RENIFORM NEMATODE REPRODUCTION ON SOYBEAN CULTIVARS AND BREEDING LINES IN 2016

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Abstract

In 2016, 142 private soybean cultivars and lines from the Arkansas Variety Testing Program and 211 breeding lines and varieties from Public Soybean Breeders: 5 from USDA Jackson TN (Arelli), 35 from Arkansas (Chen), 17 from Missouri (Shannon), 91 from Southern Illinois (Kantartzi), 19 from Clemson (Fallen), and 44 from Georgia (Li) were tested in the greenhouse to determine their suitability as hosts for the reniform nematode (RN), *Rotylenchulus reniformis*. Resistant soybean lines provide an economically effective management tactic to suppress RN population densities for a subsequent cotton crop. All genotypes were inoculated with 2,000 vermiform RN in two separate greenhouse studies grown for 84 days. The RN resistant varieties Anand and Hartwig, the RN susceptible cultivars Braxton and Ellis, and fallow reniform nematode infested soil (to show survival without a host) served as controls. The reproductive index (RI = Pf/Pi) was calculated based on the average number of vermiform nematodes extracted from the soil of each treatment. Soybean lines with a greater (P = 0.05) RI than the resistant controls were considered suitable hosts for *R. reniformis*. Of the 142 Arkansas Variety test lines, 137 were considered suitable hosts; however private lines Dyno-Gro S49xs76, Delta Grow DG4995 RR, Armor AR5206C, Go Soy 4914GTS, and Go Soy 49G16 had a magnitude of resistance that was similar to the resistant checks. The Reniform nematode did not reproduce more than the resistant checks on Anand (22 of the 211) and on Hartwig (17 of the 211) on breeding lines and varieties submitted by the Public Soybean Breeders. These lines may be of interest for developing reniform resistant cultivars in a soybean breeding programs. The five commercially available soybean lines from the Arkansas variety test may be useful in a cotton - soybean rotation to reduce the numbers of reniform nematodes and allow cotton to be grown economically.

Introduction

The reniform nematode (*Rotylenchulus reniformis*) causes considerable damage and yield loss to cotton in the United States from the middle-Atlantic states south then west thru Texas. Presently no commercial upland cotton varieties have reniform nematode resistance, whereas several sources of reniform nematode resistance exist in soybean. Soybean reniform nematode resistance is most often linked to resistance to the soybean cyst nematode (SCN (*Heterodera glycines*)) obtained from Peking, PI90763, and PI437654. It has been shown that SCN resistance obtained from PI-88788 lacks resistance to reniform nematode (Robbins & Rakes, 1996). This is unfortunate because the majority (about 98%) of soybean varieties with SCN resistance are linked to PI 88788. The reniform nematode non-host crops of corn, sorghum and rice would also be useful in rotation with cotton.

The use of reniform nematode resistant soybean in a rotation with cotton can be a useful management option. Public soybean breeding lines from programs at the University of Arkansas, Clemson University, University of Missouri, University of Southern Illinois, and USDA from Jackson Tennessee that have a low rate of reniform nematode reproduction may prove very useful in breeding soybean for reniform nematode resistance.

Information on the reproduction of the reniform nematode on contemporary soybean cultivars is limited. Robbins, et al. (1994) reported on the reproduction of the reniform nematode on 30 soybean cultivars. In 1996, Robbins & Rakes reported reniform nematode reproduction on 16 soybean cultivars, 45 germplasm lines, and the differentials used in the soybean cyst nematodes race determination tests (Peking, PI90763, PI88788). A history of the reniform nematode in the South was given to the Southern Soybean Disease Workers (Robbins 2013b). During the 1999 to 2016 period yearly tests have determined the host status for over 2,600 soybean lines (Robbins et al., 1999, 2000, 2001, 2002, 2003, 2004, 2005, 2006, 2007a, 2008, 2009, 2010, 2011, 2012, 2013a, 2014, 2015, 2016). These papers are the basis for reniform nematode reproduction information on contemporary soybean lines. The breeding lines tested for reniform nematode reproduction are given by Robbins et al. (2007b, 2008, 2009, 2010, 2011, 2012, 2013a, 2014, 2015, and 2016).

The objectives of the 2016 studies were to: 1) identify new soybean cultivars that are poor hosts for the reniform nematode that could be useful in rotation with cotton or other reniform nematode susceptible crops in reniform nematode infested fields. 2) to identify useful breeding soybean lines for use in selection of new reniform nematode resistant cultivars and 3) to list useful lines for cotton-soybean rotations from 2012 to 2016.

Materials and Methods

The soybean lines and cultivars tested in 2016 were from both private and public sources. 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 (approximately 86% sand, 8% silt, 6 % clay, <1% O.M.) for the private lines and 8 ounce Styrofoam cups containing 180 cm^3. The reniform nematode inoculum 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. A total of 2,000 vermiform reniform nematodes were injected with an autopipe into two, 2.5 cm-deep holes made in the soil in each pot containing one seedling in the cotyledon stage the day of transplanting. Pots were arranged in a randomized complete block design, with five replications per line or cultivar. Soybean cultivars Anand and Hartwig were included as resistant controls, Braxton as a susceptible control and an inoculated pot with no plant (fallow) as an inoculum survivor control. After 84 days the number of vermiform reniform nematodes in the soil of each pot was determined (Jenkins, 1974). 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 Anand (RA) and Hartwig (RH) was calculated. The log ratio data of both [log10 (RA + 1)] and [log10 (RH + 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. All statistical analyses were carried out using SAS version 8 (SAS Institute, Cary, NC).

Results

Of the 144 Arkansas Variety test lines, 139 were considered suitable hosts to reniform; however; Dyno-Gro S49xs76, Delta Grow DG4995 RR, Armor AR5206C, Go Soy 4914GTS, and Go Soy 49G16 had a magnitude of resistance that was similar to the highly resistant controls Anand and Hartwig. These commercially available reniforn nematode resistant soybean lines may be useful in a cotton - soybean rotation to reduce the numbers of reniform nematodes and allow the economically growing of cotton (Table 1).

The reniform nematode did not reproduce more than Anand on 22 lines (17 than Hartwig) of the 211 breeding lines and varieties submitted by Public Soybean Breeders. These lines may be of interest for developing reniform resistant cultivars in a soybean breeding programs (Table 2).

Public breeding lines with a useful level of reniform resistance in varieties and breeding lines tested in 2016 are listed in Table 2. Of 2016's 211 public breeding lines, varieties, and lines up to 22 would be useful in reniform resistance breeding programs. In table 3 all soybean varieties with levels of resistance to reniform nematode useful in cotton-soybean rotations of tests since 2013 are listed. Annual Reproductive Indexes of Reniform nematode have been reported by the senior author since 1998. Finding the older varieties may be a challenge as many private varieties last only a very few seasons (years).

Table 1. *Rotylenchulus* reniformis data of Average Soil Count per Pot (500 $cm^{3)}$, Reproduction index (Pf/Pi) and Disease Rating on 144 selected soybean cultivars and lines from the Arkansas Soybean Variety Testing Program 2016 tests.

Test line	Converted RI	Soil Count	RI (Pf/Pi)	Disease Rating
Fallow	0.2471	432	0.22	Survival Check
Anand	0.7923	1676	0.84	Resistant Check
Go Soy 49G16	0.8851	1608	0.80	Resistant
Hartwig	0.9224	1752	0.88	Resistant Check
Go Soy 5214GTS	0.9622	1704	0.85	Resistant
Armor AR5206C	1.1331	2208	1.10	Resistant
Delta Grow DG4995 RR	1.1792	2352	1.18	Resistant
Dyna-Gro S49XS76	2.2243	4668	2.33	Resistant
Asgrow AG 53X6	4.5077	9352	4.68	Moderate Resistant
Progeny P 5016RXS	4.7061	17464	8.73	Moderate Resistant
GS43R216	4.8891	14096	7.05	Moderate Resistant
USG 7536XT	6.0282	14528	7.26	Moderate Susceptible
Progeny P 4588RY	6.3838	33540	16.77	Moderate Susceptible
GS48R216	6.3864	22136	11.07	Moderate Susceptible
NK S42-E5 Brand	6.6659	18852	9.43	Moderate Susceptible
Delta Grow DG4977 LL/STS	6.6665	21420	10.71	Moderate Susceptible
Armor 47-D17	6.9977	25128	12.56	Moderate Susceptible
AvDx-F216	7.7595	20476	10.24	Susceptible
LG C4615RX	8.4202	25024	12.51	Susceptible
Delta Grow DG4790 RR2	8.4259	21048	10.52	Susceptible
Armor 48-D24	8.5049	26472	13.24	Susceptible
Delta Grow DG5580 RR2	8.9822	24976	12.49	Susceptible
Eagle Seed ES4998RR	9.3841	44260	22.13	Susceptible

AvZx-D515	9.4255	30032	15.02	Susceptible
GS45R216	9.7756	20840	10.42	Susceptible
NK S47-C8 Brand	9.8637	25808	12.90	Susceptible
Progeny P 4944RX	9.9507	25016	12.51	Susceptible
Asgrow AG 42X6	10.0095	40492	20.25	Susceptible
Armor 47-R70	10.0192	23828	11.91	Susceptible
S12-4718	10.281	38242	19.12	Susceptible
Progeny P 5768RX	10.6956	37468	18.73	Susceptible
GS47R216	10.878	28356	14.18	Susceptible
REV® 49L49™	11.0433	38332	19.17	Susceptible
Go Soy 4912LL	11.3297	54404	27.20	Susceptible
Eagle Seed ES4870RYX	11.4131	25568	12.78	Susceptible
Go Soy 4913LL	11.9034	25316	12.66	Susceptible
Go Soy 483.C	12.3958	32404	16.20	Susceptible
S12-3782	12.4277	40164	20.08	Susceptible
Delta Grow DG4845 RR2X	12.5615	33236	16.62	Susceptible
REV® 48A76™	12.5809	27580	13.79	Susceptible
Mycogen 5N424R2	12.6553	34368	17.18	Susceptible
Armor ARX4706	12.6843	33296	16.65	Susceptible
NK S49-B1 Brand	12.9002	31172	15.59	Susceptible
Progeny P 4516RXS	13.0216	39992	20.00	Susceptible
REV® 45A46™	13.1983	35176	17.59	Susceptible
Delta Grow DG4680 RR2	13.2062	34936	17.47	Susceptible
Delta Grow DG4781 LL	13.5608	30376	15.19	Susceptible
Delta Grow DG4855 RR2X/STS	13.7022	47336	23.67	Susceptible
Eagle Seed ES4460RYX	13.7631	33220	16.61	Susceptible
AvDx-E816	13.8944	34236	17.12	Susceptible
NK S48-D9 Brand	14.5926	43048	21.52	Susceptible
Mycogen 5N480R2	14.8599	35344	17.67	Susceptible
Armor AR4906	14.9251	39412	19.71	Susceptible
CZ 4898 RY	15.0263	36320	18.16	Susceptible
Asgrow AG 48X7	15.4733	46256	23.13	Susceptible
Progeny P 4613RYS	16.2631	41332	20.67	Susceptible
Delta Grow DG5461 LL	16.3009	43124	21.56	Susceptible
Asgrow AG 49X6	16.41	29200	14.60	Susceptible
LG C4900RX	16.4519	48984	24.49	Susceptible
Eagle Seed ES5930RYX	16.457	50828	25.41	Susceptible
USG 74B83RS	16.7662	35784	17.89	Susceptible
Dyna-Gro S48XT56	16.8053	30900	15.45	Susceptible
Asgrow AG 46X6	16.9753	51864	25.93	Susceptible
UAX 59313GT	17.102	33300	16.65	Susceptible
AvDx-D916	17.1153	56884	28.44	Susceptible
UAX 59013C	17.3088	63746	31.87	Susceptible

