RENIFORM NEMATODE REPRODUCTION ON SOYBEAN CULTIVARS AND BREEDING LINES IN 2012

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Abstract

During 2012, 157 soybean varieties from the Arkansas Variety Testing Program and 92 breeding lines and varieties from Public Soybean Breeders: 34 from Arkansas (Chen), 18 from Clemson (Shipe), 18 from the Missouri (Shannon), and 22 from Southern Illinois (Kantartzi) were tested in the greenhouse to determine their suitability as hosts for the reniform nematode, *Rotylenchulus reniformis*. All treatments were inoculated with 2,000 vermiform RN. The Variety Testing Varieties were grown for 67 days and the Public Breeders Lines for 75 days. The RN resistant varieties Anand, Forrest, and Hartwig, the RN susceptible cultivar Braxton, and fallow reniform nematode infested soil served as controls. The mean number of vermiform nematodes extracted from the soil of each treatment was calculated, as were the reproductive indices (RI = Pf/Pi), and PF/PI's of Anand, Hartwig, and Forrest for both tests. Arkansas Variety testing Program cultivars with RI's significantly greater than the RI on the resistant checks Anand, Hartwig and Forrest were considered suitable hosts for *R. reniformis*. Of the Arkansas Variety test lines 152 of 157 supported more reniform reproduction than Anand, Hartwig and Forrest The following private varieties; ARMOR 49-C3 (tested also as ARMOR 50-C3), MPG 5214 (tested as AgBorn S06-X79464), and REV®55R83™ and the public conventional lines JTN-4408, JTN-5110, and JTN-4307 from the USDA, Jackson, TN were not different than the resistant checks Anand, Hartwig or Forrest (Table 1). The Reniform Nematode did not reproduce more than: Anand on 8 of the 92 ; Hartwig on 15 of the 92; and Forrest on 25 of the 92 Breeding lines and Varieties submitted Public Soybean Breeders (Table 2). These resistant lines and JTN-4408, JTN-5110, and JTN-4307 from the USDA, Jackson, TN tested in the Arkansas Variety Testing Program may be of interest for reniform nematode resistant soybean breeding programs. The soybean varieties (ARMOR 49-C3, MPG 5214, and REV®55R83™) that did not support more reproduction than the 3 resistant checks (Anand, Hartwig and Forrest) may be useful in a Cotton-Soybean Rotation to reduce the numbers of reniform nematodes and allow cotton to be grown economically. This is especially important because most chemical nematicides are being phased out.

Introduction

In the United States from the middle-Atlantic states south and west to Texas the reniform nematode (*Rotylenchulus reniformis*) causes considerable damage and yield loss to cotton and soybean. At present no commercial upland cotton varieties have reniform nematode resistance, whereas several sources of reniform nematode resistance exist in soybean. This resistance is often linked to resistance from Peking and PI437654 to the soybean cyst nematode (*Heterodera glycines*) and excludes resistance form PI-88788. Use of reniform nematode resistant soybean in a

rotation with cotton can be a useful option. Public soybean breeding lines from programs at Arkansas, Clemson, Missouri, North Carolina, Southern Illinois, and USDA in 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. During the 1999 to 2012 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). 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).

The objectives of the 2012 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 and 2) to identify useful breeding lines for use in selection of new reniform nematode resistant cultivars.

Methods

The soybean lines and cultivars tested in 2012 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 three, 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 67 days for the private varieties and 75 days for the public 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

Three lines in the Arkansas Soybean Variety program (ARMOR 49-C3, MPG 5214, and REV®55R83™) tested had log ratios not significantly ($P \leq 0.05$) higher than Anand, Forrest, and Hartwig (Red in Table 1). This indicates they were not different in supporting reproduction from the three resistant checks.

Table 1. *Rotylenchulus* reniformis reproduction on 157 selected soybean cultivars and lines from the Arkansas Soybean Variety Testing Program in 2012 tests.

