, C). Numbers of *Pratylenchus* spp. in the C-C-C-C sequence were greatest from July to October each year (Tables 3-6). *Pratylenchus* spp. densities reached highest levels in the S-S-S-S sequence during October or November. In the C-P-Co-S rotation, *Pratylenchus* spp. increased on corn in 1968, declined on peanut and

TABLE 2. Dates land was prepared and crops were planted in crop rotation/herbicide plots

Year	Date land prepared	Planting dates: Corn	Cotton	Peanut	Soybean
1968	26-27 March	1 April	11 April	26 April	27 May
1969	1-2 April	3 April	21 April	23 April	12 May
1970	7-8 April	8 April	21 April	21 April	1 June
1971	14-15 April	19 April	23 April	16 April	20 May

TABLE 3. Seasonal cropping-sequence effects on field populations of five plant parasitic nematodes in 1968 (the first year of a four-year comparison) in Georgia, U.S.A.

Nematode species and cropping sequence[a]	May	June	July	Aug	Sept	Oct	Nov	Dec
Meloidogyne incognita								
C-C-C-C	2	0	45	48	15	33	3	23
Co-Co-Co-Co	7	7	17	7	23	2	3	92
P-P-P-P	0	0	0	0	0	5	0	7
S-S-S-S	0	0	0	3	5	8	62	0
C-P-Co-S	0	0	0	2	2	7	2	10
P-Co-S-C	0	0	2	0	0	0	0	0
Co-S-C-P	0	0	3	0	15	33	8	2
S-C-P-Co	0	0	2	2	0	0	0	3
LSD ($P = 0.01$) = 302								
LSD ($P = 0.05$) = 230								
Pratylenchus spp.								
C-C-C-C	28	7	85	287	143	58	177	200
Co-Co-Co-Co	33	3	2	6	8	5	13	27
P-P-P-P	49	0	0	3	10	0	5	13
S-S-S-S	44	2	0	2	38	48	112	65
C-P-Co-S	25	5	57	75	70	93	307	105
P-Co-S-C	26	3	0	12	23	2	8	20
Co-S-C-P	58	2	2	10	12	0	8	7
S-C-P-Co	58	10	0	5	47	25	152	167
LSD ($P = 0.01$) = 202								
LSD ($P = 0.05$) = 153								
Criconemoides ornatus								
C-C-C-C	79	3	3	145	28	2	173	160
Co-Co-Co-Co	45	0	2	7	12	3	83	57
P-P-P-P	38	3	0	37	200	7	290	300
S-S-S-S	41	0	0	3	8	0	28	43
C-P-Co-S	35	2	17	35	0	8	152	72
P-Co-S-C	98	12	7	90	183	15	295	278
Co-S-C-P	66	2	3	13	32	0	58	80
S-C-P-Co	62	3	0	7	0	2	33	35
LSD ($P = 0.01$) = 301								
LSD ($P = 0.05$) = 229								
Helicotylenchus dihystera								
C-C-C-C	9	3	5	10	0	0	5	12
Co-Co-Co-Co	9	0	0	3	3	0	7	5
P-P-P-P	3	0	0	0	0	0	3	0
S-S-S-S	8	7	8	2	18	3	17	2
C-P-Co-S	3	0	0	2	0	0	3	3
P-Co-S-C	2	0	0	0	0	0	0	0
Co-S-C-P	0	0	0	0	0	2	0	0
S-C-P-Co	3	0	2	0	2	2	3	3
LSD ($P = 0.01$) = 631								
LSD ($P = 0.05$) = 480								
Trichodorus christiei								
C-C-C-C	14	17	18	12	2	2	5	18
Co-Co-Co-Co	13	2	3	7	5	8	5	17
P-P-P-P	11	5	2	0	0	5	3	10
S-S-S-S	8	2	7	8	5	22	5	3
C-P-Co-S	16	15	13	7	0	5	15	7
P-Co-S-C	5	0	0	0	3	7	2	7
Co-S-C-P	20	3	0	3	3	10	2	17
S-C-P-Co	11	3	5	7	2	7	13	23
LSD ($P = 0.01$) = 38								
LSD ($P = 0.05$) = 29								

[a]C = corn, Co = cotton, P = peanut, S = soybean.

