

Reniform Nematode Resistance in Selected Soybean Cultivars¹

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Abstract: Two hundred eighty-two soybean cultivars from the variety testing programs of Arkansas and Mississippi were tested in greenhouse pot experiments during summer 1998 to identify soybean cultivars with resistance to the reniform nematode, *Rotylenchulus reniformis*. Also included in the tests were the resistant cultivars Forrest and Hartwig, the susceptible control Braxton, and fallow infested soil, which were used as controls. Numbers of reniform nematode extracted from the soil and roots and the ratio of the numbers reproducing on each cultivar compared to the number reproducing on Forrest are reported. Cultivars with reproduction not significantly different from Forrest were classified resistant, whereas those with greater reproductive indices were considered susceptible. One of the 18 cultivars of relative maturity group (RMG) ≤ 4.4 was classified as resistant. For the 86 cultivars of RMG 4.5–4.9, 18 were found to be resistant. Of the 43 cultivars of RMG 5.0–5.4, 16 were resistant, while 43 of the 91 cultivars of RMG 5.5–5.9 were resistant. Fifteen of the cultivars with an RMG of ≥ 6.0 were classed as resistant. These data will be useful in the selection of soybean cultivars to use in rotation with cotton to help control the reniform nematode.

Key words: *Glycine max*, nematode, reniform nematode, reproductive index, resistance, rotation, *Rotylenchulus reniformis*, soybean, susceptibility.

The reniform nematode, *Rotylenchulus reniformis*, was first described in 1931 in Hawaii (Linford and Oliveira, 1940) and has long been considered primarily a tropical nematode pest (Heald and Thames, 1982). *Rotylenchulus reniformis* has a wide host range with at least 314 hosts out of 364 species evaluated, including soybean and cotton (Robinson et al., 1997). Since 1960 the reniform nematode has spread northward throughout much of the eastern half of the U.S. Cotton Belt (Heald and Robinson, 1990). Although the greatest incidence appears to be along the Gulf Coast in the southern part of the Belt, the nematode apparently has the ability to survive in colder climates, and *R. reniformis* has been found associated with cotton as far north as the Lubbock, Texas area (Heald and Thames, 1982) and the Missouri bootheel (Wrather et al., 1992). During the past 10 years, incidence of *R. reniformis* has increased in eco-

nomic importance in the mid-South at an alarming rate (Lawrence et al., 1990; Lorenz et al., 1996; Overstreet and McGawley, 1994).

The reniform nematode reproduces well in a much broader range of soil types than does the root-knot nematode (Koenning et al., 1996) and appears to be able to survive in large numbers in fallow soil (Heald and Thames, 1982; Koenning et al., 1996; Sivakumar and Seshadri, 1976). These factors likely have contributed to the spread of reniform nematodes throughout the southern region of the United States. Much of this area historically has been in cotton monoculture and, prior to the advent of the reniform nematode, the most widespread and damaging nematode pest of the crop was the root-knot nematode (*Meloidogyne incognita*). While the ranges of these two cotton and soybean pests overlap, intensive surveys in several states including Arkansas, Alabama, Mississippi, and Louisiana indicate that the two nematode species are rarely detected together in the same fields. The reasons that these two species apparently do not coexist on hosts such as cotton or soybean, which are excellent hosts for both species, are not obvious. It is also unclear whether a shift in the predominant nematode pest species over a wide geographical area is under way.

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Earlier reports indicated that soybean cultivars resistant to *Heterodera glycines* (soybean cyst nematode) were also resistant to *R. reniformis* (Rebois et al., 1970). However, Robbins et al. (1994) reported that of the 30 soybean cultivars most commonly grown in Arkansas in 1990, only five (Forrest, Coker 485, Centennial, Stonewall Sharkey) were resistant to the reniform nematode, and more recent studies have shown that soybean cultivars with *H. glycines* resistance derived from PI 88.788 are susceptible to *R. reniformis* (Robbins and Rakes, 1996). The bulk of contemporary soybean cultivars are either susceptible to *H. glycines* or derive their resistance from PI 88.788. No soybean cultivar or line has been shown to be resistant to the reniform nematode and susceptible to the soybean cyst nematode.

Rotylenchulus reniformis can cause significant yield suppression in both cotton and soybean (Koenning et al., 1996; Lawrence and McLean, 1996; Lawrence et al., 1990; Rebois, 1970). In addition to direct effects due to nematode parasitism, reniform nematodes may also interact with certain fungal pathogens, including *Rhizoctonia solani* (Brodie and Cooper, 1964; Sankaralingam and McGawley, 1994) and *Verticillium dahliae* (Tachathoua and Sikora, 1978). The current circumscription of *R. reniformis* is very broad and includes morphotypes that differ greatly in size (Lehman and Inserra, 1990; Robbins, 1994).