Eagle Seed ES4680RYX	17.8213	59632	29.82	Susceptible
Delta Grow DG5170 RR2/STS	18.0573	49936	24.97	Susceptible
MSX 48XDS1	18.295	43552	21.78	Susceptible
Asgrow AG 55X7	18.4105	44452	22.23	Susceptible
NK S52-Y2 Brand	18.9084	51592	25.80	Susceptible
Armor 48-D80	19.0414	40960	20.48	Susceptible
USG 7506XTS	19.2169	59604	29.80	Susceptible
S12-3791	19.2783	33800	16.90	Susceptible
USG 7487XTS	19.6093	66760	33.38	Susceptible
UAX 59012C	19.7258	66000	33.00	Susceptible
Armor 43-D34	19.7777	34400	17.20	Susceptible
Mycogen 5N406R2	19.9483	50136	25.07	Susceptible
Asgrow AG 45X6	20.8199	35920	17.96	Susceptible
UAX 5102	20.8395	52492	26.25	Susceptible
Shillinger e4510	20.8687	61156	30.58	Susceptible
Asgrow AG 47X6	21.058	46000	23.00	Susceptible
Blue River 50SK7	21.7805	66248	33.12	Susceptible
Eagle Seed ES5650RR	22.0545	68372	34.19	Susceptible
Asgrow AG 44X6	22.1668	60772	30.39	Susceptible
MSX 46XDS1	22.1765	64900	32.45	Susceptible
Delta Grow DG5067 LL	22.4586	39600	19.80	Susceptible
Progeny P 4816RX	22.5426	48980	24.49	Susceptible
Armor AR 49-61	22.6121	50116	25.06	Susceptible
Armor 44-D40	22.6612	45900	22.95	Susceptible
CZ 4222 LL	22.712	44280	22.14	Susceptible
Dyna-Gro S49XT07	23.1144	43500	21.75	Susceptible
Mycogen 5N414R2	23.5457	75556	37.78	Susceptible
LG C4845RX	24.4738	58700	29.35	Susceptible
Go Soy 4814GTS	24.5531	44500	22.25	Susceptible
Progeny P 4799RXS	24.5736	48020	24.01	Susceptible
NK S47-K5 Brand	24.6303	81504	40.75	Susceptible
Blue River 47FC7	25.2844	72548	36.27	Susceptible
Armor AR4606	25.7486	47540	23.77	Susceptible
Go Soy 42L16	26.3035	68916	34.46	Susceptible
Eagle Seed ES5420RYX	26.5801	71076	35.54	Susceptible
NK S45-W9 Brand	27.1833	54500	27.25	Susceptible
Eagle Seed ES5015RYX	27.5008	70540	35.27	Susceptible
UAX 59011C	27.548	88388	44.19	Susceptible
USG 7496XTS	28.1712	52680	26.34	Susceptible
S12-2418	28.2873	79128	39.56	Susceptible
Dyna-Gro S45XS66	28.6462	55780	27.89	Susceptible
NK S42-P6 Brand	28.6877	53460	26.73	Susceptible
Dyna-Gro S45LL97	28.8119	74160	37.08	Susceptible

Delta Grow DG4587 LL/STS	28.9341	58120	29.06	Susceptible
USG 756XT	29.3743	68020	34.01	Susceptible
Armor ARX5506	29.674	72480	36.24	Susceptible
Armor 46-D08	29.6816	50900	25.45	Susceptible
MSX 49XD1	29.7663	61760	30.88	Susceptible
UAX 59113GT	30.6595	57800	28.90	Susceptible
Delta Grow DG4545 RR2X/STS	31.1105	55020	27.51	Susceptible
Mycogen 5N433R2	31.1294	62700	31.35	Susceptible
Armor 39-D90	31.3517	91664	45.83	Susceptible
Armor ARX4906	31.3776	96300	48.15	Susceptible
Go Soy 43L16	32.0304	56700	28.35	Susceptible
REV® 48L63™	32.1366	91400	45.70	Susceptible
USG 7497XT	33.4315	69020	34.51	Susceptible
Dyna-Gro SX16844XS	33.9079	62900	31.45	Susceptible
Armor 53-D04	34.1866	58660	29.33	Susceptible
Asgrow AG 4632	34.9293	66680	33.34	Susceptible
CZ 4656 RY	35.0261	65260	32.63	Susceptible
Progeny P 4620RXS	35.4178	62800	31.40	Susceptible
Asgrow AG 46X7	35.601	76160	38.08	Susceptible
USG 7557XT	36.0206	65700	32.85	Susceptible
Shillinger e4892	36.3736	65700	32.85	Susceptible
Dyna-Gro S45XS37	37.0855	72760	36.38	Susceptible
NK S56-M8 Brand	37.8131	67220	33.61	Susceptible
Progeny P 5417RX	38.5454	79600	39.80	Susceptible
Shillinger e4993	39.5728	71100	35.55	Susceptible
Armor 49-D66	40.2734	83800	41.90	Susceptible
Armor 49-D90	40.4218	68560	34.28	Susceptible
Progeny P 4247LL	41.0544	87700	43.85	Susceptible
Asgrow AG 54X6	44.0006	86000	43.00	Susceptible
UAX 51010	45.345	100020	50.01	Susceptible
Armor 55-R68	46.0664	88100	44.05	Susceptible
REV® 48A26™	46.5067	81920	40.96	Susceptible
MSX 49XD3	49.5712	93800	46.90	Susceptible
GS4915R2	50.1182	93100	46.55	Susceptible
USG 7547XT	57.01	119900	59.95	Susceptible
UAX 59111C	59.6877	108900	54.45	Susceptible
Ellis	62.061	133300	66.65	Susceptible Check
Braxton	82.804	167400	83.70	Susceptible Check

Blue = Resistant
Red = Moderate Resistant
Green = Moderate Susceptible
Black = Susceptible

Table 2. *Rotylenchulus reniformis* data of Breeder, Line, Soil Count Average per Pot (500 cm^3), Reproduction Index = (Pf/Pi) and Disease Rating on 219 selected soybean breeding lines from cooperating Southern Soybean Breeders 2015 tests.

Test Line	Breeder	Soil Count	RI (Pf/Pi)	Disease Rating
Fallow		324	0.16	Survival Check
S14-7233	Shannon	2860	1.43	Resistant
S13-1805	Shannon	3729	1.86	Resistant
S13-11733	Shannon	3972	1.99	Resistant
Hartwig		4553	2.28	Resistant Check
SC13-5535RR1	Fallen	4839	2.42	Resistant
SC12-5712R2	Fallen	4866	2.43	Resistant
S14-9999	Shannon	5160	2.58	Resistant
S14-3831	Shannon	5280	2.64	Resistant
Anand		5840	2.92	Resistant Check
S14-9017	Shannon	5960	2.98	Resistant
S14-8982	Shannon	6560	3.28	Resistant
SC10-07	Fallen	6618	3.31	Resistant
JTN-5316	Arelli	6760	3.38	Resistant
G13-3461R2	Li	6900	3.45	Resistant
JTN-5516	Arelli	7020	3.51	Resistant
S14-9051	Shannon	7080	3.54	Resistant
SC12-5713R2	Fallen	7233	3.62	Resistant
G13-1121R2	Li	10440	5.22	Moderate Resistant
ExF12	Kantartzi	14100	7.05	Moderate Resistant
ExF1	Kantartzi	15058	7.53	Moderate Resistant
G13-2300R2	Li	15180	7.59	Moderate Resistant
G13-1699R2	Li	15280	7.64	Moderate Resistant
R13-1019	Chen	15580	7.79	Moderate Resistant
ExF39	Kantartzi	17420	8.71	Moderate Resistant
ExF10	Kantartzi	17600	8.80	Moderate Resistant
Forrest (Tartartzi CK)	Kantartzi	19400	9.70	Moderate Resistant
JTN-5216	Arelli	19940	9.97	Moderate Resistant
ExF59 B	Kantartzi	20260	10.13	Moderate Susceptible
ExF88	Kantartzi	23240	11.62	Moderate Susceptible
ExF76	Kantartzi	23620	11.81	Moderate Susceptible
S11-16882	Shannon	28380	14.19	Moderate Susceptible
R12-514	Chen	28574	14.29	Moderate Susceptible
S14-4034	Shannon	30360	15.18	Moderate Susceptible
SC14-5503R2	Fallen	30760	15.38	Moderate Susceptible
ExF17	Kantartzi	31640	15.82	Moderate Susceptible

JTN-5416	Arelli	32756	16.38	Moderate Susceptible
ExF2	Kantartzi	35227	17.61	Moderate Susceptible
ExF7	Kantartzi	38720	19.36	Moderate Susceptible
ExF59 A	Kantartzi	39820	19.91	Moderate Susceptible
S14-9872	Shannon	42220	21.11	Susceptible
S98-1930	Fallen	42680	21.34	Susceptible
SC03-9151	Fallen	44660	22.33	Susceptible
ExF63	Kantartzi	47160	23.58	Susceptible
ExF4	Kantartzi	47840	23.92	Susceptible
JTN-5116	Arelli	51820	25.91	Susceptible
SC13-5538RR1	Fallen	52722	26.36	Susceptible
SC07-108RR	Fallen	55160	27.58	Susceptible
Hartwig	Li	58200	29.10	Susceptible
ExF30	Kantartzi	58960	29.48	Susceptible
ExF9	Kantartzi	59840	29.92	Susceptible
ExFF38	Kantartzi	62680	31.34	Susceptible
S14-3942	Shannon	66313	33.16	Susceptible
ExF77	Kantartzi	75700	37.85	Susceptible
ExF67	Kantartzi	82280	41.14	Susceptible
R13-818	Chen	85460	42.73	Susceptible
S14-9003	Shannon	88120	44.06	Susceptible
ExF24	Kantartzi	89600	44.80	Susceptible
G13-1269R2	Li	89700	44.85	Susceptible
ExF52	Kantartzi	94020	47.01	Susceptible
ExF55	Kantartzi	96280	48.14	Susceptible
ExF98	Kantartzi	105880	52.94	Susceptible
SC07-1490RR	Fallen	106398	53.20	Susceptible
ExF62	Kantartzi	114440	57.22	Susceptible
ExF91	Kantartzi	122700	61.35	Susceptible
ExF31	Kantartzi	131060	65.53	Susceptible
ExF29	Kantartzi	136100	68.05	Susceptible
R13-359	Chen	136600	68.30	Susceptible
ExF57	Kantartzi	138860	69.43	Susceptible
ExF74	Kantartzi	141680	70.84	Susceptible
ExF73	Kantartzi	144700	72.35	Susceptible
R12-4786	Chen	146800	73.40	Susceptible
G11-2663R2	Li	150440	75.22	Susceptible
R13-354	Chen	153440	76.72	Susceptible
S13-15764	Shannon	157720	78.86	Susceptible
ExF8	Kantartzi	159580	79.79	Susceptible