TABLE 4. Seasonal cropping-sequence effects on field populations of five plant parasitic nematodes in 1969 (the second year of a four-year comparison) in Georgia, U.S.A.

Nematode species and cropping sequence[a]	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
Meloidogyne incognita												
C-C-C-C	3	0	2	5	5	23	97	112	82	65	52	120
Co-Co-Co-Co	13	3	3	0	0	0	0	107	83	25	83	28
P-P-P-P	2	0	0	2	2	0	0	5	3	0	2	0
S-S-S-S	5	10	8	5	0	0	0	2	2	0	33	32
C-P-Co-S	0	2	2	0	0	0	0	0	0	0	3	0
P-Co-S-C	0	0	0	0	0	0	0	2	0	0	10	12
Co-S-C-P	15	0	0	0	0	0	2	0	0	0	27	5
S-C-P-Co	3	0	0	0	0	12	2	0	5	0	2	0
LSD (P = 0.01) = 302												
LSD (P = 0.05) = 230												
Pratylenchus spp.												
C-C-C-C	143	105	87	70	28	52	560	333	180	207	210	218
Co-Co-Co-Co	18	12	12	7	3	2	2	13	7	22	13	28
P-P-P-P	17	13	10	7	5	2	3	32	7	2	17	27
S-S-S-S	25	32	38	42	50	33	15	73	158	107	413	283
C-P-Co-S	43	57	47	40	23	20	0	18	8	3	7	10
P-Co-S-C	13	3	5	8	10	8	3	30	2	0	18	35
Co-S-C-P	2	10	5	8	2	2	3	12	55	40	238	195
S-C-P-Co	30	35	27	32	22	20	367	578	502	162	500	385
LSD (P = 0.01) = 202												
LSD (P = 0.05) = 153												
Criconemoides ornatus												
C-C-C-C	92	137	123	103	88	28	362	128	83	10	185	292
Co-Co-Co-Co	62	48	43	33	30	15	57	33	0	0	67	67
P-P-P-P	180	167	147	127	112	153	1428	257	68	0	148	197
S-S-S-S	102	58	55	50	43	10	48	25	3	2	33	20
C-P-Co-S	72	63	68	68	72	47	835	435	135	3	45	110
P-Co-S-C	165	112	103	83	78	58	112	103	5	2	47	38
Co-S-C-P	52	32	27	30	22	13	95	95	18	7	52	40
S-C-P-Co	53	40	33	38	30	15	127	50	10	0	28	30
LSD (P = 0.01) = 301												
LSD (P = 0.05) = 229												
Helicotylenchus dihystera												
C-C-C-C	2	5	5	3	3	7	7	0	0	3	2	3
Co-Co-Co-Co	7	5	3	0	0	3	2	2	0	3	7	5
P-P-P-P	3	0	0	0	0	0	0	0	0	0	0	0
S-S-S-S	2	10	8	3	3	0	7	10	0	2	38	38
C-P-Co-S	7	2	2	0	0	0	0	0	2	0	0	0
P-Co-S-C	0	0	0	0	0	0	0	0	0	0	0	0
Co-S-C-P	0	0	0	0	0	0	0	0	2	0	5	0
S-C-P-Co	0	0	0	0	0	0	18	10	7	3	13	15
LSD (P = 0.01) = 631												
LSD (P = 0.05) = 480												
Trichodorus christiei												
C-C-C-C	25	5	7	10	13	37	13	5	0	13	8	12
Co-Co-Co-Co	12	12	10	7	5	5	85	28	8	7	15	12
P-P-P-P	0	0	0	2	3	0	0	3	2	0	2	0
S-S-S-S	7	7	7	5	3	3	30	22	3	5	17	5
C-P-Co-S	2	0	0	0	0	3	7	7	0	2	3	3
P-Co-S-C	0	2	2	0	0	0	97	27	5	0	7	5
Co-S-C-P	7	3	0	3	0	3	65	3	7	2	8	23
S-C-P-Co	8	8	2	8	2	17	17	10	12	0	7	20
LSD (P = 0.01) = 38												
LSD (P = 0.05) = 29												

[a]C = corn, Co = cotton, P = peanut, S = soybean.

