HOST SUITABILITY OF SELECTED TROPICAL LEGUMES AND OTHER CROPS FOR THE RENIFORM NEMATODE, *ROTYLENCHULUS RENIFORMIS* LINFORD & OLIVEIRA, 1940

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ABSTRACT

Rodríguez-Kábana, R., W. S. Gazaway, D. W. Weaver, P. S. King, and C. F. Weaver. 1998. Host suitability of selected tropical legumes and other crops for the reniform nematode, *Rotylenchulus reniformis*, Linford & Oliveira, 1940. Nematropica 28:195-203.

The adequacy of velvetbean (*Mucuna deeringiana*), swordbean (*Canavalia ensiformis*), hairy indigo (*Indigofera hirsuta*), castor (*Ricinus communis*), and sesame (*Sesamum indicum*) as hosts for the reniform nematode was compared in the greenhouse with that of 'Davis' soybean (*Glycine max*), 'DP-50' cotton (*Gossypium hirsutum*), a tropical corn cultivar, 'Pioneer 3156' corn (*Zea mays*), and 'FFR 331' sorghum (*Sorghum bicolor*). Cotton and soybean sustained large populations (>500 nemas/100 cm^3 soil or per root system) of the nematode in both root and soil samples. High numbers of the nematode were also found in soil with castor, but roots of this plant had very low numbers (<10 nematodes/root system). All other plant species were either non-hosts or very poor hosts for the nematode. In other experiments with 24 selected cotton cultivars and nine soybean cultivars, all soybean cultivars except 'Maxcy' and 'Stonewall' sustained significant populations of the reniform nematode in soil. All cotton cultivars except one ['Hartz H 1215'] sustained significant soil and root populations of the nematode.

Key words: corn, cotton, exotic crops, maize, new crops, phytonematodes, plant parasitic nematodes, reniform nematode, resistance, *Rotylenchulus reniformis*, sorghum, soybean, tropical legumes.

RESUMEN

Rodríguez-Kábana, R., W. S. Gazaway, D. W. Weaver, P. S. King y C. F. Weaver. 1998. Capacidad de algunas leguminosas tropicales y otros cultivos para servir como plants hospedadoras del nematodo reniforme, *Rotylenchulus reniformis*, Lindford & Oliveira, 1940. Nematrópica 28:195-203.

Se comparo en un experimento de invernadero, las capacidades como plantas hospedadoras para el nematodo reniforme del ajonjoli (*Sesamum indicum*), el frijol pica-pica (*Mucuna deeringiana*), la haba criolla (*Canavalia ensiformis*), el indigo o anil (*Indigofera hirsuta*) y el ricino (*Ricinus communis*) con las de: la soja (*Glycine max*) 'Davis', el algodón 'DP-50', un cultivar de maiz tropical, el maiz 'Pioneer 3156' y el sorgo (*Sorghum bicolor*) 'FFR 331'. Las muestras de suelo y raíz de algodón y soja mostraron grandes poblaciones de *R. reniformis* (>500 nematodos/sistema radicular). La densidad de población del nematodo fue también elevada en muestras de suelo con ricino aunque las raíces de esta planta contenían niveles muy bajos del mismo (<10 nematodos/sistema radicular). Todas las demás plantas resultaron no hospedadoras o muy poco adecuadas para el nematodo. En otros experimentos con 24 cultivares de algodón y nueve variedades de soja, todos los cultivares de soja con excepción de 'Maxcy' y 'Stonewal' y todos los de algodón excepto uno ('Hartz H 1215') presentaron poblaciones significativas tanto en el suelo como en las raíces.

Palabras claves: algodón, cultivos exóticos, fitonematodos, leguminosas tropicales, maiz, nematodo reniforme, nuevos cultivos, resistencia, *Rotylenchulus reniformis*, soja, sorgo.