Cultivar	Mean Nematode Count	Cultivar Log + 1 Mean	Reniform RI = Pf/Pi Mean
Fallow	576	0.26	0.29
ARMOR 50-C3	1848	0.80	0.92
JTN-4307	1848	0.82	0.92
ARMOR 49-C3	2028	0.87	1.01
AgBorn S06-X79464	2088	0.92	1.04
JTN-5110	2220	0.93	1.11

Anand	2136	1.00	1.07
Hartwig	3116	1.09	1.56
Forrest	3600	1.56	1.80
REV®55R83™	4032	1.81	2.02
JTN-4408	4908	2.11	2.45
JTN-5108	19816	6.35	9.91
Progeny 5388RY	22540	7.31	11.27
REV®53R23™	57092	8.36	28.55
Eagle Seed LL	39052	9.08	19.53
Progeny 4747RY	35890	9.80	17.95
Davis 4148RR2Y	39004	10.33	19.50
Croplan R2C4541	57900	10.95	28.95
Willcross RR2544NS	47880	11.21	23.94
HALO X55	93632	11.31	46.82
Armor X1312	35700	11.60	17.85
NK S49-F8 Brand	40300	11.71	20.15
Pioneer 95Y50	32600	11.72	16.30
Croplan R2C5482	31400	12.07	15.70
Progeny 5412RY	31200	12.25	15.60
Delta Grow 5461LL	34296	12.50	17.15
ASGROW AG5233	57660	12.64	28.83
AgBorn S08-X27041	57092	13.11	28.55
Croplan R2C5371	52548	13.16	26.27
Armor X1306	54752	13.19	27.38
R09-1607RR	104792	14.17	52.40
Delta Grow 4925RR2	69344	14.25	34.67
Armor X1314	48688	14.32	24.34
LG C4411R2	50680	14.49	25.34
ASGROW AG4433	55336	15.05	27.67
LG C4625R2	55932	15.32	27.97
REV®52R74™	35500	15.37	17.75
NK S46-T3 Brand	53092	15.41	26.55
Armor X1307	68884	15.46	34.44
HALO X48	52700	15.47	26.35
AvDX - D812	87104	15.55	43.55
Armor X1315	44300	15.56	22.15
Delta Grow 5175RR2	75508	15.61	37.75
Dyna-Gro 39RY57	53956	15.99	26.98
Croplan LC4880	64992	15.99	32.50
AGS 553LL	64128	17.35	32.06
Armor 46-R64	51380	17.83	25.69
AvDX - E112	75320	17.88	37.66
AgBorn S08-X78041	54600	18.11	27.30
S08-X14117	111280	18.17	55.64
AGS 43R212	41920	18.21	20.96
Armor X1310	87096	18.23	43.55
AvDX - E513	62140	18.39	31.07
NK S48-P4 Brand	51304	18.41	25.65
Dyna-Gro S44RS93	74156	18.44	37.08
Delta Grow 4825 RR2/STS	49800	18.49	24.90
MORSOY XTRA 44X82	46000	19.00	23.00
REV®54R84™	104184	19.21	52.09
USG 74G82L	97020	19.28	48.51
Croplan R2C4801S	64860	19.34	32.43
NK S44-D5 Brand	64100	19.95	32.05
NK S56-G6 Brand	85956	19.97	42.98

Go Soy 5410 LL	65700	20.22	32.85
Delta Grow 4715RR2	114620	20.38	57.31
Progeny 4819LL	50160	20.55	25.08
Delta Grow 4875RR2/STS	100852	21.00	50.43
Dyna-Gro 35RY51	93464	21.08	46.73
Progeny 5610RY	74000	21.08	37.00
ASGROW AG3833	77880	21.16	38.94
HALO X50	121460	21.30	60.73
Go Soy 4912 LL	85052	21.71	42.53
HALO X51	75160	21.72	37.58
Progeny 4900RY	65600	21.84	32.80
Delta Grow 4990LL	90200	22.03	45.10
Armor 44-R08	91348	22.04	45.67
AvDX - D613	128548	22.20	64.27
Armor 48-R91	77088	22.65	38.54
Armor X1309	98040	22.79	49.02
DB03-8416	74500	22.93	37.25
HALO X456	64800	22.98	32.40
MORSOY XTRA 53X82	82300	23.17	41.15
Dyna-Gro S48RS53	103560	23.37	51.78
Delta Grow 5625RR2	79660	23.38	39.83
LG C4885R2	109924	23.89	54.96
S08-X17371	64800	24.06	32.40
ARMOR X1305	97244	24.15	48.62
Pioneer 95Y10	91772	24.36	45.89
MORSOY XTRA 48X02	73240	24.64	36.62
Eagle Seed ES5519	80720	24.69	40.36
Armor 55-R22	74000	24.71	37.00
AGS 45R212	70820	24.98	35.41
MORSOYXTRA 47X12	85090	25.05	42.55
Armor X1308	63800	25.43	31.90
S08-X6399	60700	25.46	30.35
HALO X49	71800	25.53	35.90
Armor X1303	61300	25.58	30.65
Delta Grow 5535RR2	97724	25.87	48.86
Dyna-Gro S53RY23	76880	26.08	38.44
ASGROW AG5533	104824	26.44	52.41
REV®49R54™	91800	26.62	45.90
Eagle Seed ES5650	84200	26.83	42.10
Delta Grow 4980RR2	75800	26.85	37.90
Pioneer 94Y23	85500	26.87	42.75
Go Soy 4812 LL	75820	26.97	37.91
Armor 46-R42	74940	27.04	37.47
Dyna-Gro S48LL23	97300	27.21	48.65
REV®55R53™	105340	27.34	52.67
USG 74H92R	82396	27.34	41.20
Eagle Seed ES5400	83880	27.88	41.94
NK S41-J6 Brand	87700	27.97	43.85
Armor X1316	79436	28.07	39.72
USG 75Q42R	81900	28.16	40.95
ASGROW AG4933	107000	28.90	53.50
HALO 5:45	91000	29.52	45.50
MORSOY XTRA 51X52	109308	30.26	54.65
UA 5612	73400	30.48	36.70
Delta Grow 4755RR2	153324	30.68	76.66
Delta Grow 4867LL	76820	30.75	38.41

