EFFECT OF SORGHUM CROPPING PRACTICES ON WINTER POTATO PRODUCTION[1]

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ABSTRACT

McSorley, R., J. L. Parrado, R. V. Tyson, V. H. Waddill, M. L. Lamberts, and J. S. Reynolds. 1987. Effect of sorghum cropping practices on winter potato production. Nematropica 17:45-60.

Four summer cropping practices (sorghum cover crop, weed cover, chemical fallow, or mechanical fallow) had no influence on total tuber weights of a subsequent winter potato crop, despite reduction of certain plant-parasitic nematode species by some systems. Marketable yields were significantly affected, however, since wireworm damage to tubers was increased following non-fallow treatments compared with fallow treatments, and was greatest following sorghum cropping. In two subsequent experiments, maintenance of various intervals of sorghum cover and clean fallow had minimal effect on soil fertility and nematode populations, and did not effect total potato yields. In both experiments, wireworm damage to tubers showed significant linear and quadratic relationships to the number of days a sorghum cover crop had been present.

Additional key words: cropping systems, nematodes, pest management, soil fertility, wireworms, Solanum tubersoum, Sorghum bicolor.

RESUMEN

McSorley, R., J. L. Parrado, R. V. Tyson, V. H. Waddill, M. L. Lamberts, y J. S. Reynolds. 1987. Efecto de las cosechas de cobertura de millo en la producción de papa de invierno. Nematropica 17:45-60.

Cuatro manejos estratégicos de verano (cosecha de cobertura de millo, cobertura de hierbas, barbecho limpio por productos químicos y barbecho limpio por labores mecánicas) no tuvieron influencia en los rendimientos totales en la subsiguente cosecha de papa de invierno, a pesar de la reducción de ciertos nematodos parasiticos por algunos de los sistemas. El daño por el gusano blanco a los tubérculos aumentó después de los tratamientos sin barbecho limpio en comparación con los tratamientos de barbecho limpio y alcanzó su nivel más alto en los lotes sembrados con millo. En dos experimentos subsiguientes el mantenimiento de varios intervalos de cobertura de millo y barbecho limpio tuvieron un efecto mínimo en la fertilidad del terreno y las poblaciones de nematodos y

no afectaron los rendimientos totales de la papa. Sin embargo en ambos experimentos el daño del gusano blanco a los tubérculos de papa mostró una relación linear y cuadrática significativa con respecto al número de dias que la cobertura de millo estuvo presente.
Palabras claves adicionales: sistemas de cosechas, nematodos, gusanos blancos, fertilidad del suelo, manejo de plagas, Solanum tuberosum, Sorghum bicolor.

INTRODUCTION

Production of potato (*Solanum tuberosum* L.) is hindered in many localities by the occurrence of various combinations of soil-inhabiting pests, including plant-parasitic nematodes (2,21) and insects, particularly wireworms (1). In Dade County, Florida, control of soil pests in winter potato production was possible during the 1970's because of the availability and low cost of preplant soil fumigation with ethylene dibromide (EDB). With the suspension of the use of EDB in the United States in 1983, concern about control of soil pests in Florida potato production increased. Although granular insecticides could provide some control of wireworms (1), few alternatives to EDB existed for chemical control of nematodes.

In southeastern Florida, several nematode species have the potential to damage potatoes. The root-knot nematode, *Meloidogyne incognita* (Kofoid and White) Chitwood, is considered the principal nematode problem because of its ability to deform tubers (3). The reniform nematode, *Rotylenchulus reniformis* Linford and Oliveira, which is common locally, also has the ability to damage potatoes (17). *Criconemella onoensis* (Luc) Luc and Raski is common in the area, but its effect on potatoes is unclear (15).

