1459 *Rotylenchulus reniformis* Host Status Evaluations of Common Weeds Associated with the *Gossypium hirisutum* – *Zea mays* Rotation System

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The reniform nematode (*Rotylenchulus reniformis*) is the primary economical nematode pest of cotton (*Gossypium hirisutum*) in the southern states of Alabama, Louisiana, and Mississippi. Corn (*Zea mays*), a non-host to *R. reniformis,* is the principal crop rotated with cotton to reduce *R. reniformis* populations. However, nematode soil samples recently collected have contained economically significant populations of *R. reniformis* after a season of corn. Such findings suggested that non-controlled common weed species associated with the cotton - corn rotation may serve as hosts for *R. reniformis* and sustain populations during the corn crop. Therefore, selected weed species commonly associated with corn and cotton production in the southeast United States were screened to determine their host status to R*. reniformis* in the greenhouse. In a microplot field study, corn and individual weed species were grown in mixtures to evaluate *R. reniformis* population density changes. Corn was also produced under four herbicide regimes simulating various weed densities to determine if increasing weed populations would maintain or increase *R. reniformis* numbers.

Greenhouse trials indicated that of 43 species tested, the majority of dicotyledonous weed species serve as host to *R. reniformis* while the monocotyledonous weeds did not. In field microplot studies, corn growing in mixtures with individual weed species increased *R. reniformis* nematode populations. Non-controlled weed species in corn field plots treated with only a pre-emergence herbicide application increased *R. reniformis* populations compared to the weed-free treatments. The presence of non-controlled weeds in the cotton-corn rotation system may support a persistent *R. reniformis* population during rotations with a non-host crop.

Keywords: *Gossypium hirisutum,* reniform nematode, *Rotylenchulus reniformis,* weed hosts, *Zea mays.*

The reniform nematode (*Rotylenchulus reniformis*) is the primary nematode pest of cotton (*Gossypium hirisutum*) in the southern states of Alabama, Louisiana, and Mississippi. This nematode is estimated to reduce cotton production in these states by an average of 8% or 146,000 bales of cotton valued at $36 million dollars (Blasingame, 2006). This estimate does not include the cost of nematicides applied and therefore the total economic loss is greater. Crop rotation is a viable alternative for nematode management because at this time there is a lack of available cotton cultivars with resistance to *R. reniformis*. The primary rotation crop recommended for managing *R. reniformis* in cotton in the southeast region is corn (*Zea mays*). Corn hybrids do not serve as hosts for R. reniformis, making this crop an ideal alternate rotation sequence. One growing season in corn can reduce *R. reniformis* populations by 90 % (Gazaway, 2006). Recently, however, populations of *R. reniformis* in soil samples submitted to nematode laboratories have not declined following the corn season of the annual rotation (Lawrence, unpublished). Thus persistent populations of *R. reniformis* been observed from fields cropped to corn. Non-controlled weed species may account for this problem. The non-controlled weed species associated with corn production

may be serving as hosts for *R. reniformis* and sustaining nematode numbers during the non-host crop season. The purpose of this research is to determine if non-controlled weeds associated with the corn phase of the cotton-corn rotation cause persistence of *R. reniformis.*. The objectives of this research were: 1) to determine if selected weed species common to the southeast United States will serve as hosts and allow reproduction of the *R. reniformis*; 2) to determine if corn growing in a mixture with individual weed species increases *R. reniformis* numbers; and 3) to determine if corn with different densities of weeds growing in mixtures will sustain *R. reniformis* populations in the field. The outcome of this research will determine if weed species associated with corn serve to sustain *R. reniformis* numbers under field conditions.

MATERIALS AND METHODS

Tests were established in the greenhouse, microplot, and field condition to determine the host status of selected weed species to *R. reniformis* and to determine the magnitude of reproduction on potential weed hosts when corn is rotated with cotton.

