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Host Suitability in Soybean Cultivars for the Reniform Nematode, 2000 Tests[1]

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Abstract: In greenhouse pot experiments during summer 2000, 118 soybean cultivars were tested to determine their suitability as hosts for the reniform nematode, *Rotylenchulus reniformis*. The cultivars included 115 new entries into the Arkansas and Mississippi soybean variety testing programs and three entries submitted by an extension nematologist from Texas. Also included in the tests were the *R. reniformis*-resistant cultivars Forrest and Hartwig, the susceptible cultivar Braxton, and fallow *R. reniformis*-infested soil that served as controls. Total number of eggs and nematodes extracted from both the soil and roots from each pot and reproductive indices (Pf/Pi) were calculated for each cultivar. The ratio of the Pf/Pi of each cultivar to the Pf/Pi of Forrest (RF), and the log ratio[$\log_{10}$ (RF + 1)], are reported. Cultivars with reproductive indices that were greater than the reproductive index on Forrest were considered to be suitable hosts for *R. reniformis*. These data will be useful in the selection of soybean cultivars to use in rotation with cotton or other susceptible crops to help control the reniform nematode.

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

In 1998, 282 cultivars and lines entered in the Arkansas and Mississippi soybean variety testing programs were screened for resistance to reniform nematode (*Rotylenchulus reniformis* Lindford and Oliveira, 1940), and 93 of the cultivars were classed as resistant (Robbins et al., 1999). In 1999, an additional 226 cultivars and lines new to the Arkansas and Mississippi soybean variety testing programs and submitted by extension nematologists from Auburn University and Louisiana State University were screened for host suitability for reniform nematode. Fifty-six of the cultivars were as resistant as Forrest, which served as an *R. reniformis*-resistant standard (Robbins et al., 2000). Tests previous to 1998 by various authors reporting reniform nematode resistance in soybean, the history of the spread of reniform nematodes on soybean, the relationship of reniform resistance in soybean to that of the soybean cyst nematode (*Heterodera glycines*), and effects of the nematode on seed yield were discussed and summarized (Robbins et al., 1999).

One hundred fifteen additional soybean cultivars and lines entered in the 2000 Arkansas and Mississippi soybean variety testing programs, as well as three cultivars submitted by an extension nematologist from Texas, were tested in a greenhouse pot study to determine their host suitability for *R. reniformis*. The objective of the study was to identify new soybean cultivars that are poor hosts for the reniform nematode that would be useful for rotation with cotton or other susceptible crops in reniform nematode-infested fields.

Materials and Methods

Soybean cultivars and lines from both private and public sources were included in this test. Seeds of all cultivars were germinated in vermiculite and transplanted into 10-cm-diam. clay pots containing 500 cm^3 of pasteurized fine sandy loam soil (ca. 91% sand, 5% silt, 4% clay, <1% O.M.). Inoculum from the same source as used in the 1998 and 1999 tests was obtained by washing the soil from the roots of the susceptible cultivar Braxton grown in the greenhouse for at least 10 weeks, suspending the nematodes in water, and pouring the nematode suspension through nested 850- and 38-µm-pore sieves. The material on the 38-µm-pore sieve was placed on a tissue in a Baermann funnel. All vermiform stages of *R. reniformis* were collected after 16 hours. On the same day a total of 2,256 nematodes were injected with an autopipe into three, 2.5-cm-deep holes made in the soil in each pot containing one seedling in the cotyledon stage. Pots were arranged in a randomized complete block design, with five replications per cultivar. Soybean cultivars Forrest and Hartwig were included as resistant controls and Braxton as a susceptible control. Reniform nematode-infected fallow soil was included as a survival baseline control in the absence of a host. Due to damping off, two cultivars ended the test with only three replications and 22 cultivars ended with four replications. The experiment was conducted in a greenhouse with the ambient temperature maintained at 28 to 34 °C. All pots were watered twice daily (8 a.m. and 4 p.m.) and fertilized each week with 20-20-20 (N-P-K) fertilizer.