Use of summer cover crops or fallow may be an important nonchemical method for managing nematode populations in southeastern Florida and other subtropical areas (13,15). Traditionally, potato growers in this region have grown a cover crop of sorghum (*Sorghum bicolor* [L.] Moench) during the summer because the presence of a uniform, tall, closely-spaced cover has prevented colonization of cropping sites by by weed species which may interfere with production operations. There is a belief among some growers that the mowing and discing of the cover crop improves fertility by incorporating additional organic matter into the soil. A sorghum cover crop is of no benefit where nematodes such as *Belonolaimus longicaudatus* Rau or *Paratrichodorus christiei* (Allen) Siddiqi occur (18). However, a sorghum cover crop could be useful in managing a system in which the major nematodes are *M. incognita* and *R. reniformis,* since neither species increased on this host (11,13). Sorghum cover crops are attractive for oviposition by wireworm adults of some species, however (Baranowski, unpublished), and thus careful monitoring is needed to insure that wireworm populations do not increase above damage threshold levels (14).

The objectives of this study were: 1) to compare the effects of several different summer cropping practices on nematode and wireworm populations and on subsequent yields of a winter potato crop; and 2) to determine the influence of various time intervals of sorghum cover cropping and clean fallow on pest populations, soil fertility, and potato yields.

MATERIALS AND METHODS

Summer fallow experiment. A 32-ha field of Perrine marl soil (5) located about 10 km northeast of Homestead, Florida, was disced and prepared for planting in early April, 1984. Sixteen 0.4-ha plots were established within the field in a randomized complete block design with four treatments and four replications. The four treatments were: sorghum-sudangrass cover crop, weed cover, chemical fallow, and mechanical fallow.

The sorghum-sudangrass (*Sorghum bicolor* [L.] Moench x *S. arundinaceum* [Desv.] Stapf var. *sudanense* [Stapf] Hitchc.) cover crop consisted of 'Funk FP-4' planted on 17 April. The crop had died by September, when it was mowed.

Weed cover plots were permitted to be colonized by naturally-occurring weeds during the summer months. Weed cover was rated on 6 June and 30 July in four locations within each weed plot. At each location, a 3-m x 3-m quadrat was measured, and the percentage of ground within the square covered by individual weed species was rated on a 1-12 scale (7), where: 1=0% of ground covered; 2=0-3%; 3=3-6%; 4=6-12%; 5=12-25%; 6=25-50%; 7=50-75%; 8=75-88%; 9=88-94%; 10=94-97%; 11=97-100%; and 12=100% of ground covered. An average rating of ground covered by each species was determined for each plot.

The chemical fallow plots received three applications of herbicides to reduce weed growth. The first application, on 5 June, was 1.1 kg a.i. each of diquat (6,7-dihydrodipyridol [1,2-: 2′,1′-c] pyrazidium ion) and paraquat (1,1′-dimethyl-4,4′-bipyridinium ion) applied in 374L of water per ha. On 5 July, 0.55 kg a.i. of metribuzin (4-amino-6-[1,1-dimethylethyl]-3-[methylthio]-1,2,4-triazin-5[4H]-one), 1.1 kg a.i. of oryzalin (3,5-dinitro-N_4,N_4-dipropylsulfanilamide), and 0.55 kg a.i. of paraquat were applied, and on 9 August, 0.55 kg a.i. of paraquat and 1.7 kg a.i. of cyanazine (2-[[4-chloro-6-[ethylamino]-S-triazin-2-yl] amino]-2- methylpropionitrile) were applied.

The mechanical fallow plots were maintained by discing (2 passes per plot) at monthly intervals beginning on 25 May. Plots for all treatments were disced on 23 October in preparation for planting of 'La Rouge' potatoes on 20 November-3 December.

Prior to planting the potatoes, 10 soil samples, each 15 cm x 15 cm square x 15 cm deep were removed from each plot (14). Each sample was examined for wireworms (fam. Elateridae) after washing the sample through three progressively smaller screens (4.0 mm, 2.0 mm, and 0.50 mm).

Nematode populations were assessed by collecting a single soil sample from each plot on 19 April 1984, and near monthly intervals thereafter. Each soil sample consisted of 20 cores (2.0-cm diam. x 20-cm deep) of soil collected in a systematic pattern over the 0.4-ha area. The 20 cores were combined together and the nematodes extracted from a 100-cm^3 subsample by a modification (12) of Jenkins' (8) sieving and centrifugation technique.