A test of eight soybean cultivars showed Dyer and Pickett to have resistance to the *R. reniformis* in pot tests (Rebois et al., 1968); a more recent test of 19 soybean cultivars confirmed the high degree of resistance in Dyer and Pickett and indicated moderate resistance in Hardee, Coker 318, Bragg, Lee 68, Davis, and Dare (Birchfield and Brister, 1969). Birchfield et al. (1971) screened five soybean cultivars plus 15 breeding lines and reported resistance in the cultivars Pickett and Pickett 71 and five breeding lines. Soybean cultivar registrations reported resistance to reniform nematode in Forrest (Hartwig and Epps, 1973), Centennial (Hartwig and Epps, 1977), Gregg (Harville

et al. 1988), and Padre (Hartwig et al., 1988). In a field test of 65 cultivars and lines, seven lines showed a high degree of resistance to reniform nematode and 13 lines had moderate resistance (Lim and Castillo, 1979).

Soybean cultivars with resistance to *R. reniformis* would be useful for rotation with cotton in reniform nematode-infested fields. The soybean cultivars entered in the 1998 Arkansas soybean variety testing program, as well as several from the Mississippi soybean variety testing program, were tested in a greenhouse pot study to determine the reproductive capacity of *R. reniformis*. The objective of the study was to identify currently available soybean cultivars that have reniform nematode resistance comparable with that of the reniform-resistant standard cultivar Forrest.

MATERIALS AND METHODS

The soybean cultivars tested included both private and publicly bred cultivars from the relative maturity groups (RMG; Palmer and Kilen, 1987): 4.4 or earlier, 4.5–4.9, 5.0–5.4, 5.5–5.9, and 6.0 or later; the number tested from each RMG was 18, 86, 43, 91, and 44, respectively. Soybean seeds of all cultivars were germinated in vermiculite and transplanted into 10-cm-diam. clay pots containing 500 cm³ of pasteurized fine sandy loam soil (ca. 91% sand, 5% silt, 4% clay, <1% O.M.). The soil in each pot was infested with ca. 1,166 vermiform *R. reniformis*, obtained from Braxton soybean grown in the greenhouse. Soil was washed from the roots, suspended in water, and poured through nested 841- and 38- μ m-pore sieves. The material on the 38- μ m-pore sieve was placed on a tissue in a Baermann funnel. All vermiform stages of *R. reniformis* were collected after 16 hours and at the proper dilution were injected with an autopipet into three, 2.54-cm-deep holes made in the soil of each pot containing the soybeans. Pots were arranged in a randomized complete block design with five replications per treatment. Soybean cultivars Forrest and Hartwig were

included as resistant controls, and Braxton was included as a susceptible control. Reniform nematode-infested fallow soil was included as a survival baseline control in the absence of a host. The experiment was conducted in a greenhouse with the ambient temperature maintained between 28 and 34 °C. All test pots were watered twice daily (8 am and 4 pm) and fertilized once a week with 20-20-20 (N-P-K) fertilizer.

After 11 weeks (June 17–September 3), the number of reniform nematode eggs on the roots and the number of vermiform nematodes in the soil of each pot were determined. The eggs and vermiform nematodes in the egg masses on roots were extracted with a 0.525% sodium hypochlorite solution (Hussey and Barker, 1973), and numbers were recorded. To calculate the final reniform nematode soil population (Pf), a 100-cm³ aliquot of well-mixed soil from each pot was suspended in water and

poured through nested 841- and 38-µm-pore sieves to remove plant debris and extract the nematodes. Nematodes caught on the 38-µm-pore sieve were separated from soil with sucrose centrifugal-flotation (Jenkins, 1964), counted, and multiplied by 5 to give the number per pot. The total number of reniform nematode eggs and vermiform nematodes per pot was calculated by adding the number from the soil to the number from the roots. Reproductive indices (final population/initial population = Pf/Pi) and the relative reproduction on each cultivar as a ratio to the reproduction on Forrest were calculated in all tests (not reported). Because of variation for each maturity group, the ratio of cultivar to Forrest data were transformed by log₁₀ (x + 1) and analyzed as a randomized complete block design. Cultivar ratio to Forrest means were separated using a protected LSD at *P* = 0.05, where appropriate. Cultivars were declared signifi-

TABLE 1. Reproduction of *Rotylenchulus reniformis* on 18 soybean cultivars of relative maturity group ≤4.4 in greenhouse pot tests after 11 weeks.