Rotylenchulus reniformis: The nematode inoculum used for all greenhouse tests consisted of *R. reniformis* populations collected from numerous cotton fields throughout the mid-south and southeast. The *R. reniformis* populations were propagated and maintained in the greenhouse on Delta and Pineland 555 BG/RR (

DPL 555 BR) cotton in 10-cm diameter polystyrene pots containing 500 cm^3 of a loamy sand soil (72.5% sand, 25% silt, 2.5% clay, ph 6.4). The soil was autoclaved at 121° C and 103.4 kPa for two hours on two successive days for sterilization. Nematode inoculum was composed of *R. reniformis* eggs and vermiform life stages extracted from the soil and root systems of cotton plants using combined gravity screening and sucrose centrifugal flotation methods (Jenkins, 1964). Eggs were extracted by agitating the root system for 4 minutes in a 0.6 % sodium hypochlorite (NaOCl) solution (Hussey and Barker, 1973). The *R. reniformis* life stages were enumerated using a Nikon Eclipse TS100 inverted microscope and adjusted to 2,000 eggs and vermiform life stages per 2 ml of water.

Greenhouse Evaluations: Greenhouse trials were conducted at the Plant Science Research Center on the campus of Auburn University in Auburn, Alabama. Forty-three individual species of weeds were evaluated in comparison with cotton to determine if they are suitable hosts that support reproduction of *R. reniformis* (Table 1). The weed species chosen for testing include: *Abutilon theophrasti* (velvetleaf), *Allium canadense* (wild onion), *Amaranthus retroflexus* (redroot pigweed), *Amaranthus rudis* (common waterhemp), *Ambrosia artemisifolia* (common ragweed), *Avena fatua* (wild oat), *Urochloa platyphylla* (broadleaf signalgrass), *Chenopodium album* (lambsquarter), *Commelina benghalensis,* (tropical spiderwort), *Convolvulus arvensis* (field bindweed), *Cyperus esculentus* (yellow nutsedge), *Cyperus rotundus* (purple nutsedge), *Datura stramonium* (Jimsonweed), *Digitaria sanguinalis* (large crabgrass), *Echinochloa crus-galli* (barnyardgrass), *Geranium carolinianum (*Carolina geranium), *Imperata cylindrica* (Cogongrass), *Ipomea hederacea* (ivyleaf morningglory), *Ipomea lacunosa* (pitted morningglory), *Kochia scoparia* (kochia), *Lamium amplexicaule* (henbit), *Medicago lupulina* (black medic), *Mullugo verticillata* (carpetweed), *Panicum dichotomiflorum* (fall panicum), *Panicum texaanum* (Texas panicum), *Plantago lanceolata*, (buckhorn plantain), *Polygonum convolvulus* (wild buckwheat), *Polygonum lapathifolium* (pale smartweed), *Rumex acetosella,* (red sorrel), *Rumex crispus* (curly dock), *Senna obtusifola* (sicklepod), *Senna occidentalis* (coffee senna), *Sesbania herbacea* (hemp sesbania), *Sesbania punicea,* (rattle box), *Setaria glauca,* (yellow foxtail), *Setaria viridis* (green foxtail), *Sida spinosa* (prickly sida), *Sinapis arvensis* (wild

mustard), *Sorghum bicolor* (shattercane), *Sorghum halepense* (Johnsongrass), *Spergula arvensis* (corn spurry), and *Taraxacum officinale* (dandelion). All weed species tested were grown from seed with the exception of *C. rotundus* and *I. cylindrica*, which were increased from root nodules and rhizomes, respectively.

Seeds from each of the individual weed species were planted into 500 cm^3 of autoclaved loamy sand soil placed in 10 cm diameter polystyrene containers. DPL 555 cotton was included as a positive control. Each experiment was arranged in a randomized complete block design with five replications and each test was repeated twice. Fourteen to 21 days after planting, the weed seeds had germinated and were inoculated by pipetting 2 ml containing 2,000 *R. reniformis* eggs and vermiform life stages into depressions in each pot. Temperatures in the greenhouse throughout the experiments ranged from 24 to 35º C. All tests were harvested sixty days after *R. reniformis* inoculation. *Rotylenchulus reniformis* nematode eggs and vermiform life stages were extracted from the soil and roots as previously described. Populations were enumerated and reproduction factors were determined (Rf = final population / initial population). Weed species with populations above the original inoculum level of 2,000 are considered hosts of *R. reniformis*. *Rotylenchulus reniformis* numbers on each weed species were also recorded as a ratio to the numbers produced on cotton [(weed population/cotton population)*100].

