RENIFORM NEMATODE REPRODUCTION ON SOYBEAN IN TESTS CONDUCTED IN 2002

R.T. Robbins, L. Rakes, L.E. Jackson[1], E.R. Shipe[2], E.E. Gbur[1], and D.G. Dombek
[1] 2601 N. Young Avenue, Fayetteville, AR 72704 USA. E-mail: rrobbin@uark.edu
[2] Clemson University, Poole Agric. Center, Box 340359, Clemson, SC 29634-0359 USA,
[3] Agricultural Statistics Laboratory, University of Arkansas, Fayetteville, AR, 72701,
[4]Arkansas Crop Improvement Program

Abstract

In 2002 greenhouse pot experiments,127 soybean varieties from the Arkansas and Mississippi variety testing programs and 34 breeding lines from Clemson University were tested to determine their suitability as hosts for the reniform nematode, *Rotylenchulus reniformis*. The *R. reniformis*-resistant varieties Forrest and Hartwig, the susceptible variety Braxton, and fallow *R. reniformis*-infested soil served as controls. Total number of eggs and nematodes extracted from both the soil and roots from each pot, reproductive indices (RI = Pf/Pi), RI/RI of Forrest (RF), log ratio [$\log_{10}$ (RF + 1)], and RF calculated from $\log_{10}$ (RF + 1) were calculated for each cultivar or breeding line in each test. Varieties with RF's significantly greater than the RF on Forrest (1.00) were considered suitable hosts for *R. reniformis*. In the Arkansas and Mississippi variety test 58 of 127 lines had significantly more reproduction than Forrest when the log ratio [$\log_{10}$ (RF + 1)] were compared. In the Clemson test 14 of the 34 Clemson varieties and breeding lines were suitable hosts when the log ratio [$\log_{10}$ (RF + 1)] were compared. Of the 20 Clemson lines not significantly different than Forrest eight were retests from 2001 that agreed with the 2001results, whereas two of the 20 shown to be significantly different in 2001 were not shown to be different in 2002. The last of 11 retests was found to be different than Forrest both years.

Introduction

Robbins, et al.(1994) reported on reproduction of the reniform nematode on 30 soybean cultivars. Robbins & Rakes (1996) reported 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. Robbins et al.(1999) reported on 282 soybean lines from the Arkansas and Mississippi Soybean Variety Testing programs and Robbins et al. (2000) reported on 226 cultivars from the Arkansas and Mississippi Soybean Variety Testing programs, and varieties submitted by extension nematologists from Auburn and Louisiana State University. Robbins et al. (2001) reported on 115 cultivars from the Arkansas and Mississippi Soybean Variety Testing programs and three cultivars submitted by a Texas extension nematologist. Robbins et al. (2002) found 137 of 139 lines from Arkansas, Mississippi, and Louisiana reproduced significantly more than Forrest. These papers form the basis for reniform nematode reproduction information on contemporary soybean lines.

In 2001 Robbins et al. (2002) tested 34 lines and cultivars from the Clemson soybean breeding program for reniform nematode reproduction. Of the 34, eight lines and two cultivars (Motte, Santee) did not reproduce more than the reniform resistant cultivar Forrest and may be of valve in controlling reniform nematodes in rotation with cotton and other hosts and as sources of resistance for other breeding programs.

The objectives of the 2002 study were to 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 to identify useful breeding lines for use in selection of new reniform resistant cultivars.

Materials and Methods

The 127 soybean cultivars were from both private and public sources, whereas the 32 breeding lines and two varieties were from the Clemson University Soybean breeding program, 11 of which were retests of 2001. Seeds of all cultivars were germinated in vermiculite and transplanted into 10-cm-diam. clay pots containing 500 cm^3 of pasteurized fine sandy loam soil (ca. 91% sand, 5% silt, 4 % clay, <1% O.M.). Inoculum 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 38μm-pore sieve was placed on a tissue in a Baermann funnel. All vermiform stages of R. reniformis were collected after 16 hours. On the same day a total of 1,956 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 cultivar. Soybean cultivars Forrest and Hartwig were included as resistant controls and Braxton as a susceptible control.