After 10 weeks (July 7–September 15), the number of reniform nematode eggs and vermiform nematodes contained in egg masses on the roots and the numbers 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 counted. To calculate the final reniform nematode soil population (Pf), a 100-cm^3 aliquot of well-mixed soil from each pot was suspended in water and poured

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TABLE 1. Reproduction of *Rotylenchulus reniformis* on 118 selected soybean cultivars and lines.

Cultivar (RMG)[a]	Count per pot[b]	Pf/Pi[c]	RF ratio[d]	Log ratio[e]	Reps[f]
Hornbeck Seed HBK X555-00 (5.5)	209,050	92.66	75.34	1.86	5
DT97-4290 USDA-ARS (4.9)	166,356	73.74	59.95	1.68	5
Eagle Seed ES 5000RR (5.5)	139,770	61.95	50.37	1.67	4
MFA Morsoy 5080 (5.0)	147,900	65.56	53.30	1.67	4
Hornbeck Seed HBK X590-00 (5.9)	121,728	53.96	43.87	1.63	5
Progeny Ag Products EK XP5100 (5.0)	135,182	59.92	48.72	1.63	5
Braxton (Check)	123,264	54.64	44.42	1.63	5
TN 93-142-17 Tennessee (6.0)	116,544	51.66	42.00	1.61	5
MFA Morsoy 5108N (5.1)	124,896	55.36	45.01	1.61	5
MFA Morsoy 5050 (5.0)	108,240	47.98	39.01	1.59	3
Progeny Ag Products EK XP 4901RR (4.9)	116,712	51.73	42.06	1.58	5
MFA Morsoy 4850 (4.8)	115,836	51.35	41.74	1.56	5
Asgrow AG 4324 (4.3)	104,250	46.21	37.57	1.57	4
Delta Grow Seed Excel (5.8)	141,444	62.70	50.97	1.57	5
Advanced Seed Test AST-25RR (5.2)	119,250	52.86	42.97	1.56	4
Deltapine 4344RR (4.3)	108,632	48.15	39.15	1.55	5
Advanced Seed Test AST-82 (5.8)	105,459	46.75	38.00	1.53	4
Dyna-Gro 3582N RR (5.9)	101,730	45.09	36.66	1.52	4
Novartis Seeds NK X053R (5.3)	98,280	43.56	35.42	1.51	5
Croplan Genetics 5770RR (5.7)	99,456	44.09	35.84	1.48	5
Asgrow AG5902 (5.9)	109,061	48.34	39.30	1.48	5
Southern States Exp4899 (4.8)	98,568	43.69	35.52	1.48	5
Asgrow AG 4403 (4.4)	85,008	37.68	30.63	1.47	5
R96-209 Arkansas (5.2)	145,538	64.51	52.45	1.47	5
Progeny Ag Products EK XP5050RR (5.0)	83,040	36.81	29.93	1.46	4
Pioneer Brand 9492RR (4.9)	99,180	43.96	35.74	1.45	4
Pioneer Brand 94B01RR (4.0)	78,336	34.72	28.23	1.45	5
