RENIFORM NEMATODE REPRODUCTION ON SOYBEAN CULTIVARS AND BREEDING LINES IN 2009

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Abstract

During 2009, 148 soybean varieties from the Arkansas variety testing program , 78 breeding lines and varieties: 21 from Clemson (Shipe), 22 from Arkansas (Chen), 4 from the USDA Jackson TN (Arelli), and 31 from the Missouri (Shannon), and 31 late maturity Southern varieties submitted by C. Overstreet from LSU were tested in the greenhouse to determine their suitability as hosts for the reniform nematode (RN), *Rotylenchulus reniformis*. All treatments were inoculated with 1, 600 vermiform RN. The treatments were grown for 94 days. The RN resistant varieties Anand, Forrest, and Hartwig, the RN susceptible cultivar Braxton, and fallow RN 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, and Forrest for both tests. Arkansas test cultivars with RI's significantly greater than the RI on Forrest (1.00) were considered suitable hosts for *R. reniformis*. Of the Arkansas test varieties 137 of 148 supported more reproduction than Forrest. The following varieties; MorSoyRT4919N, DB04-10997, DB04-10836, S05-11482, Pioneer 95Y30, V03-4705, S05-11268, S05-11268, S06-3027, S06-3095, and S06-4649 were not different than Forrest. Fifty-eight of the 78 breeding lines RN reproduced more than on Forrest. Of the 31 late maturing varieties from LSU the 8 varieties Cropland 4877, Progeny 4807, USG 7553, USG 7553, Asgrow4605, Delta Grow 4870, Pioneer 94Y70, and Delta King 4968 were not different than Forrest. The lines that did not support more reproduction than Forrest may be useful in a Cotton-Soybean Rotation to reduce the numbers of reniform nematodes and allow cotton to be grown economically.

Introduction

In the Southeastern United States reniform nematode (*Rotylenchulus reniformis*) causes considerable damage and yield loss to cotton and soybean. No cotton varieties have reniform nematode (RN) resistance, whereas several sources of RN resistance exist in soybean. This resistance is often linked to resistance to the soybean cyst nematode (*Heterodera glycines*). Use of RN resistant soybean in a rotation with cotton can be a useful option. Public soybean breeding lines from programs at Arkansas, Clemson, Missouri, North Carolina and USDA in Jackson Tennessee having low reniform reproduction may prove very useful in breeding for RN resistance.

Information on the reproduction of the RN on contemporary soybean cultivars is limited. Robbins, et al. (1994) reported on the reproduction of the RN on 30 soybean cultivars. In 1996 Robbins & Rakes reported RN 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 2008 period yearly tests have shown the host status for over 1,650 soybean lines (Robbins et al. 1999, 2000, 2001, 2002, 2003, 2004, 2005, 2006, 2007a, 2008, 2009). These papers form the basis for RN reproduction information on contemporary soybean lines. The breeding lines tested for reniform nematode reproduction are given by Robbins et al. (2007b, 2008)

The objectives of the 2009 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 RN susceptible crops in RN infested fields.
2) To identify useful breeding lines for use in selection of new RN resistant cultivars.
3) To identify late maturing soybean cultivars generally grown South of Arkansas for possible reniform resistance.

Methods

The soybean test lines and cultivars in 2009 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 (ca. 91% sand, 5% silt, 4 % clay, <1% O.M.). The RN 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 1,600 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. 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 and Braxton as a susceptible control.

After 94 days (June 5-September 3, 2009), 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 and Forrest 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 and Discussion

Eleven lines in the Arkansas Soybean Variety program tested had log ratios not significantly ($P \leq 0.05$) higher than Forrest (italics, bold, & both red and blue in Table 1). This indicates they were not different in supporting reproduction from Forrest (Resistant). Those lines in bold, italics, and red on table 1 are not different than Anand or Hartwig (more Resistant than Forrest).

