RESEARCH/INVESTIGACIÓN

PATHOGENICITY AND REPRODUCTION OF ISOLATES OF RENIFORM NEMATODE, *ROTYLENCHULUS RENIFORMIS,* FROM LOUISIANA ON SOYBEAN

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ABSTRACT

Kularathna, M. T., C. Overstreet, E. C. McGawley, S. R. Stetina, C. Khanal, F. M. C. Godoy, and B. K. McInnes. 2019. Pathogenicity and reproduction of isolates of reniform nematode, *Rotylenchulus reniformis,* from Louisiana on soybean. Nematropica 49:31-41.

The reniform nematode (*Rotylenchulus reniformis*) is one of the major pests on both soybean and cotton in the southern United States. Although resistant soybean cultivars are available, this resistance may not be uniform across geographical isolates of the pathogen. Experiments were conducted to evaluate responses of indigenous isolates of reniform nematode in Louisiana on commercial soybean cultivars and resistant germplasm lines. Experiments in greenhouse and microplot environments were conducted during 2016 and 2017 to evaluate the comparative reproduction and pathogenicity of populations of *R. reniformis* isolated from West Carroll (WC), Rapides (RAP), Tensas (TEN), and Morehouse (MOR) parishes of Louisiana. Data from full-season microplot studies, averaged over 2 trials, showed differences in reproduction and pathogenicity of the nematode on REV 56R63, Pioneer P54T94R, and Dyna-Gro 39RY57 soybean cultivars (P<0.01). Reproduction by the MOR isolate was 46.8% lower than that by the WC isolate. However, the MOR isolate was the most pathogenic isolate with 20.8% lower plant and 44.6% lower pod weight compared to the non-inoculated control. Data from 60-day duration greenhouse experiments reflected a similar trend. In greenhouse trials, the susceptible cultivar Progeny P4930LL and the resistant PI lines 90763 and 548316 were included with the cultivars employed in the microplots. Reproduction by the MOR isolate was 33% less than that by WC isolate. Reduced reproduction by the MOR isolate relative to the WC isolate was accounted for by a 50% reduction in the numbers of eggs per root system. In both microplot and greenhouse environments, REV 56R63 was a significantly less suitable host for reniform nematode than was Pioneer P54T94R, Dyna-Gro 39RY57, and PI 548316.

Key words: geographical isolates, germplasm lines, greenhouse, microplot, reniform nematode

RESUMEN

Kularathna, M. T., C. Overstreet, E. C. McGawley, S. R. Stetina, C. Khanal, F. M. C. Godoy, and B. K. McInnes. 2019. Patogenicidad y reproducción de aislados del nematodo reniforme, *Rotylenchulus reniformis*, de Louisiana en soja. Nematropica 49:31-41.

El nematodo reniforme (*Rotylenchulus reniformis*) es una de las principales plagas de la soja y el algodón en el sur de los Estados Unidos. Si bien existen variedades de soya resistentes, esta resistencia

puede no ser uniforme en todos los aislamientos geográficos del patógeno. Se realizaron experimentos para evaluar las respuestas de aislados indígenas de nematodos reniformes en Louisiana en cultivares de soja comerciales y líneas de germoplasma resistente. Durante 2016 y 2017 se realizaron experimentos en ambientes de invernadero y microparcelas para evaluar la reproducción comparativa y la patogenicidad de las poblaciones de *R. reniformis* aisladas de las parroquias de West Carroll (WC), Rapides (RAP), Tensas (TEN) y Morehouse (MOR) de Louisiana. Los datos de los estudios de microplote de temporada completa, promediados en 2 ensayos, mostraron diferencias en la reproducción y patogenicidad del nematodo en los cultivares de soja REV 56R63, Pioneer P54T94R y Dyna-Gro 39RY57 (P <0.01). La reproducción por el aislamiento de MOR fue un 46,8% inferior a la del aislamiento de WC. Sin embargo, el aislado MOR fue el aislado más patógeno, con 20.8% menos de planta y 44.6% menos de peso de vaina en comparación con el control no inoculado. Los datos de experimentos de invernadero de 60 días de duración reflejaron una tendencia similar. En los ensayos en invernadero, el cultivar susceptible Progeny P4930LL y las líneas PI resistentes 90763 y 548316 se incluyeron con los cultivares empleados en los microparcelas. La reproducción por el aislamiento de MOR fue un 33% menor que por el aislamiento de WC. La reducción de la reproducción por el aislado de MOR en relación con el aislado de WC se explica por una reducción del 50% en el número de huevos por sistema radicular. En ambos ambientes, microplot e invernadero, REV 56R63 fue un huésped significativamente menos adecuado para nematodos reniformes que Pioneer P54T94R, Dyna-Gro 39RY57 y PI 548316.