ExF3	Kantartzi	163240	81.62	Susceptible
ExF69	Kantartzi	168020	84.01	Susceptible
SC11-5140	Fallen	176560	88.28	Susceptible
R13-1724	Chen	181320	90.66	Susceptible
S14-15156	Shannon	181760	90.88	Susceptible
ExF90	Kantartzi	185040	92.52	Susceptible
ExF81	Kantartzi	186680	93.34	Susceptible
R10-298	Chen	191440	95.72	Susceptible
G13-3855R2	Li	191920	95.96	Susceptible
Ellis		192560	96.28	Susceptible Check
ExF60	Kantartzi	192980	96.49	Susceptible
R13-907	Chen	193068	96.53	Susceptible
ExF75	Kantartzi	194700	97.35	Susceptible
G13-2947R2	Li	198000	99.00	Susceptible
R13-14007	Chen	199640	99.82	Susceptible
R12-7446RY	Chen	200000	100.00	Susceptible
G13-2454R2	Li	201700	100.85	Susceptible
ExF48	Kantartzi	201888	100.94	Susceptible
R13-4638RY	Chen	204820	102.41	Susceptible
R13-4244	Chen	206080	103.04	Susceptible
S14-2088	Shannon	206320	103.16	Susceptible
SC10-302	Fallen	206800	103.40	Susceptible
ExF71	Kantartzi	207440	103.72	Susceptible
G93-9106	Li	207920	103.96	Susceptible
G12-2103R2	Li	211040	105.52	Susceptible
ExF56	Kantartzi	211940	105.97	Susceptible
R13-335	Chen	212000	106.00	Susceptible
Essex (Tartartzi CK)	Kantartzi	214400	107.20	Susceptible
ExF78	Kantartzi	214800	107.40	Susceptible
G13-2114R2	Li	214880	107.44	Susceptible
ExF49	Kantartzi	215120	107.56	Susceptible
R13-14575RR	Chen	216460	108.23	Susceptible
ExF87	Kantartzi	217120	108.56	Susceptible
ExF40/41	Kantartzi	217300	108.65	Susceptible
ExF19	Kantartzi	220080	110.04	Susceptible
G13-2842R2	Li	220500	110.25	Susceptible
R13-13997	Chen	220800	110.40	Susceptible
R12-2069	Chen	221120	110.56	Susceptible
ExF37	Kantartzi	222160	111.08	Susceptible
ExF83	Kantartzi	222760	111.38	Susceptible
R12-2142	Chen	225040	112.52	Susceptible

ExF94	Kantartzi	225760	112.88	Susceptible
SC10-455RR	Fallen	225840	112.92	Susceptible
R10-1809	Chen	226000	113.00	Susceptible
R13-2423RR	Chen	226400	113.20	Susceptible
G12-2731R2	Li	226640	113.32	Susceptible
G13-1183R2	Li	227920	113.96	Susceptible
R11-6870	Chen	229320	114.66	Susceptible
ExF11	Kantartzi	231680	115.84	Susceptible
R13-13433	Chen	235520	117.76	Susceptible
R13-532	Chen	237760	118.88	Susceptible
SC10-406RR	Fallen	238640	119.32	Susceptible
G13-2759R2	Li	239680	119.84	Susceptible
SC02-011	Fallen	240500	120.25	Susceptible
CNS	Li	241540	120.77	Susceptible
G13-2755R2	Li	243980	121.99	Susceptible
ExF68	Kantartzi	246320	123.16	Susceptible
ExF45	Kantartzi	247040	123.52	Susceptible
ExF36	Kantartzi	247440	123.72	Susceptible
G93-9009	Li	247560	123.78	Susceptible
R11-171	Chen	250500	125.25	Susceptible
ExF46	Kantartzi	251120	125.56	Susceptible
G12-2259R2	Li	252800	126.40	Susceptible
G12PR-63R2	Li	253620	126.81	Susceptible
G13-1769R2	Li	254640	127.32	Susceptible
ExF93	Kantartzi	254720	127.36	Susceptible
Bossier	Li	256560	128.28	Susceptible
G12-2062R2	Li	256760	128.38	Susceptible
ExF84	Kantartzi	257120	128.56	Susceptible
ExF79	Kantartzi	258560	129.28	Susceptible
ExF28	Kantartzi	258680	129.34	Susceptible
R13-9687	Chen	259160	129.58	Susceptible
ExF80	Kantartzi	260000	130.00	Susceptible
R13-4187RY	Chen	260520	130.26	Susceptible
Hagood	Li	260920	130.46	Susceptible
G13-1089R2	Li	261800	130.90	Susceptible
ExF53	Kantartzi	262080	131.04	Susceptible
Cook	Li	263320	131.66	Susceptible
ExF5	Kantartzi	263360	131.68	Susceptible
R11-2517	Chen	263920	131.96	Susceptible
R13-13333	Chen	266000	133.00	Susceptible
ExF27	Kantartzi	266660	133.33	Susceptible

ExF89	Kantartzi	268000	134.00	Susceptible
G13-2369R2	Li	268980	134.49	Susceptible
ExF21	Kantartzi	270880	135.44	Susceptible
ExF43/44	Kantartzi	271200	135.60	Susceptible
SC10-79	Fallen	271920	135.96	Susceptible
Benning	Li	272800	136.40	Susceptible
ExF50	Kantartzi	274480	137.24	Susceptible
R12-226	Chen	274960	137.48	Susceptible
UA 5612	Chen	278000	139.00	Susceptible
R13-1419	Chen	278000	139.00	Susceptible
G12-6543	Li	283920	141.96	Susceptible
ExF58	Kantartzi	284160	142.08	Susceptible
ExF18	Kantartzi	284240	142.12	Susceptible
G12-6515	Li	284640	142.32	Susceptible
G13-2939R2	Li	285920	142.96	Susceptible
ExF51	Kantartzi	288720	144.36	Susceptible
G12-1784R2	Li	292320	146.16	Susceptible
G11PR-56151R2	Li	298640	149.32	Susceptible
R13-9736	Chen	299520	149.76	Susceptible
ExF22	Kantartzi	300000	150.00	Susceptible
S13-11061	Shannon	304320	152.16	Susceptible
ExF23	Kantartzi	306000	153.00	Susceptible
ExF26	Kantartzi	306960	153.48	Susceptible
R12-712	Chen	310660	155.33	Susceptible
ExF34	Kantartzi	310660	155.33	Susceptible
R11-328	Chen	314000	157.00	Susceptible
ExF72	Kantartzi	314240	157.12	Susceptible
G12-3107R2	Li	318000	159.00	Susceptible
ExF6	Kantartzi	319460	159.73	Susceptible
G12-6386	Li	321200	160.60	Susceptible
G12-6518	Li	323360	161.68	Susceptible
Braxton		324640	162.32	Susceptible Check
ExF20	Kantartzi	329200	164.60	Susceptible
ExF65	Kantartzi	330000	165.00	Susceptible
ExF54	Kantartzi	330500	165.25	Susceptible
G11-1614R2	Li	331920	165.96	Susceptible
ExF32+33 mix	Kantartzi	335360	167.68	Susceptible
ExF15/16	Kantartzi	336000	168.00	Susceptible
R12-7448RY	Chen	338400	169.20	Susceptible
ExF25	Kantartzi	339920	169.96	Susceptible
SC07-1518RR	Fallen	341280	170.64	Susceptible

ExF64	Kantartzi	342000	171.00	Susceptible
G11PR-56238R2	Li	345940	172.97	Susceptible
SC09-210RR	Fallen	356660	178.33	Susceptible
ExF66	Kantartzi	366480	183.24	Susceptible
ExF70	Kantartzi	374000	187.00	Susceptible
G13-1488R2	Li	374960	187.48	Susceptible
G12-1475R2	Li	375200	187.60	Susceptible
Haskell	Li	380660	190.33	Susceptible
ExF97	Kantartzi	396000	198.00	Susceptible
SC10-69	Fallen	397200	198.60	Susceptible
GaSoy 17	Li	402000	201.00	Susceptible
ExF35	Kantartzi	426320	213.16	Susceptible
ExF47	Kantartzi	436000	218.00	Susceptible
ExF95	Kantartzi	440000	220.00	Susceptible
ExF61	Kantartzi	454000	227.00	Susceptible
ExF42	Kantartzi	456000	228.00	Susceptible
ExF13	Kantartzi	560400	280.20	Susceptible

Blue = Resistant
Red = Moderate Resistant
Green = Moderate Susceptible
Black = Susceptible

A list of Public Soybean Breeders commercial lines and varieties from the test years 2013 to 2016 are given (Table 3). These varieties would be especially important for a cotton-soybean rotation where reniform is a problem. Other earlier tests are not given because of rapid replacement of these varieties by new varieties and their subsequent unavailability.

Table 3. Private commercial soybean varieties tested in 2012, 2013, 2014, and 2015 that exhibit variety reniform resistance.

2013	**2014**	**2015**	**2016**
Delta Grow 4940	Delta Grow DG4940RR	Delta Grow DG 4995 RR	Armor AR5206C
ARMOR X1410	Armor AX4520	Go Soy 4914GTS	Delta Grow DG4995 RR
MPG-S-5214NRR	Eagle Seed ES5335RY	Delta Grow DG 5128	Dyno-Gro S49xs76
Willcross RY2513N	LG Seeds C5252R2	Go Soy Leland	Go Soy 4914GTS
Leland	Asgrow AG5535 GENRR2Y		Go Soy 49G16
ARMOR X47C	Willcross WX 2524N		
Schillinger 4712R2	Armor AX4450		
Eagle Seed 5650RR	Dyna-Gro S52RY75		
	Delta Grow DG5230GENRR2Y		
	Mycogen X54522NR2		

Summary

Commercial reniform nematode resistant soybean varieties may be useful in cotton-soybean rotations. Of the 142 private soybean lines tested in 2016 five exhibited adequate resistance to be considered useful in a cotton-soybean rotation (Table 1). All Commercial Varieties tested in 2016 can be found in Table 1.

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RENIFORM NEMATODE REPRODUCTION ON SOYBEAN CULTIVARS AND BREEDING LINES IN 2015

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Abstract

In 2015, 116 private soybean cultivars and lines from the Arkansas Variety Testing Program and 219 breeding lines and varieties from Public Soybean Breeders: 68 from Arkansas (Chen), 21 from the Missouri (Shannon), 40 from Georgia (Li) and 90 from Southern Illinois (Kantartzi) were tested in the greenhouse to determine their suitability as hosts for the reniform nematode (RN), *Rotylenchulus reniformis*. Resistant soybean lines provide an economically effective management tactic to suppress RN population densities for a subsequent cotton crop. All genotypes were inoculated with 2,000 vermiform RN in two separate greenhouse studies, with private tested lines grown for 91 days and the public breeders lines tested 83 days. The RN resistant varieties Anand and Hartwig, the RN susceptible cultivars Braxton and Ellis, and fallow reniform nematode infested soil (to show survival without a host) served as controls. The reproductive index (RI = Pf/Pi) was calculated based on the average number of vermiform nematodes extracted from the soil of each treatment. Soybean lines with a greater (P = 0.05) RI than the resistant controls were considered suitable hosts for *R. reniformis*. Of the 116 Arkansas Variety test lines, 109 were considered suitable hosts; however private lines Delta Grow DG 4995 RR, Go Soy 4914GTS, Delta Grow DG 5128, and Go Soy Leland had a magnitude of resistance that was similar to the resistant controls while lines S11-20337, S11-17025, and S11-20195 are public breeder lines submitted by Missouri. The Reniform nematode did not reproduce more than the resistant checks Anand on (22 of the 219) and on (7 of the 219) Hartwig on breeding lines and varieties submitted by the Public Soybean Breeders. These lines may be of interest for developing reniform resistant cultivars in a soybean breeding programs. The four commercially available soybean lines from the Arkansas variety test may be useful in a cotton - soybean rotation to reduce the numbers of reniform nematodes and allow cotton to be grown economically.

Introduction

The reniform nematode (*Rotylenchulus reniformis*) causes considerable damage and yield loss to cotton in the United States from the middle-Atlantic states south and west to Texas. Presently no commercial upland cotton varieties have reniform nematode resistance, whereas several sources of reniform nematode resistance exist in soybean. Soybean reniform nematode resistance is most often linked to resistance to the soybean cyst nematode (SCN (*Heterodera*

glycines)) obtained from Peking and PI437654. It is known that SCN resistance obtained from PI-88788 lacks reniform resistance (Robbins & Rakes, 1996), which is unfortunate as the majority (over 95%) of soybean varieties with SCN resistance is linked to PI 88788.