Cultivar ^a	Relative maturity group	Final population per pot ^b	Ratio of cultivar reproduction to Forrest ^c	Rating ^d
Fallow		636	0.103 e	
Hartwig	5.3	5,025	0.726 de	R
Forrest	5.7	6,034	1.00	R
Triumph TR 5409 RR	4.3	10,633	1.549 cd	R
DEKALB CX445	4.4	14,413	1.967 bc	S
Triumph TR 4339 RR	4.3	12,833	1.983 bc	S
DEKALB CX399	3.9	14,748	2.151 abc	S
Asgrow A4341	4.3	14,615	2.154 abc	S
Novartis NK Brand S43-B5	4.3	15,406	2.189 abc	S
Novartis NK Brand S39-11	3.9	16,826	2.335 abc	S
Midland X421N	4.2	16,368	2.383 abc	S
Hartz H3090 RR	3.9	16,646	2.393 abc	S
Chesapeake	4.0	18,136	2.420 abc	S
Novartis NK Brand S39-D9	3.9	16,588	2.473 abc	S
Novartis NK Brand S42-K2	4.2	18,514	2.658 abc	S
Pioneer Var. 94B41	4.4	17,495	2.788 abc	S
Terra TS 4792	4.0	18,475	2.824 abc	S
MFA Morsoy 4477 (MO)	4.4	19,625	2.881 abc	S
MPV 437NRR (MO)	4.4	22,522	3.380 ab	S
Williams	3.9	23,922	3.453 ab	S
Novartis NK Brand S38-L5	3.8	29,289	3.636 ab	S
Braxton	2.9	29,200	4.298 a	S

^a Hartwig and Forrest: resistant checks; Braxton: susceptible check; Fallow: infested soil with no host.

^b Final population per pot = mean of the total vermiform nematodes in the soil (500 cm³) + eggs and vermiform nematodes from egg masses in 5 replications at harvest.

^c Ratio of cultivar reproduction to Forrest data followed by the same letter are not significantly different (*P* ≤ 0.05) according to Duncan's multiple-range test. Ratio means from data transformed by log₁₀ (x + 1). Forrest ratio by definition = 1.000.

^d R: resistant; S: susceptible. Means > 1.904 are significantly larger than Forrest and are termed susceptible.

TABLE 2. Reproduction of *Rotylenchulus reniformis* in 86 soybean cultivars of relative maturity group 4.5–4.9 in greenhouse pot tests after 11 weeks.

Cultivar ^a	Relative maturity group	Final population per pot ^b	Ratio of cultivar reproduction to Forrest ^c	Rating ^d
Fallow		636	0.103 q	
Terral TV4770	4.7	2,964	0.171 pq	R
Hartwig	5.3	5,025	0.726 o–q	R
Asgrow A4702RR	4.7	7,538	0.942 n–p	R
Forrest	5.7	6,034	1.00	R
Delta Grow 4710	4.7	17,955	1.031 n–p	R
TN 4–86	4.8	7,851	1.101 m–p	R
Deltapine DP 4969 RR	4.9	8,361	1.289 l–p	R
Asgrow A4501 RR	4.5	8,461	1.298 k–p	R
Pioneer Var. 94B81	4.8	10,185	1.403 j–p	R
Hornbeck HBK R4515 Roundup	4.5	11,360	1.517 i–p	R
Elite FFR 495	4.9	10,706	1.549 h–p	R
AgriPro 4602 RR	4.6	10,427	1.595 g–p	R
APX 4602RR	4.6	10,966	1.599 f–o	R
Riverside 490	4.9	11,214	1.632 f–o	R
KS 4895	4.7	11,834	1.642 e–o	R
Asgrow A4604	4.6	12,033	1.716 e–o	R
Terral TV4479	4.5	15,185	1.739 e–o	R
Hartz Var. H4252 RR	4.6	11,473	1.800 e–o	R
Asgrow A4901RR	4.9	12,716	1.828 e–o	R
Asgrow A4922	4.9	11,916	1.848 e–o	R
Mycogen 470	4.7	12,545	1.978 e–o	S
Terral TV 4466 RR	4.5	15,618	1.986 e–o	S
SF Services SF 477RR	4.7	12,643	1.991 e–o	S
Genesis GN 9482	4.8	17,061	2.000 e–n	S
Hartz Var. 4998RR	4.9	12,766	2.068 d–n	S
Manokin	4.9	14,900	2.070 d–n	S
Deltapine DP X8S49	4.9	13,551	2.083 d–n	S
Pioneer Var. 9482	4.8	14,338	2.088 d–n	S
Asgrow A4715	4.7	15,220	2.091 d–n	S
TN 4–94	4.9	13,958	2.105 d–n	S
Deltapine DP 4750 RR	4.8	14,070	2.211 d–n	S
Elite FFR 467RR	4.6	13,406	2.121 d–n	S
Delta King 4860	4.6	15,835	2.135 d–n	S
Eagle ES 4	4.7	15,174	2.136 d–n	S
AgriPro APX 4980RR	4.9	16,472	2.144 d–n	S
Hornbeck HBK 4600	4.6	15,280	2.160 d–n	S
Caverndale CF492	4.9	14,191	2.172 d–n	S
Hornbeck HBK X9749	4.9	16,622	2.211 d–n	S
AgriPro APX 4510RR	4.5	15,958	2.213 d–n	S
Hornbeck HBK X9746	4.6	14,678	2.227 d–n	S
Asgrow A4602RR	4.6	14,383	2.228 d–n	S
DEKALB CX494	4.9	14,960	2.244 c–n	S
Sure-Grow SG 468RR	4.6	16,882	2.254 c–n	S
Mycogen 5474	4.7	14,399	2.302 c–n	S
Delta Grow 4650RR	4.6	15,662	2.312 c–n	S
Novartis NK Brand RA452	4.9	17,835	2.370 b–m	S
Delta King X9849RR	4.9	16,063	2.400 b–m	S
Hornbeck HBK X9744s	4.5	17,350	2.487 b–m	S
Erwin-Keith EK 4998	4.9	16,900	2.534 b–m	S
Hartz Var. H4994RR	4.9	17,517	2.541 b–m	S
Caverndale CF461	4.6	16,537	2.542 b–m	S
HyPerformer HY4540	4.5	17,461	2.590 b–l	S
DEKALB CX450c	4.5	19,189	2.665 b–l	S
Sure-Grow SG 498RR	4.9	25,399	2.721 b–k	S
Terral TV4664	4.6	17,586	2.722 b–k	S
Hornbeck HBK R4898 Roundup	4.8	18,247	2.738 b–k	S
Willcross 2467N-RR	4.6	20,516	2.755 b–k	S