Delta Grow 4967LL	91760	30.84	45.88
HALO X478	89020	31.60	44.51
USG 75Q52R	125800	31.88	62.90
LG C4780R2	85300	33.34	42.65
Progeny 4850RY	78700	33.81	39.35
ASGROW AG5732	116572	34.05	58.29
AgBorn S08-X0448	90460	34.30	45.23
Go Soy 5110 LL	89380	34.91	44.69
Delta Grow 4815RR2	94700	34.96	47.35
Go Soy 4910 LL	126900	36.11	63.45
R02-3065	104400	37.33	52.20
Armor DK 4744	89960	37.69	44.98
S08-X2499	103640	37.86	51.82
S08-X7279	102980	38.41	51.49
Delta Grow 4765RR2/STS	135300	39.68	67.65
USG 75J62R	113020	40.05	56.51
Delta Grow 4670RR2	112800	40.14	56.40
Dyna-Gro S54RY43	163504	40.40	81.75
ASGROW AG4533	119880	40.63	59.94
AGS 47R212	129000	40.91	64.50
JGL EXP 481	106140	41.83	53.07
Progeny 4814RY	96500	41.92	48.25
NK S51-H9 Brand	122400	42.46	61.20
ARMOR X1304	97600	42.74	48.80
NK S46-A1 Brand	118000	42.80	59.00
Braxton	129400	43.10	64.70
Delta Grow 4575RR2	97600	43.46	48.80
REV®47R74™	124220	43.97	62.11
Go Soy 4711 LL	141580	46.78	70.79
REV®59R13™	148600	46.83	74.30
Armor X1313	110200	48.29	55.10
JGL EXP 480	123880	48.40	61.94
Armor X1312-5	110100	49.07	55.05
Armor X1311	116400	51.30	58.20
Delta Grow 4970RR	113440	51.86	56.72
Dyna-Gro S47RY13	165900	51.86	82.95
Delta Grow 5556RR1	170500	52.32	85.25
ASGROW AG5633	136300	53.52	68.15
Davis D-147RRCNS	138480	58.65	69.24
Delta Grow 5475RR2	142100	61.76	71.05
Croplan R2C4391	138000	63.20	69.00
AvDX - V411	209000	74.44	104.50
ASGROW AG4633	207000	84.93	103.50

From a total of 92 Public Breeder lines and cultivars listed in Table 2 from the test of Arkansas, Clemson, Missouri, and Southern Illinois breeding lines, 24 were not significantly higher than Forrest (Red), 15 than Hartwig (Green), and 9 than Anand (Blue). From the 24 resistant lines and cultivars tested; two were from Arkansas, seven were from Clemson, ten were from Missouri, and five from Southern Illinois. These and three resistant conventional lines JTN-4408, JTN-5110, and JTN-4307 from the USDA, Jackson, TN that were tested in the Arkansas Variety Testing Program may be useful in breeding new soybean varieties with resistance to the reniform nematode. They would be especially important if they are also determined to have soybean cyst and root-knot nematode resistance.

Table 2. *Rotylenchulus reniformis* reproduction on 134 breeding lines and selected cultivars in 2012 tests.