The use of reniform nematode resistant soybean in a rotation with cotton can be a useful management option. Public soybean breeding lines from programs at the University of Arkansas, Clemson University, University of Missouri, University of Southern Illinois, and USDA from Jackson Tennessee that have a low rate of reniform nematode reproduction may prove very useful in breeding for reniform nematode resistance.

Information on the reproduction of the reniform nematode on contemporary soybean cultivars is limited. Robbins, et al. (1994) reported on the reproduction of the reniform nematode on 30 soybean cultivars. In 1996, Robbins & Rakes reported reniform nematode reproduction on 16 soybean cultivars, 45 germplasm lines, two cultivars Hartwig and Cordell with resistance from PI's 437654 and 90763, respectively, and the differentials used in the soybean cyst nematodes race determination tests. A history of the reniform nematode in the South was given to the Southern Soybean Disease Workers (Robbins 2013b). During the 1999 to 2015 period yearly tests have determined the host status for over 2,400 soybean lines (Robbins et al., 1999, 2000, 2001, 2002, 2003, 2004, 2005, 2006, 2007a, 2008, 2009, 2010, 2011, 2012, 2013a, 2014, 2015). These papers form the basis for reniform nematode reproduction information on contemporary soybean lines. The breeding lines tested for reniform nematode reproduction are given by Robbins et al. (2007b, 2008, 2009, 2010, 2011, 2012, 2013a, 2014, 2015).

The objectives of the 2015 study were to: 1) identify new soybean cultivars that are poor hosts for the reniform nematode that would be useful in rotation with cotton or other reniform nematode susceptible crops in reniform nematode infested fields. 2) to identify useful breeding lines for use in selection of new reniform nematode resistant cultivars and 3) to list useful lines for cotton-soybean rotations from 2012 to 2015.

Materials and Methods

The soybean lines and cultivars tested in 2015 were from both private and public sources. 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 (approximately 86% sand, 8% silt, 6 % clay, <1% O.M.). The reniform nematode inoculum 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. A total of 2,000 vermiform reniform nematodes were injected with an autopipe into two, 2.5 cm-deep holes made in the soil in each pot containing one seedling in the cotyledon stage the day of transplanting. Pots were arranged in a randomized complete block design, with five replications per line or cultivar. Soybean cultivars Anand and Hartwig were included as resistant controls, Braxton as a susceptible control and an inoculated pot with no plant (fallow) as an inoculum survivor control. After 91 days for the private and 83 days for public varieties and lines, the number of vermiform reniform nematodes in the soil of each pot was determined (Jenkins, 1974). 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 Anand (RA) and Hartwig (RH) was calculated. The log ratio data of both [log10 (RA + 1)] and [log10 (RH + 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. All statistical analyses were carried out using SAS version 8 (SAS Institute, Cary, NC).

Results

Of the Arkansas Variety test lines, 104 were considered suitable hosts; however; Delta Grow DG 4995 RR, Go Soy 4914GTS, Delta Grow DG 5128, and Go Soy Leland were commercial varieties and Missouri lines S11-17025, S11-20195, and S11-20337; 2524N had a magnitude of resistance that was similar to the highly resistant controls Anand and Hartwig. Four commercial varieties (Morsoy Xtra 55X75, Willcross WXR2524N, Progeny P 5752RY, USG 75B75R) and one Missouri line (S11-16653) were considered to be moderately resistant. The commercially available reniform nematode resistant soybean lines may be useful in a cotton - soybean rotation to reduce the numbers of reniform nematodes and allow cotton to be grown economically (Table 1).

Table 1. *Rotylenchulus reniformis* data of Average Soil Count per Pot (500 $cm^{3)}$, Reproduction index (Pf/Pi) and Disease Rating on 116 selected soybean cultivars and lines from the Arkansas Soybean Variety Testing Program 2015 tests.

Test Line	Soil Count	RI = Disease Pf/Pi	Rating
Fallow - Survival Check	296	0.148	Check
Delta Grow DG 4995 RR	816	0.408	Resistant
Anand - Check	996	0.498	Check
S11-20337 (Missouri Line)	996	0.498	Resistant
Go Soy 4914GTS	1104	0.552	Resistant
Hartwig - Check	1092	0.546	Check
S11-17025 (Missouri Line)	1212	0.606	Resistant
S11-20195 (Missouri Line)	1464	0.732	Resistant
Delta Grow DG 5128	1788	0.894	Resistant
Go Soy Leland	1968	0.984	Resistant
S11-16653	3252	1.626	Mod Res
Morsoy Xtra 55X75	4692	2.346	Mod Res
Willcross WXR2524N	5188	2.594	Mod Res
Progeny P 5752RY	5203	2.602	Mod Res
USG 75B75R	5064	2.532	Mod Res
CZ 5147LL	5612	2.806	Mod Susc
Armor AR5605	6944	3.472	Mod Susc
Delta Grow DG 5230 RR2	6636	3.318	Mod Susc
Mycogen 5N522R2	8632	4.316	Mod Susc
CZ 5150LL	13364	6.682	Susceptible
Go Soy 5115LL	16376	8.188	Susceptible
Armor 53-L55	12600	6.300	Susceptible
Progeny P 5226RYS	21844	10.922	Susceptible
HBK 4653LL	14772	7.386	Susceptible
HALO 4:98	13856	6.928	Susceptible
Armor AR4615	15532	7.766	Susceptible
Willcross WXR2494NS	13588	6.794	Susceptible
Go Soy 4714GTS	16688	8.344	Susceptible
Armor AR4705	13628	6.814	Susceptible
CZ 4590RY	19476	9.738	Susceptible
AvDx-D415	17940	8.970	Susceptible
Pioneer P49T09BR	18260	9.130	Susceptible
CZ 4959RY	13864	6.932	Susceptible
Armor 44X5L	18984	9.492	Susceptible
UA 5014C	22156	11.078	Susceptible
Armor AR4504	18960	9.480	Susceptible
Dyna-Gro S44LS76	16592	8.296	Susceptible
Mycogen 5N404R2	16936	8.468	Susceptible

UA 5414RR	16968	8.484	Susceptible
Mycogen 5N433R2	21904	10.952	Susceptible
LG Seeds C4867R2	25656	12.828	Susceptible
UA 5814HP	21936	10.968	Susceptible
Delta Grow DG 4977 LL/STS	21044	10.522	Susceptible
Progeny P 5414LL	32972	16.486	Susceptible
HBK 4950LL	25004	12.502	Susceptible
Croplan R2C4914S	21760	10.880	Susceptible
Go Soy 4415LL	19200	9.600	Susceptible
Armor 57-R17	20548	10.274	Susceptible
Go Soy 5215LL	21512	10.756	Susceptible
Go Soy 4915R2	20960	10.480	Susceptible
USG 74A74RS	21384	10.692	Susceptible
Eagle Seed ES4772RY	31804	15.902	Susceptible
HALO 4:80	20720	10.360	Susceptible
Armor AR53X	28936	14.468	Susceptible
Go Soy 5315LL	21744	10.872	Susceptible
HBK 4953LL	21548	10.774	Susceptible
Delta Grow DG 4935 RR2/STS	35008	17.504	Susceptible
CZ 4105LL	37952	18.976	Susceptible
Pioneer P50T15BR	23464	11.732	Susceptible
LG Seeds C4780R2	32356	16.178	Susceptible
Armor AR4205	24176	12.088	Susceptible
Eagle Seed ES5508RY	20700	10.350	Susceptible
Willcross WXE2535NS	38288	19.144	Susceptible
REV® 44A14™	22060	11.030	Susceptible
LG Seeds C4322R2	24768	12.384	Susceptible
Armor 48-C5	32924	16.462	Susceptible
Armor 41X5L	40424	20.212	Susceptible
Go Soy Ireane	22800	11.400	Susceptible
Dyna-Gro S48RS53	22200	11.100	Susceptible
Morsoy Xtra 46X95	22900	11.450	Susceptible
S12-3791	22400	11.200	Susceptible
CZ 4540LL	26832	13.416	Susceptible
Go Soy Glider	32284	16.142	Susceptible
Armor 49X5L	27100	13.550	Susceptible
Dyna-Gro S42RY46	24600	12.300	Susceptible
Go Soy 4714LL	24700	12.350	Susceptible
NK S55-Q3 Brand	38444	19.222	Susceptible
CZ 4044LL	26500	13.250	Susceptible
Delta Grow DG 4781 LL	52868	26.434	Susceptible

CZ 5445LL	26088	13.044	Susceptible
CZ 5225LL	27300	13.650	Susceptible
USG 74K95RS	45844	22.922	Susceptible
Morsoy Xtra 49X85	35196	17.598	Susceptible
Pioneer P41T33R	29900	14.950	Susceptible
LG Seeds C4994R2	26600	13.300	Susceptible
CZ 4748LL	38728	19.364	Susceptible
Delta Grow DG 5067 LL	28600	14.300	Susceptible
Armor 51X5L	29680	14.840	Susceptible
Croplan R2C4654	28600	14.300	Susceptible
Progeny P 4757RY	30000	15.000	Susceptible
Dyna-Gro S52LL66	31732	15.866	Susceptible
USG 75J45R	28100	14.050	Susceptible
CZ 5242LL	29000	14.500	Susceptible
Mycogen 5N490R2	32000	16.000	Susceptible
Mycogen 5N501R2	31400	15.700	Susceptible
Armor AR4305	32000	16.000	Susceptible
REV® 51A56™	33380	16.690	Susceptible
Armor AR4904	32100	16.050	Susceptible
Armor AR5615	37020	18.510	Susceptible
Braxton Check	45212	22.606	Check
Delta Grow DG 5367 LL	34300	17.150	Susceptible
Croplan R2C4700S	39400	19.700	Susceptible
NK S58-Z4 Brand	40464	20.232	Susceptible
USG 74D95RS	36600	18.300	Susceptible
USG Ellis	38936	19.468	Susceptible
Armor 47X5L	33700	16.850	Susceptible
Delta Grow DG 4567 LL	40212	20.106	Susceptible
Armor AR5205	36500	18.250	Susceptible
CZ 4818LL	39840	19.920	Susceptible
REV® 48A46™	42800	21.400	Susceptible
Ellis - Check	66968	33.480	Check
Delta Grow DG 4587 LL/STS	47200	23.600	Susceptible
Progeny P 4214RY	44900	22.450	Susceptible
CZ 4181RY	45100	22.550	Susceptible
Delta Grow DG 4775 RR2	46700	23.350	Susceptible
Dyna-Gro S55LS75	54700	27.350	Susceptible
Go Soy 5515LL	46900	23.450	Susceptible
Delta Grow DG 4985 RR2	56800	28.400	Susceptible
REV® 55L95™	57900	28.950	Susceptible
Progeny P 4814LLS	66560	33.280	Susceptible

Armor 49-X	67500	33.750	Susceptible

The reniform nematode did not reproduce more on 16 lines than Anand on the179 breeding lines and varieties submitted by Public Soybean Breeders. These lines may be of interest for developing reniform resistant cultivars in a soybean breeding programs (Table 2).

Table 2. *Rotylenchulus reniformis* data of Breeder, Line, Soil Count Average per Pot (500 cm^3), Reproduction Index = (Pf/Pi) and Disease Rating on 219 selected soybean breeding lines from cooperating Southern Soybean Breeders 2015 tests.