Microplot trials: Microplot experiment field trials were conducted at the R. R. Foil North Plant Science Research Farm on the campus of Mississippi State University. Corn and selected individual weed species populations were grown in mixtures to monitor *R. reniformis* population development over time. Treatments consisted of cotton alone (a positive control), corn alone (negative control) and corn grown singularly with the following weed species: *A. theophrasti*, *A. artemisifolia*, *B. platyphlla*, *S. obtusifola, S. occidentalis, S. spinosa, S. halepense* or a combination of *I. hederacea, I. lacunose,* and *I. puepuew,* (Table 2). The microplots were infested with *R. reniformis* and were cropped with cotton the previous year. Each microplot was composed of 76 cm diam. fiberglass cylinders, placed 45 cm deep into the soil. The soil within the microplots was as a sandy loam (61.25% sand, 31.25% silt, 7.5% clay, ph 6.4). Dyna-Grow 58K22 RR corn and DPL 555 cotton were planted in the appropriate plots. Weed seeds (40 cc of seed) were hand-broadcasted into the respective treatment plots and lightly covered by hand hoeing Each microplot test was arranged in a randomized complete block design with four replications and the test was repeated once. Soil samples were collected at corn planting, and continued monthly through the growing season. Six soil cores, 2.5-cm in diameter. and 15-cm deep, were collected per microplot. Upon collection, each microplot sample was placed in a sealed plastic bag, labeled, and contained within an insulated ice chest for transport to the Auburn University Plant Science Research for nematode extraction. Samples were stored for no more than 7 days in a temperature controlled refrigeration unit at 4º C. *Rotylenchulus reniformis* life stages were extracted and enumerated as previously described. Cotton and corn yields were determined at harvest.

Field trials: Field experiments were conducted in 2005 and 2006 in a cotton field naturally infested with *R. reniformis*, located near Huxford, Alabama. Dyna-Gro 58K22 RR corn was grown utilizing four different herbicide regimes designed to produce different weed densities and species composition. The four herbicide regimes included: 1) S-metolachlor plus atrazine applied pre-emergence (PRE), followed by monthly applications of glyphosate; 2) a PRE application of S-metolachlor plus atrazine, followed by a single application of glyphosate before corn plants were 76 cm in height; 3) a PRE application of S-metolachlor plus atrazine; and 4) S-metolachlor applied PRE alone. S-metolachlor, atrazine, and glyphosate were applied at recommended rates of 0.23 L (1.12 kg ai/ha), 0.75 L (2.24 kg ai/ha), and

0.68 L (0.84 kg ai/ha) per hectare, respectively. The field plots consisted of four rows, 7.6 m long with 102 cm row spacing arranged in a randomized complete block design with six replications. The soil within the plot area intergraded from a Grady loam to a Poarch fine sandy loam (56.25% sand, 28.75% silt, 15% clay, ph 6.4). Nematode samples were taken at planting and were repeated monthly through the growing season. Samples were composed of ten soil cores, 2.5 cm in diameter and 20 cm deep collected from the center two rows per plot, using a systematic zig-zag sampling pattern. Soil samples were transported, stored and processed as previously described. Weed biomass samples were collected at 60 days after corn planting, and continued monthly until the end of the growing season. Biomass samples were collected from two 0.25 m^2 areas selected randomly between the two center rows of each plot. All weed growth within the areas was clipped at the soil line, bagged, and oven-dried at 55° C for 48 hours.

Generalized mixed models (GLMM) methodology with the lognormal distribution function for nematode numbers was employed to analyze the data utilizing the Statistical Analysis System (SAS Institute, Cary, NC). The weed treatments were considered to be fixed effects, whereas block and year (block) were random effects.

Means were separated either with Fisher's protected least significant difference test ($P \leq 0.05$) or comparisons to cotton were estimated using Dunnett's test (Reference for Dunnett's). All levels of significance reported herein are at the $P \leq 0.05$ level unless otherwise stated.