INTRODUCTION

The reniform nematode (*Rotylenchulus reniformis* Linford & Oliveira) is a polyphagous plant pathogen of common occurrence in tropical and subtropical regions of the world (Birchfield and Jones, 1961; Heald and Thames, 1982; Holdeman *et al.*, 1974). In some areas its economic importance rivals that of the root-knot nematodes (*Meloidogyne* spp.) (Gazaway, W. S., 1993). *R. reniformis* was detected on cotton in the southeastern United States in 1940 soon after it was first described in Hawaii (Heald and Thames, 1982). It is a major pest of cotton, soybean, cucurbits, tomato and other crops important to agriculture in the southern United States (Blasingame, 1993; Holdeman *et al.*, 1974). The nematode is found widespread throughout the cotton growing area of the southern United States, occurring not only in the warm subtropical regions but also in the more northern areas of the South (Blasingame, 1993; Starr and Page, 1990). The recent expansion of cotton acreage in Alabama and neighboring states has resulted in increased reports on the incidence of the nematode. The reniform nematode can be managed by application of nematicides or with crop rotation using nonhost crops or resistant cultivars (Brathwaite, 1974; Gilman *et al.*, 1978; Thames and Heald, 1974). Current cost of nematicides and limitations in their efficacy or reliability under adverse environmental conditions make their use in soybean prohibitive, and in cotton nematicide use is restricted to fields with severe infestations. There is evidence of wide differences in susceptibility to the reniform nematode within the cotton and soybean genomes (Birchfield *et al.*, 1971; Robinson and Percival, 1997; Starr and Page, 1990). The nematode, with several recognized physiological races, has a high degree of adaptability to various crops and to different ecological situations (Dasgupta and Seshadri, 1971; Heald and Thames, 1982). Genetic variability in the nematode poses problems for development of cultivars tolerant (or resistant) to the nematode (Robinson and Percival, 1997). Crop rotations with corn can be very effective, but in most cases are not economical except where rainfall is abundant or irrigation is available (Brathwaite, 1974; Holdeman *et al.*, 1974). Rotations with sorghum have also been effective for the management of the nematode in cotton (Thames and Heald, 1974); however, the market for sorghum is limited. There is presently in Alabama and elsewhere in the southeastern United States a need to develop new cropping systems to manage problems caused by the reniform nematode in cotton, soybean and other important susceptible crops of the region. This paper presents results of a study to determine the reaction of some tropical and subtropical crops and selected cotton and soybean cultivars to the reniform nematode. The study represents a first step in the development of new cropping systems for the management of the nematode in Alabama's principal crops.

MATERIALS AND METHODS

Soil for the experiments was a silty loam from a cotton field in Elmore county, Alabama, infested with the reniform nematode [100 adults and juveniles/100 cm^3 soil]. The soil had a pH = 6.2, organic matter content <1.0%(w/w), and cation exchange capacity < 10 meq/100 g soil. The soil was sieved [<1 mm] to remove large particles and debris, and was mixed with equal volumes of fine [<1 mm] siliceous river sand. The moist [60% field capacity] mixture, referred to hereafter as soil, was apportioned in 1-kg amounts in 10-cm-diam, 1-L capacity PVC pots.

Exotic Crops. The suitability of 5 selected tropical and subtropical crops as hosts for the reniform nematode was compared with those of 'Davis' soybean (*Glycine max*), 'DP-50' cotton (*Gossypium hirsutum*), 'Pioneer 3156' corn (*Zea mays*), and 'FFR 331' sorghum (*Sorghum bicolor*), in a greenhouse experiment. The crops were: hairy indigo (*Indigophora hirsuta*), swordbean (*Canavalia ensiformis*), 'Alabama' velvetbean (*Mucuna deeringiana*), castor (*Ricinus communis*), and two sesame (*Sesamum indicum*) cultivars: 'S-19' and 'S-21'. All crops were planted using 5 seeds per pot except indigo, sorghum and sesame which were planted at a rate of 15 seed per pot. The experiment consisted of 13 treatments [crops] with 8 replications [pots] per treatment arranged in a completely randomized design on a greenhouse bench. Soil in the pots was moistened as needed and plants were maintained in good growing condition for 8 weeks when the experiment was terminated.

At the end of the experiment, roots were carefully separated from soil, washed, excised from the shoots, weighed and incubated with the "salad bowl" technique to recover nematodes (Rodríguez-Kábana and Pope, 1981). Soil from each pot was thoroughly mixed and a 100 cm^3 sample was taken for nematode analysis with the salad bowl method.

Soybean. The suitability of soybean as host for the reniform nematode was studied in a greenhouse experiment with eight cultivars ('Brim', 'Haskell', 'Dillon', 'Maxcy', 'Carver', 'Stonewall', 'Young', 'Hutcheson') and a breeding line (PI 437654). These soybean were selected as being within maturity groups suitable for Alabama and because of their susceptibility or resistance to cyst nematode *Heterodera glycines* and the root-knot nematodes, *Meloidogyne arenaria* and *M. incognita.* The design of the experiment, methods and procedures were identical to those described for the exotic plants experiment. The general condition of the root systems was evaluated using a subjective scale ranging from 1-5 where a value of 1 represented well-developed "clean" roots with no necrotic spots or damaged areas and a value of 5 corresponded to roots with poor growth and dark color showing necrotic or damaged areas over the entire root system; values between 1 and 5 represented progressive deterioration in appearance and damage. Five soybean seeds were planted per pot.