Palabras clave: aislamientos geográficos, invernadero, líneas de germoplasma, microparcela, nematodo reniforme

INTRODUCTION

Soybean is a major crop that has an enormous impact on the economy of the United States. About 83 million ha of soybean were planted in 2016 throughout the country (Anonymous, 2017). In 2016, about 8 million ha in the southern United States were devoted to soybean and produced about 24.3 million metric tons of soybeans with yield in Louisiana at 1.7 million metric tons (Allen *et al*., 2017).

In the United States, several nematode species including *Rotylenchulus reniformis* are known to damage soybeans (Noel and Schroeder, 2015). The reniform nematode is widespread and damaging to soybean in the South (McGawley and Overstreet, 2015). The genus *Rotylenchulus* includes 11 recognized species (Robinson *et al*., 1997; Berg *et al*., 2016). Of these, *R. reniformis* causes the greatest economic loss (Robinson *et al.,* 1997). *Rotylenchulus reniformis* was identified in Hawaii in 1940 (Linford and Oliveira), and reported in Louisiana, U.S. in 1941 (Smith and Taylor). Over the past 2 decades, this nematode has become the dominant nematode species in several southern states, including Louisiana (Gazaway, 2005; Overstreet and McGawley, 1998, 2000; Overstreet, 2006, 2015).

Currently, *R. reniformis* is distributed throughout the 16 cotton-producing states of south-east and mid-south of the U.S. (Bagwell *et al.,* 2006). In this region, many producers have recently switched their cropping preference from cotton to the more profitable soybean. This change in cropping preference has produced immediate challenges to soybean growers due to the widespread occurrence of *R. reniformis* and the susceptibility of many soybean cultivars. In this region in 2016, reniform nematode caused losses in soybean yield estimated at 92,000 metric tons (Allen *et al.,* 2017). Mississippi and Louisiana reported the greatest yield losses and plant damage to this nematode (Allen *et al*., 2017).

Management strategies for reniform nematode include resistant cultivars, crop rotation, biological control, nematicide application, and precision agriculture (Koenning *et al.,* 2004). Resistant cultivars are the most desirable but least frequently used management option (Khanal *et al*., 2018a). This is due to lack of desirable traits such as high yield and better oil composition in resistant cultivars than those in susceptible cultivars (Stetina *et al.,* 2014; Overstreet, 2015; Robbins *et al.,* 2015).

Reports describe differences in reproduction and pathogenicity among geographic isolates of *R. reniformis* on both cotton and soybean (McGawley *et al*., 2010, 2011; Xavier *et al*., 2014; Bhandari *et*

al., 2015). Moreover, the study by McGawley *et al.* in 2011 showed that the nematode was actually more damaging to soybean than to cotton. Isolates of the nematode from Louisiana and Mississippi had significantly greater rates of reproduction and were more virulent than the isolates from Alabama, Arkansas, Hawaii, and Texas. Stetina *et al.* (2014) speculated that the geographic origin of isolates of the nematode may have different pathogenic effects on soybeans.

Variability in the reproduction and pathogenicity among reniform nematode populations has a major impact on management options including breeding, cultivar selection, nematicide selection, and rotation recommendations. For example, soybean cultivar recommendations for Louisiana are made on the basis of reproduction data for isolates of the nematode present in Arkansas (Robbins *et al.,* 2015). To date, no studies have been conducted to evaluate reproductive and pathogenic variation in indigenous isolates of *R. reniformis* on cultivars of soybean produced in Louisiana. A better understanding of *R. reniformis* within Louisiana will enhance nematode management recommendations and assist plant breeders and seed companies in producing or selecting cultivars with resistance. To date, cultivars with resistance to the reniform nematode have primarily been derived from germplasm sources containing resistance to the soybean cyst nematode (SCN). Therefore, the objectives of this work were to evaluate the host status and susceptibility of soybean cultivars popular in Louisiana and the germplasm lines PI 90763 and PI 548316, hereafter referred to as PI90, and PI54, respectively, which have known resistance to SCN and reniform nematode, to isolates of *R. reniformis* present in Louisiana.