The potato crop was maintained using cultural practices recommended for the region (20), and was harvested four months after planting by digging 3.05 m of row from each of three different locations, for a total of 9.2 m harvested per plot. Potatoes were graded (6) by size into three categories: A (over 5.0 cm diam.), B (3.8-5.0 cm diam.), and C (2.5-3.8 cm diam). Potatoes less than 2.5 cm in diameter were culled. Graded potatoes were weighed and examined for damage from wireworms or root-knot nematodes.

Sorghum cropping experiments: sorghum planting and removal. These two experiments were conducted in adjacent sites on Perrine marl soil east of Naranja, Florida. In each experiment, combinations of a sorghum (*S. bicolor* '877F') cover crop and clean fallow were maintained for various intervals of time by planting sorghum on various dates, or by removing an existing sorghum cover crop by mowing and discing (Table 1). In each experiment, treatments were arranged in a randomized complete block, replicated four times, with individual plots each comprising 0.14 ha.

All plots in both experiments were disced on 25 October and planted with 'La Rouge' potatoes on 19-21 December. Plots were maintained as in the summer fallow experiments, and potatoes were harvested on 14-16 April by digging four 3.0-m sections of row per plot, for a total of 12 m of row harvested per plot. Tubers were graded for size and damage as described in the previous experiment.

Five soil samples (15 cm x 15 cm x 15 cm) were collected from each plot on 4-7 November and assayed for wireworms as described previously. Soil samples for estimation of nematode populations were collected from all plots near the initiation (15 May) and termination (2 October) of the summer cover cropping period, and approximately once per month thereafter. A 100-cm^3 portion was used for nematode extraction and the remainder for soil analyses. Soil moisture was determined gravimetrically by weighing 40-g soil samples before and after heating in an oven overnight at 115 C. Organic matter was determined by heat-

Table 1. Summary of cultural operations for two summer sorghum cropping experiments. Summer, 1985.

Days planted to sorghum	Date sorghum was planted[z]	Date sorghum removed by discing[z]	Dates of discing to maintain fallow[z]
		Sorghum removal experiment	
0	—	—	7 May, 5 June, 17 July, 9 Aug., 30 Sept.
29	7 May	5 June	17 July, 9 Aug., 30 Sept.
71	7 May	17 July	9 Aug., 30 Sept.
94	7 May	9 Aug.	30 Sept.
146	7 May	30 Sept.	—
		Sorghum planting experiment	
0	—	—	7 May, 5 June, 17 July, 9 Aug., 30 Sept.
46	15 Aug.	30 Sept.	7 May, 5 June, 17 July, 9 Aug.
74	18 July	30 Sept.	7 May, 5 June, 17 July
116	6 June	30 Sept.	7 May, 5 June
146	7 May	30 Sept.	—

[z]Dashes (—) indicate operation not performed.

ing 3 to 4 g of the dried soil at 250 C for one hr and then igniting it at 500 C for 3 hr. Other soil analyses (pH, N, P, K, Cl, Ca, conductivity) were performed on air-dried soil. For pH and conductivity measurements, 20 ml of soil were combined with 40 ml of distilled water, and measurements were taken on the resultant slurry using a pH meter (Corning® Model 610A) and a conductivity meter (Beckman Solu Bridge Model RD-B15). Extract for the remaining nutrient analyses was prepared by combining 10 g of soil with decolorizing carbon and 50 ml of distilled water. The mixture was shaken for 30 min and filtered through Whatman® #42 filter paper (10). Nitrate-N and P were determined colorimetrically. A brucine-salicylic acid-sulfuric acid solution was used as the reagent for NO_3^- determination, and an aqueous ammonium molybdate-sulfuric acid solution and an aqueous stannous chloride solution were used as reagents for P determination (16). K and Ca were determined directly on the extract using a spectrophotometer (Beckman® Model DU) with flame attachment, and Cl was determined using an specific ion meter (Orion® Model 407) with reference and chloride electrodes.

Data analysis. Data in all experiments were analyzed using analysis of variance. In the summer fallow experiment, single degree of freedom contrasts (4) were used to test for significance of three contrasts: 1) sorghum plots vs. weed plots, 2) chemical fallow vs. mechanical fallow, and 3) fallow plots vs. non-fallow plots. In the sorghum cropping experiments, regression analysis (4) was used following analysis of variance to test for possible significant linear or quadratic effects.