Cotton. A greenhouse experiment was conducted to assess the reactions of 24 selected commercial cotton cultivars (Table 4) to the reniform nematode. The cultivars were chosen to represent those utilized most by producers in Alabama and other adjacent southeastern states. The experiment was designed and conducted as described for the exotic and soybean experiments except that each pot was planted with 6 cotton seeds and the experiment was terminated 10 weeks after planting.

Statistical Analyses. All data were analyzed following standard procedures for analyses of variance (Steel and Torrie, 1980). Fisher's least significant differences were calculated when F values were significant and are included in the results tables. All differences referred to in the text were significant at the 5% or lower level of probability.

RESULTS

Exotic Crops. Numbers of reniform nematode (all forms) in soil were highest in pots with soybean, cotton and castor (Table 1). The population densities in soils of all other crops ranged from 87-98% lower than the average density (775 nematodes/100 cm^3 soil) for soybean, cotton and castor. No crop species except soybean

Table 1. Number of reniform nematodes (*Rotylenchulus reniformis*) in soil and roots of plants following 8 weeks in a greenhouse experiment using naturally infested soil.

	Nematodes per 100 cm^3 Soil	Nematodes per total root system
'Davis' Soybean	465	249
'DP-50' Cotton	907	1436
Hairy Indigo	75	39
Swordbean	42	0
Tropical Corn	88	36
'Pioneer 3156' Corn	91	5
Velvetbean	15	0
Castor	954	3
'FFR 331' Grain Sorghum	25	11
'S-19' Sesame	62	0
'S-21' Sesame	104	0
FLSD (P = 0.05)	107	28

and cotton supported significant populations of the nematodes in the roots. Numbers of the nematodes in cotton roots (653/g root) were 19 times higher than in soybean roots (34/gm root).

Soybean. All soybean cultivars had almost perfect emergence (94-100%) except for 'Stonewall' (75%) and PI 437654 (36%) (Table 2). The weights of fresh shoots ranged from 18.1 g to 26.4 g for the soybean cultivars but was very low (8.4 g) for PI 437654. Fresh root weights ranged from 10.8 to 16.5 g among the commercial cultivars but was only 2.9 g for the PI entry. Root condition indices ranged from a value of 2.0 for 'Dillon' to as high as 3.8 for PI 437654. All soybean cultivars except 'Maxcy' and 'Stonewall' supported significant populations of the reniform nematode in soil (Table 3). The highest numbers of the nematode in soil were in pots with the 'Brim', 'Haskell', and 'Young' cultivars. Roots of all cultivars contained sizable populations of the nematode but with significant differences among cultivars in numbers per root system.

Cotton. The weights of fresh shoots ranged from 6.9-11.1 g averaging 9.2 ± 1.1 g (Table 4). The range of weights of fresh roots was 2.4-6.1 g with an average of 4.6 ± 0.9 g. There was no clear relationship between the weights of roots and shoots. Values for the root condition index varied from 2.0-3.5, averaging 2.5 ± 0.4.

All cotton cultivars except one (Hartz H 1215) supported significant soil and root populations of the reniform nematode (Table 5). Soil and root populations of the reniform nematode were directly related and were well fit ($R^2 = 0.81^{**}$) by a logistic model. Numbers of reniform nematodes/g fresh root in the cultivars varied from 26-116 averaging 79 ± 36, indicating a wide range in adequacy as hosts for the nematode.

DISCUSSION

Velvetbean, swordbean, sesame, and hairy indigo were very poor hosts or non-hosts of the reniform nematode. These crops can be grown successfully in Ala-

Table 2. Plant numbers and weights, and root condition of eight soybean (*Glycine max*) cultivars and one plant introduction line in a greenhouse experiment with soil naturally infested with the reniform nematode, *Rotylenchulus reniformis*.