MATERIALS AND METHODS

General procedures

Isolates of reniform nematode were collected from Rapides (RAP), Tensas (TEN), Morehouse (MOR), and West Carroll (WC) parishes, confirmed morphologically as *R. reniformis,* and used to establish single egg mass (SEM) cultures. These cultures were maintained under greenhouse conditions on tomato (*Solanum lycopersicum* L. cultivar Rutgers PS, Seedway; Hall, NY) and employed in greenhouse and microplot experiments with the soybean cultivars REV 56R63, Pioneer P54T94R, Progeny P4930LL, and Dyna-Gro 39RY57, which will be abbreviated as RV56, Pp54, Pr49, and DG39, respectively, hereafter. Details of greenhouse and microplot experiments are presented below under the appropriate subheadings.

Pots for all experiments, as well as a soil mixture consisting of one-part sand and three parts commerce silt loam soil (fine-silty, mixed, superactive, nonacid, thermic Fluvaquentic endoaquepts), utilized in all experiments were heat sterilized for 5 hr at 135°C prior to use. In each test, two soybean seeds were planted to a depth of 2.5 cm and thinned to one per pot after germination. Soil was infested by pipetting aqueous suspensions of vermiform individuals of *R. reniformis* into three depressions arranged into a triangular pattern, 0.5-cm diam. × 5- to 7.5-cm deep, surrounding a 10-day-old seedling. Inoculum for all tests contained a mixture of juveniles, pre-adult females, and males at a level, irrespective of pot size, of 6 per gram of soil. Therefore, inoculum density was 5,500 vermiform nematodes per pot in greenhouse tests and 50,000 nematodes per pot in microplot tests. Half of the inoculum was added to soil in microplots at 10 days after planting and the remainder at 21 days after planting.

In all cases, nematode population density was estimated by extracting a 250-g subsample of soil from each pot using a semi-automatic elutriator (Byrd *et al*., 1976) and the centrifugal/sugar flotation technique (Jenkins, 1964). Vermiform life-stages were enumerated using a dissecting microscope at ×40 magnification. All experiments were repeated once. Standard fertilization, weeding and insect management practices were employed in all trials.

Analysis of data

Each experiment employed a factorial treatment structure and was established as randomized block design with five replications. Data obtained from all studies were analyzed using SAS JMP version 12.0 (SAS Institute, Cary, NC) analysis of variance (ANOVA) and Fisher's LSD mean separation technique ($P \leq 0.05$). Analysis was conducted using the "Fit Model" module of SAS JMP, version 12.0. Analysis of variance was initially conducted using test as a fixed effect and

there was no significant test by treatment interaction in any of the tests described herein. Therefore, data from all like trials was combined for analysis, and test was modeled as a random effect.

Greenhouse experiments

This study involved six soybean genotypes: four cultivars of soybean widely planted in Louisiana and the resistant PI90 and the moderately resistant PI54 germplasm line. Terra cotta pots having a top diameter of 15 cm and containing 1.6 kg of soil mixture were used. Average greenhouse temperature was maintained at 27-29°C. Supplemental lighting was added above the experimental area to provide a 16-hr light period. A total of 150 pots were established to evaluate the 6 genotypes, 4 isolates of reniform nematode, a non-inoculated control for each cultivar and 5 replications. The experiments were terminated after 60 days and nematode life stages in soil were quantified as described above. Eggs were extracted from entire root systems. Root samples were agitated in 0.6% NaOCl for 10 min to dislodge eggs from egg masses (Hussey and Barker, 1973). Females of reniform nematode were stained using the red-food coloring technique (Thies *et al*., 2002) and numbers present on the whole root system were enumerated at 40× magnification using a dissecting microscope. Fresh shoot and root materials were dried at 30-35°C for 2 wk and weighed.