Breeder	Line	Reniform Pot Average	Log 10 + 1 Anand	Log 10 + 1 Hartwig	Log 10 + 1 Forrest	RI Pf/Pi
Check	Fallow	1188	0.53	0.27	0.06	0.59
Shannon	S10-9117	1416	0.59	0.30	0.07	0.71
Shipe	SC98-1930	1575	0.58	0.31	0.08	0.79
Shannon	S10-9446	2136	0.90	0.46	0.11	1.07
Check-res	Anand	2200	1.00	0.49	0.11	1.10
Shannon	S10-9260	2412	0.91	0.48	0.12	1.21
Shannon	S10-11200	3864	1.48	0.78	0.18	1.93
Shannon	S10-11227	4132	1.25	0.70	0.18	2.07
Check-res	Hartwig	4392	1.46	1.00	0.20	2.20
Shannon	S05-11482	4960	1.86	0.98	0.23	2.48
Shannon	S10-10461	8276	2.53	1.39	0.36	4.14
Shannon	S10-8860	8528	3.00	1.59	0.39	4.26
Kantartzi	LS 05-0216	9920	4.29	2.17	0.49	4.96
Shipe	SC09-183RR	11736	4.89	2.48	0.56	5.87
Chen	R07-1826	12064	4.03	2.15	0.54	6.03
Shipe	SC06-051	12688	4.24	2.27	0.57	6.34
Shipe	MOTTE	13636	5.39	2.75	0.64	6.82
Kantartzi	LS 05-3110	15528	5.05	2.69	0.68	7.76
Shipe	SANTEE	17204	6.01	3.14	0.77	8.60
Kantartzi	LS 05-6521	17348	5.39	2.81	0.71	8.67
Shipe	SC05-642	18885	9.98	5.10	1.20	9.44
Shipe	SC07-786	19884	5.82	3.08	0.80	9.94
Check-res	Forrest	20044	6.79	3.65	1.00	10.02
Kantarzi	LS 05-6513	24512	7.34	3.86	0.99	12.26
Chen	R09-1607	38284	7.04	3.78	1.06	19.14
Shannon	S10-4974	45108	4.30	2.80	1.07	22.55
Kantarzi	LS 05-6442	65900	18.31	9.35	2.25	32.95
Shannon	S10-6228	67356	7.46	4.48	1.59	33.68
Kantarzi	LS 05-2610	71940	27.35	13.80	3.14	35.97
Chen	R09-1827	72700	26.09	13.19	3.03	36.35
Kantarzi	LS 05-0107	86600	23.68	12.10	2.93	43.30
Shannon	S08-9942	88500	33.68	16.98	3.85	44.25
Kantarzi	LS 04-49077	90036	21.24	11.22	2.99	45.02
Chen	R08-107	96100	34.30	17.31	3.96	48.05
Kantarzi	LS 05-0242	96900	26.55	13.47	3.17	48.45
Kantarzi	LS 05-2658	107664	34.88	17.74	4.18	53.83
Kantarzi	LS 05-3229	110980	28.38	14.71	3.72	55.49
Chen	R08-2776	115700	40.36	20.32	4.60	57.85
Chen	R08-141	116100	39.45	19.99	4.64	58.05
Shannon	S08-14117	121400	50.33	25.28	5.63	60.70
Chen	R09-319	125400	44.36	22.49	5.22	62.70
Shipe	SC09-090RR	125528	34.28	18.26	4.76	62.76
Shannon	S10-11914	127084	33.70	17.51	4.41	63.54
Kantartzi	LS 04-30080	130300	45.60	22.98	5.22	65.15
Chen	R07-6669	132900	45.35	23.06	5.41	66.45
Chen	RM 9508 C2	135100	45.77	23.25	5.44	67.55
Shipe	SC09-103	135600	57.20	28.70	6.35	67.80
Shipe	SC09-092RR	136500	46.43	23.44	5.37	68.25
Chen	R08-2797	139420	54.26	27.28	6.10	69.71
Shannon	S10-12053	141220	26.47	13.82	3.61	70.61
Kantartzi	LS 05-0220	143000	57.39	28.81	6.41	71.50