Cultivar	No.Plants/Pot	Fresh Shoot Weight (g)	Fresh Root Weight (g)	Root Condition Index[1]
Brim	4.7	20.4	13.6	2.5
Haskell	5.0	22.7	16.5	2.2
Dillon	5.0	26.4	15.8	2.0
Maxcy	5.0	24.9	12.1	2.3
Carver	4.7	24.7	12.5	2.7
Stonewall	3.8	22.7	10.8	2.8
Young	5.0	25.5	14.1	2.5
Hutcheson	4.7	18.1	11.9	3.0
PI 437654	1.8	8.4	2.9	3.8
FLSD (P = 0.05)	0.6	2.8	2.2	0.4

[1]Root condition index based on a subjective scale from 1-5, where a value of 1 represented well developed roots without necrosis and a value of five represented roots with poor growth and extensive necrosis.

bama and other southeastern states (Rodríguez-Kábana *et al.*, 1988; 1989; Rodríguez-Kábana, Robertson *et al.*, 1989). They have been used successfully to manage root-knot nematode problems in field experiments with cotton, peanut, soybean and a variety of horticultural crops (Rodríguez-Kábana, Kloepper *et al.*, 1992, Rodríguez-Kábana, Pinochet *et al.*, 1992; Rodríguez-Kábana, Kokalis-Burelle *et al.*,

Table 3. Population development of the reniform nematode (*Rotylenchulus reniformis*) in soil and roots of eight soybean (*Glycine max*) cultivars and a plant introduction accession after 8 weeks in a greenhouse experiment using naturally infested soil.

Cultivar	Nematodes per 100 cm^3 Soil	Nematodes in the root system	Nematodes per g roots
Brim	774	847	65
Haskell	410	1634	101
Dillon	232	1391	90
Maxcy	91	1229	106
Carver	136	882	74
Stonewall	27	394	38
Young	362	1140	83
Hutcheson	147	1264	108
PI 437654	301	578	175
FLSD (P = 0.05)	98	215	33

Table 4. Growth parameters for twenty four commercial cotton cultivars (*Gossypium hirsutum*) in a greenhouse experiment with field soil infested with the reniform nematode (*Rotylenchulus reniformis*).

Cultivars	No. Seedlings per Pot	Fresh Shoot Weight (g)	Fresh Root Weight (g)	Root Condition[1]
Stoneville 474	5.7	10.8	4.9	3.0
LA 887	5.2	11.1	5.0	3.0
HS 23	4.3	9.4	5.6	2.2
HS 44	4.2	9.4	4.8	2.2
HS 46	4.3	8.9	3.6	2.7
SG 404	4.5	9.1	4.8	2.5
SG 501	5.0	8.8	4.0	2.7
SG 1001	4.8	9.4	6.0	2.0
DP 5415	4.5	7.6	4.4	2.5
DP 51	4.8	8.1	4.7	2.3
DP 5409	4.8	6.9	4.3	2.7
DP 5690	4.3	8.6	4.6	2.2
DP 20	4.8	7.7	4.3	2.3
DP 90	4.5	7.8	4.9	2.2
DP 50	5.0	10.2	6.1	2.0
DP NuCotn 33[B]	5.0	9.6	5.7	2.3
DP NuCotn 35[B]	4.8	10.4	4.5	2.5
Hartz H 1560	5.0	10.4	5.4	2.3
Hartz H 1215	4.5	9.8	2.6	3.0
Hartz H 1220	4.5	9.3	3.8	3.0
Hartz H 1244	4.3	9.9	3.7	3.0
Terra 302	3.5	9.8	2.4	3.5
Terra 366	4.7	10.1	5.1	2.0
Terra 292	4.7	8.8	4.2	2.7
FLSD ($P = 0.05$)	0.9	1.3	1.3	0.6

[1]Root condition index based on a subjective scale from 1-5, where a value of 1 represented well developed roots without necrosis and a value of five represented roots with poor growth and extensive necrosis.

1994, Rodríguez-Kábana, Robertson, *et al.*, 1988; 1991; Rodríguez-Kábana, Weaver *et al.*, 1990). Indeed, velvetbean was the premiere leguminous rotation crop in the South prior to the mid-1940's (Taylor and Rodríguez-Kábana, 1998). At one time, there were over 500 000 hectares of velvetbean planted annually in Alabama in various cropping systems with corn and cotton. The possibility of 'resurrecting' these velvetbean systems and adapting them to modern agriculture is now being actively evaluated in producers' fields in Alabama (Weaver *et al.*, 1993; 1995).