RESULTS

Greenhouse Evaluations: Of the 43 weed species tested, 79% of dicotyledonous weed species served as a host to *R. reniformis,* while the monocotyledonous species tested did not. Weed species with populations over the initial inoculum level of 2,000 resulting in Rf values of greater than one are considered hosts to *R. reniformis*. Seventeen of the 43 weed species produced a Rf value equal to one or above (Table 1). By these criterion, the weed species, *A. theophrasti , A. retroflexus, A. rudis, A. artemisifolia, C. benghalensis, G. carolinianum, I. hederacea, I. lacunosa, M. lupulina, M. verticillata, P. convolvulus, P. lapathifolium, S. obtusifola, S. occidentalis, S. herbacea, S. punicea,* and *S. spinosa* are hosts of *R. reniformis.* The weed species that produced a Rf values less than one (Rf < 1) indicating an inability to host this nematode are: *A. canadense, A. fatua, B. platyphylla, C. album, C. arvensis, C. esculentus, C. rotundus, D. stramonium, D. sanguinalis, E. crus-galli, I. cylindrica, K. scoparia, L. amplexicaule, P. dichotomiflorum, P. texanum, P. lanceolata, R. acetosella, R. crispus, S. glauca, S. viridis, S. arvensis, S. bicolor, S. halepense, S. arvensis, T. officinale, and U. platyphylla*. Total reproduction of *R. reniformis* on the weed species was standardized as a percentage of each produced on cotton to provide an estimate of the relative host status of each weed plant species (Table 1). Total reproduction ranged from 0 to 121 % of reproduction on cotton with Rf values ranging from 0 to 6.1. From the 43 weed species, 13 produced *R. reniformis* numbers that were not different from cotton based on Dunnett's test. The nematode numbers on the remaining weeds were lower ($P \geq 0.05$) than that on cotton. *Ambosia artemisfolia*, *S. occidentalis*, *A. rudis*, and *S. spinosa* were excellent hosts for *R. reniformis* producing Rf values greater than those produced by cotton. The weed species species *P. convolvulus, G. carolinianum P. lapathifolium S. obtusifola, M. lupulina*, *S. punicea*, *I. hederacea*, *I. lacunose*, *M. verticillata, A. theophrasti, C. benghalensis, A. retroflexus*, *S. herbacea*, all were all considered to be hosts for *R. reniformis* although they produced fewer nematodes numbers on the weed species than on cotton. The remaining weed species produced Rf values of less than 1 and did not maintain the nematode populations indicating they are poor hosts of *R. reniformis.*

Field Trials

Microplot Field Trials:

In the microplot trials, *R. reniformis* populations remained higher ($P \leq 0.05$) throughout the growing season in the cotton alone compared to corn alone, and any treatment with both corn and weeds (Table 2). The season total of *R. reniformis* numbers increased ($P \leq 0.05$) in the plots where *A. theophrasti, Ipomea spp.,* and *S. obtusifola* were growing with corn as compared to corn alone. *Rotylenchulus reniformis* numbers were not observed to increase in any of the weed species at 30 DAP. At 60 and 90 DAP populations increased as the nematode generations progressed over time. The season total nematode numbers recovered from microplots with *A. theophrasti, Ipomea spp.,* and *S. obtusifola* and corn were greater than 20,000 *R. reniformis* per 150 cm^3 of soil ($P \leq 0.05$), which was 40 % of the population obtain in the cotton plots. Nematode numbers were 92 % lower in plots with corn alone. *Rotylenchulus reniformis* numbers from cotton increased ($P \leq 0.05$) by 15% from the initial populations present at planting in May to the final populations taken at cotton harvest in September. *Rotylenchulus reniformis* numbers were reduced only 62 % in plots planted with *A. theophrasti, Ipomea spp.,* and *S. obtusifola.* The monocotyledonous weeds, *S. halapense* and *U. platyphlla* when grown with corn did not affect *R. reniformis* numbers at any sampling time in the growing season compared to corn alone.

Field Trials:

Rotylenchulus reniformis populations increased ($P \leq 0.05$) in the field plots with poor weed management. Treatments with higher weed densities had more nematodes compared to the weed-free treatment (Table 3.). At 60 DAP, plots receiving only PRE herbicide treatments contained higher ($P \leq 0.05$) *R. reniformis* numbers than did the weed-free treatment. Compared to the cotton plots, *Rotylenchulus reniformis* populations declined by 88 % in the weed-free treatment but only 33% at the highest weed density. . At harvest, *R. reniformis* population levels had increased above the initial at-plant populations only in the treatment that received only S-metolachlor PRE. . All lower weed density treatments had fewer *R. reniformis.* Weed biomass weights collected before harvests were greater ($P \leq 0.05$) in the S-metolachlor alone and S-metolachlor plus atrazine PRE treatments compared to the S-metolachlor plus atrazine followed by one or multiple glyphosate applications. Corn yields were also reduced as weed density increased (Pearson's correlations -0.47213; P= 0.0198).