Microplot experiments

Terra cotta pots having top diameters of 35.6 cm were used as microplots. Microplots were placed in depressions in soil so that only the rim was exposed. Each microplot was filled with 13.6 kg of soil mixture. The entire microplot area was bounded by an aluminum Quonset hut skeletal frame open at both ends. The skeletal frame was covered with polyethylene (6 mm) film and one layer of 20% reflective foilcloth to protect plants from excessive rainfall and to maintain near-ambient air and soil temperatures. A total of 75 microplots were established to evaluate 3 cultivars RV56, Pp54, and DG39, 4 isolates of the nematode, a non-inoculated control for each cultivar and 5 replications. Establishment of plants, inoculation with nematodes, and processing of plant and nematode materials after 125 days were as described above. Additional plant data collected included: numbers of pods per plant, pod weight per plant, weight of 100 seeds, total seed weight per plant, and plant dry weight. All plant materials were dried at 30-35°C for 2 wk before measuring the weights.

RESULTS

Greenhouse experiments

Across genotypes of soybean and isolates of the reniform nematode, there were significant main and interactive effects that impacted both nematode and plant parameters. Significant main effects of soybean genotypes influenced both vermiform nematode stages in soil and eggs per root system as well as final dry root weight. Main effects of reniform nematode isolate as well as interactive effects of reniform isolate and soybean genotypes significantly influenced only the nematode reproduction.

Individual treatment means across the 6 soybean genotypes and geographic parish of origin of each of the 4 isolates of *R. reniformis* is presented as Fig. 1. Soil populations of the WC isolate of the nematode recovered from RV56, which averaged 40.9 thousand vermiform nematodes per 500 cm^3 of soil, were significantly greater than the 17.7 and 15.0 thousand recovered from this genotype with the TEN and MOR isolates, respectively. Similarly, soil populations of the isolate from WC recovered from Pp54, 111.2 thousand, were significantly greater than the 87.9, 75.7, and 56.0 thousand for the RAP, TEN, and MOR isolates, respectively. Of the 4 isolates, reproduction by the ones from RAP and TEN parishes on DG39 was very similar, averaging 76.3 and 75.8 thousand per 500 cm^3 of soil, and were significantly greater than the 50.5 and 48.2 averages for the isolates from WC and MOR parishes. Reproduction by all 4 isolates of the nematode was similar and not significantly different on Pr49, averaging respectively 36.4, 39.9, 42.3, and 29.3 thousand per 500 cm^3 of soil for WC, RAP, TEN, and MOR parishes. Also, with PI54, reproduction by the 4 isolates was similar and not significantly different, with population density values of 28.4 thousand for MOR, 34.1 thousand for RAP, 32.5 thousand for TEN, and 29.4 thousand for the MOR isolate. Lastly, population