RESULTS AND DISCUSSION

Summer fallow experiment. A variety of plant species were evident in the weed plots on 6 June. Average ratings (7) of the percent of ground covered by the more common species were: lambsquarters (*Chenopodium* spp.), 5.9; morningglory (*Ipomoea* spp.), 3.9; nutsedge (*Cyperus* spp.) 1.8; volunteer potatoes, 1.8; spiny amaranth (*Amaranthus spinosus* L.), 1.8; grasses (*Echinochloa* spp., *Panicum* spp., *Digitaria* spp., *Cynodon* spp.), 1.7; *Acalypha alopecuroides* Jacq., 1.6; sowthistle (*Sonchus oleraceus* L.), 1.4; and purslane (*Portulaca oleracea* L.), 1.2. By 30 July, morningglory had almost completely covered three of the four weed plots, and by September, morningglory had even begun to encroach in the sorghum plots to some extent.

Plant-parasitic nematodes found in the test plots included *C. onoensis*, *R. reniformis*, *Tylenchorhynchus martini* Fielding, *M. incognita*, and *Helicotylenchus dihystera* (Cobb) Sher. Populations of the three most abundant species before and after summer management and the subsequent potato crop are presented (Table 2). Numbers of *Criconemella onoensis*

Table 2. Nematode populations on selected sampling dates in summer fallow experiment, 1984-85.

Summer management treatment	Nematodes per 100 cm³ soil by sampling date[z]				
	19 Apr.	9 Oct.	23 Oct.	10 Dec.	12 Mar.
Criconemella onoensis					
Weeds	698	1099	901	692	512
Sorghum	808	1994	1561	1190	841
Chemical fallow	810	911	1002	795	551
Mechanical fallow	819	1137	859	648	486
Significant contrasts:					
Fallow vs. non-fallow	n.s.	n.s.	n.s.	n.s.	n.s.
Sorghum vs. weeds	n.s.	n.s.	n.s.	*	n.s.
Chemical vs. mechanical fallow	n.s.	n.s.	n.s.	n.s.	n.s.
Rotylenchulus reniformis					
Weeds	21	289	576	301	35
Sorghum	22	192	216	172	20
Chemical fallow	80	1	92	89	2
Mechanical fallow	45	96	41	44	0
Significant contrasts:					
Fallow vs. non-fallow	n.s.	*	*	*	*
Sorghum vs. weeds	n.s.	n.s.	n.s.	n.s.	n.s.
Chemical vs. mechanical fallow	n.s.	n.s.	n.s.	n.s.	n.s.
Tylenchorhynchus martini					
Weeds	4	96	85	1	0
Sorghum	1	139	34	2	0
Chemical fallow	4	0	36	0	1
Mechanical fallow	0	8	2	0	0
Significant contrasts:					
Fallow vs. non-fallow	n.s.	*	n.s.	n.s.	n.s.
Sorghum vs. weeds	n.s.	n.s.	n.s.	n.s.	n.s.
Chemical vs. mechanical fallow	n.s.	n.s.	n.s.	n.s.	n.s.

[z]Data are means of 4 replications; asterisk (*) indicates significant contrast at (P=0.05); n.s.=not significant. Sampling dates correspond to start of summer management treatment (19 Apr.), first discing (9 Oct.), second discing (23 Oct.), shortly after potato planting (10 Dec.), and potato harvest (12 Mar.).