TABLE 2. *Continued*

Cultivar ^a	Relative maturity group	Final population per pot ^b	Ratio of cultivar reproduction to Forrest ^c	Rating ^d
AgriPro AP 4880	4.8	21,453	2.763 b-k	S
Novartis NK Brand S46-W8	4.6	23,532	2.841 b-k	S
MPV 457NRR (MO)	4.6	21,926	2.856 a-k	S
Delta King 4762 RR (10)	4.7	17,674	2.858 a-k	S
Delta King DK 4965RR	4.9	17,678	2.858 a-k	S
DEKALB CX 460RR	4.6	21,673	2.900 a-k	S
Elite FFR RT467	4.6	20,669	2.909 a-k	S
AgriPro AP 4880	4.8	18,898	2.911 a-k	S
DEKALB CX470c	4.7	20,867	2.975 a-k	S
Asgrow A4701RR	4.7	22,248	2.989 a-k	S
Midland 8486	4.8	20,523	3.013 a-j	S
Hornbeck HBK 4755	4.7	22,004	3.022 a-i	S
MFA Morsoy 4426	4.5	22,635	3.028 a-i	S
Delta Grow 4646RR	4.7	19,806	3.034 a-i	S
MFA Morsoy 444	4.5	20,677	3.087 a-i	S
Terral TV4975	4.9	20,434	3.099 a-i	S
Deltapine DP 3478	4.7	23,866	3.240 a-h	S
HyPerformer HY498	4.9	22,681	3.250 a-h	S
Novartis NK Brand 3474	4.7	20,506	3.274 a-h	S
DynaGro 3495	4.8	23,038	3.286 a-h	S
Hornbeck HBK 4890	4.8	24,093	3.320 a-h	S
DynaGro 3463RR	4.6	25,518	3.328 a-h	S
Terra TS 466RR	4.6	20,984	3.427 a-g	S
Terral TV4666RR	4.5	24,154	3.449 a-g	S
Hornbeck HBK 49	4.9	26,056	3.456 a-f	S
Midland 8475	4.7	30,555	3.463 a-f	S
Novartis NK Brand S46-44	4.6	24,302	3.520 a-f	S
Delta Grow 4640	4.6	24,085	3.616 a-e	S
Braxton	2.9	29,200	4.298 a-d	S
Asgrow A4601RR	4.6	28,830	4.656 a-c	S
Cache River Dixie 478	4.7	45,026	4.816 ab	S
Pioneer Var. 9492	4.9	35,846	5.735 a	S

^a Hartwig and Forrest: resistant checks; Braxton: susceptible check; Fallow: infested soil with no host.

^b Final population per pot = mean of the total vermiform nematodes in the soil (500 cm³) + eggs and vermiform nematodes from egg masses in 5 replications at harvest.

^c Ratio of cultivar reproduction to Forrest data followed by the same letter are not significantly different ($P \leq 0.05$) according to Duncan's multiple-range test. Ratio means from data transformed by $\log_{10}(x + 1)$. Forrest ratio by definition = 1.000.

^d R: resistant; S: susceptible. Means > 1.970 are significantly larger than Forrest and are termed susceptible.

cantly more susceptible than Forrest if their means were larger than $\log(2) \cong 0.301$. The ratio of cultivar to Forrest means of the transformed data were transformed back to the original scale for presentation (SAS Institute, Cary, NC).