DISCUSSION

Overall, the findings of this research validate the hypothesis that non-controlled weeds associated with the cotton - corn rotation system, serve as hosts for *R. reniformis* and allow for increases in populations of this pest nematode. Previous findings by Windham and Lawrence (1992) indicated that corn was not a host to this nematode. The introduction of the genetically modified (GMO) corn hybrids did not change the host status of the crop to *R. reniformis* (Lawrence et al., 2006). Many of the weed species tested in this study are hosts to *R. reniformis.* The rotation of corn with cotton will not adequately reduce *R. reniformis* numbers if season long weed control is not maintained. The high rate of reproduction of *R. reniformis* on *A. artemisifolia, S. occidentalis, A. rudis*, and *S. spinosa* is a significant concern. since these are common weeds in corn fields and can increase *R. reniformis* populations as efficiently as can cotton during the non-host rotation cycle. Robinson *et al.* 1997 reported 77 plant families have been previously identified as host to *R. reniformis* in the literature. The majority of the crop and ornamental plant species reported are of major economic importance in the tropical regions of the world. Any plant species which allows for

the increase in numbers of *R. reniformis* is considered a host. However, it is more difficult to determine if a plant species is a poor host or a non-host. When the Rf value of the nematode on a given host is less than 1, it indicates the nematode population is not sustaining itself on that specific host. A low level of nematode reproduction on non-controlled weeds could possibly maintain a field nematode population serving as a nematode reservoir. Such weed-supported reproduction would reduce the potential decline of the nematode numbers during the non-host corn rotation. The effect of a weed reservoir is not unique to the cotton - corn rotation system. Numerous weed species common to fruits, vegetables and ornamentals in Brazil, (Ferraz, 1985), Martinique, (Quéne-hérvé *et al.*, 1995), USA (Inserra et al., 1999 and Starr, 1991) and Trinidad (Edmunds *et al.*, 1971) have been reported to act as host for *R. reniformis* and promote their reproduction. Most of the weed species in these cropping systems are in the same families and genera as those reported here

A recent report by Davis and Webster (2005) evaluated 11 weed species and three crops for host status to *R. reniformis* and *M. incognita.* The numbers of *R. reniformis* did not increase above the initial inoculum level on any of the weeds or crops tested in Davis and Webster's first greenhouse tests but some did in the second test. In our tests, *I. hederaces, S. obtusifolia,* and *S. spinosa* were good hosts for *R. reniformis* increasing nematode numbers above the initial inoculum, while in Davis and Webster's test only *S. obtusifolia* and *S. spinosa* consistently increases nematode numbers. They also indicated *C. rotundus* was considered a good host from the findings in one test but did not increase *R. reniformis* numbers in any of our studies. Our *R. reniformis* isolate is a composite consisting of nematode populations from across the southeast and mid-south allowing for a broad spectrum of genetic variability and pathogenicity which may explain the differences between these reports.

The microplot and field trials also demonstrated that specific weed species have the ability to serve as hosts and allow for the reproduction of *R. reniformis* under natural field conditions. Davis and Webster state that most of the weeds they examined would not maintain high population levels of *R. reniformis* when non-host or nematode-resistant crops were grown in Georgia (2005). Our microplot evaluations indicated that of the eight common weeds tested, *S. occidentalis*, *A. artemisifolia*, *S. spinosa*, *A. theophrasti*, *Ipomea spp.*, and *S. obtusifola* all allowed *R. reniformis* numbers to increase to levels higher than those on corn growing alone. Our results indicate that lack of season-long weed control can potentially adversely affect the benefits of a non-host crop in a rotation system. Gaur and Haque (1986) suggested that fallowing of *R. reniformis* nematode infested fields, without weed control, could do more harm than good by allowing for the increase of the nematode numbers on the weed species. Our results support this point. Inadequate weed control resulted in higher *R. reniformis* populations compared to the good weed control with standard treatments. In selection of a weed management programs for a non-host rotation crop, growers should consider the *R. reniformis* reproduction potential as a factor in the type and timing of herbicide applications to control weed growth, because their choices will affect subsequent nematode populations. .

Heald and Thames (1982) found the optimum soil temperature for *R. reniformis* life stage development was 25 to 36° C, although life cycle completion could occur at 21.5° C (Bird, 1983) but required twice the amount of time to complete. Thus, winter weeds could potentially serve to increase *R. reniformis* populations in the early spring before cotton planting if soil temperatures are warm. In our tests, the winter weeds, *G. carolinianum* and *M. lupulina* did serve as good host for *R. reniformis.*

This study provided insight into why *R. reniformis* population densities remain above threshold levels after a production season growing a non-host corn rotation crop. Season-long weed management during the corn rotation is essential to obtain the full benefit of the rotation, potentially including after harvest. These findings stress the importance of weed management decisions in a rotation crop option of a nematode management system.