TABLE 5. Seasonal cropping-sequence effects on field populations of five plant parasitic nematodes in 1970 (the third year of a four-year comparison) in Georgia, U.S.A.

Nematode species and cropping sequence[a]	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
Meloidogyne incognita												
C-C-C-C	12	10	7	0	32	25	362	82	165	210	160	45
Co-Co-Co-Co	30	15	8	0	7	3	272	38	183	78	53	5
P-P-P-P	2	0	0	0	0	5	12	0	3	8	0	0
S-S-S-S	2	7	3	0	0	0	2	0	0	22	0	2
C-P-Co-S	2	2	0	0	0	0	8	2	3	57	12	2
P-Co-S-C	3	12	5	0	0	0	0	2	0	3	0	0
Co-S-C-P	0	2	2	0	0	0	7	2	12	10	5	0
S-C-P-Co	7	0	0	0	2	0	12	0	0	0	0	0
LSD (P = 0.01) = 302												
LSD (P = 0.05) = 230												
Pratylenchus spp.												
C-C-C-C	60	108	93	82	23	28	93	135	118	142	73	22
Co-Co-Co-Co	20	15	12	11	8	7	32	27	45	25	15	5
P-P-P-P	2	5	7	8	0	2	20	12	23	22	17	7
S-S-S-S	155	75	73	70	77	18	8	25	65	222	128	62
C-P-Co-S	7	5	3	0	2	2	32	12	43	30	2	3
P-Co-S-C	27	20	17	12	15	2	8	17	63	143	48	15
Co-S-C-P	53	38	48	63	15	53	165	130	255	172	155	65
S-C-P-Co	152	133	138	147	55	5	22	10	20	12	13	5
LSD (P = 0.01) = 202												
LSD (P = 0.05) = 153												
Criconemoides ornatus												
C-C-C-C	55	43	47	67	5	145	277	125	53	95	65	132
Co-Co-Co-Co	15	25	20	16	3	18	60	32	17	23	15	2
P-P-P-P	53	85	53	36	5	293	350	62	85	132	67	27
S-S-S-S	7	28	20	13	2	5	23	13	20	23	2	5
C-P-Co-S	123	97	73	53	0	95	132	65	53	83	25	5
P-Co-S-C	15	23	18	17	5	13	15	7	8	48	12	5
Co-S-C-P	48	20	22	32	0	68	188	123	138	132	72	78
S-C-P-Co	20	27	33	40	0	115	595	142	115	255	93	102
LSD (P = 0.01) = 301												
LSD (P = 0.05) = 229												
Helicotylenchus dihystera												
C-C-C-C	2	10	5	0	2	7	18	10	7	12	3	13
Co-Co-Co-Co	7	3	10	16	7	2	37	32	58	62	47	37
P-P-P-P	0	0	0	0	3	0	0	0	0	0	0	0
S-S-S-S	28	8	7	8	15	8	10	53	252	113	300	47
C-P-Co-S	0	0	0	0	0	0	0	2	0	0	3	0
P-Co-S-C	2	0	0	0	0	0	0	0	0	12	5	3
Co-S-C-P	0	0	0	0	2	0	0	7	8	5	2	5
S-C-P-Co	0	0	3	5	0	2	5	8	12	2	7	17
LSD (P = 0.01) = 631												
LSD (P = 0.05) = 480												
Trichodorus christiei												
C-C-C-C	2	0	0	0	0	130	20	15	3	8	8	0
Co-Co-Co-Co	7	10	8	0	0	62	8	8	15	3	0	0
P-P-P-P	2	5	5	0	0	5	2	0	0	2	3	0
S-S-S-S	15	3	3	5	0	10	15	8	2	0	2	0
C-P-Co-S	0	3	3	2	0	53	33	3	3	3	3	0
P-Co-S-C	13	7	5	2	2	12	17	10	3	8	0	0
Co-S-C-P	18	2	3	5	5	57	12	2	0	13	3	0
S-C-P-Co	15	8	5	3	0	3	7	2	0	3	2	0
LSD (P = 0.01) = 38												
LSD (P = 0.05) = 29												

[a]C = corn, Co = cotton, P = peanut, S = soybean.

TABLE 6. Seasonal cropping-sequence effects on field populations of five plant parasitic nematodes in 1971 (the fourth year of a four-year comparison) in Georgia, U.S.A.