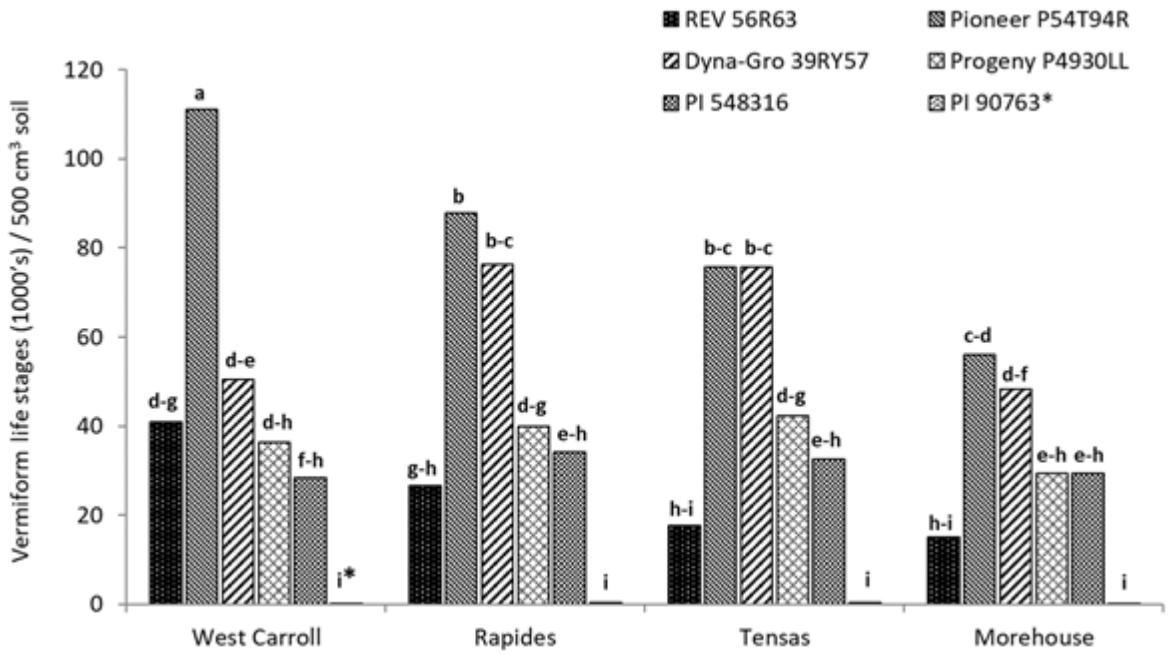

Figure 1. Vermiform life stages of *Rotylenchulus reniformis* per 500 cm^3 of soil, after 60 days in a greenhouse environment from soybean genotypes REV 56R63 (RV56), Pioneer P54T94R (Pp54), Dyna-Gro 39RY57 (DG39), Progeny P4930LL (Pr49), PI 90763 (PI90), and PI 548316 (PI54). Data are means of 10 replications averaged over two trials.*indicates the mean value (West Carroll; 200, Rapides; 240, Tensas; 250, and Morehouse; 160) for vermiform life stages per 500 cm^3 soil of *R. reniformis* with the germplasm line PI 90763. Bars with common letters are not significantly different based on Fisher's LSD test ($P \leq 0.05$).

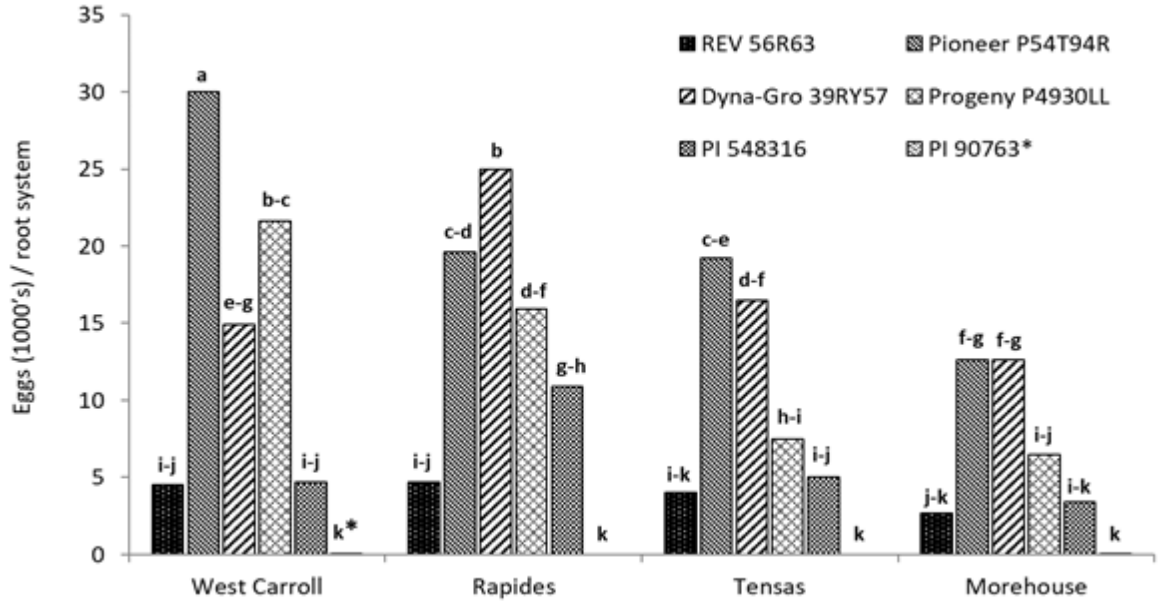

Figure 2. Egg stages of *Rotylenchulus reniformis* from whole root systems of soybean genotypes REV 56R63 (RV56), Pioneer P54T94R (Pp54), Dyna-Gro 39RY57 (DG39), Progeny P4930LL (Pr49), PI 90763 (PI90), and PI 548316 (PI54) after 60 days in a greenhouse environment. Data are means of 10 replications averaged over two trials. *indicates the mean value (West Carroll, 2; Rapides, 0; Tensas, 0; and Morehouse, 4) for eggs per root system for *R. reniformis* with the germplasm line PI 90763. Bars with common letters are not significantly different based on Fisher's LSD test ($P \leq 0.05$)

levels of the nematode in soil for each of the isolates on PI90 actually fell below the initial infestation level averaging about 0.2 thousand per root system for each of the 4 isolates of the nematode.