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Table 1. Evaluations of common weed species for host status to *Rotylenchulus reniformis* as measured by the number of eggs, vermiform, and total nematodes per 500 cm^3 of soil, reproductive factors, and percentage to the cotton standard.

Scientific Name	Common Name	*Rotylenchulus reniformis**			Rf value	% to	Dunnett's
		Eggs	Vermiforms	Total	**	Cotton	P-value
Cotton	*Gossypium hirsutum* L.	3084	7005	10089	5.0	100.0	
Common Ragweed	*Ambrosia artemisifolia* L.	4620	7607	12227	6.1	121.2	0.869
Coffee Senna	*Senna occidentalis* (L.) Link	7934	4025	11959	6.0	118.5	0.831
Common Waterhemp	*Amaranthus rudis* Sauer	6141	5531	11672	5.8	115.7	0.721
Tea Weed	*Sida spinosa* L.	5016	6311	11327	5.7	112.3	0.575
Wild buckwheat	*Polygonum convolvulus* L.	845	6610	7455	3.7	73.9	0.286
Carolina Geranium	*Geranium carolinianum* L.	1638	4992	6630	3.3	65.7	0.283
Pale Smartweed	*Polygonum lapathifolium* L.	1653	4388	6041	3.0	59.9	0.282
Sicklepod	*Senna obtusifolia* (L.) Irwin and Barneby	2068	3445	5513	2.8	54.6	0.211
Black Medic	*Medicago lupulina* L.	3106	2078	5184	2.6	51.4	0.162
Rattle Box	*Sesbania punicea* (Cav.) Benth.	613	4164	4777	2.4	47.3	0.156
Morningglory, Ivy leaf	*Ipomoea hederacea* (L.) Jacq.	2106	2590	4696	2.3	46.5	0.151
Morningglory, Pitted	*Ipomoea lacunose* L.	420	3453	3873	1.9	38.4	0.085
Carpet Weed	*Mullugo verticillata* L.	570	2794	3364	1.7	33.3	0.065
Velvet leaf	*Abutilon theophrasti* Medik.	453	2884	3337	1.7	33.1	0.054
Tropical Spiderwort	*Commelina benghalensis* L.	464	1864	2328	1.2	23.1	0.028

Redroot Pigweed	*Amaranthus retroflexus* L.	232	1885	2117	1.1	21.0	0.017
Hemp Sesbania	*Sesbania herbacea* (P. Mill.) McVaugh	409	1679	2088	1.0	20.7	0.006
Wild Onion	*Allium canadense* L.	796	780	1576	0.8	15.6	0.004
Wild Mustard	*Sinapis arvensis* L.	340	989	1329	0.7	13.2	0.001
Henbit	*Lamium amplexicaule* L.	303	962	1265	0.6	12.5	<0.001
Buckhorn Plantain	*Plantago lanceolata* L.	245	760	1005	0.5	10.0	<0.001
Field Bindweed	*Convolvulus arvensis* L.	178	502	680	0.3	6.7	<0.001
Kochia	*Kochia scoparia* (L.) Schrad.	62	494	556	0.3	5.5	<0.001
Broadleaf Signalgrass	*Urochloa platyphylla* (Nash) R. D. Webster	23	518	541	0.3	5.4	<0.001
Green Foxtail	*Setaria viridis* (L.) Beauv.	8	523	531	0.3	5.3	<0.001
Lambsquarter	*Chenopodium album* L.	8	489	497	0.2	4.9	<0.001
Red Sorrel	*Rumex acetosella* L.	68	293	361	0.2	3.6	<0.001
Texas Panicum	*Panicum texanum* Buckl.	98	216	314	0.2	3.1	<0.001
Yellow Foxtail	*Setaria glauca* (L.) Beauv.	55	212	267	0.1	2.6	<0.001
Jimson Weed	*Datura stramonium* L.	31	216	247	0.1	2.4	<0.001
Curly Dock	*Rumex crispus* L.	31	201	232	0.1	2.3	<0.001
Corn Spurry	*Spergula arvensis* L.	57	147	204	0.1	2.0	<0.001
Purple Nutsedge	*Cyperus rotundus* L.	10	106	116	0.1	1.2	<0.001
Fall Panicum	*Panicum dichotomiflorum* Michx.	26	85	111	0.1	1.1	<0.001
Johnson Grass	*Sorghum halepense* (L.) Pers.	3	100	103	0.1	1.0	<0.001
Cogongrass	*Imperata cylindrical* (L.) Beauv.	0	77	77	0.0	0.8	<0.001
Large crabgrass	*Digitaria sanguinalis* (L.) Scop.	6	61	67	0.0	0.7	<0.001
Shatter Cane	*Sorghum bicolor* (L.) Moench	8	23	31	0.0	0.3	<0.001
Yellow Nutsedge	*Cyperus esculentus* L.	0	23	23	0.0	0.2	<0.001
Wild Oat	*Avena fatua*L.	0	13	13	0.0	0.1	<0.001
Barnyard Grass	*Echinochloa crus-galli* L.	3	0	3	0.0	0.0	<0.001
Dandelion	*Taraxacum officinale* G.H. Weber ex Wiggers	0	0	0	0.0	0.0	<0.001