Nematode species and cropping sequence[a]	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
Meloidogyne incognita												
C-C-C-C	48	5	71	33	3	37	412	305	316	142	238	125
Co-Co-Co-Co	45	3	31	68	7	13	135	110	171	220	138	197
P-P-P-P	0	0	9	1	1	0	0	0	0	2	7	3
S-S-S-S	0	0	0	1	1	0	0	2	35	0	0	5
C-P-Co-S	0	0	0	3	0	0	0	0	0	0	0	0
P-Co-S-C	0	0	0	0	0	0	0	15	21	0	3	5
Co-S-C-P	0	2	0	3	0	0	0	2	0	0	0	0
S-C-P-Co	0	0	0	0	0	0	10	2	0	0	2	3
LSD ($P = 0.01$) = 302												
LSD ($P = 0.05$) = 230												
Pratylenchus spp.												
C-C-C-C	68	17	52	76	9	8	52	82	63	63	67	52
Co-Co-Co-Co	20	8	7	12	3	0	7	15	1	8	3	20
P-P-P-P	3	5	3	1	0	12	53	28	1	2	5	13
S-S-S-S	52	35	33	40	12	18	38	50	99	133	87	80
C-P-Co-S	13	12	21	12	4	7	18	62	28	68	35	12
P-Co-S-C	12	15	13	15	0	7	55	30	43	28	27	32
Co-S-C-P	52	58	32	80	60	5	2	10	4	5	3	0
S-C-P-Co	12	8	5	11	0	0	7	45	16	28	8	32
LSD ($P = 0.01$) = 202												
LSD ($P = 0.05$) = 153												
Criconemoides ornatus												
C-C-C-C	160	18	47	11	89	85	288	97	17	53	40	77
Co-Co-Co-Co	10	13	5	0	3	12	12	22	1	8	3	15
P-P-P-P	53	30	28	0	36	73	147	42	3	10	2	118
S-S-S-S	10	10	7	0	1	2	5	3	5	3	2	3
C-P-Co-S	42	13	44	0	7	10	20	10	1	5	5	25
P-Co-S-C	10	10	17	1	4	20	107	40	24	37	3	55
Co-S-C-P	57	100	48	20	60	140	133	102	31	55	35	225
S-C-P-Co	133	90	40	37	51	55	107	98	13	40	35	58
LSD ($P = 0.01$) = 301												
LSD ($P = 0.05$) = 229												
Helicotylenchus dihystera												
C-C-C-C	10	8	13	3	1	7	15	13	13	13	20	28
Co-Co-Co-Co	60	17	21	15	12	13	78	103	291	173	275	237
P-P-P-P	2	0	1	0	0	0	0	0	0	0	0	2
S-S-S-S	58	43	44	19	31	27	220	530	427	633	680	520
C-P-Co-S	5	0	0	0	1	0	7	60	15	78	10	43
P-Co-S-C	2	2	3	1	0	8	10	5	25	7	15	17
Co-S-C-P	0	0	3	3	3	0	3	0	7	0	3	8
S-C-P-Co	2	0	8	4	0	2	18	50	39	138	103	192
LSD ($P = 0.01$) = 631												
LSD ($P = 0.05$) = 480												
Trichodorus christiei												
C-C-C-C	5	0	12	3	7	23	5	7	0	2	5	10
Co-Co-Co-Co	12	3	17	1	3	0	8	2	12	57	7	57
P-P-P-P	0	3	1	0	0	2	0	0	0	0	0	0
S-S-S-S	0	0	3	0	0	7	7	0	0	0	3	2
C-P-Co-S	7	0	4	1	3	20	12	15	0	2	3	2
P-Co-S-C	2	3	1	0	7	7	8	5	1	2	3	2
Co-S-C-P	0	0	1	0	0	0	3	2	0	0	0	0
S-C-P-Co	0	2	0	1	0	5	15	3	0	2	2	12
LSD ($P = 0.01$) = 38												
LSD ($P = 0.05$) = 29												

[a]C = corn, Co = cotton, P = peanut, S = soybean.

increased slightly on cotton and soybean; but when corn followed soybean in the S-C-P-Co rotation, *Pratylenchus* spp. increased to high levels on soybean and to very high levels on corn. Population densities of *Pratylenchus* spp. were significantly higher when corn followed soybean as a base crop than in any other multicrop sequence.