After 13 weeks (June 13-September 2, 2002), the number of reniform nematode eggs and vermiform nematodes contained in egg masses on the roots and the numbers of vermiform nematodes in the soil of each pot were determined. The total number of reniform nematode eggs and vermiform nematodes per pot was calculated by adding the number from the soil to the number from the roots. A reproductive index (RI), defined as the number of eggs + vermiform nematodes at test termination (Pf)/initial inoculation level (Pi), was calculated for each cultivar. In addition, the ratio of the RI of each cultivar to the RI of Forrest (RF) was calculated. The log ratio data $[\log_{10}(RF + 1)]$ were analyzed as a randomized complete block using analysis of variance. Log ratio transformations were used because of the high degree of variation in nematode counts within a cultivar. Cultivar means were separated using a protected LSD at $\underline{P} = 0.05$, where appropriate. Due to unidentified causes all nematodes in several pots of two replications died, their results were not used in the analysis. Cultivars were considered suitable hosts if their log-ratio means were significantly higher than $\log_{10}(2) \cong 0.301$. Cultivars were considered suitable hosts at log-ratios higher than 0.761 for five replications, 0.816 for four, and 0.895 for three of the 127 Arkansas and Mississippi lines and cultivars. For Clemson's 32 breeding lines and two cultivars were considered suitable hosts at log-ratios higher than 0.741 for 5 replications, 0.793 for four, and 0.869 for three. All statistical analyses were carried out using SAS version 8 (SAS Institute, Cary, NC).

Results

Seven of the 69 cultivars with log ratios not significantly higher than Forrest ($\log_{10}(2) = 0.301$), KS 5502N (0.149), Terral TVX49CN201 (0.214), HBK R5422 (0.260), HBK 4944CX (0.271), PGY 5250RR (0.271), Southern States RT446N (0.280), and Deltapine DPX5734RR (0.280) were ranked below Forrest (Table 1). The other 62 lines and cultivars not significantly higher than Forrest log ratios ($\log_{10}(2)$ ranged from 0.325 to 0.82 for four reps and 0.838 for three reps. There were 58 lines and cultivars with reproduction significantly greater that Forrest and ranged from 0.820 for four reps to a high of 1.668. The log ratio for Hartwig = 0.343 while that of the fallow = 0.017.

From the Clemson breeding program two varieties (Santee and Motte) and 18 breeding lines had log ratios not significantly higher than Forrest ($\log_{10}(2) = 0.301$) as shown in Table 2. Eight of the 11 lines tested in 2002 that were also tested in 2001 were again not significantly different in reproduction than Forrest (SC95-1070, Motte, Santee, SC98-318, SC98-249, SC94-1573, SC97-1770, SC98-353). Two lines that tested significantly different in 2001, tested not significantly different in 2002 (SC96-1628, SC96-1524) while the remaining line tested significantly different than Forrest both years (SC98-1063).

Discussion

Several of the Arkansas test cultivars gave mixed results, some pots with high reniform reproduction, others with low reproduction, and yet others with intermediate reproduction. This in addition to a reduced number of replications in several lines accounts in part for the much greater number of lines not significantly greater in reproduction than Forrest in 2002 (69 lines) than in 2001 (2 lines). The Clemson data reinforces the low reniform reproduction (not significantly different than Forrest) for the eight lines found not significantly different for both 2001 and 2002. The cultivars Motte and Santee may be useful in reducing reniform numbers in rotation with cotton and the breeding lines with reproduction not greater than Forrest may be useful in developing new cultivars with low levels of reniform reproduction.

The main objective of these tests is to identify soybean varieties and breeding lines with low reniform nematode reproductive indices. These varieties may be important to use in rotation with cotton in fields with large numbers of the reniform nematode, whereas the breeding lines with low reproductive indices may be useful in the breeding process of new varieties.

Literature Cited

Hussey, R. S., and K. R. Barker. 1973. A comparison of methods of collecting inocula of Meloidogyn*e* spp., including a new technique. Plant Disease Reporter 57:1025-1028.

Jenkins, W. R., 1964. A rapid centrifugal-flotation technique for separating nematodes from soil. Plant Disease Reporter 48:692.