RESULTS

All cultivars supported at least some reniform nematode reproduction. Mean survival of reniform nematode in the infested fallow pots was 636 or 10.5% of the number found on Forrest. The mean total number of eggs + vermiform nematodes and the reproductive index (in parentheses) of the resistant

control cultivars Forrest and Hartwig were 6,034 (5.17) and 5,025 (4.31), respectively, and on the susceptible control cultivar Braxton were 29,200 (25.04) from non-transformed data. Cultivars as resistant as Forrest as well as susceptible cultivars were identified from each RMG using the ratio of cultivar to Forrest transformed data. Of the 18 cultivars in the RMG of 4.4 or earlier, only Triumph TR 5409 RR was as resistant as Forrest (Table 1). Of the 86 cultivars with an RMG of 4.5 to 4.9, 18 were comparable in resistance to Forrest (Table 2). Of the 43 cultivars with an RMG rating of 5.0 to 5.4, 16 were comparable in resistance to Forrest

(Table 3). Forty-three of 91 cultivars in the 5.5–5.9 RMG entries were comparable in production to Forrest (Table 4). Among the 44 cultivars with relative maturity group ratings of 6.0 or greater, 15 were comparable to Forrest in resistance (Table 5).

TABLE 3. Reproduction of *Rotylenchulus reniformis* on 43 soybean cultivars of relative maturity group 5.0–5.4 in greenhouse pot tests after 11 weeks.

Cultivar ^a	Relative maturity group	Final population per pot ^b	Ratio of cultivar reproduction to Forrest ^c	Rating ^d
Fallow		636	0.103 o	
S94-1956 (MO)	5.3	2,590	0.425 no	R
Novartis NK S53-Q7	5.3	3,168	0.513 no	R
Hartwig	5.3	5,025	0.726 m-o	R
Hornbeck HBK R5411	5.4	5,734	0.931 l-n	R
Forrest	5.7	6,034	1.00	R
Hornbeck HBK R5404	5.4	7,039	1.066 k-n	R
Md 92-5769	5.0	8,054	1.182 j-n	R
Willcross 2517RR	5.1	8,002	1.259 i-n	R
Deltapine DP 3519s	5.1	7,932	1.273 h-n	R
DEKALB DG531	5.3	10,542	1.363 g-n	R
Hartz Var. H5545RR	5.4	8,754	1.379 f-n	R
Genesis GN 9511	5.1	9,568	1.379 f-n	R
DEKALB DG500B	5.0	10,058	1.617 e-m	R
Elite FFR RT517	5.1	10,065	1.619 e-m	R
Midland 8530	5.3	11,859	1.736 e-m	R
R93-174 (AR)	5.4	11,747	1.751 e-m	R
Novartis NK Brand S51-00	5.1	11,325	1.835 d-m	R
Pioneer Var. 95B41	5.4	13,705	1.936 c-m	R
Riverside 529I	5.2	12,715	1.958 c-m	S
DEKALB DG500A	5.0	14,309	1.993 b-l	S
Delta King 5263 RR	5.2	12,219	1.996 b-l	S
Terral TVX 5266RR	5.2	17,410	2.041 b-l	S
Pioneer Var. P 9511	5.1	13,692	2.158 a-l	S
Riverside 520	5.2	14,625	2.229 a-l	S
Terral TV 5466RR	5.4	18,380	2.258 a-l	S
V89-805 (VPI)	5.2	16,434	2.286 a-l	S
Deltapine DP 5354	5.3	18,215	2.296 a-l	S
Asgrow A5401RR	5.4	16,413	2.491 a-k	S
Pioneer Var. 95B33	5.3	17,498	2.500 a-k	S
Hornbeck HBK 5149	5.1	15,527	2.502 a-k	S
AgriPro AP 543RR	5.4	17,414	2.512 a-k	S
Erwin-Keith EK 5398N	5.3	20,224	2.734 a-j	S
Essex RSV1	5.1	19,710	2.804 a-h	S
Shogun	5.3	20,931	2.922 a-h	S
Delta Grow 5330	5.3	23,634	3.037 a-g	S
MPV 537NRR (MO)	5.0	20,467	3.049 a-g	S
Novartis NK Brand S51-T1	5.1	20,729	3.099 a-f	S
R93-171 (AR)	5.4	29,967	3.153 a-e	S
Erwin-Keith EK 5498	5.4	23,159	3.434 a-e	S
Essex	5.1	23,846	3.513 a-e	S
Terral TV5495	5.4	29,066	3.791 a-d	S
TN 5-95	5.3	24,288	3.902 a-c	S
Hartz Var. HX5013RR	5.1	27,106	3.981 a-c	S
Novartis NK X9851	5.1	26,295	4.068 a-c	S
Buckshot 55	5.4	33,398	4.137 ab	S
Braxton	2.9	29,200	4.298 a	S

^a Hartwig and Forrest: resistant checks; Braxton: susceptible check; Fallow: infested soil with no host.

^b Final population per pot = mean of the total vermiform nematodes in the soil (500 cm³) + eggs and vermiform nematodes from egg masses in 5 replications at harvest.