C. ornatus increased rapidly on monocultured corn and peanut (Fig. 1-A, C), but was suppressed by cotton and soybean (Fig. 1-B, D). *C. ornatus* reached highest levels on a peanut monoculture (Tables 3-6). The population density increased from below detectable levels in July 1968 to 1,428 in July 1969, and decreased during July 1970 and 1971. The second most favorable cropping sequence for *C. ornatus* was a corn monoculture. Populations of *C. ornatus* in the C-C-C-C sequence reached the highest levels during July each year, except 1968. *C. ornatus* was favored most in multicropping sequences when peanut followed corn.

Numbers of *H. dihystera* increased each year on a monoculture of cotton and soybean (Fig. 1-B, D), were suppressed to low levels by corn (Fig. 1-A), and to even lower levels by peanut (Fig. 1-C). From August through December, 1971, population densities of *H. dihystera* in the Co-Co-Co-Co sequence increased to moderate levels (Table 6). In the S-S-S-S sequence, population densities reached moderate levels during the third year and reached high levels during the fourth year. Population densities of *H. dihystera* remained below detectable levels or at very low levels in

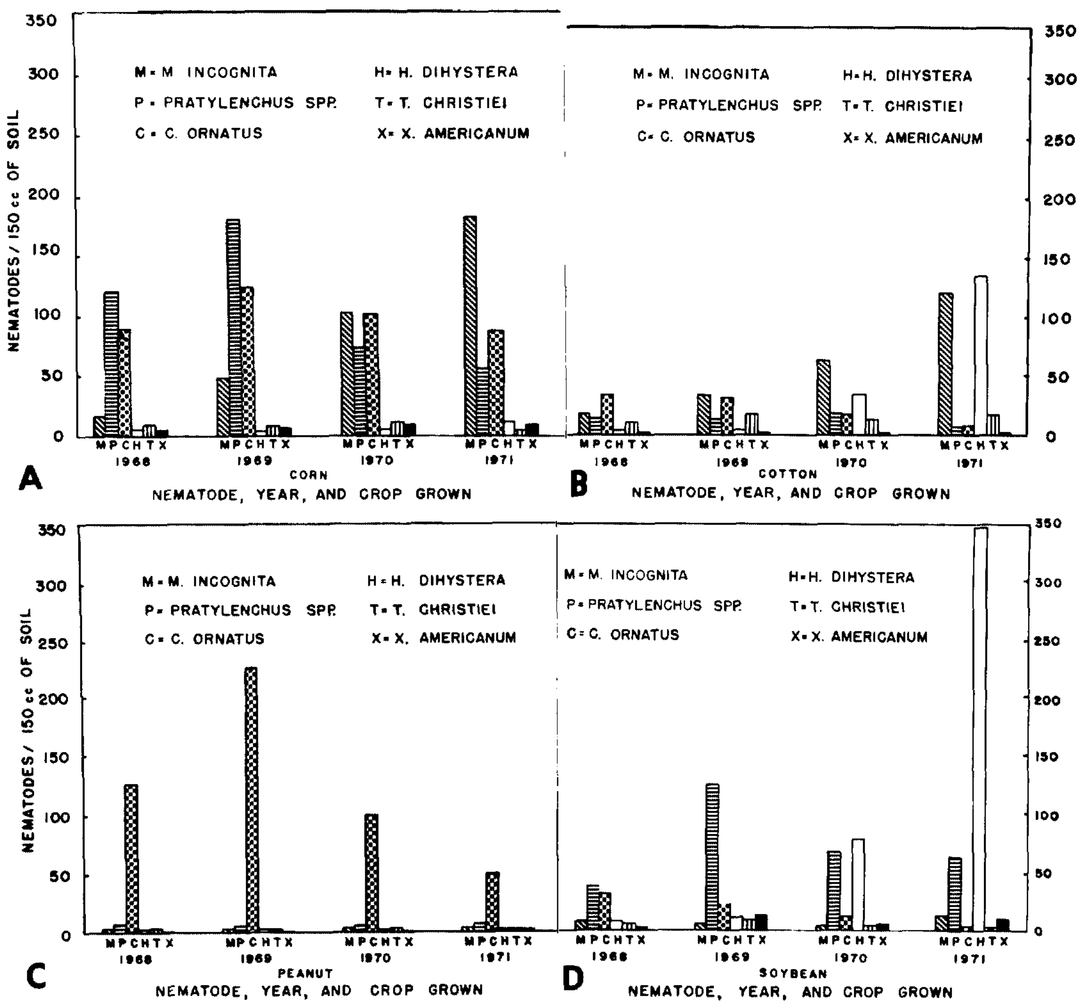

FIG. 1-(A to D). Average number of nematodes recovered per month over a period of four years with monocultured corn **A**), cotton **B**), peanut **C**), and soybean **D**).

all multicropping systems except S-C-P-Co. In the S-C-P-Co sequence *H. dihystera* increased to moderate levels on cotton in 1971; even so, population densities at that time were lower on cotton in the S-C-P-Co sequence than on monocultured cotton.

Generally, *T. christiei* was more abundant on corn and cotton (Fig. 1-A, B), than on peanut and soybean (Fig. 1-C, D). Numbers of *T. christiei* were highest during June or July on monocultured corn and cotton (Tables 3-6). The population densities in the C-C-C-C sequence increased during the first 3 years, and decreased during 1971. A similar trend occurred on monocultured cotton. Generally, more *T. christiei* were present when cotton appeared in the cropping sequence. Soybean and corn, when preceded by cotton, also favored *T. christiei*. Peanut in monoculture and multicropping sequences suppressed *T. christiei*.