were usually highest following sorghum growth, but this trend was significant on only one sampling date. Populations of *R. reniformis* were significantly reduced by fallow, but consistent reductions of the other nematode species were not noted. Greater differences in nematode populations from fallow plots vs. populations from cover crops were observed in previous studies (13,15). However, for the duration of this study, soil moisture averaged 31.1% (range 29.2 to 35.1%). Because of this relatively high soil moisture level, desiccation probably had only a limited role in reducing nematode populations. Relatively high populations of *R. reniformis* on sorghum, a nonhost (9), are attributed to encroachment of morningglory into sorghum plots during the late summer. Numbers of *T. martini* were unaffected by summer management treatments, except on 9 October by fallow. Root-knot nematodes were rare in this test, with juveniles of *M. incognita*, race 1, recovered only from weed plots on 23 October, at a mean density of 26/100 cm^3 of soil. During the previous summer, galls were found frequently on the root systems of *Acalypha ostryifolia* Riddell, occasionally on *A. alopecuroides* and *Chenopodium* spp., but never on the other weeds, including moringglory. Populations of all plant-parasitic nematode species declined during growth of the potato crop (Table 2).

Wireworm densities per preplant sample averaged 0.20 in sorghum plots, 0.18 in weed plots, and 0.02 and zero in chemical and mechanical fallow plots, respectively. In all cases, densities were below the 0.44 wireworm/sample level, at which treatment would be recommended (14). Nevertheless, substantial wireworm damage occurred to tubers in this test. Although total potato weights (marketable and unmarketable) showed no differences (P=0.05) with treatment (Table 3), wireworm damage was greater (P=0.001) in non-fallow plots compared with fallow plots, reaching highest levels following sorghum. Over 20% of the large, grade A potatoes grown in plots following sorghum were culled for wireworm damage. Only the summer fallow treatments resulted in wireworm culls below 5%.

Sorghum cropping experiments. Results of these two experiments were similar, even though the sorghum cover crops were maintained at different periods of time and by different methods (planting vs. removal). Levels of most physical and chemical soil parameters monitored showed no differences (P=0.05) with treatment (*i.e.*, days of sorghum). For example, soil moisture ranged from 30 to 33% and soil pH from 7.6 to 8.0, regardless of treatment or season. Percent soil organic matter ranged from 4.21 to 5.70 throughout the year, and was not affected (P=0.05) by the number of days the sorghum cover crop was maintained, despite the availability of much plant residue disced into the plots which had sorghum for 71-74 days or longer. Soil chloride levels were greater than 1100 ppm prior to initiation of both experiments in

Table 3. Potato yields by treatment and grade in summer fallow experiment, spring 1985.

Summer management treatment	Weight (kg) per plot[y] by grade[z] A	B	C	Total
Wireworm damage by grade				
Weeds	2.76	0.16	0.06	2.97
Sorghum	5.95	0.32	0.06	6.34
Chemical fallow	0.92	0.02	0.02	0.95
Mechanical fallow	0.42	0.08	0.00	0.50
Significant contrasts:				
Fallow vs. non-fallow	***	***	***	***
Sorghum vs. weeds	**	**	n.s.	**
Chemical vs. mechanical fallow	n.s.	n.s.	n.s.	n.s.
Total yield by grade				
Weeds	21.6	3.44	1.23	26.2
Sorghum	23.9	3.44	1.16	28.5
Chemical fallow	28.2	3.46	1.20	33.0
Mechanical fallow	25.0	3.58	1.20	29.7
Significant contrasts:				
Fallow vs. non-fallow	n.s.	n.s.	n.s.	n.s.
Sorghum vs. weeds	n.s.	n.s.	n.s.	n.s.
Chemical vs. mechanical fallow	n.s.	n.s.	n.s.	n.s.

[y]Plot size is 9.2 m of row.
[z]Data are means of 4 replications; asterisks (**, ***) indicate significant contrasts at P=0.01, and P=0.001, respectively; n.s.=not significant.

May, but decreased to 100-140 ppm on 2 October, following cover cropping (data not shown). There was a slight decrease (P=0.05) in chloride levels with increasing days of sorghum on 2 October, but not at other times. Soil conductivity measurements followed a similar pattern. Levels of soil P, K, and Ca (data not shown) showed some seasonal fluctuations but no differences (P=0.05) related to treatment (days of sorghum). Nitrate nitrogen showed some decreases as length of the sorghum cover crop increased (Table 4). These differences were apparent after the summer cover cropping period, but were obscured in early December when potatoes were planted and fertilizer was applied. The nitrogen data do not support the idea that the plant residues might contribute to soil fertility since highest N levels were found in fallow plots or plots in sorghum for only a short time. The test used measured only nitrate-N, but organic matter did not increase with sorghum cover cropping. Observed nitrate-N trends may have resulted from depletion of nitrate-N

Table 4. Soil nitrogen by sampling date for two summer sorghum cropping experiments, 1985-86.