Breeder	Line	Soil Count	RI = Pf/Pi	Disease Rating
Fallow Ck	- - -	92	0.05	Survival CK
Kantartzi	FxH 23	2130	1.10	Resistant
Shannon	S13-11733	2311	1.20	Resistant
Kantartzi	Hartwig	2634	1.30	Resistant
Kantartzi	FxH 35	2796	1.40	Resistant
Kantartzi	Peking	3438	1.70	Resistant
Shannon	S13-1955	3365	1.70	Resistant
Shannon	S13-16712	3440	1.70	Resistant
Shannon	S13-10590	3520	1.80	Resistant
Shannon	S13-1961	3515	1.80	Resistant
Li	Hartwig	3738	1.90	Resistant
Res CK	Hartwig	4054	2.00	Resistant
Kantartzi	FxH 92	4000	2.00	Resistant
Kantartzi	FxH 26	4280	2.10	Resistant
Res CK	Anand	4460	2.20	Resistant
Kantartzi	FxH 37	5580	2.80	Resistant
Kantartzi	FxH 22	5720	2.90	Resistant
Li	G11-1614R2	6420	3.20	Resistant
Kantartzi	FxH 5	6584	3.30	Resistant
Kantartzi	FxH 40	8025	4.00	Mod. Resistance
Shannon	S13-8912	8160	4.10	Mod. Resistance
Li	G12-3698R2	8480	4.20	Mod. Resistance
Shannon	S13-5358	9798	4.90	Mod. Resistance
Chen	R12-514	13734	6.90	Mod. Resistance
Li	G11-2294R2	17229	8.60	Mod. Resistance
Kantartzi	FxH 8	19280	9.60	Mod. Susceptible
Chen	R09-5026	19633	9.80	Mod. Susceptible
Kantartzi	FxH 78	19640	9.80	Mod. Susceptible
Kantartzi	FxH 90	25672	12.80	Susceptible
Kantartzi	FxH 46	25780	12.90	Susceptible
Kantartzi	FxH 83	28960	14.50	Susceptible
Kantartzi	FxH 80	31140	15.60	Susceptible
Li	G12-2554R2	31640	15.80	Susceptible

Kantartzi	FxH 72	32420	16.20	Susceptible
Li	G93-9009	32760	16.40	Susceptible
Kantartzi	FxH 91	34800	17.40	Susceptible
Kantartzi	FxH 79	35160	17.60	Susceptible
Kantartzi	FxH 64	35300	17.70	Susceptible
Li	G11PR-56238R2	35680	17.80	Susceptible
Li	G11PR-209R2	35840	17.90	Susceptible
Chen	RM-21464	36820	18.40	Susceptible
Li	G13PR-110	37140	18.60	Susceptible
Kantartzi	FxH 76	37680	18.80	Susceptible
Chen	R10-563	38140	19.10	Susceptible
Kantartzi	FxH 33	38180	19.10	Susceptible
Chen	R12-6522RR	38960	19.50	Susceptible
Shannon	S13-16675	39336	19.70	Susceptible
Chen	R07-167	41075	20.50	Susceptible
Shannon	S13-9860	42040	21.00	Susceptible
Shannon	R11-1057	43280	21.60	Susceptible
Chen	S13-13084	43200	21.60	Susceptible
Li	G11-2675R2	43500	21.80	Susceptible
Kantartzi	R12-2079	44000	22.00	Susceptible
Chen	FxH 53	44077	22.00	Susceptible
Kantartzi	FxH 55	43959	22.00	Susceptible
Chen	R07-6614RR	44128	22.10	Susceptible
Shannon	R09-345	44680	22.30	Susceptible
Kantartzi	FxH 20	44592	22.30	Susceptible
Chen	S13-16392	44567	22.30	Susceptible
Shannon	S13-10021	45296	22.60	Susceptible
Chen	R11-7999	45780	22.90	Susceptible
Chen	R12-6529RR	45740	22.90	Susceptible
Chen	R09-4010	46000	23.00	Susceptible
Li	G12-2482R2	46000	23.00	Susceptible
Kantartzi	FxH 85	46440	23.20	Susceptible
Chen	R05-655	48000	24.00	Susceptible
Kantartzi	FxH 2	49160	24.60	Susceptible
Kantartzi	FxH 58	49200	24.60	Susceptible
Chen	R08-1830	50260	25.10	Susceptible
Kantartzi	FxH 3	50680	25.30	Susceptible
Kantartzi	FxH 30	50520	25.30	Susceptible
Li	G10PR-56444R2	52288	26.10	Susceptible
Li	G11PR-56151R2	52380	26.20	Susceptible
Sus Ck	FxH 9	52660	26.30	Susceptible

Kantartzi	Braxton	52640	26.30	Susceptible
Chen	Osage	52940	26.50	Susceptible
Shannon	S13-12611	53000	26.50	Susceptible
Kantartzi	FxH 42	53200	26.60	Susceptible
Kantartzi	FxH 19	53820	26.90	Susceptible
Kantartzi	FxH 29	54160	27.10	Susceptible
Kantartzi	R09-430	54800	27.40	Susceptible
Chen	RM-2463	54800	27.40	Susceptible
Chen	FxH 4	54780	27.40	Susceptible
Li	FxH 21	54880	27.40	Susceptible
Kantartzi	G12PR-63R2	54800	27.40	Susceptible
Chen	R10-28	54900	27.50	Susceptible
Kantartzi	FxH 12	55280	27.60	Susceptible
Chen	UA 5612	55340	27.70	Susceptible
Shannon	S13-16663	56200	28.10	Susceptible
Chen	R08-4004	56440	28.20	Susceptible
Kantartzi	FxH 39	57200	28.60	Susceptible
Chen	RM-1144	57660	28.80	Susceptible
Li	G12-2731R2	58680	29.30	Susceptible
Kantartzi	FxH 51	59000	29.50	Susceptible
Kantartzi	FxH 50	59200	29.60	Susceptible
Chen	R10-2622	59340	29.70	Susceptible
Li	G13LL-44	60100	30.10	Susceptible
Kantartzi	FxH 6	60880	30.40	Susceptible
Li	FxH 14	61020	30.50	Susceptible
Kantartzi	G00-3213	61000	30.50	Susceptible
Li	R10-2346	61620	30.80	Susceptible
Chen	CNS	61600	30.80	Susceptible
Chen	R12-7448RY	61800	30.90	Susceptible
Chen	R11-1525	62100	31.10	Susceptible
Li	FxH 70	62420	31.20	Susceptible
Kantartzi	G11-2663R2	62360	31.20	Susceptible
Chen	R11-89RY	62540	31.30	Susceptible
Li	Bossier	63400	31.70	Susceptible
Li	G13LL-56	63600	31.80	Susceptible
Chen	R11-8346	63800	31.90	Susceptible
Kantartzi	FxH 84	64400	32.20	Susceptible
Li	G12-2152R2	64800	32.40	Susceptible
Li	G12-2103R2	64800	32.40	Susceptible
Kantartzi	FxH 94	65000	32.50	Susceptible
Chen	R09-1589	65340	32.70	Susceptible

Chen	R10-5086	66040	33.00	Susceptible
Li	G12-1475R2	66400	33.20	Susceptible
Chen	R11-2419	66600	33.30	Susceptible
Li	G11PR-407R2	66800	33.40	Susceptible
Li	G00-3880	66800	33.40	Susceptible
Li	G93-9106	67000	33.50	Susceptible
Shannon	S13-2743	67175	33.60	Susceptible
Kantartzi	FxH 10	67200	33.60	Susceptible
Chen	R11-2559	67600	33.80	Susceptible
Kantartzi	FxH 75	67600	33.80	Susceptible
Kantartzi	FxH 45	67800	33.90	Susceptible
Kantartzi	FxH 43	68000	34.00	Susceptible
Kantartzi	FxH 17	68120	34.10	Susceptible
Kantartzi	FxH 81	68400	34.20	Susceptible
Li	G12-6543	68800	34.40	Susceptible
Li	G13LL-5	68720	34.40	Susceptible
Li	Haskell	69080	34.50	Susceptible
Chen	R06-3733	69120	34.60	Susceptible
Chen	R10-5828	69600	34.80	Susceptible
Chen	R10-1261	70000	35.00	Susceptible
Kantartzi	FxH 48	70400	35.20	Susceptible
Chen	R09-4467	70600	35.30	Susceptible
Li	G12-1816R2	70800	35.40	Susceptible
Kantartzi	FxH 74	70920	35.50	Susceptible
Li	G12-3107R2	71400	35.70	Susceptible
Kantartzi	FxH 93	71640	35.80	Susceptible
Chen	R07-2000	71800	35.90	Susceptible
Chen	R10-2436	71740	35.90	Susceptible
Chen	UARK-292	71800	35.90	Susceptible
Kantartzi	FxH 7	72000	36.00	Susceptible
Kantartzi	FxH 65	72320	36.20	Susceptible
Chen	R11-6447	72600	36.30	Susceptible
Chen	R07-2001	72800	36.40	Susceptible
Kantartzi	FxH 1	73000	36.50	Susceptible
Shannon	S13-12582	73700	36.90	Susceptible
Chen	R12-226	74300	37.20	Susceptible
Kantartzi	FxH 28	74400	37.20	Susceptible
Li	G13LL-7	74400	37.20	Susceptible
Li	R11-357RY	74760	37.40	Susceptible
Chen	S13-11061	74850	37.40	Susceptible
Shannon	G12-2259R2	74720	37.40	Susceptible

Kantartzi	FxH 62	74960	37.50	Susceptible
Kantartzi	FxH 24	75200	37.60	Susceptible
Shannon	S13-11940	75200	37.60	Susceptible
Kantartzi	FxH 18	75400	37.70	Susceptible
Kantartzi	FxH 25	75400	37.70	Susceptible
Li	G12-3298R2	75560	37.80	Susceptible
Chen	R11-7141	76800	38.40	Susceptible
Kantartzi	FxH 82	76920	38.50	Susceptible
Kantartzi	FxH 47	77180	38.60	Susceptible
Kantartzi	FxH 54	77250	38.60	Susceptible
Kantartzi	FxH 59	77200	38.60	Susceptible
Chen	UARK-602	77600	38.80	Susceptible
Kantartzi	FxH 11	78000	39.00	Susceptible
Chen	R12-937	78800	39.40	Susceptible
Chen	R11-2299	80400	40.20	Susceptible
Kantartzi	FxH 13	80400	40.20	Susceptible
Kantartzi	FxH 57	80800	40.40	Susceptible
Chen	R11-171	81000	40.50	Susceptible
Chen	R11-2354	81400	40.70	Susceptible
Kantartzi	FxH 56	81600	40.80	Susceptible
Chen	R12-1012	82000	41.00	Susceptible
Chen	UARK-282	82000	41.00	Susceptible
Kantartzi	FxH 15	82000	41.00	Susceptible
Kantartzi	FxH 27	82000	41.00	Susceptible
Kantartzi	FxH 87	82800	41.40	Susceptible
Chen	R10-197RY	83060	41.50	Susceptible
Kantartzi	FxH 63	83400	41.70	Susceptible
Kantartzi	FxH 69	83400	41.70	Susceptible
Chen	R08-4002	83840	41.90	Susceptible
Chen	R12-6878RR	84020	42.00	Susceptible
Kantartzi	FxH 89	84800	42.40	Susceptible
Shannon	S13-11167	84800	42.40	Susceptible
Li	Ellis	85000	42.50	Susceptible
Sus Ck	G12-1149R2	85000	42.50	Susceptible
Kantartzi	FxH 44	85200	42.60	Susceptible
Kantartzi	Flyer	86000	43.00	Susceptible
Kantartzi	FxH 77	86000	43.00	Susceptible
Kantartzi	FxH 61	88000	44.00	Susceptible
Kantartzi	FxH 73	88000	44.00	Susceptible
Chen	R10-230	88400	44.20	Susceptible
Li	G12-6515	89200	44.60	Susceptible