X. americanum population densities were erratic, however the data indicate that monocultured corn and soybean were more favorable than cotton or peanut for increase of this nematode (Fig. 1-A, B, C, D). In the S-C-P-Co cropping sequence, soybean and corn were most favorable for *X. americanum*.

The yearly and 4-year mean yields of all crops are reported in Table 7. The influence of nematodes on yield could not be evaluated because no nematode control agents, except crop rotation, were included in the study. Crop yields were affected by rainfall distribution. Rainfall was much below normal (60%) for the entire growing season of 1968 and also below normal (40%) for about half of the growing season in 1969. The yield for all crops in 1968 was low due to extended drought for the entire growing season. Corn yields in 1969 were also low because of limited rainfall during the growing season. Rotation sequence did not significantly affect corn yields over the 4-year period.

There were no significant differences in the 4-year mean yield of monocropped vs. multicropped cotton. Yield of cotton in 1969 following peanut was significantly lower than in the monocrop sequence.

Yield of peanut was very low in 1968. Much of the low peanut yields can be attributed to weed competition; however, during the 1971 growing season, the incidence of white mold (*Sclerotium rolfsii* Sacc.) was much greater

TABLE 7. Effect of cropping sequences on yield.

Cropping sequence[x]	Yield[y] (quintal/ha)[z] 1968	1969	1970	1971	4-yr mean (quintal/ha)	
C-C-C-C	14.8 a	23.1 a	63.4 a	68.3 a	Corn (cont.)	42.4 a
Co-Co-Co-Co	9.5 a	13.2 a	12.4 a	12.0 ab	Cotton (cont.)	11.8 ab
P-P-P-P	3.7 a	28.4 a	16.1 a	14.2 b	Peanut (cont.)	15.6 b
S-S-S-S	5.2 a	9.3 c	16.1 a	17.5 a	Soybean (cont.)	12.0 b
C-P-Co-S	6.4 a	24.7 b	15.4 ab	19.0 a	Corn (seq.)	39.3 a
P-Co-S-C	4.0 a	5.7 b	17.5 a	75.5 a	Peanut (seq.)	15.7 b
Co-S-C-P	6.5 a	15.9 b	62.6 a	9.2 b	Cotton (seq.)	10.3 ab
S-C-P-Co	5.4 a	12.7 a	25.0 a	13.5 a	Soybean (seq.)	14.5 b

[x]C = corn, Co = cotton, P = peanut, S = soybean.
[y]Means followed by the same letter do not differ ($P=0.05$) according to Duncan's multiple range test.
[z]One quintal = 100 kilograms.