Robbins, R. T., L. Rakes, and C. R. Elkins. 1994. Reproduction of the reniform nematode on thirty soybean cultivars. Supplement to the Journal of Nematology 26:659-664.

Robbins, R. T., and L. Rakes. 1996. Resistance to the reniform nematode in selected soybean cultivars and germplasm lines. Journal of Nematology 28:612-615.

Robbins, R. T., L. Rakes, L. E. Jackson, and D. G. Dombek. 1999. Reniform nematode resistance in selected soybean cultivars. Supplement to the Journal of Nematology 31:667-677.

Robbins, R. T., L. Rakes, L. E. Jackson, E. E. Gbur, and D. G. Dombek. 2000. Host suitability in soybean cultivars for the reniform nematode, 1999 tests. Supplement to the Journal of Nematology Vol. 32:614-621.

Robbins, R. T., L. Rakes, L. E. Jackson, E. E. Gbur, and D. G. Dombek. 2001. Host suitability in soybean cultivars for the reniform nematode, 2000 tests. Supplement to the Journal of Nematology Vol. 33:314-317.

Robbins, R. T., E. R. Shipe, L. Rakes, L. E. Jackson, E. E. Gbur, and D. G. Dombek. 2002. Host suitability in soybean cultivars for the reniform nematode, 2001 tests. Supplement to the Journal of Nematology Vol. 33 (In Press).

Table 1. Reproduction of Rotylenchulus reniformis on 127 selected soybean cultivars and lines in 2002.[1]

Line or cultivar	# of Reps	Total reniform Nematodes/pot[2]	RI[3] (Pf/Pi)	RF[4]	Log$_{10}$ Mean RF[5]	Log Ratio[6]
Fallow	5	84	0.04	0.02	0.040	0.017*
KS 5502N	5	2107	1.08	0.44	0.409	0.149*
Terral TVX49CN201	4	3266	1.67	0.67	0.636	0.214*
HBK R5422	5	4954	2.53	1.02	0.082	0.260*
HBK 4944CX	3	4996	2.55	1.03	0.086	0.271*
PGY 5250RR	5	4831	2.47	1.00	0.866	0.271*
Southern States RT446N	4	10425	5.33	2.15	0.905	0.280*
Deltapine DPX5734RR	5	4354	2.23	0.90	0.907	0.280*
Forrest	4	4839	2.47	1.00	1.000	0.301*
DT98-7278	5	15074	7.71	3.12	1.114	0.325*
Delta King XTJ055RR	4	17673	9.04	3.65	1.151	0.333*
Southern States RT5702N	4	6539	3.34	1.35	1.156	0.334*
R98-1817	4	19033	9.73	3.93	1.183	0.339*
Hartwig	5	14462	7.39	2.99	1.205	0.343*
H-5492RR	3	11620	5.94	2.40	1.474	0.393*
Croplan Genetics RC4992	4	10471	5.35	2.16	1.529	0.403*
PGY 4932RR	3	8385	4.29	1.73	1.622	0.419*
Delta King XTJ048RR	5	11350	5.80	2.35	1.714	0.434*
DT97-6308	4	37433	19.14	7.74	1.788	0.445*
Delta King XTJ046RR	3	16187	8.28	3.35	1.813	0.449*
Garst D484RR/N	3	10168	5.20	2.10	1.839	0.453*
Armor 39-E9	5	20837	10.65	4.31	1.863	0.457*
Terral TVX62R001	4	28113	14.37	5.81	1.873	0.458*
PGY 4303RR	5	21924	11.21	4.53	1.882	0.460*
Deltapine DPX3940RR	4	15636	7.99	3.23	1.947	0.469*
Terral TVX39R201	5	10949	5.60	2.26	1.948	0.470*
Southern States RT4902N	4	12393	6.34	2.56	2.113	0.493*
Pioneer 94B74	3	13152	6.72	2.72	2.187	0.503*
FFR 5225RR	4	22602	11.56	4.67	2.204	0.506*
Southern States RT3799N	4	21189	10.83	4.38	2.208	0.506*
Delta King XTJ303RR	4	34677	17.73	7.17	2.315	0.520*
Southern States RT517N	4	22010	11.25	4.55	2.350	0.525*
Croplan Genetics RC4772	3	12092	6.18	2.50	2.382	0.529*
Pioneer Brand 95B42	5	23956	12.25	4.95	2.455	0.538*
FFR 4455RR	5	25411	12.99	5.25	2.479	0.541*
H-4850RR	4	23505	12.02	4.86	2.610	0.557*
Delta King XTJ051RR	3	18344	9.38	3.79	2.615	0.558*
Asgrow AG5301	3	23925	12.23	4.94	2.651	0.562*
Croplan Genetics RC5892	4	21273	10.88	4.40	2.694	0.567*
Southern States RT540N	4	23652	12.09	4.89	2.942	0.596*
AXR 5135	4	30812	15.75	6.37	3.004	0.602*
Morsoy RT5252	5	22027	11.26	4.55	3.038	0.606*