^c Ratio of cultivar reproduction to Forrest data followed by the same letter are not significantly different ($P \leq 0.05$) according to Duncan's multiple-range test. Ratio means from data transformed by $\log_{10}(x + 1)$. Forrest ratio by definition = 1.000.

^d R: resistant; S: susceptible. Means > 1.943 are significantly larger than Forrest and are termed susceptible.

Resistance to Reniform Nematode in Soybean: *Robbins et al.* 673TABLE 4. Reproduction of *Rotylenchulus reniformis* on 91 soybean cultivars of relative maturity group 5.4–5.9 in greenhouse pot tests after 11 weeks.

Cultivar ^a	Relative maturity group	Final population per pot ^b	Ratio of cultivar reproduction to Forrest ^c	Rating ^d
Fallow		636	0.103 u	
Delsoy 5710	5.7	1,584	0.254 tu	R
Riverside Robin-5	5.7	3,751	0.206 s-u	R
Deltapine DP 5806RR	5.8	4,094	0.668 r-u	R
Accomac	5.8	4,411	0.700 q-u	R
AgriPro AP 588RR	5.8	4,805	0.711 p-u	R
Hartwig	5.3	5,025	0.726 o-u	R
Terral TV5797	5.7	4,822	0.767 o-u	R
Hartz Var. H5181RR	5.8	5,578	0.860 n-u	R
Asgrow A5843	5.8	6,803	0.972 m-u	R
DT 95-15091 (USDA-ARS)	5.8	6,899	0.982 m-u	R
Forrest	5.7	6,034	1.000	R
Deltapine DP 5644RR	5.5	8,406	1.101 l-t	R
Novartis NK X9855	5.5	9,098	1.141 k-t	R
Hornbeck HBK 5990	5.9	8,215	1.199 j-t	R
Asgrow A5944	5.9	9,636	1.234 i-s	R
DEKALB CX570c	5.7	8,014	1.290 h-s	R
Delta Grow 5179	5.7	9,406	1.355 h-s	R
Eagle ES 56	5.6	11,327	1.369 h-s	R
HyPerformer HY 574	5.7	9,446	1.396 h-s	R
Deltapine DP 5960RR	5.9	9,362	1.405 h-s	R
Cache River Dixie X5501RR	5.5	11,746	1.507 g-s	R
Elite FFR RT587	5.7	11,015	1.534 g-s	R
Hornbeck HBK X571-98	5.7	10,320	1.557 f-s	R
Riverside 549	5.7	10,346	1.571 f-s	R
Tri-State UAPX 0038RR	5.8	10,274	1.575 f-s	R
Hartz Var. H5057RR	5.5	12,429	1.716 e-s	R
Deltapine DPX 8S59	5.9	12,545	1.734 e-s	R
Hartz Var. H5050	5.5	10,973	1.741 d-s	R
Delta Grow 5858RR	5.8	12,342	1.743 d-s	R
Delta Grow 5710	5.7	11,960	1.768 d-s	R
Deltapine DP 3588	5.8	11,488	1.769 d-s	R
Hartz Var. H5889RR	5.8	13,254	1.784 d-s	R
Cache River Dixie X5502RR	5.5	14,327	1.800 d-s	R
DEKALB CX 550RR	5.5	12,261	1.802 d-s	R
Deltapine DPX 8S56	5.6	11,694	1.813 d-s	R
Delta King 5961 RR	5.9	13,029	1.839 d-s	R
SF Services SF 567 RR	5.6	18,890	1.841 d-s	R
Terral TV 5666RR	5.6	13,097	1.857 d-s	R
Sure-Grow SG 597RR	5.9	12,597	1.874 d-s	R
UARK-5896	5.8	15,577	1.900 d-r	R
Hutcheson	5.7	12,384	1.900 d-r	R
Novartis NK X9857RR	5.7	12,483	1.964 c-r	R
Asgrow A5602 RR	5.6	14,074	1.965 c-r	R
Hornbeck HBK R5588	5.5	12,663	1.971 c-r	R
Elite FFR 597	5.9	13,395	2.030 c-q	R
Novartis NK Brand S59-V6	5.9	14,102	2.074 c-p	S
Terral TV 5926	5.9	14,216	2.094 c-o	S
Hornbeck HBK 5770	5.7	15,291	2.101 c-o	S
Elite FFR RT557	5.5	14,774	2.183 c-o	S
Hornbeck HBK X591-98	5.9	16,275	2.243 b-n	S
Asgrow A5901 RR	5.9	16,221	2.252 b-n	S
Hartz Var. HLA 572	5.7	15,480	2.260 b-n	S
Crowley	5.9	17,058	2.286 b-n	S
Sure-Grow SG 567RR	5.6	15,498	2.295 b-n	S
Delta King 5995	5.9	14,498	2.304 b-n	S
Hornbeck HBK R5884	5.8	15,712	2.354 b-m	S
Prince	5.5	16,558	2.383 b-m	S