The overall pattern of Fig. 2 mirrors closely that of Fig. 1 for soil stages of the nematode and visualizes the production of eggs by females of the 4 isolates of *R. reniformis* on the 6 soybean genotypes. Data are expressed as thousands of eggs each genotype. From RV56, 4.5, 4.7, 4.0 and 2.7 thousand eggs per plant, with no significant differences among the 4 isolates, were recovered for the WC, RAP, TEN, and MOR isolates. As with juveniles from the WC isolate in soil for Pp54, the 30 thousand eggs per plant from this genotype was significantly greater than the numbers recovered from roots of the other 3 isolates. Root systems of DG39 yielded a significantly greater number of eggs, 14.9 thousand, with the RAP isolate with the other 3 isolates; 16.5 for TEN, 14.9 for WC, and 12.6 for MOR. With Pr49 there was almost significantly declining stair-step effect in egg numbers per root system across the 4 isolates of the nematode: eggs densities averaging 21.6 thousand for the WC isolate, 15.9 for RAP, 7.5 for TEN, and 6.5 for MOR. From roots of PI54, the number of eggs of the RAP isolate recovered averaged 10.9 thousand and was significantly greater than the 4.7 thousand for the WC isolate and the 5.0 and 3.4 for the TEN and MOR isolates, respectively. Very few to no eggs of any of the 4 nematode isolates were recovered from PI90.

Microplot experiments

In the microplot environment, there were significant main effects of cultivar and isolate but no cultivar by isolate interactions (Tables 1 and 2). The influence of cultivar significantly impacted the number of reniform nematode vermiform life stages in soil and hundred seed weight. The influence of isolate was significant for life stages of reniform nematode in soil and weights of soybean pods and plants. Across the 4 isolates of *R. reniformis,* soil populations from RV56 were significantly lower in number, averaging 61.5 thousand per 500 cm^3 of soil, than those recovered from soil with the cultivars Pp54 or DG39 that averaged 111.6 and 103.7 thousand vermiform life stages, respectively (Table 3). Weights of 100 seeds averaged 15.2 g for DG39, significantly less, 12.4 g, for RV56 and even less, 11.4 g for Pp54. The lowest soil population levels of the nematode, 76.3 thousand, were from the MOR isolate (Table 4) Populations of the other 3 isolates were significantly greater, averaging 143.3 for WC, 125.0 for RAP, and 117.0 for TEN. Reproductive values reflected these population densities in soil. However, while exhibiting the lowest level of reproduction of the 4 isolates, the MOR isolate was the most damaging (Table 4). Weights for pods and plants were reduced significantly in comparison to those of both non-inoculated controls and other isolates. Weights of plants were reduced significantly by isolates from RAP and MOR, which averaged 114.2 and 99.6 g, respectively,

Table 1. Vermiform life stages of *Rotylenchulus reniformis* as influenced by main and interaction effects (*P* values) of isolates and soybean cultivars in a microplot environment[x].

Source	DF	Vermiform life stages
Cultivar (C)[y]	2	0.001**
Isolate (I)[z]	3	<0.0001**
C × I	6	0.069

[x]Data were combined over two full-season trials and are means of ten replications. Plant material was dried at 30-35°C. Data were analyzed as a 3 × 4 factorial with ANOVA ($P \leq 0.05$); ** indicate *P* values significant at the 0.01% level.

[y]Cultivars were REV 56R63, Pioneer P54T94R, and Dyna-Gro 39RY57, which were recommended for use in Louisiana in 2015.

[z]Isolates were derived from a single egg mass from roots of soybean from West Carroll, Rapides, Morehouse, and Tensas parishes in Louisiana.

Table 2. Number of pods, pod weights, seed weights, and plant weights as influenced by main and interaction effects (*P* values) of isolates of *Rotylenchulus reniformis* and cultivars of soybean in a microplot environment[x].