From a total of 78 lines and cultivars in the test of the Arkansas, Clemson, USDA Jackson TN, and Missouri 19 were not significantly higher than Forrest (italics, bold, both red and blue in Table 2). Six of the 19 lines were not different in supporting reproduction from Anand and Hartwig. From the 19 lines and cultivars tested none were from Arkansas, 5 were from Clemson, 13 were from Missouri, and 1 were from USDA Jackson TN. This indicates these 19 were not different in supporting RN reproduction from Forrest. These lines may be useful in breeding new soybean varieties with resistance to the reniform nematode. They would be especially important if they are also shown to also have soybean cyst and root knot nematode resistance.

Out of 31 late maturing soybean varieties entered by Overstreet, 8 were not significantly higher than Forrest (italics, bold, and blue in Table 3). All varieties supported reproduction significantly higher than Anand and Hartwig.

Table 1. *Rotylenchulus reniformis* reproduction on 148selected soybean cultivars and lines from the Arkansas Soybean Variety Testing Program in 2009 tests. Italicized, Red and Blue not different that Forrest, Red not different than Hartwig and Anand.

Cultivar	Mean Log + 1	Mean Nematode count	Mean RI = Pf/Pi
Fallow	*0.113*	*936*	*0.59*
S06-4649	*0.135*	*1116*	*0.70*
S06-3095	*0.229*	*1896*	*1.19*
Anand	*0.232*	*1980*	*1.24*
S06-3027	*0.268*	*2256*	*1.41*
Hartwig	*0.299*	*2536*	*1.59*
S05-11268	*0.768*	*10380*	*6.49*
V03-4705	*0.980*	*9620*	*6.01*
Forrest	*1.000*	*8152*	*5.10*
Pioneer 95Y30	*1.169*	*19200*	*12.00*
S05-11482	*1.176*	*16316*	*10.20*
DB04-10836	*1.236*	*11536*	*7.21*
DB04-10997	*1.237*	*10720*	*6.70*
MorSoy RT4919N	*1.667*	*14008*	*8.76*
AgVenture AV50X0RR	1.932	19475	12.17
S06-3929	2.162	19156	11.97
REV RV49R11	2.196	19920	12.45
JGL 481	2.298	21272	13.30
Pioneer 93Y92	2.419	21120	13.20
Delta King GP-500	2.429	29124	18.20
NC+ 4A82RS	2.620	22244	13.90
Pioneer 94Y80	2.651	23224	14.52
457.RCP	2.706	24460	15.29
ASGROW AG3803	2.738	22884	14.30
AgVenture AVEXA49B	2.770	34764	21.73
Delta King DK4770	2.773	23800	14.88
REV RV45R10	2.776	23600	14.75
VPM44X1RR	2.908	24400	15.25
Armor ARX0473	2.939	24908	15.57
USG 74B58	2.963	25696	16.06
REV RV48R10	2.987	25900	16.19
Willcross 2878NSTS	3.029	26000	16.25
Dyna-Gro 36C44	3.037	28404	17.75
Willcross RR2446N	3.053	26172	16.36
478.RCS	3.108	26300	16.44
Willcross RR2544NSTS	3.109	27948	17.47
Eagle Seed ES 4922RR	3.115	27500	17.19
Willcross RR2470NSTS	3.121	27400	17.13