Li	FxH 66	89860	44.90	Susceptible
Kantartzi	G11-1984R2	89800	44.90	Susceptible
Shannon	S13-10592	90160	45.10	Susceptible
Chen	R09-1237	91600	45.80	Susceptible
Chen	R11-399	91600	45.80	Susceptible
Kantartzi	FxH 88	92000	46.00	Susceptible
Shannon	S13-1261	92000	46.00	Susceptible
Chen	R12-2142	92800	46.40	Susceptible
Chen	UA 5414RR(R04-1268RR)	94000	47.00	Susceptible
Chen	UA 5014C (R05-3239)	95000	47.50	Susceptible
Chen	R11-262	96400	48.20	Susceptible
Kantartzi	FxH 16	96600	48.30	Susceptible
Chen	R11-2517	96800	48.40	Susceptible
Kantartzi	FxH 41	98400	49.20	Susceptible
Kantartzi	FxH 67	98800	49.40	Susceptible
Chen	R09-1223	100800	50.40	Susceptible
Chen	UA 5814HP (R09-3789)	101000	50.50	Susceptible
Chen	R12-1622	102800	51.40	Susceptible
Chen	R02-6268F	103200	51.60	Susceptible
Chen	UA 5213C	103200	51.60	Susceptible
Chen	R12-11713	107200	53.60	Susceptible
Kantartzi	FxH 32	110420	55.20	Susceptible
Li	G12-2062R2	112800	56.40	Susceptible
Li	G12-1784R2	116400	58.20	Susceptible
Kantartzi	FxH 36	118000	59.00	Susceptible
Kantartzi	FxH 38	123280	61.60	Susceptible
Kantartzi	FxH 68	141400	70.70	Susceptible

List of Public Soybean Breeders commercial lines and varieties from the test years 2012 to 2015 are given (Table 3). These varieties would be especially important for a cotton-soybean rotation where reniform is a problem. Other earlier tests are not given because of rapid replacement of these varieties by new varieties and their subsequent unavailability.

Table 3. Private commercial soybean varieties tested in 2012, 2013, 2014, and 2015 that exhibit variety reniform resistance.

2012	**2013**	**2014**	**2015**
Armor 49-C3	Delta Grow 4940	Delta Grow DG4940RR	Delta Grow DG 4995 RR
MPG 5214	ARMOR X1410	Armor AX4520	Go Soy 4914GTS
REV®55R83	MPG-S-5214NRR	Eagle Seed ES5335RY	Delta Grow DG 5128
	Willcross RY2513N	LG Seeds C5252R2	Go Soy Leland
	Leland	Asgrow AG5535 GENRR2Y	
	ARMOR X47C	Willcross WX 2524N	
	Schillinger 4712R2	Armor AX4450	
	Eagle Seed 5650RR	Dyna-Gro S52RY75	
		Delta Grow DG5230GENRR2Y	
		Mycogen X54522NR2	

Summary

Commercial reniform nematode resistant soybean varieties may be useful in cotton-soybean rotations. Of the 116 private soybean lines tested in 2015 seven exhibited adequate resistance to be considered useful in a cotton-soybean rotation (Table 1). All Commercial Varieties tested in 2015 can be found in Table 1.

Public breeding lines with a useful level of reniform resistance in varieties and breeding lines tested in 2015 are listed in Table 2. Of 2015's 219 public breeding lines, varieties, and lines 11 would be useful in reniform resistance breeding programs. In table 3 all soybean varieties with levels of resistance to reniform nematode useful in cotton-soybean rotations of tests since 2012 are listed. Annual Reproductive Indexes of the reniform nematode have been reported by the senior author since 1998. Finding the older varieties may be a challenge as many private varieties last only a very few seasons (years).

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RENIFORM NEMATODE REPRODUCTION ON SOYBEAN CULTIVARS AND BREEDING LINES IN 2014

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Abstract

In 2014, 184 soybean varieties from the Arkansas Variety Testing Program and 179 breeding lines and varieties from Public Soybean Breeders: 5 from USDA Jackson, TN (Arelli), 12 from Clemson (Fallen), 69 from Arkansas (Chen), 14 from the Missouri (Shannon), and 79 from Southern Illinois (Kantartzi) were tested in the greenhouse to determine their suitability as hosts for the reniform nematode (RN), *Rotylenchulus reniformis*. Resistant soybean lines provide an economically effective management tactic to suppress RN population densities for a subsequent cotton crop. All genotypes were inoculated with 2,000 vermiform RN in two greenhouse studies, the tested lines were grown for 91 days. The RN resistant varieties Anand, Forrest, and Hartwig, the RN susceptible cultivar Braxton, and fallow reniform nematode infested soil served as controls. The reproductive index (RI = Pf/Pi) was calculated based on the average number of vermiform nematodes extracted from the soil of each treatment. Soybean lines with a greater ($P = 0.05$) RI than the resistant controls were considered suitable hosts for *R. reniformis*. Of the Arkansas Variety test lines, 158 were considered suitable hosts; however Armor AX4450, Armor AX4460, Armor AX4520, Asgrow AG5535 GENRR2Y, Croplan R2C4873S, Croplan R2C5103, Delta Grow DG4940RR, Delta Grow DG5230GENRR2Y, Dyna-Gro S52RY75, Eagle Seed ES5335RY, HALO X440, LG Seeds C5252R2, MPG 5214NRR, Mycogen X54522NR2, Progeny P 4848 RYS, Progeny P 4928 LL, REV® 46R64™, S09-6262, S11-20124, S11-20356, and Willcross WX 2524N had a magnitude of resistance that was similar to the resistant controls. Lines S09-6262, S11-20124, and S11-20356 are public breeder lines from Missouri. The Reniform nematode did not reproduce more than: Hartwig on 31 of the 179 and 23 of the Anand 179 breeding lines and varieties submitted by the Public Soybean Breeders. These lines may be of interest for developing reniform resistant cultivars in a soybean breeding programs. The eighteen commercially available soybean lines from the Arkansas variety test may be useful in a cotton - soybean rotation to reduce the numbers of reniform nematodes and allow cotton to be grown economically.

Introduction

The reniform nematode (*Rotylenchulus reniformis*) causes considerable damage and yield loss to cotton and soybean in the United States from the middle-Atlantic states south and west to Texas. Presently no commercial upland cotton varieties have reniform nematode resistance, whereas several sources of reniform nematode resistance exist in soybean. Soybean reniform nematode resistance is often linked to resistance obtained from Peking and PI437654 to the soybean cyst nematode (*Heterodera glycines*) and excludes resistance PI-88788. The use of reniform nematode resistant soybean in a rotation with cotton can be a useful management option. Public soybean breeding lines from programs at the University of Arkansas, University of Missouri, Clemson University, University of Southern Illinois, and USDA from Jackson Tennessee that have a low rate of reniform nematode reproduction may prove very useful in breeding for reniform nematode resistance. Information on the reproduction of the reniform nematode on contemporary soybean cultivars is limited. Robbins, et al. (1994) reported on the reproduction of the reniform nematode on 30 soybean cultivars. In 1996, Robbins & Rakes reported reniform nematode reproduction on 16 soybean cultivars, 45 germplasm lines, 2 cultivars (Hartwig, Cordell) with resistance from PI's 437654 and 90763, respectively, and the differentials used in the soybean cyst nematodes race determination tests. A history of the reniform nematode in the South was given to the Southern Soybean Disease Workers (Robbins, 2013b). During the 1999 to 2013 period yearly tests have determined the host status for over 2,100 soybean lines (Robbins, et al., 1999, 2000, 2001, 2002,

2003, 2004, 2005, 2006, 2007a, 2008, 2009, 2010, 2011, 2012, 2013a, 2014). These papers form the basis for reniform nematode reproduction information on contemporary soybean lines. The breeding lines tested for reniform nematode reproduction are given by Robbins et al. (2007b, 2008, 2009, 2010, 2011, 2012, 2013a, 2014). The objectives of the 2014 study were to: 1) identify new soybean cultivars that are poor hosts for the reniform nematode that would be useful in rotation with cotton or other reniform nematode susceptible crops in reniform nematode infested fields. 2) to identify useful breeding lines for use in selection of new reniform nematode resistant cultivars and 3) to list useful lines for cotton-soybean rotations from 2011 to 2014.

Methods and Materials

The soybean lines and cultivars tested in 2014 were from both private and public sources. 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 (approximately 86% sand, 8% silt, 6 % clay, <1% O.M.). The reniform nematode inoculum 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. A total of 2,000 vermiform reniform nematodes were injected with an autopipe into two, 2.5 cm-deep holes made in the soil in each pot containing one seedling in the cotyledon stage the day of transplanting. Pots were arranged in a randomized complete block design, with five replications per line or cultivar. Soybean cultivars Anand, Forrest and Hartwig were included as resistant controls, Braxton as a susceptible control and an inoculated pot with no plant (fallow) as an inoculum survivor control. After 91 days for both the private and public varieties and lines, the number of vermiform reniform nematodes in the soil of each pot was determined (Jenkins, 1974). 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 Anand, Forrest and Hartwig was calculated. The log ratio data [log10 (RF + 1)] or [log10 (RA + 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. All statistical analyses were carried out using SAS version 8 (SAS Institute, Cary, NC).

Results

Of the Arkansas Variety test lines, 158 were considered suitable hosts; however, Armor AX4450, Armor AX4520, Asgrow AG5535 GENRR2Y, Delta Grow DG4940RR, Delta Grow DG5230GENRR2Y, Dyna-Gro S52RY75, Eagle Seed ES5335RY, LG Seeds C5252R2, MPG 5214NRR, Mycogen X54522NR2, and Willcross WX 2524N had a magnitude of resistance that was similar to the higher resistant controls Anand and Hartwig. Lines S09-6262, S11-20124, and S11-20356 are public breeder lines from Missouri; whereas Armor AX4460, Croplan R2C4873S, Croplan R2C5103, HALO X440, Progeny P 4848 RYS, Progeny P 4928 LL, and REV® 46R64™ were not different than Forrest and were not believe to have as useful of level of resistance. The commercially available reniform nematode resistant soybean lines from the Arkansas variety test may be useful in a cotton - soybean rotation to reduce the numbers of reniform nematodes and allow cotton to be grown economically (Table 1).

Table 1. *Rotylenchulus reniformis* data of Converted Log Ratio, Average count, and Reproduction index (Pf/Pi) on 184 selected soybean cultivars and lines from the Arkansas Soybean Variety Testing Program 2014 tests.