Source	DF	Number of pods	Pod weight	100 seed weight	Seed weight per plant	Plant weight
Cultivar (C)[y]	2	0.255	0.908	<0.0001**	0.062	0.672
Isolate (I)[z]	4	0.141	0.0003**	0.940	0.956	0.035**
C × I	8	0.474	0.226	0.323	0.167	0.436

[x]Data were combined over two full-season trials and are means of 10 replications. Plant material was dried at 30-35°C. Data were analyzed as a 3 × 5 factorial with ANOVA ($P \leq 0.05$); ** indicate *P* values significant at the 0.01% level.
[y]Cultivars were REV 56R63, Pioneer P54T94R, and Dyna-Gro 39RY57, which were recommended for use in Louisiana in 2015.
[z]Isolates were derived from a single egg mass from roots of soybean from West Carroll, Rapides, Morehouse, and Tensas parishes in Louisiana and were combined with a non-inoculated control.

Table 3. Main effect of cultivars of soybean on vermiform life stages and seed weight across four isolates of *Rotylenchulus reniformis* in a microplot environment[x].

Cultivars[y]	Vermiform life stages (1000's) per 500 cm^3 of soil [z]	100 seed weight (g)
REV 56R63	61.5 b	12.4 b
Pioneer P54T94R	111.6 a	11.4 c
Dyna-Gro 39RY57	103.7 a	15.2 a

[x]Data were combined over two full-season trials and are means of ten replications. Seed was dried at 30-35°C.
[y]Cultivars were recommended for use in Louisiana in 2015.
[z]Data were analyzed with ANOVA and Fisher's LSD test ($P \leq 0.05$). Within columns, means followed by a common letter are not significantly different.

Table 4. Vermiform life stages, pod and plant dry weights of cultivars of soybean as influenced by main effect of isolate of *Rotylenchulus reniformis* across cultivars of soybean in a microplot environment[w].

Isolate[x]	Vermiform life stages (1000's) per 500 cm^3 of soil [y]	Reproductive value[z]	Pod weight (g)	Plant weight (g)
Control	0.0	0.0	110.9 a	141.9 a
WC	143.3 a	77.9	99.4 ab	127.2 ab
RAP	125.0 a	67.9	88.7 b	114.2 bc
MOR	76.3 b	41.5	61.5 c	99.6 c
TEN	117.0 a	63.6	89.3 b	115.0 abc

[w]Data were combined over two full-season trials and are means of ten replications. Cultivars of soybean were REV 56R63, Pioneer P54T94R, and Dyna-Gro 39RY57.
[x]Reniform nematode isolates were each derived from single egg masses isolated from roots of soybean from West Carroll (WC), Rapides (RAP), Morehouse (MOR), and Tensas (TEN) parishes in Louisiana and Control = non inoculated.
[y]Data were analyzed with ANOVA and Fisher's LSD test ($P \leq 0.05$). Within columns, means followed by a common letter are not significantly different.
[z]Reproductive values were calculated by dividing the estimated numbers of vermiform stages per microplot (13.6 kg of soil) by the infestation level of 50,000 vermiform life stages.

compared to the non-inoculated control.

DISCUSSION

The nematological literature documents variability in the pathogenicity and reproduction within species of many plant-parasitic nematodes. Variation in SCN populations was described as far back as the 1970s (Golden *et al.*, 1970). Similarly, variability has been described in major root-knot nematode species and potato cyst nematode (Hartman and Sasser, 1985; Folkertsma *et al.*, 1996; Blok *et al.*, 1998; Cevantes-Flores *et al.*, 2002; Anwar and McKenry, 2007; Khanal *et al.*, 2016).

Nematologists have also documented differences among populations of *R. reniformis* nematode outside of North America since the 1970s (Dasgupta and Seshadri, 1971). The host differential assay of Dasgupta and Seshadri employed cowpea, castor, and cotton to distinguish two "races" of the nematode. Another study by Nakasono (2004) involved isolates of *R. reniformis* from Japan, Hawaii, and Texas and identified polymorphism between populations. Nakasono found three morphologically distinct groups of the nematode based on physiological and ecological characteristics. To date, there is only limited information on the variability in reniform nematode in the southern United States (McGawley and Overstreet, 1995; Aguedelo *et al*., 2005; McGawley *et al*., 2010; McGawley *et al*., 2011). Other research conducted by nematologists in Louisiana has evaluated variability in reproduction and pathogenicity of isolates of the nematode within the state (McGawley and Shankaralingam, 1994; Xavier *et al.*, 2014; Bhandari *et al*., 2015). In all of these studies, which involved both cotton and soybean, and isolates of the nematode from multiple states or just Louisiana, the isolate of the nematode that caused the most damage was the one that reached the highest population level. Data reported herein are in contrast to that because the reniform isolate from MOR parish is the one that reproduced least yet caused statistically the greatest reduction in weight of pods and numerically the greatest reduction in weight of plants.