Table 5. Population development of the reniform nematode (*Rotylenchulus reniformis*) in roots and soil of twenty four selected cotton (*Gossypium hirsutum*) cultivars after 10 weeks in a greenhouse experiment with field soil infested with the nematode.

Cultivars	Nematodes per 100 cm^3 Soil	Nematodes in the Root System	Nematodes per g Root
Stoneville 474	502	496	102
LA 887	604	580	117
HS 23	516	535	100
HS 44	636	580	148
HS 46	456	557	160
SG 404	502	545	115
SG 501	349	338	94
SG 1001	751	522	91
DP 5415	423	424	104
DP 51	442	273	61
DP 5409	260	375	91
DP 5690	340	383	87
DP 20	199	353	99
DP 90	288	263	55
DP 50	424	330	55
DP NuCotn 33[B]	234	268	49
DP NuCotn 35[B]	311	218	48
Hartz H 1560	301	195	39
Hartz H 1215	46	67	26
Hartz H 1220	239	214	68
Hartz H 1244	196	174	55
Terra 302	286	287	140
Terra 366	430	316	63
Terra 292	216	214	52
FLSD (P = 0.05)	141	101	38

Results obtained with castor agree with those from India where the crop is reported to be susceptible to the reniform nematode. Dasgupta and Seshadri, 1971, distinguished castor- and cotton-virulent isolates of *R. reniformis* (race A) from other isolates (race B) which could not reproduce in these crops. It is not clear from our results why numbers of the nematode were so low in castor roots when compared to numbers in soil. We plan to conduct histological studies to determine the reason.

There were significant differences in the sizes of populations of the nematode associated with the cultivars of cotton and soybean. Differences in susceptibility among cultivars of both crops have been observed before (Birchfield *et al.* 1971;

Starr and Page, 1990).There was no apparent relationship between susceptibilities of cotton and soybean cultivars to *R. reniformis* and their reaction to root-knot nematodes (*Meloidogyne* spp.) or for soybean, to their response to *H. glycines*. The cultivars chosen for both soybean and cotton provide a representation of what is available to producers today. No cultivar in either crop was a non-host or even a poor host, compared to sesame, corn, sorghum, or the tropical legumes.

LITERATURE CITED

BIRCHFIELD, W., and J. E. JONES. 1961. Distribution of the reniform nematode in relation to crop failure of cotton in Louisiana. Plant Disease Reporter 45:671-673.

BIRCHFIELD, W., C. WILLIAMS, E. E. HARTWIG, and L. R. BRISTER. 1971. Reniform nematode resistance in soybeans. Plant Disease Reporter 55:1043-1045.

BLASINGAME, D. 1993. Nematode distribution and density. Pp. 4-6 *in* Cotton Nematodes Your Hidden Enemies. Beltwide Cotton Nematode Survey and Education Committee. The Cotton Council, Memphis, TN, U.S.A.

BRATHWAITE, C. W. D. 1974. Effect of crop sequence on populations of *Rotylenchulus reniformis* in fumigated and untreated soil. Plant Disease Reporter 58:259-261.

DASGUPTA, D. R., and A. R. SESHADRI. 1971. Races of the reniform nematode, *Rotylenchulus reniformis* Lindford & Oliveira, 1940. Indian Journal of Nematology 1:21-24.

GAZAWAY, W. S. 1993. Reniform nematodes. Pp. 13-16 *in* Cotton Nematodes Your Hidden Enemies. Beltwide Cotton Nematode Survey and Education Committee. The Cotton Council, Memphis, TN, U.S.A.

GILMAN, D. F., J. E. JONES, C. WILLIAMS, and W. BIRCHFIELD. 1978. Cotton-soybean rotation for control of reniform nematodes. Louisiana Agriculture 21:10-11.

HEALD, C. M., and W. H. THAMES. 1982. The reniform nematode, *Rotylenchulus reniformis*. Nematology in the Southern Region of the United States. USDA-CSRS Southern Cooperative Series, Bulletin 276:139-143.

HOLDEMAN, Q., D. CORDAS, T. WATSON, R. MATSUMOTO, and I. SIDDIQUI. 1974. Fact Finding Study: The Reniform Nematode, *Rotylenchulus reniformis*. State of California Department of Food and Agriculture, Division of Plant Industry, Sacramento, CA, U.S.A.

ROBINSON, A. F., and A. E. PERCIVAL. 1997. Resistance to *Meloidogyne incognita* Race 3 and *Rotylenchulus reniformis* in wild accessions of *Gossypium hirsutum* and *G. barbadense* from Mexico. Annals of Applied Nematology 29:746-755.