Days planted to sorghum	Soil nitrogen (ppm NO_3^-) by sampling date[z]							
	15 May	2 Oct.	4 Nov.	2 Dec.	13 Jan.	11 Feb.	12 Mar.	3 Apr.
			Sorghum removal experiment					
0	240	46	119	102	152	208	130	128
29	229	45	120	196	142	210	146	102
71	226	37	80	120	90	162	92	88
94	181	28	54	121	112	205	132	87
146	355	38	56	69	132	185	116	102
Significant effects:								
Linear	n.s.	n.s.	***	n.s.	n.s.	n.s.	n.s.	n.s.
Quadratic	n.s.	*	***	n.s.	n.s.	n.s.	n.s.	n.s.
			Sorghum planting experiment					
0	260	71	84	215	172	210	119	130
46	310	70	119	108	188	198	98	104
74	362	45	70	137	148	228	73	104
116	295	56	68	116	157	170	116	96
146	252	46	56	99	129	178	55	85
Significant effects:								
Linear	n.s.	*	*	n.s.	n.s.	n.s.	n.s.	n.s.
Quadratic	n.s.	n.s.	*	n.s.	n.s.	n.s.	n.s.	n.s.

[z]Data are means of 4 replications; asterisks (*, ***) indicate significant effects at P=0.05 and P=0.001, respectively; n.s.=not significant.

by the sorghum crops, or possibly from increased nitrogen fixation by the many blue-green algae common in fallow soils in this region (19).

High populations of *C. onoensis* were present throughout both experiments in all treatments, but declined during the course of the potato crop (Table 5). On 4 November and 13 January, increased *C. onoensis* densities were related linearly and quadratically to number of days of sorghum (Table 5). Populations of *R. reniformis* (range 15 to 556/100 cm^3 soil) also occurred in both experiments, as well as lower populations of *T. martini* (range 0 to 119/100 cm^3 soil) and *H. dihystera* (range 0 to 46/100 cm^3 soil), but these three nematodes showed little relationship to duration of the cover crop (data not shown). Fluctuations in populations of these nematodes were seasonal, with lowest populations of all three species observed in March and April, and maximum populations observed in November and December (*R. reniformis, T. martini*) or May (*H. dihystera*).

Potato yields showed no differences with treatment in either of these two experiments (data not shown). Total number of potatoes harvested per 12-m plot ranged from 504 to 560, and total weight from 61.3 to 69.6 kg. The number of potatoes culled because of wireworm damage increased with the number of days sorghum was grown during the summer (Table 6), even though preplant wireworm counts taken in the field were low and showed no significant differences among treatments. For the sorghum removal experiment, percent of damaged potatoes (Y) was related to days of sorghum in the summer (X) by the linear equation $Y=1.87 + 0.0648X$ with $r^2=0.577$, or by the quadratic equation $Y=0.0155 + 0.166X - 0.00070X^2$ with $R^2=0.716$. For the sorghum planting experiment, the corresponding linear equation was $Y=1.79 + 0.0557X$ with $r^2=0.366$, and the corresponding quadratic equation was $Y=1.113 + 0.0919X - 0.00025X^2$ with $R^2=0.342$. The equations developed from the two experiments give similar results. The best predictor of tuber damage was the quadratic equation from the sorghum removal experiment ($R^2=0.716$). For example, according to this equation, 5% of tubers would be expected to show wireworm damage if a sorghum cover crop were maintained for 35 days.

Our results indicate that the summer cropping strategies studied had little or no impact on soil fertility or yields (numbers or weight) of a subsequent potato crop. Clean fallowing did not reduce populations of all nematode species in these sites on Perrine marl soils, probably because soil moisture was about 30% during the course of the study. Consistent reductions of nematodes with mechanical fallow have occurred on the better-drained Rockdale series soils in the area (13), but these soils are not used for potato production. The increases in *C. onoensis* populations following sorghum, observed in some instances, appeared to have no adverse impact on potato yields. Root-knot nematodes were

Table 5. Populations of *Criconemella onoensis* for two summer sorghum cropping experiments, 1985-86.