Table 1. Continued

Line or cultivar	# of Reps	Total reniform Nematodes/pot[2]	RI[3] (Pf/Pi)	RF[4]	Log_{10} Mean RF[5]	Log Ratio[6]
FFR 4891RR	5	30829	15.76	6.37	3.116	0.614*
HBK R6020	3	45119	23.07	9.32	3.252	0.629*
Delta Grow 5530	5	49126	25.12	10.15	3.499	0.653*
Delta King XTJ053RR	5	65494	33.48	13.53	3.586	0.661*
AXR 4280	5	42723	21.84	8.83	3.637	0.666*
NK Brand X248R	3	27959	14.29	5.78	3.748	0.676*
S99-2447-2RR	4	35680	18.24	7.37	3.763	0.678*
Delta King XTJ488RR	5	29973	15.32	6.19	3.771	0.679*
Garst XR53N91	4	59840	30.59	12.37	3.848	0.686*
PGY 5922RR	5	42423	21.69	8.77	3.873	0.688*
99VPI-67	4	86668	44.31	17.91	3.944	0.694*
Hartz H5223RR	3	29756	15.21	6.15	3.991	0.698*
Pioneer Brand 94B54	5	57278	29.28	11.84	4.163	0.713*
Southern StatesRT4502N	4	70129	35.85	14.49	4.176	0.714*
Pioneer Brand 95B43	3	79220	40.50	16.37	4.220	0.718*
Delta King XTJ057RR	3	35072	17.93	7.25	4.233	0.719*
FFR 4922RR	5	55878	28.57	11.55	4.431	0.735*
Garst 4512RR/N	4	31102	15.90	6.43	4.434	0.735*
HBK 4922	4	29481	15.07	6.09	4.523	0.742*
NK brand S52-U3	4	28113	14.37	5.81	4.529	0.743*
Morsoy RT4731	5	75480	38.59	15.60	4.571	0.746*
Deltapine DPX4527RR	3	38577	19.72	7.97	4.695	0.756*
Garst 4312RR/STS/N	4	91653	46.86	18.94	4.739	0.759*
Garst XR49N49	3	31832	16.27	6.58	4.965	0.776*
Delta Grow 4860RR	4	42378	21.67	8.76	5.062	0.783*
H-4534RR	3	33308	17.03	6.88	5.328	0.801*
FFR 4712RR	4	67043	34.28	13.85	5.346	0.803*
Deltapine DPX4431RR	4	58818	30.07	12.15	5.353	0.803
Morsoy RT4480	3	31836	16.28	6.58	5.566	0.817*
Pioneer 94B73	4	39318	20.10	8.13	5.576	0.818
Dyna-Gro 3600NRR	4	42120	21.53	8.70	5.746	0.829
HBK R4622	3	41040	20.98	8.48	5.887	0.838*
R95-1705	5	93240	47.67	19.27	5.900	0.839
Croplan Genetics RC5332	4	61955	31.67	12.80	6.080	0.850
NK Brand S40-R9	4	49986	25.56	10.33	6.323	0.865
Delta King XTJ059RR	5	83110	42.49	17.17	6.384	0.868
Dyna-Gro 3583NRR	4	62990	32.20	13.02	7.055	0.906
S99-2461RR	4	63537	32.48	13.13	7.210	0.914
MPV 5502NRR	4	62759	32.09	12.97	7.277	0.918
KS 4602N	4	46516	23.78	9.61	7.773	0.943
USG 7522nRR	5	76193	38.95	15.75	7.785	0.944
Asgrow AG5427	4	68209	34.87	14.10	8.206	0.964
HBK R5101	3	98355	50.28	20.33	8.432	0.975
PGY 5580RR	4	90525	46.28	18.71	8.438	0.975
Asgrow AG4201	4	84506	43.20	17.46	8.531	0.979
Morsoy RT5442	3	63461	32.44	13.11	8.581	0.981
Deltapine DPX4933RR	3	44505	22.75	9.20	8.624	0.983
MPV 4802NRR	4	81068	41.45	16.75	8.774	0.990
MPV 5302NRR	4	72593	37.11	15.00	8.846	0.993
Deltapine DPX3761RR	5	60892	31.13	12.58	8.960	0.998
Deltapine DPX3819RR	3	71247	36.42	14.72	9.068	1.003
Asgrow 4603	4	80949	41.38	16.73	9.247	1.011
Deltapine DPX4527RR	5	65858	33.67	13.61	9.306	1.013
Delta Grow 5960RR	5	53414	27.31	11.04	9.309	1.013