TABLE 8. Summary of the suitability of certain cropping sequences to use in managing plant nematode populations.

Cropping system	Nematode species: *Meloidogyne incognita*	*Pratylenchus* spp.	*Criconemoides ornatus*	*Helicotylenchus dihystera*	*Trichodorus christiei*	*Xiphinema americanum*
P-P-P-P[a]	G[b]	G	P	G	G	G
C-P-Co-S	G	F	F	G	F	G
Co-S-C-P	G	F	F	G	F	G
Co-Co-Co-Co	P	G	G	F	P	G
P-Co-S-C	G	P	P	G	P	G
S-C-P-Co	G	F	F	F	G	F
S-S-S-S	G	P	G	P	F	F
C-C-C-C	P	P	P	G	P	F

[a]P = peanut, C = corn, Co = cotton, S = soybean.
[b]P = poor, F = fair, G = good control of nematodes.

than in other years. In 1969, yield from peanut monoculture was significantly greater than yield of peanut following corn; however yield of peanut in monoculture declined during 1970 and 1971.

The rotation sequence did not affect soybean production, except in 1969 when yield of soybean in monoculture was significantly lower than yield of soybean following cotton. Yield of soybean in mono- and multicropping sequences was very low in 1968 and increased each year thereafter.

DISCUSSION

The experimental variables used in this study were limited to nematode species, mono- and multicrop systems, and herbicides vs. cultivation.

Herbicides did not significantly affect nematode population densities. Susceptible crop plants supported nematode populations regardless of whether weeds and grasses were removed from plots by cultivation, hand-hoeing, or with chemicals. Herbicides, cultivation, and hand-hoeing maintained excellent weed control until the final cultivation; therefore, the effect of poor weed management on nematode populations could not be assayed.

A summary of crop-rotation suitability for effective management of nematode species in Table 8 provides a key to the interpretation of the nematode population data presented in Fig. 1-A to D and Tables 3-6. The P-P-P-P sequence was the most effective monocrop system for suppressing most nematode species; however, *C. ornatus* increased on this cropping sequence. There was a significant positive relationship ($r = 0.73$) between *C. ornatus* population densities and yield. The C-C-C-C sequence was the poorest monocrop system used to suppress nematode population densities, primarily because it favored rapid increase of four potentially damaging nematode species, *M. incognita, Pratylenchus* spp., *C. ornatus,* and *T. christiei*. The other monocrop systems were intermediate. Low densities of *M. incognita* on peanut and soybean were expected. Peanut is a poor host for this nematode species (6, 9) and soybean 'Hampton' has resistance to *M. incognita* (6). The rapid increase of *H. dihystera* in the S-S-S-S sequence and the positive relationship ($r = 0.68$) between number of *H. dihystera* and yield was not expected. Multicrop systemsC-P-Co-S and Co-S-C-P were equally effective in suppressing nematodes. The P-Co-S-C and S-C-P-Co sequences were the poorest selection for managing nematode populations, primarily because both cropping sequences favored rapid increase of *Pratylenchus* spp., *C. ornatus,* and *T. christiei.*

Our data indicate that no single cropping system used will suppress all plant nematodes present in the test area. Furthermore, it confirms and extends previously reported results (1, 2, 5). In addition to determining the suitability of certain crop plants as hosts to *M. incognita, Pratylenchus* spp., *C. ornatus, H. dihystera, T. christiei,* and *X. americanum,* we have established the importance of growing the initial base crop (corn or cotton) in a sequence with peanut and soybean in the Southern Coastal Plain for greatest effectiveness in minimizing nematode populations studied. Use of monocrop systems in crop production is not as widely accepted as multicrop systems by growers. Garren (4) reported some of the disadvantages of peanut following peanut in relation to certain soil fungi. Nonetheless, the P-P-P-P sequence was much more effective than other cropping systems in suppressing nematode population densities. The P-Co-S-C sequence is a poor rotation choice in soil infested with *Pratylenchus* spp., *C. ornatus,* and *T. christiei;* however, if only *M. incognita, H. dihystera,* and *X. americanum* are present, this sequence would effectively minimize population increases.

We believe these data can be used as a guide in selecting crops and varieties for rotation in nematode-infested soil in the southeastern Coastal Plain of the United States.

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