Days planted to sorghum	*C. onoensis* per 100 cm^3 soil by sampling date[z]							
	15 May	2 Oct.	4 Nov.	2 Dec.	13 Jan.	11 Feb.	12 Mar.	3 Apr.
			Sorghum removal experiment					
0	954	312	1375	994	602	612	504	124
29	781	1068	1038	481	568	474	392	221
71	944	838	1506	994	672	529	575	280
94	782	891	1124	960	756	510	480	195
146	840	412	1781	819	748	499	582	241
Significant effects:								
Linear	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.
Quadratic	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.
			Sorghum planting experiment					
0	825	594	900	744	484	377	402	268
46	878	688	900	819	431	548	434	262
74	684	525	1331	781	671	498	629	201
116	840	575	1562	912	785	670	558	246
146	790	619	1244	1000	800	713	560	270
Significant effects:								
Linear	n.s.	n.s.	**	n.s.	**	n.s.	n.s.	n.s.
Quadratic	n.s.	n.s.	*	n.s.	*	n.s.	n.s.	n.s.

[z]Data are means of 4 replications; asterisks (*, **) indicate significant effects at P=0.05 amd P=0.01, respectively; n.s.=not significant.

Table 6. Wireworm data for two summer sorghum cropping experiments, 1985-86.

Days planted to sorghum	Preplant wireworm counts per sample[z]	Percent of harvested potatoes with wireworm damage[z]
	Sorghum removal experiment	
0	0.05	1.44
29	0.15	1.40
71	0.35	9.48
94	0.40	10.13
146	0.25	8.94
Significant effects:		
Linear	n.s.	***
Quadratic	n.s.	***
	Sorghum planting experiment	
0	0.25	1.32
46	0.15	3.90
74	0.00	7.57
116	0.05	8.15
146	0.05	9.32
Significant effects:		
Linear	n.s.	*
Quadratic	n.s.	*

[z]Data are means of 4 replications; asterisks (*, ***) indicate significant effects at $P=0.05$ and $P=0.001$, respectively; n.s.=not significant.

absent following sorghum and fallow, and low numbers were recorded only in weed plots in the summer fallow experiment. Damage in potato plots following weeds was minimal, with only 58 g of potatoes per plot showing any galling. Increased problems with *Meloidogyne* spp. would be anticipated if weed hosts, such as *A. ostryifolia,* were permitted to grow in abundance during the summer in potato production areas.

The main impact of the summer cropping strategies examined was the increased tuber damage from wireworms following sorghum cover crops and to a lesser extent following weeds. The extent of the damage was more severe than anticipated, since all preplant levels were below the 0.44 wireworms/sample action threshold, above which treatment is recommended (14). This threshold may not be applicable under our conditions, and perhaps should be revised downward, or a more intensive preplant sampling program utilized for more reliable detection of patches of high wireworm density within the field. Results from the sorghum cropping experiments suggest that severe wireworm damage could not be avoided by reducing the time interval when sorghum was grown or by varying the time during the summer when the cover crop was grown. Heavy damage (>5%) is anticipated even if sorghum is grown for only 5 weeks, which is hardly sufficient time for the crop to become established or exert any beneficial influence by outcompeting weed species.

Wireworm damage was minimized by mechanical or chemical fallow. Fallow was also effective in reducing nematode populations in some instances, and in all cases, never resulted in significantly higher populations than if sorghum were grown. However, fallow is achieved at a higher cost than cover-cropping, requiring more management and labor input during the off-season. Substituting a sorghum cover crop for fallow appeared to have only a small effect on the nematode community and no significant effect on total potato yields. However, the entire soilborne pest complex cannot be ignored, since sorghum cultivation would likely lead to serious wireworm damage and reduction in marketable yields of a subsequent potato crop, necessitating the application of additional, and perhaps costly, controls for wireworms.

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