Parallel research conducted at Louisiana State University (Khanal *et al*., 2018b), employed the same populations of reniform nematode, but used cotton as the host plant. Data from that research also show differences in reproduction and pathology of the nematode on cotton. A major difference in results from these two parallel lines of research involve the level of reproduction of MOR isolate on two different hosts. Across cotton genotypes, the MOR isolate exhibited the greatest level of reproduction and caused the greatest level of damage. Conversely, with soybean, the MOR isolate exhibited the lowest level of reproduction, but caused the greatest amount of damage.

Across all soybean and cotton genotypes, respectively, MOR isolate reduced plant dry weight by 29.8% and 54.8% relative to those of the non-inoculated controls. This difference in pathogenicity of MOR isolate on soybean and cotton is possibly a function of host. Averaged across four isolates of *R. reniformis* endemic in Louisiana, the reduction in harvest dry weight of plants relative to non-inoculated control was 19.6% for soybean and 27.5% for cotton. Research by McGawley *et al.* (2010, 2011) with isolates of *R. reniformis* from Alabama, Arkansas, Hawaii, Louisiana, Mississippi, and Texas showed that across isolates representing each of these states a negative impact of *R. reniformis* on plant growth and yield was greater on soybean than cotton. Averaged across the six geographic isolates, the reduction in harvest dry weight of plants relative to non-inoculated control was 27.4% for soybean and 19.7% for cotton. However, data for the Louisiana isolate of *R. reniformis* used in that research, which originated from Avoyelles parish, showed that the isolate from Louisiana was actually more damaging on cotton than soybean. Data presented herein is in agreement with this previous observation as, across endemic isolates, the reniform nematode was more damaging on cotton than soybean.

This difference in reproduction could be attributing to phenotypic polymorphism or genetic variability within this isolate of reniform nematodes as described by Aguedelo *et al*., 2005. To further clarify this finding, studies should be conducted using molecular techniques and morphometric characterization of reniform isolates from various locations in Louisiana on a range of soybean lines. To further understand the findings from the experiments discussed in this paper and to evaluate the genetic variability among the isolates of reniform nematode used, Single Nucleotide Polymorphism (SNP) analysis were conducted and the results have been published (Khanal *et al*.,

2019).

Germplasm lines PI54 and PI90 had moderate resistance and resistance levels, respectively, against the tested Louisiana isolates and are similar to that of previously tested Mississippi isolates (Stetina *et al*., 2014). The host status of the commercial cultivars used in the microplot trials were reported by Robbins *et al*., 2012; 2013; 2014; 2015. The cultivar RV56 was reported to have lower reproduction of reniform nematode than more susceptible cultivars by Robbins *et al*., 2015. This research found a similar pattern of reproduction among the different isolates of the nematode. The data from these studies provide enough evidence for the variability in resistance of commercial cultivars tested against native reniform isolates. Therefore, this information will be valuable for growers in selecting soybean cultivars suitable for their locations with the consideration of reniform nematode pressure within their geographical locations.

This research yielded information beneficial to the development of management strategies for nematodes and also provides an impetus for further investigations with *R. reniformis*. Notable conclusions from this research include i) there is significant variation among isolates of *R. reniformis* associated with soybean within Louisiana; ii) reniform nematode isolates showed greater variation in reproduction on moderately and susceptible than on resistant cultivars and germplasm lines; iii) additional studies are justified with commercial soybean cultivars and additional isolates of the nematode.

DISCLAIMER

Mention of trade names or commercial products is solely for the purpose of providing specific information and does not imply recommendation or endorsement by Louisiana State University (LSU) or the United States Department of Agriculture (USDA). LSU and USDA are equal opportunity providers and employers.

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