Variety/ Line	Converted Log Ratio	Count Average	RI Pf/Pi
DG4940RR+	***0.569***	***480***	0.24
Fallow	***0.611***	***492***	0.25
S11-20356	***0.681***	***600***	0.30
Anand	***1.000***	***765***	0.38
S11-20124	***1.007***	***828***	0.41
MPG 5214NRR	***1.408***	***1260***	0.59

Armor AX4520	***1.421***	***1188***	0.63
Hartwig	***1.687***	***1856***	0.93
Eagle Seed ES5335RY	***2.021***	***1920***	0.96
LG Seeds C5252R2	***2.352***	***2184***	1.09
AG5535 GENRR2Y*	***2.601***	***2400***	1.20
Willcross WX 2524N	***2.688***	***2724***	1.36
Armor AX4450	***3.367***	***3276***	1.64
Dyna-Gro S52RY75	***3.584***	***3360***	1.68
DG5230GENRR2Y+	***4.099***	***4352***	1.88
Forrest	***4.203***	***3924***	1.96
Mycogen X54522NR2	***4.301***	***3766***	2.18
REV® 46R64™	***6.387***	***7456***	3.73
Armor AX4460	***7.657***	***8168***	4.08
Croplan R2C4873S	***8.252***	***8784***	4.11
HALO X440	***8.336***	***9360***	4.39
Progeny P 4928 LL	***8.868***	***8222***	4.68
S09-6262	***8.963***	***11192***	4.93
Croplan R2C5103	***9.542***	***11232***	5.21
Progeny P 4848 RYS	***9.884***	***12360***	5.23
REV® 56A54™	9.999	19846	5.30
AvDx-D514	10.957	13268	5.45
Dyna-Gro S43RY95	11.003	10462	5.60
Armor AX4500	11.088	10896	5.62
REV 55L95	11.322	11754	5.69
REV® 55R53™	11.530	11580	5.79
REV® 48R22™	11.678	9866	5.88
Croplan LC4713S	11.727	11370	5.92
AvDx-D714	12.062	16240	5.98
Pioneer 95L01	12.069	12840	6.06
BX 4959 RY	12.116	10416	6.13
LG Seeds C4919R2	12.119	11844	6.18
Progeny P 4747 RY	12.585	14172	6.25
HBK LL4953	12.808	13734	6.30
Willcross WX2454N	13.175	15688	6.42
USG 74F53R	13.205	12126	6.63
Armor AX4470	13.209	10594	6.72
Progeny P 4788 RY	13.338	11960	6.74
Mycogen 5N452R2	13.582	20880	6.74
HALO 4:97	13.762	21580	6.80
Progeny P 5213 RY	13.848	15530	6.87
Progeny P 4560 LL	13.966	13860	6.88
Mycogen 5N479R2	14.160	13472	6.93
AG4135 GENRR2Y/SR*	14.324	14880	7.02

Go Soy 4914	14.400	12250	7.09
DG4867LL+	14.591	12596	7.28
Progeny P 4819 LL	14.724	16192	7.36
USG 75J23R	14.807	13476	7.44
Progeny P 4620 LLS	14.853	13756	7.57
Progeny P 4211 RY	14.903	15722	7.77
DG4930GENRR2Y+	15.020	17974	7.82
REV® 47R53™	15.022	18652	7.84
AvDx-D613	15.075	12500	7.86
DG4981LL/STS+	15.106	13432	7.87
REV® 52R74™	15.330	14560	8.10
HALO X445	15.381	17112	8.12
LG Seeds C4696R2	15.456	17096	8.16
Armor 47-R13	15.634	13600	8.21
AvDx-D814	16.306	20708	8.22
AG5335 GENRR2Y/SR*	16.420	16448	8.25
R05-4256	16.471	18902	8.27
USG 75G24L	16.492	21586	8.47
Armor 51-R50	16.689	16545	8.55
Seedway SG 4513	17.036	15140	8.56
Armor AX4550	17.058	22992	8.57
Dyna-Gro S49LS65	17.064	17142	8.73
REV® 49A55™	17.165	16494	8.83
REV® 51R53™	17.412	17764	8.83
Eagle ES4998Y	17.455	17922	8.88
Eagle Seed ES4960RY	17.531	16320	8.89
MorSoy Extra 44X82	17.602	14710	8.96
MPG 4714	17.890	18200	8.99
DG4990LL+	17.982	17972	8.99
REV® 47R34™	18.095	14032	9.09
REV® 49R94™	18.113	24304	9.10
DG5475GENRR2Y+	18.289	27880	9.30
MorSoy Extra 47X12	18.607	17784	9.33
REV® 53R23™	18.636	15634	9.45
REV® 49A75™	18.854	18608	9.50
REV® 49A14™	18.908	21452	9.53
Eagle Seed ES4720RY	18.959	20856	9.77
NK S40-N2	18.991	27758	9.85
AG4835 GENRR2Y/SR*	19.095	16944	9.90
Progeny P 5220 LLS	19.133	20886	9.92
Mycogen 5N540R2	19.273	20044	10.02
MPG 5314NRR	19.584	18990	10.04
HBK LL4653	19.807	28972	10.17

Eagle Seed ES5507RY	19.857	26300	10.17
USG 74B94RS	19.858	22576	10.23
Willcross RY2494NS	19.901	15732	10.34
Croplan LC5253S	20.039	18178	10.35
Armor 53-R16	20.052	17458	10.40
NK S55-C3 Brand	20.407	35662	10.43
Willcross WX2495N	20.725	16416	10.44
Hoegemeyer 4904 NR2S	20.780	33284	10.44
BX 5150 LL	20.911	20672	10.53
Armor 43-R43	21.212	19534	10.57
DG4967LL+	21.219	20342	10.73
MorSoy Extra 48X02	21.336	25322	10.79
BX 4748 LL	21.355	23252	10.79
USG 74G74LS	21.753	17656	10.92
DG4825GENRR2Y/STS+	21.760	19066	10.93
Armor AX4430	22.116	19700	11.07
REV® 54R84™	22.151	17666	11.20
REV® 56R63™	22.155	24292	11.29
REV® 44A15™	22.577	20082	11.50
Armor 46-R65	23.172	20338	11.53
AvDx-V213	23.173	43200	11.58
Armor AX4490	23.262	23694	11.63
DG4985GENRR2Y+	23.347	22136	11.66
MPG 483C	23.359	25910	11.69
Pioneer P53T73SR	23.602	29344	11.72
NK S51-C5 Brand	23.690	20466	11.77
Progeny P 4510 RYS	23.695	30552	11.85
Progeny P 5555 RY	23.852	23066	11.87
HALO X449	23.910	31898	11.90
MorSoy Extra 54X41	24.009	26812	12.15
DG4685GENRR2Y+	24.230	21834	12.15
HALO X448	24.310	27666	12.43
Dyna-Gro S46RY85	24.410	27460	12.45
DG4765GENRR2Y/STS+	24.453	31844	12.66
Eagle Seed ES4840RY	24.545	24852	12.90
AvDx-D914	24.790	21134	12.96
Progeny P 4613 RYS	25.127	19800	13.15
Dyna-Gro S49RY25	25.247	20800	13.41
Armor AX4390	25.455	23160	13.65
Progeny P 4440 RY	25.477	23316	13.68
Armor AX4410	25.616	23748	13.73
HALO X451	25.735	23432	13.75
HALO 4:76	25.969	23536	13.83

Willcross WX 2534N	26.208	29380	13.88
DG5267LL+	26.218	31896	13.94
Armor X447C	26.320	21066	14.42
DG4755GENRR2Y+	27.348	23796	14.49
REV® 48R44™	27.353	21866	14.52
HALO X452	27.572	27352	14.55
DG4925GENRR2Y+	27.816	22400	14.67
Croplan R2C4493	28.629	25800	14.69
Pioneer P52T50R	28.669	29100	14.95
USG 74F24RS	29.033	23380	15.10
Pioneer P56T03R2	29.256	32256	15.23
Mycogen 5N550R2	29.612	33904	15.28
REV® 52A94™	30.119	30466	15.40
Armor AX4440	30.674	32900	15.62
BX 5242 LL	30.719	30206	15.71
Progeny P 5960 LL	30.913	33244	15.75
NK S47-K5 Brand	30.949	29040	15.92
MorSoy Extra 49X54	31.167	27300	15.95
Armor AX4480	31.181	50316	15.95
Eagle Seed ES5225RY	31.194	24900	16.13
Seedway SG 4713	32.201	40572	16.45
Pioneer P45T11R	32.288	33852	16.55
LG Seeds C5122R2	33.208	28840	16.62
DG5565GENRR2Y+	33.405	37772	16.64
Pioneer P48T67L	33.990	31500	16.93
ELLIS	34.038	66124	16.95
Armor 50-R44	34.477	31420	17.40
REV® 57R21™	34.927	33100	17.72
MorSoy Extra 51X31	34.987	30800	17.83
DG5575GENRR2Y+	35.368	46530	17.85
DG5481LL+	35.594	36480	18.15
Go Soy 4713	35.636	27500	18.24
DG4767LL/STS+	36.477	31240	18.42
Pioneer P47T89R	37.533	37860	18.72
Braxton	37.647	36300	18.89
Mycogen X54490NR2	38.248	34800	18.93
MorSoy Extra 48X34	38.277	51200	20.27
DG5367LL+	38.380	55166	20.29
Progeny P 4850 RYS	38.745	29900	20.77
Progeny P 5610 RY	38.860	71364	21.48
Progeny P 4930 LL	39.577	35440	21.60
MorSoy Extra 46X04	39.683	44160	21.65
Armor 48-R66	40.152	35700	22.08

Progeny P 5160 LL	40.882	52564	23.27
Progeny P 4900 RY	40.921	41534	24.05
REV® 49L29™	42.595	37440	24.60
DG5480GENRR2Y+	43.208	36840	25.16
Hoegemeyer 4822 NRR	43.751	40534	25.49
Progeny P 5460 LL	46.216	43300	25.60
Armor AX4471	48.391	42960	26.28
Progeny P 5333 RY	51.376	50980	27.58
MorSoy Extra 53X82	52.302	49200	29.28
Hoegemeyer 5280 NRS	54.678	48100	33.06
DG4775GENRR2Y+	68.734	58560	35.68

* = Asgrow and + = Delta Grow

Red, Bold, Italics = Reniform Reproduction not different than Anand (Resistant). LSD .05 2.243 (Anand).

Blue, Bold, Italics = Reniform Reproduction not different than Hartwig (Resistant). LSD .05 4.024 (Hartwig).

Green, Bold, Italics = Reniform Reproduction not different than Forrest (Resistant). LSD .05 5.311 (Forrest).

The reniform nematode did not reproduce more on 31 lines of Hartwig and 23 lines of Anand on the179 breeding lines and varieties submitted by Public Soybean Breeders. These lines may be of interest for developing reniform resistant cultivars in a soybean breeding programs (Table 2).

Table 2. *Rotylenchulus reniformis* data of Breeder, Line, Log + 1 mean, Reniform count mean, and Reproduction index = (Pf/Pi) on 179 selected soybean breeding lines cooperating Southern Soybean Breeders 2014 tests.