499.RC	3.151	27200	17.00
Dyna-Gro V47N9RS	3.175	26400	16.50
Willcross RR2477NSTS	3.192	27700	17.31
VPM49X1RR	3.292	27800	17.38
Armor ARX0474	3.316	34300	21.44
V03-4660	3.316	28100	17.56
JGL 482	3.385	28500	17.81
HALO 4:65	3.405	30500	19.06
ASGROW AG4005	3.409	28900	18.06
Stine EXP 5.4R1	3.418	29800	18.63
MPG 48-4	3.427	31280	19.55
Pioneer 94Y91	3.430	31452	19.66
AgVenture AV45X5RR	3.434	28300	17.69
NC+ 4A65RS	3.453	31600	19.75
NK S48-C9 Brand	3.509	29200	18.25
USG 75M16	3.522	31720	19.83
Delta King DKX0461	3.556	34400	21.50
MPG 4509NRR/STS	3.591	31000	19.38
Dyna-Gro 33Y45	3.620	34416	21.51
Delta King DKX949	3.630	31000	19.38
477.TCS	3.635	32200	20.13
Legacy 55-56RR	3.666	36100	22.56
Pioneer 94Y01	3.685	32700	20.44
JGL 483	3.701	32800	20.50
Progeny 4928	3.733	34900	21.81
Croplan RC4718S	3.764	33672	21.05
N-ADR55806	3.779	37000	23.13
HALO 4:94	3.829	33800	21.13
USG 74A79	3.847	33800	21.13
Pioneer 94Y20	3.920	37416	23.39
Willcross RR2547N	3.996	38360	23.98
REV RV47R21	4.049	36600	22.88
Super Soy-09L.47N	4.098	38600	24.13
Dyna-Gro 32P48	4.147	42964	26.85
Schillinger 5440.RC	4.149	36800	23.00
REV RV47R11	4.150	40808	25.51
Willcross RR2498NSTS	4.183	35100	21.94
Armor ARX0472	4.196	37000	23.13
Schillinger 4880.RC	4.212	36000	22.50
Dyna-Gro V48N7RS	4.225	41328	25.83
Armor ARX0432	4.295	36280	22.68
Willcross RR2490NSTS	4.316	37100	23.19
Delta Grow 4790RR2	4.368	37300	23.31
USG 74E88	4.370	39632	24.77

Delta King DKX053	4.387	36200	22.63
Delta King DK4560	4.442	39500	24.69
435.TCS	4.477	38300	23.94
HBK R4729	4.533	38100	23.81
USG 74D79	4.563	37900	23.69
REV RV49R10	4.623	41000	25.63
Progeny 4990	4.681	44100	27.56
REV RV44R11	4.689	40200	25.13
USG 75M49	4.732	42200	26.38
MorSoy RTs4824	4.739	39900	24.94
Delta King GP-533	4.812	46300	28.94
Eagle Seed ES 5370RR	4.823	44600	27.88
Armor ARX0431	4.873	42300	26.44
REV RV46R11	4.927	50000	31.25
Armor ARX0471	4.948	45200	28.25
HALO 5:65	4.963	43000	26.88
458.RCS	4.993	49200	30.75
Progeny 5309RR	5.005	47700	29.81
GLENN	5.017	44700	27.94
Super Soy-10L.49N	5.075	43800	27.38
MorSoy RT5229N	5.092	43800	27.38
USG 74G78	5.173	47200	29.50
AgVenture AV51X5RR/STS	5.176	46700	29.19
REV RV49R21	5.264	46700	29.19
REV RV49R20	5.277	44400	27.75
Dyna-Gro V51N7RS	5.316	47800	29.88
Dyna-Gro 31R54	5.350	46400	29.00
DB04-290	5.381	59900	37.44
N-ADR52718	5.434	47600	29.75
S06-10572	5.445	52600	32.88
Pioneer 95Y01	5.448	53280	33.30
Schillinger 4990.RC	5.538	52800	33.00
495.RC	5.592	46800	29.25
Delta King DKX0462	5.628	48100	30.06
Dyna-Gro 33C59	5.681	49600	31.00
Super Soy-09L.49N	5.764	53200	33.25
Super Soy-10L.51N	5.948	57092	35.68
Progeny 5409RR	6.002	55500	34.69
Willcross RR2484N	6.095	50100	31.31
R05-4114	6.135	53300	33.31
USG 74A69	6.145	55400	34.63
REV RV53R21	6.247	58600	36.63
MorSoy CB5209	6.556	57600	36.00
ASGROW AG5405	6.583	70500	44.06