TABLE 4. *Continued*

Cultivar ^a	Relative maturity group	Final population per pot ^b	Ratio of cultivar reproduction to Forrest ^c	Rating ^d
Novartis NK Brand S59-60	5.9	16,039	2.390 b-m	S
Delta King 5850	5.5	15,510	2.425 b-m	S
Asgrow A5959	5.9	16,208	2.427 b-m	S
Pioneer Var. 9552	5.5	15,441	2.452 b-m	S
Novartis NK X9856RR	5.6	15,716	2.472 b-m	S
Terral TV 5866RR	5.8	27,510	2.479 b-m	S
DEKALB CX553c	5.5	17,670	2.512 a-m	S
DEKALB DG758	5.8	15,819	2.512 a-m	S
Asgrow A5848	5.8	18,841	2.531 a-m	S
Hartz Var. H5088RR	5.8	20,418	2.591 a-l	S
Hartz Var. H5350RR	5.5	18,235	2.672 a-l	S
Asgrow A5601 RR	5.6	26,367	2.701 a-l	S
R92-1294 (AR)	5.8	24,856	2.719 a-l	S
Pioneer Var. 9594	5.9	18,924	2.759 a-l	S
V91-3036 (VPI)	5.9	18,954	2.765 a-l	S
Delta King 5664 RR	5.6	17,574	2.775 a-l	S
AgriPro AP 572 STS	5.7	18,758	2.782 a-k	S
Asgrow A5547	5.5	21,302	2.790 a-k	S
DT95-17556 (USDA-ARS)	5.8	17,542	2.811 a-k	S
Hartz Var. H5999RR	5.9	20,145	2.816 a-k	S
Novartis NK Brand S57-11	5.7	18,050	2.873 a-j	S
Terra TS 566 RR	5.6	23,011	2.915 a-j	S
Asgrow A5801RR	5.8	19,441	2.997 a-i	S
DEKALB DG858	5.8	26,478	3.047 a-h	S
DT95-15550 (USDA-ARS)	5.8	21,912	3.071 a-h	S
Hartz Var. H5855RR	5.5	20,825	3.096 a-h	S
Asgrow A5704	5.7	21,203	3.099 a-h	S
Riverside 77	5.6	21,777	3.100 a-h	S
DEKALB DG759	5.8	20,568	3.401 a-g	S
Dyna-Gro 3576	5.7	22,007	3.452 a-g	S
Delta Grow 5910	5.9	28,597	3.592 a-f	S
Pioneer Var. P95B71 RR	5.7	27,697	3.654 a-e	S
Delsoy 5500	5.5	25,808	3.813 a-e	S
Pioneer Var. 95B71	5.7	23,825	3.927 a-d	S
Braxton	2.9	29,200	4.298 a-c	S
Terral TV 5893	5.8	49,465	4.683 ab	S
V90-1012 (VPI)	5.6	33,014	5.316 a	S

^a Hartwig and Forrest: resistant checks; Braxton: susceptible check; Fallow: infested soil with no host.

^b Final population per pot = mean of the total vermiform nematodes in the soil (500 cm³) + eggs and vermiform nematodes from egg masses in 5 replications at harvest.

^c Ratio of cultivar reproduction to Forrest data followed by the same letter are not significantly different ($P \leq 0.05$) according to Duncan's multiple-range test. Ratio means from data transformed by $\log_{10}(x + 1)$. Forrest ratio by definition = 1.000.

^d R: resistant; S: susceptible. Means > 2.033 are significantly larger than Forrest and are termed susceptible.

DISCUSSION

Data are scarce on resistance to the reniform nematode in contemporary cultivars. Cornelius and Lawrence (1993) evaluated 56 cultivars of maturity groups IV and V for reniform resistance in a greenhouse pot test. Nine cultivars of group IV and 20 cultivars from group V were termed resistant, while only Hartz 4464 in IV and Rhodes and Hartwig in V were identified. The cultivars

Cordell, Hartwig, Sharkey, Stonewall, Centennial, and Coker 485 were rated as good as Forrest in resistance to the reniform nematode (Robbins et al., 1994; Robbins and Rakes, 1996). The public cultivars Cordell, Hartwig, Sharkey, Stonewall, and Centennial have resistance obtained from PI-90763, PI-437654, or Peking, and are also resistant to *H. glycines*. During the last few years there has been a tremendous increase in the number of private cultivars released with re-

TABLE 5. Reproduction of *Rotylenchulus reniformis* on 44 soybean cultivars of relative maturity group ≥ 6.0 in greenhouse pot tests after 11 weeks.