LSD (*P*≤0.05)		1830	4290	5104			
*Population determined per 500 cm^3 of soil.							
** Rf (Reproductive factor) = final population / initial population.							
Significantly differences in nematode egg, vermiform and total populations are indicated by Fischer's protected least significant							
difference test (*P*≤0.05).							
Dunnett's test P values less than 0.05 indicate significant differences between each weed species and cotton.							

Table 2. Evaluations of weed species growing in combination with *Z. mays* to determine population development of *Rotylenchulus reniformis* over time.

Treatment	Planting*	30 DAP	60 DAP	90 DAP	120 DAP
	May	June	July	August	Sept
Sorghum halepense + *Z. mays*	6032	4928 b	3776 bc	956.0 c	579.4 d
Sida spinosa + *Z. mays*	8237	2816 b	2559 c	1081.5 c	820.8 cd
Urochloa platyphylla + *Z. mays*	5887	3148 b	3187 c	1303.6 c	830.4 cd
Z. mays	10232	3708 b	3527 bc	1274.6 c	849.8 cd
Senna occidentalis + *Z. mays*	8375	1651 b	3863 bc	1757.4 c	984.9 cd
Ambrosia artemisifolia + *Z. mays*	6692	3428 b	2520 c	1631.9 c	1123.3 cd
Ipomoea spp. + *Z. mays*	8111	4481 b	5259 bc	3485.9 b	1342.2 bcd
Abutilon theophrasti + *Z. mays*	10715	4007 b	3611 bc	1728.5 c	1873.3 bc
Senna obtusifola + *Z. mays*	8127	3486 b	8951 b	4451.5 b	2491.3 b
G. hirisutum	8842	20713 a	16165 a	10229.2 a	4210.1 a
LSD (*P*≤0.05)	ns	4660	5463	1583	1164
* Populations per 150 cm3 of soil.					
Nematode population reported as means from two tests with four replications each.					
The means within each column succeeded by different letters differ significantly according to Fisher's protected least significant difference test (*P*≤0.05).					

Table 3. *Rotylenchulus reniformis* populations, *Z. mays* yields, and weed biomass produced under four herbicide regimes in a corn production rotation.

Crop	Herbicide application	*Rotylenchulus reniformis* /150 cm^3 soil			*Z. mays* *	Weed biomass
		May	July	Sept	kg/ha	g/m^2
Z. mays	S-metolachlor @ pre emergence	1128	133 c	815 b	6065 a	
	Atrazine @ pre emergence					67 b
	Glyphosate monthly					
Z. mays	S-metolachlor @ pre emergence	1536	193 bc	940 b	6065 a	
	Atrazine @ pre emergence					103 b
	Glyphosate prior to 30" in height					
Z. mays	S-metolachlor @ pre emergence	1306	425 ab	1172 ab	5363 bc	462 a
	Atrazine @ pre emergence					
Z. mays	S-metolachlor @ pre emergence	1023	682 a	1455 a	4660 c	541 a
LSD (*P*≤0.05)		ns	272	414	817	236

* Yield based on 15 % moisture.

The means within each column succeeded by different letters differ significantly according to Fisher's protected least significant difference test (*P*≤0.05).