Delta King DK52K6	6.610	56200	35.13
REV RV55R11	6.812	57600	36.00
NC+ 5651	6.820	59700	37.31
MorSoy RT5429N	6.950	60300	37.69
HBK R5229	6.968	87400	54.63
REV RV53R11	6.980	66100	41.31
Osage	7.051	65100	40.69
REV RV54R10	7.139	69900	43.69
NK S54-M7 Brand	7.262	66900	41.81
Dyna-Gro 35F55	7.406	67300	42.06
HBK C5029	7.439	72800	45.50
Eagle Seed ES 5507RR	7.565	73100	45.69
USG 75Z38	7.707	66500	41.56
Progeny 3909RR	7.930	71800	44.88
AGS 597	7.951	80500	50.31
Croplan RC5419	8.064	71100	44.44
HBK C5528	8.244	69500	43.44
N-ADR56203	8.438	87300	54.56
AGS 554RR	8.598	75700	47.31
Terral TV52R79	8.905	88100	55.06
HALO 5:25	9.111	78700	49.19
USG 74C69	9.419	82600	51.63
HBK C4929	10.223	96200	60.13
Progeny 5319RR	10.378	87500	54.69
Armor ARX045	10.559	102600	64.13
Terral TV55R20	12.174	111600	69.75
Braxton	17.926	149700	93.56

Table 2. *Rotylenchulus reniformis* reproduction on selected Breeding Lines, 2009. Italicized, Red and Blue not different that Forrest, Red not different than Hartwig and Anand.

Cultivar or Line	Breeder	Mean Log + 1	Mean Nematode count	Mean RI = Pf/Pi
Fallow		*0.064*	*390*	*0.24*
SO6-4649	*Shannon*	*0.265*	*1608*	*1.01*
Hartwig		*0.291*	*9304*	*5.82*
Anand		*0.300*	*1836*	*1.15*
JTN-5109	*Arelli*	*0.301*	*1884*	*1.18*
SO6-3053	*Shannon*	*0.361*	*2256*	*1.41*
06SS-6003	*Shannon*	*0.492*	*3312*	*2.07*
06SS-6015	*Shannon*	*0.523*	*3312*	*2.07*
06SS-6299	*Shannon*	*0.594*	*4600*	*2.88*
06SS-6011	*Shannon*	*0.974*	*6208*	*3.88*

Forrest		*1.000*	*13876*	*8.67*
SC06-687RR	*Shipe*	*1.055*	*7284*	*4.55*
06SS-5983	*Shannon*	*1.199*	*11792*	*7.37*
SANTEE	*Shipe*	*1.297*	*16396*	*10.25*
06PIV-7904	*Shannon*	*1.376*	*12108*	*7.57*
SC05-642	*Shipe*	*1.519*	*11212*	*7.01*
SO6-12439	*Shannon*	*1.748*	*14848*	*9.28*
SC06-704RR	*Shipe*	*1.853*	*24372*	*15.23*
06DIV-7843	*Shannon*	*1.865*	*16380*	*10.24*
SO7-2680	*Shannon*	*1.886*	*17612*	*11.01*
SO7-10199	*Shannon*	*1.985*	*13636*	*8.52*
06SS-6301	*Shannon*	*2.064*	*22080*	*13.80*
SC01-803	*Shipe*	*2.102*	*15324*	*9.58*
SC03-9093	Shipe	2.134	18144	11.34
SO6-12749	Shannon	2.312	18240	11.40
SC03-9151	Shipe	2.401	26608	16.63
SC02-208	Shipe	2.825	19860	12.41
06SS-6028	Shannon	3.087	18668	11.67
SC06-708RR	Shipe	3.503	37956	23.72
SO7-4455	Shannon	3.933	26444	16.53
SO7-16041	Shannon	4.117	30740	19.21
06SS-6296	Shannon	4.453	32800	20.50
SC03-9090	Shipe	4.688	48692	30.43
SO7-3626	Shannon	4.802	36476	22.80
JTN-4109	Arelli	4.848	52212	32.63
SO7-3666	Shannon	5.199	42040	26.28
09RU-7	Chen	5.393	32900	20.56
JTN-4209	Arelli	5.485	42496	26.56
SC06-375RR	Shipe	5.538	36400	22.75
SO6-11278	Shannon	5.657	37900	23.69
JTN-5209	Arelli	5.666	40100	25.06
09RU-17	Chen	5.833	51148	31.97
09RU-18	Chen	5.866	47596	29.75
SO7-2667	Shannon	5.933	40700	25.44
09RU-19	Chen	5.934	37800	23.63
06ST-6815	Shannon	6.031	38400	24.00
SC06-688RR	Shipe	6.040	44468	27.79
09RU-21	Chen	6.532	41200	25.75
09RU-11	Chen	7.113	46500	29.06
09RU-16	Chen	7.115	74796	46.75
SC06-317RR	Shipe	7.285	103608	64.76
SO7-3614	Shannon	7.404	47500	29.69
09RU-13	Chen	7.550	47300	29.56
SC06-337	Shipe	7.606	56172	35.11