RODRIGUEZ-KABANA, R., P. S. KING, D. G. ROBERTSON, and C. F. WEAVER. 1989. Potential of crops uncommon to Alabama for management of root-knot and soybean cyst nematodes. Supplement to the Journal of Nematology 2:116-120.

RODRIGUEZ-KABANA, R., P. S. KING, D. G. ROBERTSON, C. F. WEAVER, and E. L. CARDEN. 1988. New crops with potential for management of soybean nematodes. Nematropica 8:45-52.

RODRIGUEZ-KABANA, R., J. W. KLOEPPER, D. G. ROBERTSON, and L. W. WELLS. 1992. Velvetbean for the management of root-knot and southern blight in peanut. Nematropica 22:75-80.

RODRIGUEZ-KABANA, R., N. KOKALIS-BURELLE, D. G. ROBERTSON, and L. W. WELLS. 1994. Evaluation of sesame for control of *Meloidogyne arenaria* and *Sclerotium rolfsii* in peanut. Nematropica 24:55-61.

RODRIGUEZ-KABANA, R., J. PINOCHET, D. G. ROBERTSON, C. F. WEAVER, and P. S. KING. 1992. Horsebean (*Canavalia ensiformis*) and crotalaria (*Crotalaria spectabilis*) for the management of *Meloidogyne* spp. Nematropica 22:29-35.

RODRIGUEZ-KABANA, R., J. PINOCHET, D. G. ROBERTSON, and L. WELLS. 1992. Crop rotation studies with velvetbean (*Mucuna deeringiana*) for the management of *Meloidogyne* spp. Supplement to the Journal of Nematology 24:662-668.

RODRIGUEZ-KABANA, R., and M. H. POPE. A simple incubation method for the extraction of nematodes from soil. Nematropica 11:175-186.

RODRIGUEZ-KABANA, R., D. G. ROBERTSON, C. F. WEAVER, and L. WELLS. 1991. Rotations of bahiagrass and castorbean with peanut for the management of *Meloidogyne arenaria*. Supplement to the Journal of Nematology 23:658-661.

RODRIGUEZ-KABANA, R., D. G. ROBERTSON, L. WELLS, P. S. KING, and C. F. WEAVER. 1989. Crops uncommon to Alabama for the management of *Meloidogyne arenaria* in peanut. Supplement to the Journal of Nematology 21:712-716.

RODRIGUEZ-KABANA, R., D. G. ROBERTSON, L. WELLS, and R. W. YOUNG. 1988. Hairy indigo for the management of *Meloidogyne arenaria* in peanut. Nematropica 18:137-142.

RODRIGUEZ-KABANA, R., D. B. WEAVER, D. G. ROBERTSON, R. W. YOUNG, and E. L. CARDEN. 1990. Rotations of soybean with two tropical legumes for the management of nematode problems. Nematropica 20:101-110.

STARR, J. L., and S. L. J. PAGE. 1990. Nematode parasites of cotton and other tropical fibre crops. Pp. 539-556 *in* M. Luc, R. A. Sikora, and J. Bridge, eds. Plant Parasitic Nematodes in Subtropical and Tropical Agriculture. CAB International, Wallingford, U.K.

STEEL, R. G. D., and J. H. TORRIE. 1980. Principles and Procedures of Statistics: A Biometrical Approach. McGraw Hill, NY, U.S.A.

TAYLOR, C. R., and R. RODRÍGUEZ-KÁBANA. 1998. History of the Alabama velvetbean and its potential for the future. Farm Systems Research Forum. Auburn University, College of Agriculture, Auburn, AL, U.S.A.

THAMES, W. H., and C. M. HEALD. 1974. Chemical and cultural control of *Rotylenchulus reniformis* on cotton. Plant Disease Reporter 58:337-341.

WEAVER, D. B., R. RODRIGUEZ-KABANA, and E.L. CARDEN. 1993. Velvetbean in rotation with soybean for management of *Heterodera glycines* and *Meloidogyne arenaria.* Supplement to the Journal of Nematology 25:809-813.

WEAVER, D. B., R. RODRIGUEZ-KABANA, and E. L. CARDEN. 1995. Comparison of crop rotations and fallow for the management of *Heterodera glycines* and *Meloidogyne* spp. in soybean. Supplement to the Journal of Nematology 27:585-591.

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