DEKALB DKB 44-51 (4.4)	104,256	46.21	37.57	1.44	5
Novartis Seeds NK X056 (5.6)	76,872	34.07	27.70	1.44	5
Hartz H5231RR (5.3)	87,090	38.60	31.39	1.43	4
Hartz H5885RR (5.8)	83,616	37.06	30.13	1.43	5
Armor Seed X1035 (5.3)	71,328	31.62	25.70	1.42	5
Hornbeck Seed HBK X630-00 (6.3)	71,592	31.73	25.80	1.41	5
Progeny Ag Products EK XP5585 (5.5)	100,344	44.48	36.16	1.41	5
R95-2210 Arkansas (5.9)	84,984	37.67	30.63	1.40	5
TN 93-87 Tennessee (4.8)	128,237	56.84	46.21	1.39	5
Terral TVX50R901 (5.0)	88,661	39.30	31.95	1.38	5
Hornbeck Seed HBK X631-00 (6.3)	66,456	29.46	23.95	1.38	5
Southern States 4985STS (4.9)	87,451	38.76	31.52	1.38	5
Southern States 597N (5.9)	88,752	39.34	31.98	1.38	5
Delta King 5267 RR (5.2)	80,556	35.71	29.03	1.38	5
Delta Grow 4740 (4.7)	62,280	27.61	22.44	1.37	5
Terral TVX47C902 (4.7)	67,176	29.78	24.21	1.37	5
MFA Morsoy RT5900N (5.9)	77,547	34.37	27.95	1.37	4
Deltapine 5541RR (5.5)	84,108	37.28	30.31	1.35	5
Southern States Exp5409N (5.4)	96,386	42.72	34.74	1.34	5
Delta Grow 5630RR (5.6)	59,208	26.24	21.34	1.34	5
Eagle Seed ES 5700RR (5.7)	58,409	25.89	21.05	1.33	5
South States ExpRT5609 (5.6)	78,257	34.69	28.20	1.33	5
TN 94-213 Tennessee (5.7)	89,009	39.45	32.08	1.32	5
Vernal (6.0)	74,906	33.20	26.99	1.30	5
Midwest Premium Genetics MPV 519NRR (5.1)	99,492	44.10	35.85	1.30	5
Terral TV4589RR (4.5)	53,952	23.91	19.44	1.30	5
Dyna-Gro 3562NRR (5.6)	64,764	28.71	23.34	1.29	5
South States ExpRT5399 (5.3)	53,712	23.81	19.36	1.29	5
MFA Morsoy RT 4729SCN (4.7)	50,764	22.50	18.29	1.28	3
Midwest Premium Genetics MPV 457NRR (4.5)	56,234	24.93	20.27	1.28	5
Terral TVX49R901 (4.9)	67,099	29.74	24.18	1.27	5
Armor Seed X1074 RR (4.7)	51,363	22.77	18.51	1.27	4
MFA Morsoy RT5990N (5.9)	49,698	22.03	17.91	1.26	4
Garst Seed D472RR/N (4.6)	56,472	25.03	20.35	1.26	5
Southern States SS ExpRT46704 (5.0)	62,203	27.57	22.42	1.26	5
MFA Morsoy 5220N (5.2)	51,893	23.00	18.70	1.26	5
Dyna-Gro 3521NRR (5.1)	57,002	25.27	20.54	1.25	5
South States RT6299N (6.3)	47,414	21.02	17.09	1.25	5
MFA Morsoy RT 5540N (5.4)	48,739	21.60	17.56	1.23	5
MFA Morsoy 4580 (4.5)	85,594	37.94	30.85	1.22	5