Table 1. Continued

Line or cultivar	# of Reps	Total reriform Nematodes/pot[2]	RI[3] (Pf/Pi)	RF[4]	Log_{10} Mean RF[5]	Log Ratio[6]
USG 7499nRR	4	48009	24.54	9.92	9.490	1.021
Delta King XTJ4824RR	4	89262	45.63	18.45	9.656	1.028
Hartz H5887RR	5	150502	76.94	31.10	10.113	1.042
PGY 5440RR	4	89412	45.71	18.48	10.114	1.046
PGY 4401RR	5	108570	55.51	22.44	10.154	1.047
KS 4202	5	131906	67.44	27.26	10.424	1.058
Southern States RT3802N	4	115181	58.89	23.80	11.048	1.081
PGY 5001RR	5	78297	40.03	16.18	11.749	1.105
Delta King XTJ301RR	4	112626	57.58	23.27	11.818	1.108
Garst XR59N24	3	62920	32.17	13.00	12.122	1.118
Morsoy RT3881	4	82339	42.10	17.02	12.375	1.126
Asgrow AG5903	4	83399	42.64	17.23	12.395	1.127
Garst XR553N64	5	120113	61.41	24.82	12.634	1.135
H-4772RR	3	69498	35.53	14.36	12.800	1.140
Armor 56-C4	5	125197	64.01	25.87	13.126	1.150
Southern States RT5001N	4	108321	55.38	22.38	13.257	1.154
Croplan Genetics RC5972	3	72892	37.27	15.06	13.819	1.171
Delta King XTJ040RR	4	87970	44.97	18.18	14.718	1.196
Pioneer Brand 94B13	4	173679	88.79	35.89	14.933	1.202
Hartz H3090RR	4	84098	42.99	17.38	15.394	1.215
Morsoy RT4802	4	154909	79.20	32.01	15.937	1.229
Southern States RT5302N	5	92981	47.54	19.21	16.000	1.230
MPV 4102NRR	4	105640	54.01	21.83	13.704	1.248
Southern States RT6202N	3	59220	30.28	12.24	16.737	1.249
Delta King XTJ302RR	4	163017	83.34	33.69	16.817	1.251
99VPI-120	4	107820	55.12	22.28	17.346	1.264
Delta Grow 5350RR	3	125371	64.10	25.91	18.112	1.281
Garst XR57N19	4	69329	35.44	14.33	18.672	1.294
Delta King XTJ044RR	3	100147	51.20	20.70	19.443	1.311
USG 7582nRR	3	126187	64.51	26.08	22.119	1.364
PGY 5990RR	3	166057	84.90	34.32	25.019	1.415
Braxton	5	208244	106.46	43.03	26.138	1.434
Garst XC49Y30	3	149373	76.37	30.87	26.412	1.438
DT98-9102	4	261840	133.87	54.11	37.654	1.587
R92-1258	4	253630	129.67	52.41	45.598	1.668

1 = Inoculated with 1956 vermiform nematodes.

2 = Total eggs + vermiform reniform nematodes / pot.

3 = RI (reproductive index) = final reniform population/ initial reniform population (Pf/Pi).