Breeder	Line	Converted Log Ratio	Reniform Count Mean	Reproductive Index Pf/Pi
Fallow	***Fallow inoculated***	***0.40***	***470***	***0.24***
Resistant	***Hartwig***	***1.00***	***1105***	***0.55***
Shannon	***S12-5562***	***1.08***	***1454***	***0.73***
Shannon	***S12-7977***	***1.12***	***1415***	***0.71***
Arelli	***JTN-5110***	***1.12***	***1522***	***0.76***
Kantartzi	***Hartwig(Kantartzi)***	***1.15***	***1506***	***0.75***
Kantartzi	***Peking bg1***	***1.15***	***1612***	***0.81***
Fallen	***TN12-6502R2***	***1.24***	***1606***	***0.80***
Fallen	***TN12-5712R2***	***1.30***	***1881***	***0.94***
Shannon	***S11-15857***	***1.31***	***1701***	***0.85***
Shannon	***S12-5912***	***1.37***	***1855***	***0.93***
Kantartzi	***FH21***	***1.39***	***2001***	***1.00***
Fallen	***TN12-5713R2***	***1.57***	***2048***	***1.02***
Shannon	***S12-5942***	***1.62***	***2132***	***1.07***
Fallen	***TN09-44,121R2***	***1.65***	***2048***	***1.02***
Fallen	***SC98-1930***	***1.67***	***1940***	***0.97***

Kantartzi	***FHRIL35***	***1.69***	***2107***	***1.05***
Fallen	***TN09-44,420R2***	***1.69***	***5821***	***2.91***
Shannon	***S12-4465***	***1.92***	***2166***	***1.08***
Shannon	***S11-16653***	***1.97***	***2694***	***1.35***
Resistant	***Anand***	***2.00***	***2534***	***1.27***
Kantartzi	***Peking bg2***	***2.05***	***3093***	***1.55***
Kantartzi	***FH5***	***2.21***	***3263***	***1.63***
Kantartzi	***FH19***	***2.32***	***2857***	***1.43***
Kantartzi	***FH37***	***2.43***	***3177***	***1.59***
Arelli	***DC 2864 AM***	***2.57***	***4255***	***2.13***
Kantartzi	FH8	2.74	4219	2.11
Kantartzi	FH25	2.75	14964	7.48
Shannon	S11-16882	3.08	5011	2.51
Kantartzi	FRIL72	3.80	7640	3.82
Shannon	S12-8325	3.94	5050	2.53
Kantartzi	FH60	4.01	4941	2.47
Arelli	JTN-4114	4.54	7905	3.95
Kantartzi	FHRIL74	4.75	5703	2.85
Chen	R11-262	5.02	21779	10.89
Chen	R08-3119	5.12	12490	6.25
Shannon	S12-3807	5.92	7847	3.92
Kantartzi	FH1	6.23	13635	6.82
Kantartzi	FH14	6.35	14200	7.10
Fallen	TN12-5706R2	6.38	8350	4.18
Fallen	TN12-6508R2	6.42	10750	5.38
Kantartzi	FH28	7.29	14879	7.44
Kantartzi	FHRIL48	7.82	19281	9.64
Chen	R11-1578	8.19	17169	8.58
Chen	R08-2797	8.25	16205	8.10
Chen	R09-1237	8.35	16645	8.32
Kantartzi	FH12	8.39	11317	5.66
Chen	R07-2001	8.75	21474	10.74
Kantartzi	FH22	8.93	15983	7.99
Kantartzi	FHRIL40	9.06	20408	10.20
Chen	R05-3239	9.19	31661	15.83
Kantartzi	FH18	9.30	18137	9.07
Kantartzi	FH16	9.47	19809	9.90
Kantartzi	FH17	9.48	28836	14.42
Kantartzi	FH65	9.55	15793	7.90
Kantartzi	FHRIL74	9.63	20745	10.37
Chen	R10-4892	9.69	22746	11.37
Kantartzi	FHRIL44	9.83	21978	10.99
Chen	R10-2436	9.87	19204	9.60

Chen	R08-4002	9.91	39464	19.73
Kantartzi	FHRIL50	10.04	18021	9.01
Shannon	S12-3835	10.19	15387	7.69
Arelli	JTN-4214	10.19	18235	9.12
Chen	R10-130RY	10.28	19417	9.71
Kantartzi	FH3	10.68	18357	9.18
Chen	Osage	11.34	17726	8.86
Kantartzi	FH62	11.48	19103	9.55
Kantartzi	FH31	11.54	18400	9.20
Kantartzi	FH33	11.60	15283	7.64
Chen	R09-5137	11.70	22405	11.20
Chen	R09-4095	11.92	24683	12.34
Chen	R10-5795	11.99	20059	10.03
Chen	R10-197RY	12.01	58054	29.03
Chen	R09-4571	12.05	17183	8.59
Kantartzi	FHRIL52	12.12	29817	14.91
Kantartzi	FH73	12.16	15750	7.88
Chen	R10-453RY	12.38	15917	7.96
Chen	R08-4004	12.45	24250	12.13
Chen	R09-4798	12.45	17283	8.64
Kantartzi	FH20	12.47	18200	9.10
Chen	R10-2465	12.48	24605	12.30
Kantartzi	FH51RIL	12.50	19541	9.77
Kantartzi	FH13	12.59	23087	11.54
Arelli	DC 7816 AM	12.63	30874	15.44
Chen	R07-6614RR	12.76	22425	11.21
Kantartzi	FHRIL54	12.85	22307	11.15
Chen	UA 5213C	12.98	21602	10.80
Kantartzi	FHRIL47	13.10	26489	13.24
Kantartzi	FHRIL39	13.31	17600	8.80
Chen	R10-3747	13.54	20697	10.35
Fallen	SC10-400RR	13.83	33547	16.77
Kantartzi	FH58	14.06	20000	10.00
Chen	R10-428RY	14.48	27157	13.58
Kantartzi	FH66	14.66	24687	12.34
Shannon	S12-3318	14.78	18517	9.26
Chen	R02-6268F	14.86	21500	10.75
Blank	RIL41	14.89	27729	13.86
Shannon	S12-3064	14.99	41322	20.66
Kantartzi	FHRIL49	15.03	22665	11.33
Kantartzi	FHRIL45	15.10	33377	16.69
Chen	R10-4892	15.10	19983	9.99
Chen	R11-2354	15.11	20633	10.32

Kantartzi	FH29	15.62	18483	9.24
Chen	R07-167	15.68	25912	12.96
Chen	R09-3789	16.01	27323	13.66
Chen	R11-2517	16.03	21417	10.71
Fallen	SC10-456RR	16.08	27300	13.65
Chen	UA 5612	16.13	19700	9.85
Chen	R11-927	16.15	39067	19.53
Chen	Ozark	16.31	25433	12.72
Kantartzi	FHRIL53	16.41	23633	11.82
Chen	R09-1822	16.54	29151	14.58
Kantartzi	FH7	16.97	38864	19.43
Kantartzi	FH4	16.99	34716	17.36
Kantartzi	FH32	17.11	23533	11.77
Kantartzi	FHRIL67	17.14	23617	11.81
Kantartzi	FH24 DAL	17.25	22283	11.14
Chen	R09-345	17.26	29566	14.78
Kantartzi	FH6	17.28	32105	16.05
Kantartzi	FH57	17.31	24833	12.42
Chen	R04-1250RR	17.37	23000	11.50
Kantartzi	FH38	17.44	21867	10.93
Kantartzi	FH15	17.60	29637	14.82
Kantartzi	FH55	17.65	35066	17.53
Chen	R09-5026	17.78	29917	14.96
Kantartzi	FH68	17.81	20933	10.47
Chen	R09-4798	17.97	24800	12.40
Kantartzi	FHRIL43	18.05	24183	12.09
Kantartzi	FH9	18.06	32567	16.28
Kantartzi	FH26	18.25	22567	11.28
Kantartzi	FHRIL42	18.57	41985	20.99
Chen	R11-1192	18.62	34607	17.30
Kantartzi	FH23	18.71	23183	11.59
Shannon	S12-3443	18.86	26683	13.34
Chen	R11-1546	18.93	32100	16.05
Chen	R10-5086	18.97	37763	18.88
Kantartzi	FH2	19.20	34175	17.09
Chen	R07-2004	19.64	25317	12.66
Kantartzi	FHRIL56	20.00	24617	12.31
Chen	R10-230	20.15	30433	15.22
Kantartzi	FH27	20.25	27217	13.61
Kantartzi	FH70	20.30	46803	23.40
Chen	R11-7141	20.38	30100	15.05
Chen	R09-1589	20.44	69183	34.59
Chen	R11-89RY	20.44	28167	14.08

Chen	R05-4256	20.51	32085	16.04
Kantartzi	FH30	20.52	27550	13.78
Chen	R10-28	20.62	31067	15.53
Chen	R11-245	20.85	29167	14.58
Kantartzi	FH10	20.93	27533	13.77
Chen	R07-10397	21.22	27733	13.87
Chen	R11-4306	21.37	27350	13.68
Fallen	SC10-394RR	21.48	30850	15.43
Chen	R11-2299	21.70	27150	13.58
Fallen	SC10-397RR	21.94	43968	21.98
Kantartzi	FH76	22.06	28633	14.32
Chen	R09-430	22.64	35400	17.70
Chen	R08-1450	23.12	34750	17.38
Chen	R05-374	23.22	27700	13.85
Chen	R07-2000	23.31	33217	16.61
Chen	R04-1268RR (UA 5414RR)	23.69	30067	15.03
Kantartzi	RIL41	23.83	43048	21.52
Kantartzi	FH61	23.91	29433	14.72
Kantartzi	FHRIL64	24.14	35367	17.68
Kantartzi	FH36	24.30	29667	14.83
Chen	R11-213RY	24.82	33050	16.53
Chen	R11-2419	25.34	28767	14.38
Chen	R11-1617	25.74	32433	16.22
Chen	R10-1191	25.82	30750	15.38
Kantartzi	FH24	27.36	35167	17.58
Chen	R07-7044	27.94	55883	27.94
Chen	R11-171	28.46	41983	20.99
Kantartzi	FHRIL59	28.60	48383	24.19
Chen	R10-5828	29.15	52683	26.34
Susc	Braxton	29.48	34000	17.00
Kantartzi	FHRIL46	32.03	69883	34.94
Kantartzi	FH11	32.04	43833	21.92
Chen	R10-366RY	34.45	43400	21.70
Chen	R11-1057	35.80	43000	21.50
Chen	R11-1756	36.24	68667	34.33
Kantartzi	FH63	36.36	56300	28.15
Kantartzi	FH69	36.44	47017	23.51
Chen	R11-2282	39.66	57650	28.83

Blue, Bold, Italics = Reniform Reproduction not different than Hartwig (Resistant). LSD 0.05 = 1.568 (Hartwig).

Red, Bold, Italics = Reniform Reproduction not different than Anand (Resistant). LSD 0.05 = 3.75 (Anand)

List of Public Soybean Breeders commercial lines and varieties from the test years 2011 to 2014 are given with their Reproductive Indexes (Table 3). These varieties would be especially important for a cotton-soybean rotation where reniform is a problem. Other earlier tests are not given because of rapid replacement of these varieties by new varieties and their subsequent unavailability.

Table 3. Private commercial soybean varieties tested in 2011, 2012, 2013, and 2014 with their Reproductive Indexes that exhibit variety reniform resistance and those of the susceptible check Braxton.

Year/Variety	Reproductive Index
2011	
JTN-5203	0.64
Delta Grow DG5252R2Y	1.14
Progeny 5191	2.44
Braxton (Susceptible Check)	23.00
2012	
Armor 49-C3	1.01
MPG 5214	1.04
REV®55R83	2.02
Braxton (Susceptible Check)	64.70
2013	
MPG-S-5214NRR	1.47
Delta Grow 4940	2.74
ARMOR X1410	3.15
Willcross RY2513N	3.28
Leland	6.70
Braxton (Susceptible Check)	165.90
2014	
Delta Grow DG4940RR	0.24
MPG 5214NRR	0.59
Armor AX4520	0.63
Eagle Seed ES5335RY	0.96
LG Seeds C5252R2	1.09
Asgrow AG5535 GENRR2Y	1.20
Willcross WX 2524N	1.36
Armor AX4450	1.64
Dyna-Gro S52RY75	1.68
Delta Grow DG5230GENRR2Y	1.96
Mycogen X54522NR2	2.18
Braxton (Susceptible Check)	18.89

Summary

Reniform nematode resistant soybean varieties may be useful in cotton-soybean rotations. Of the 184 private soybean lines tested in 2014 eleven exhibited adequate resistance to be considered useful in a cotton-soybean rotation (Table 3). All Varieties tested can be found in Table 1. Public breeding lines with a useful level of reniform resistance in varieties and breeding lines tested in 2014 are listed in Table 2. Of 2014's 179 public breeding lines varieties and lines 31 would be useful in reniform resistance breeding programs. In table 3 all soybean varieties with levels of resistance to reniform nematode useful in cotton-soybean rotations of tests since 2011 are listed. Annual Reproductive Indexes of Reniform nematode have been reported by the Senior since 1998. Finding the older varieties may be a challenge as many private varieties last only a very few seasons.

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