Cultivar ^a	Relative maturity group	Final population per pot ^b	Ratio of cultivar reproduction to Forrest ^c	Rating ^d
Fallow		636	0.103 o	R
SC91-2007 (SC)	7.0	3,262	0.526 no	R
Hartwig	5.3	5,025	0.726 m-o	R
Eagle ES 48N	6.0	5,782	0.834 l-o	R
Forrest	5.7	6,034	1.000	R
Asgrow A6711	6.7	7,880	1.068 k-n	R
Hartz Var. H6200	6.0	8,140	1.218 j-n	R
Southern Genetics SGA Boggs	6.6	9,662	1.362 i-n	R
Riverside 678	6.7	9,468	1.410 h-n	R
Asgrow A6297	6.3	11,095	1.553 g-n	R
Southern Genetics SGX68RR	6.8	1,934	1.616 f-n	R
Eagle ES 34	6.9	14,318	1.633 f-n	R
Asgrow A6785	6.7	2,357	1.634 f-n	R
Asgrow A6961	6.9	10,919	1.680 e-n	R
Stonewall	7.0	4,638	1.730 d-m	R
Eagle ES MA	6.0	13,206	1.833 c-m	R
Buckshot 66	6.9	12,627	1.883 c-m	R
TN 6-90	6.4	13,115	1.987 c-m	R
Eagle ES 35F	6.4	15,759	2.293 b-l	S
Southern Genetics SGA Benning	7.0	14,409	2.100 b-l	S
Sure-Grow SG 617RR	6.1	13,249	2.176 b-l	S
Hornbeck HBK 6800	6.8	16,220	2.206 b-l	S
SC89-147 (SC)	6.6	17,316	2.360 b-k	S
Southern Genetics SGA Haskell	7.0	15,687	2.423 b-k	S
Elite FFR 665	6.6	15,810	2.478 b-k	S
Asgrow A6101RR	6.1	21,513	2.529 b-k	S
Pioneer Var. P9631	6.3	17,390	2.609 b-k	S
Eagle ES 11	6.7	23,069	2.787 b-j	S
Dekalb DG 762	6.2	19,754	2.854 a-j	S
Musen	6.9	22,070	2.982 a-i	S
Novartis NK Brand S62-62	6.2	21,046	3.041 a-i	S
Pioneer Var. 96B01	6.0	22,247	3.113 a-i	S
R92-1258 (AR)	6.1	29,125	3.217 a-h	S
Cache	6.4	20,992	3.252 a-h	S
Deltapine DP6200RR	6.1	22,644	3.270 a-g	S
Hornbeck HBK 6600	6.6	22,101	3.305 a-g	S
Pioneer Var. 9692	6.9	22,352	3.350 a-g	S
Lamar	6.6	23,530	3.366 a-g	S
Hartz Var. H6191	6.9	23,927	3.577 a-f	S
Davis	6.4	22,494	3.607 a-f	S
Sure-Grow SGX66RR	6.7	25,134	3.668 a-e	S
Eagle ES 2-77	6.0	22,945	3.726 a-e	S
Sure-Grow SG 678RR	6.7	24,581	3.811 a-d	S
Dillon	6.7	25,505	3.938 a-c	S
Deltapine 8S60	6.0	27,051	3.986 a-c	S
Braxton	2.9	29,200	4.298 a-b	S
Hartz Var. H6255RR	6.5	34,646	4.376 ab	S
Pioneer Var. 9611	6.1	40,414	5.746 a	S

^a Hartwig and Forrest: resistant checks; Braxton: susceptible check; Fallow: infested soil with no host.

^b Final population per pot = mean of the total vermiform nematodes in the soil (500 cm³) + eggs and vermiform nematodes from egg masses in 5 replications at harvest.

^c Ratio of cultivar reproduction to Forrest data followed by the same letter are not significantly different ($P \leq 0.05$) according to Duncan's multiple-range test. Ratio means from data transformed by $\log_{10}(x + 1)$. Forrest ratio by definition = 1.000.

^d R: resistant; S: susceptible. Means > 1.990 are significantly larger than Forrest and are termed susceptible.

ported high yields and resistance to soybean cyst nematode. However, personal communications with private breeders and nematologists revealed that resistance to reniform nematode is not tested by many seed companies.

Sixteen germplasm lines out of 45 reported to have resistance to the soybean cyst nematode (*H. glycines*) were found to have reniform nematode resistance (Robbins and Rakes, 1996). Of 22 soybean accessions from PI-458024A through PI-540740 with resistance to *H. glycines*, 19 had reniform nematode resistance (Robbins and Rakes, 1998).

In soybean fields that exhibit seed yield loss due to reniform nematode, high-yielding cultivars with resistance are available. These cultivars should give cotton producers with a reniform nematode problem an alternative to nematicides for control of reniform nematode by rotation with resistant soybean. Rotation of resistant soybean cultivars and cotton combined with the use of reniform nematode-tolerant cottons (Cook et al., 1997) hold promise for future control of this pathogen in production systems that include both crops.

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