4 = RF = RI/ RI of Forrest.

5 = Mean RF from log-transformed data.

6 = Log ratio of transformed data (Log $_{10}$ [RF + 1]. RF of Forrest = 1. Log $_{10}$ (1 + 1) = 0.301. Cutoff for log ratios being significantly larger than 1 (RF of Forrest) = 0.761 for 5 replications, 0.816 for 4 replications, and 0.895 for 3 replications.

* = not significantly larger than Forrest.

Table 2. Reproduction of *Rotylenchulus reniformis* on 32 breeding lines and 2 cultivars from the Clemson breeding program in 2002.

Line or cultivar	# of Reps	Total reniform Nematodes/pot[2]	RI[3] (Pf/Pi)	RF[4]	Log$_{10}$ Mean RF[5]	Log Ratio[6]
Fallow	5	84	0.04	0.02	0.04	0.017*
SC95-1070	5	2998	1.53	0.62	0.56	0.194*
SC98-1930	4	9279	4.74	1.92	0.90	0.279*
Forrest	4	4839	2.47	1.00	1.00	0.301*
MOTTE	4	6651	3.40	1.37	1.01	0.301*
SANTEE	4	6048	3.09	1.25	1.08	0.318*
SC98-318	4	7848	4.01	1.62	1.12	0.327*
SC98-249	4	5961	3.05	1.23	1.16	0.335*
Hartwig	5	1878	0.96	0.39	1.20	0.343*
SC94-1573	5	12248	6.26	2.53	1.33	0.367*
SC97-1770	4	7792	3.98	1.61	1.38	0.376*
SC98-1948	4	9433	4.82	1.95	1.64	0.422*
SC00-892	3	12072	6.17	2.49	1.74	0.438*
SC98-353	3	12428	6.35	2.57	2.14	0.497*
SC98-2100	5	52548	26.87	10.86	2.18	0.502*
SC96-1628	5	18110	9.26	3.74	2.35	0.525*
SC96-1624	4	24924	12.74	5.15	2.82	0.582*
SC00-883	5	46526	23.79	9.61	3.04	0.606*
SC99-280	4	55116	28.18	11.39	3.56	0.659*
SC00-977	5	49710	25.41	10.27	3.88	0.688*
SC99-615	3	58663	29.99	12.12	4.01	0.700*
SC98-1853	4	49290	25.20	10.19	4.87	0.769*
SC00-948	3	34428	17.60	7.11	5.08	0.784*
SC98-1836	3	40485	20.70	8.37	6.83	0.894
SC99-356	4	144504	73.88	29.86	9.42	1.018
SC99-279	4	95705	48.93	19.78	11.49	1.096
SC97-2184	5	75378	38.54	15.58	11.72	1.105
SC99-284	4	74348	38.01	15.36	12.14	1.119
SC00-947	4	89485	45.75	18.49	12.15	1.119
SC99-605	4	87028	44.49	17.98	13.22	1.153
SC00-1075	4	173800	88.85	35.92	15.24	1.211
SC98-2107	4	152198	77.81	31.45	16.68	1.248
SC98-2070	5	193344	98.85	39.96	19.83	1.319
SC98-1063	3	121245	61.99	25.06	20.72	1.337
Braxton	5	208244	106.46	43.03	26.14	1.434
SC98-1850	5	160048	81.82	33.07	27.92	1.461
SC93-1287	3	169827	86.82	35.10	31.87	1.517
SC98-1925	3	319868	163.53	66.10	41.36	1.627

1 = Inoculated with 1956 vermiform nematodes.

2 = Total eggs + vermiform reniform nematodes / pot.

3 = RI (reproductive index) = final reniform population/ initial reniform population (Pf/Pi).

4 = RF = RI/ RI of Forrest.

5 = Mean RF from log-transformed data.

6 = Log ratio of transformed data (Log $_{10}$ [RF + 1]. RF of Forrest = 1. Log$_{10}$ (1 + 1) = 0.301. Cutoff for log ratios being significantly larger than 1 (RF of Forrest) = 0.741 for 5 replications, 0.793 for 4 replications, and 0.869 for 3 replications.

* = not significantly larger than Forrest.