09RU-23	Chen	7.898	99812	62.38
SO7-3530	Shannon	8.069	50400	31.50
SO7-4575	Shannon	8.200	60625	37.89
09RU-6	Chen	8.314	52100	32.56
06ST-6869	Shannon	8.354	50700	31.69
09RU-3	Chen	8.381	55100	34.44
SC06-388	Shipe	8.387	67164	41.98
09RU-1	Chen	8.447	55400	34.63
09RU-12	Chen	8.471	58900	36.81
09RU-4	Chen	9.219	67400	42.13
SO7-10311	Shannon	9.368	68125	42.58
09RU-24	Chen	9.373	69800	43.63
09RU-2	Chen	9.677	71500	44.69
09RU-20	Chen	10.091	71400	44.63
SO6-10572	Shannon	10.094	79400	49.63
09RU-8	Chen	10.260	72600	45.38
SC00-643	Shipe	10.944	82500	51.56
09RU-25	Chen	11.046	69700	43.56
SC06-301	Shipe	11.249	73900	46.19
09RU-9	Chen	11.759	84900	53.06
09RU-22	Chen	11.891	76400	47.75
SC06-407	Shipe	12.236	89000	55.63
SO7-10248	Shannon	12.381	78600	49.13
SC06-334	Shipe	13.175	80700	50.44
SC06-387	Shipe	13.329	80900	50.56
SO7-4124	Shannon	13.869	91500	57.19
SC06-676RR	Shipe	13.916	102900	64.31
Braxton		15.760	96900	60.56
09RU-14	Chen	18.803	116800	73.00

Table 3. *Rotylenchulus reniformis* reproduction on selected late maturity group from LSU, 2009. Italicized and Blue not different that Forrest.

Cultivar	Mean Log + 1	Mean Nematode count	Mean RI = Pf/Pi
Fallow	*0.062*	*552*	*0.35*
Anand	*0.120*	*1104*	*0.69*
Hartwig	*0.193*	*1860*	*1.16*
Delta King 4968	*0.883*	*9020*	*5.64*
Forrest	*1.000*	*19304*	*12.07*
Pioneer 94Y70	*1.033*	*12620*	*7.89*
Delta Grow 4870	*1.036*	*12828*	*8.02*
Asgrow 4605	*1.353*	*14432*	*9.02*

Asgrow 5606	*1.502*	*16284*	*10.18*
USG 7553	*1.792*	*18432*	*11.52*
Progeny 4807	*1.804*	*17348*	*10.84*
Cropland 4877	*1.915*	*26008*	*16.26*
Asgrow 5335	2.062	25120	15.70
Pioneer 94M80	2.087	26304	16.44
NLT 4A81	2.330	23716	14.82
Pioneer 95Y20	2.344	29808	18.63
USG 74A91	2.351	24816	15.51
Cropland RC5007	2.399	32592	20.37
Armor 47F8	3.083	32452	20.28
Terral 47R18	3.151	42380	26.49
NK S52-F2	3.192	38760	24.23
Dyna Gro 36Y48	3.304	31644	19.78
Dyna Gro 33X55	3.552	35100	21.94
Armor 53-Z5	3.646	34600	21.63
Morsoy 4824	3.653	32500	20.31
NK 49-H7	3.844	39700	24.81
Pioneer 95Y70	4.025	43396	27.12
Delta Grow 5555	4.180	46276	28.92
Dyna Gro 33C59	4.786	45700	28.56
Terral 54R28	4.948	45700	28.56
Delta Grow 5450	5.614	54500	34.06
Morsoy 5168	6.138	65400	40.88
Progeny 5218	6.456	61500	38.44
Terral 55R15	7.772	73700	46.06
Delta King CP533	7.818	86200	53.88
Braxton	8.637	88300	55.19

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