TABLE 1. Continued

Cultivar (RMG)[a]	Count per pot[b]	Pf/Pi[c]	RF ratio[d]	Log ratio[e]	Reps[f]
Deltapine 4748S (4.7)	67,406	29.88	24.29	1.22	5
Progeny 4910 (4.7)	44,562	19.75	16.06	1.21	4
Southern States RT4980 (4.9)	58,838	26.08	21.20	1.20	5
Hartz H4884RR (4.8)	42,761	18.95	15.41	1.18	5
Progeny AG Products EK XP 4800 (4.8)	75,511	33.47	27.21	1.18	5
Croplan Genetics 4979RR (4.9)	42,667	18.91	15.38	1.18	5
Terral TVX 5794RR (5.7)	39,588	17.55	14.27	1.18	5
MFA Morsoy RT 5110N (5.1)	47,578	21.09	17.15	1.16	5
Pioneer Brand 94B53 (4.5)	57,915	25.67	20.87	1.16	4
Novartis Seeds NK X57R (5.7)	45,955	20.37	16.56	1.16	5
Delta King 5366 RR (5.3)	57,466	25.47	20.71	1.15	5
Hornbeck Seed HBK XR535-00 (5.3)	58,270	25.83	21.00	1.15	5
Deltapine DPX 5877 (5.8)	51,158	22.68	18.44	1.15	5
Advanced Seed Test AST-41RR (5.4)	42,017	18.62	15.14	1.13	5
Terral TV4787RR (4.7)	43,485	19.28	15.67	1.13	4
Santa-Rosa-R (6.0)	47,148	20.90	16.99	1.12	5
Progeny Ag Products EK XP5660 RR (5.6)	54,374	24.10	19.60	1.10	5
Hornbeck Seed HBK XR575-99 (5.9)	40,853	18.11	14.72	1.09	5
Terral TVX54R908 (5.4)	41,682	18.48	15.02	1.08	4
Terral TVX62R901 (6.2)	37,867	16.79	13.65	1.08	5
Armor Seed X1025 (5.2)	54,218	24.03	19.54	1.08	5
Garst Seed529RR (5.3)	39,084	17.32	14.08	1.06	5
Dyna-Gro 3535N RR (5.3)	43,461	19.26	15.66	1.05	4
Hornbeck Seed HBK R4920 (4.9)	40,298	17.86	14.52	1.04	5
Armor Seed X1094 RR (4.9)	38,813	17.20	13.99	1.04	5
Dyna-Gro 3484N RR (4.8)	34,800	15.43	12.54	1.04	5
Novartis Seeds NK Brand S57-A4 (5.7)	34,109	15.12	12.29	1.02	5
Delta King 5668 RR (5.6)	65,206	28.90	23.50	1.01	5
Delta Grow 5310RR (5.3)	49,562	21.97	17.86	1.01	5
Eagle Seed ES 123P-RR (5.9)	36,843	16.33	13.28	1.01	4
Terral TVX48R908 (4.8)	29,894	13.25	10.77	1.00	5
Progeny 5410RR (5.5)	33,002	14.63	11.89	0.99	5
Garst Seed D484 (4.8)	27,569	12.22	9.94	0.97	5
Terral TVX52R901 (5.2)	29,232	12.96	10.53	0.97	5
Croplan Genetics 6299RR (6.2)	27,706	12.28	9.98	0.94	5
MFA Morsoy RT4889N (4.8)	30,331	13.44	10.93	0.94	5
Terral TV4886RR (4.8)	48,425	21.46	17.45	0.94	5
Hornbeck Seed HBK X570-00 (5.7)	30,610	13.57	11.03	0.93	5
Deltapine DPX 4910S (4.9)	29,796	13.21	10.74	0.92	5
Terral TVX59R901 (4.9)	26,430	11.72	9.52	0.90	4
Terral TVX48R901 (4.8)	21,346	9.46	7.69	0.89	5
Southern States Exp5709 (5.7)	40,634	18.01	14.64	0.88	5
Eagle Seed ES 4902 RR (4.9)	30,137	13.36	10.86	0.87	5
Eagle Seed ES 4900 RR (5.0)	22,745	10.08	8.20	0.77	5
Delta King 5465 RR (5.4)	24,055	10.66	8.67	0.75	5
Progeny Ag Products EK XP 4858 RR (4.8)	13,461	5.97	4.85	0.68	4
Southern States RT5999N (5.9)	19,339	8.57	6.97	0.63	5
Padre (6.0)	8,586	3.81	3.09	0.59	4
S96-2641 Missouri (5.9)	20,112	8.91	7.25	0.58	5
Hartwig (check)	4,111	1.82	1.48	0.38	5
S96-2692 Missouri (5.5)	3,612	1.60	1.30	0.34	5
Forrest (check)	2,764	1.23	1.00	0.30	5
Delta Grow 5940 (5.9)	2,358	1.05	0.85	0.26	4
S94-1867 Missouri (5.8)	1,630	0.72	0.59	0.19	5

[a] Cultivar includes released varieties, experimental varieties, and breeding lines. Forrest and Hartwig = resistant checks; Braxton = susceptible check. Relative Maturity Group is listed in parentheses following the cultivar name.

[b] Final population of eggs from roots and vermiform nematodes from 500 cm^3 soil in pots inoculated with 2,256 vermiform nematodes.