Kantartzi	LS 05-4007	144216	42.60	21.80	5.26	72.11
Shipe	SC09-210RR	146800	44.98	22.93	5.46	73.40
Chen	R09-1822	148960	35.98	18.38	4.46	74.48
Chen	RM1639 C1	149900	58.35	29.37	6.61	74.95
Chen	R07-6654	151300	52.40	26.51	6.11	75.65
Shipe	SC09-102	154700	47.12	24.00	5.69	77.35
Kantartzi	LS 05-1065	157560	45.48	23.08	5.41	78.78
Kantartzi	LS 03-4294	158900	56.37	28.42	6.46	79.45
Kantartzi	LS 05-2202	159600	49.81	25.41	6.05	79.80
Chen	R09-4571	162540	45.58	23.12	5.41	81.27
Chen	R05-374	174980	27.24	14.85	4.35	87.49
Chen	R08-47	175000	69.90	35.09	7.79	87.50
Shannon	S10-3003	175500	69.78	35.01	7.76	87.75
Shannon	S10-6883	178300	58.10	29.35	6.74	89.15
Shannon	S08-9936	186000	65.59	32.99	7.40	93.00
Chen	R09-400	186000	76.26	38.25	8.45	93.00
Chen	R09-430	187000	83.18	41.67	9.15	93.50
Kantartzi	LS 05-3915	193100	63.81	32.25	7.41	96.55
Chen	Kirksey E1	194200	61.55	31.09	7.15	97.10
Kantartzi	LS O4-27138	196280	67.47	33.96	7.67	98.14
Chen	R06-4475	197700	65.63	33.21	7.67	98.85
Shipe	SC09-052	207600	55.41	28.17	6.68	103.80
Shipe	SC09-238RR	207744	51.47	27.21	7.08	103.87
Kantartzi	LS 05-2705	221000	95.20	47.71	10.49	110.50
Shipe	SC09-059RR	221000	96.60	48.41	10.63	110.50
Check-sus	Braxton	222000	93.82	47.04	10.36	111.00
Chen	R07-10322	224100	50.64	26.05	6.48	112.05
Kantartzi	LS 05-8130	231720	88.88	44.69	10.02	115.86
Chen	R09-1589	240600	58.47	29.82	7.19	120.30
Kantartzi	LS 05-0202	241492	73.58	37.42	8.83	120.75
Shipe	SC09-039	243300	73.96	37.49	8.74	121.65
Shannon	S08-9727	248080	74.33	37.88	9.01	124.04
Chen	R09-5088	252400	73.40	37.19	8.68	126.20
Chen	R07-5351	256000	106.26	53.27	11.74	128.00
Shipe	SC09-057RR	260000	74.83	37.99	8.92	130.00
Chen	R09-886	265700	106.14	53.27	11.81	132.85
Chen	R09-5225	266000	115.03	57.65	12.67	133.00
Chen	R07-1685	266100	63.83	32.74	8.03	133.05
Chen	R09-2988	269800	66.79	34.45	8.54	134.90
Shipe	SC09-142	270000	101.15	50.75	11.24	135.00
Chen	R08-1178	275000	88.09	44.24	9.87	137.50
Chen	JYC2 E2	298000	122.33	61.33	13.51	149.00
Chen	R09-209	301196	74.75	38.40	9.42	150.60
Chen	R07-1857	321200	117.08	58.85	13.17	160.60
Chen	R09-2567	341000	144.88	72.61	15.97	170.50
Chen	R08-527	432200	101.63	52.26	12.87	216.10

Blue is not significantly different from Anand.
Green is not significantly different from Hartwig.
Red is not significantly different from Forrest.

The lists of the public varieties from the test years, 2009, 2010, 2011, and 2012 are located in Table 3. These varieties would be especially important for a soybean-cotton rotation where reniform nematode is present.

Table 3. Private soybean varieties tested in 2009, 2010, 2011, and 2012 exhibiting Reniform nematode resistance that could be of use in a Cotton-Soybean rotation.

2009	2010	2011	2012
DB04-10836	Armor ARX492	JTN-5203	Armor 49-C3
DB04-10997	ASGROW AG5431	Delta Grow DG5252R2Y	MPG 5214
MorSoy RT4919N	ASGROW AG5531	Progeny 5191	REV®55R83
Pioneer 95Y30	HBK RY5520		
V03-4705	SSC-049N		
	SSC-051N		
	USG 75T40		

Summary

Reniform nematode resistant soybean varieties may be useful in cotton-soybean rotations. Of the 157 private soybean varieties tested in 2011 only 3 exhibited adequate resistance to be considered useful in a cotton-soybean rotation. 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 2012 are listed in Table 2. Of 92 varieties and lines 24 are of possible use in reniform resistance breeding programs. Those with resistance to root-knot nematode would be especially important in breeding programs. In table 3 all soybean varieties with levels of resistance to reniform nematode useful in cotton-soybean rotations of my tests since 2009 are listed. Finding the older varieties may be a challenge as many private varieties last only a very few seasons.

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