[c] Reproductive index (RI) = final population/initial population (Pf/Pi). The value of cutoffs for RI significantly ($P \leq 0.05$) larger than Forrest are 18.01 for 5 replications, 20.02 for 4 replications, and 22.96 for 3 replications.

[d] Ratio of cultivar reproduction to Forrest reproduction (RF).

[e] Log ratio of RF from transformed data ($\log_{10}$ [RF + 1]). RF of Forrest = 1. Log_{10} (1 + 1) = 0.301. Cutoffs for log ratios being significantly larger than 1 are: 0.624 for 5 replications, 0.662 for 4 replications, and 0.717 for 3 replications. The LSD to compare any pair of log ratios is 0.456.

[f] Number of replications per cultivar.

through nested 850- 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. A reproductive index (RI), defined as the number of eggs + vermiform nematodes at test termination (Pf)/ initial inoculation level (Pi), was calculated for each cultivar. In addition, the ratio of the RI of each cultivar to the RI of Forrest (RF) and the log ratio[$\log_{10}$(RF + 1)] were analyzed as a randomized complete block using analysis of variance. Log ratio transformations were used because of the high degree of variation in nematode counts within a cultivar. Cultivar means were separated using a protected LSD at $P = 0.05$, where appropriate. Cultivars were considered suitable hosts if their log-ratio means were significantly higher than $\log_{10}$ (2) $\cong$ 0.301. Cultivars were considered suitable at log-ratios higher than 0.624 when $n = 5$, 0.662 when $n = 4$, and 0.717 when $n = 3$. All statistical analyses were carried out using SAS version 7 (SAS Institute, Cary, NC).

RESULTS

All cultivars supported some reniform nematode reproduction. Mean survival of reniform nematode in the infested fallow pots was 420 nematodes or 19% of the inoculation number and 15.2% of the number found on Forrest. The mean Pf and the RI (in parentheses) of the resistant control cultivars Forrest and Hartwig and the susceptible control cultivar Braxton were 2,764 (1.23), 4,111 (1.82), and 123,264 (54.64), respectively. The log ratio[$\log_{10}$(RF + 1)] was used to determine host suitability because of the great variability of counts for many of the cultivars. Of the 118 cultivars and lines tested, only the cultivars Delta Grow 5940, Padre, and the three Missouri lines s94-1867, s96-2692, and s96-2641 were comparable to Forrest in host suitability, whereas the remaining 113 cultivars were suitable hosts (Table 1). Only Delta Grow 5940, Padre, and the Missouri line s94-1867 supported numerically lower reniform nematode reproduction than Forrest (Table 1).

DISCUSSION

In this study the nematode survival in the fallow check (Pf/Pi = 0.19) was lower than for previous tests in 1998 and 1999, whereas the RI for the susceptible Braxton was higher (Robbins, et al., 1999, 2000). The RI for the resistant cultivars Forrest and Hartwig were intermediate between those found in 1998 and 1999. The range of the RF values of the cultivars in this study (range = 0.72 to 92.66) was more similar to the range in RF values found in 1999 (range = 0.34 to 70.89) than in 1998 (range = 0.17 to 5.75). The duration of this test was 10 weeks; the duration of the 1998 and 1999 tests was 11 weeks and 9 weeks, respectively. As in the earlier studies (Robbins et al., 1999, 2000), a greater number of later-maturing cultivars (RMG 4.5 or later) were poor hosts for the reniform nematode.

This work and earlier studies (Robbins et al., 1999, 2000) demonstrate that, while the majority of soybean cultivars available to southern growers are good hosts for *R. reniformis*, a few are relatively poor hosts. In soybean fields where reniform nematode population densities are sufficiently high to be of economic concern, these cultivars may limit yield suppression. In addition, the cultivars that are relatively poor hosts may be of considerable value in crop rotation programs by lowering population densities for subsequent highly susceptible crops such as cotton. Rotation with appropriate soybean cultivars in combination with the use of reniform nematode-tolerant cotton cultivars (Cook et al., 1997) may hold considerable promise for managing this nematode in southern cropping systems.

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