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Soybean Cultivars Resistant and Susceptible to *Heterodera glycines*[1]

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Abstract: Additional tests of 178 cultivars and lines of soybean against soybean cyst nematode are reported. Cultivars are available with some level of resistance to races 1, 2, 3, 4, 5, 6, 9, and 14, but in some cases the resistance level is moderate. No cultivar or line (except possibly PI 437654) has resistance to all of the races tested. Thirteen cultivars and lines, however, were resistant or moderately resistant to race 1, 14 to race 2, 87 to race 3, 2 to race 4, 3 to race 5, 42 to race 6, 18 to race 9, and 36 to race 14. Some have resistance to more than one race.

Key words: Glycine max, Heterodera glycines, nematode, resistance, soybean, soybean cyst nematode.

Soybean cyst nematode (SCN) *Heterodera glycines* Ichinohe is known to occur in 26 of 28 soybean producing states in the United States of America (3). Many of these states have soybean breeders who are developing cultivars with resistance to SCN. In addition, numerous private companies are producing cultivars with resistance to one or more races of SCN. In most cases, cultivars are tested against one or more of races 1, 3, 4, and 14 of SCN because they are the most commonly occurring races.

The purpose of this study was to collect as many new cultivars of soybean as possible each year and test them against as many races of SCN as possible. The results of earlier tests have already been published (2).

Materials and Methods

The methods used in these tests were basically the same as those used earlier (2). Seeds of the test cultivars and lines were germinated in vermiculite, transplanted in the cotyledon stage to sterilized fine river sand in 7.5-cm-d clay pots, inoculated with 4,000 eggs and juveniles of a race of SCN 24 hours after transplanting, and processed for the enumeration of females 28 to 35 days later. The race differentials (1) were included in each test. Because of occasional problems with the reproduction of SCN race 3 on the Lee cultivar (1), Lee 74 was used as the standard susceptible cultivar, except in the tests with race 14, where Lee was the standard. The test cultivars and lines were replicated five times—except in a few cases where seed germination was poor and fewer plants were available or where a plant died during the test. Each differential was replicated 10 times. Resistance was judged on the basis of an index calculated as a percentage of the number of females produced on Lee 74 or Lee as follows: Index = average number of females on test line divided by the average number of females on Lee 74 (or Lee) times 100. An entry with an index less than 10 was considered to be resistant and one with an index of 10–25 was moderately resistant. A total of 178 cultivars and lines were tested, with 39 tested against SCN race 1, 95 against race 2, 178 against race 3, 97 against race 4, 96 against race 5, 122 against race 6, 97 against race 9, and 178 against race 14. Some were tested 1 year only, and some for 3 years (1988–90).

Results

Of the 178 cultivars and lines tested, 79 were susceptible to all races tested (Table 1), 18 were moderately resistant to at least one race (Table 2), and 81 were resistant to at least one race (Table 3). Only six cultivars were resistant to race 1 (Table 3), and seven cultivars were moderately resistant (Tables 2, 3). Of the cultivars tested against race 2, only one was resistant (Table 3), and 13 cultivars and one line had

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TABLE 1. Indices indicating relative reproduction of eight races of *Heterodera glycines* on the susceptible soybean cultivars and lines tested in 1988–90.

Variety	Race 1		Race 2		Race 3		Race 4		Race 5		Race 6		Race 9		Race 14	
	No. test	Index	No. test	Index	No. test	Index	No. test	Index	No. test	Index	No. test	Index	No. test	Index	No. test	Index
A 7258					1	81	1	65	1	159			2	68	2	64
AT 525					1	57	1	73	1	53			2	83	2	84
AT 575	1	31	1	38	3	68	2	37	2	85	2	83	3	71	4	78
AT-700			1	76	1	80					1	55			1	53
Bragg			1	23	1	113					1	56			1	91
Branel 401			1	26	1	32					1	61			1	67
Braxton			1	19	1	100					1	58			1	51
Buckshot 603					1	110	1	187	1	75			2	67	2	94
Buckshot 703					1	61	1	75					2	87	2	54
Capehart 5636			1	60	1	78					1	84			1	64
Capehart 5896			1	44	1	67					1	66			1	77
Capehart EXP7636			1	93	1	71					1	58			1	72
Capehart/FFR Stone					1	99	1	115	1	108			2	70	2	72
Capehart/FFR 515					1	71	1	69	1	70			2	73	2	101
Capehart/FFR 695					1	72	1	62	1	98			2	96	2	112
Coker 237			1	28	1	60					1	73			1	117
Coker 614	1	81			1	120	1	113	1	78	1	94	1	47	1	94
Crawford	1	76			2	118	2	89	2	79	1	93	3	68	3	92
Crockett					1	51	1	95					2	27	2	126
Deltapine 105			1	62	1	98					1	61			1	70
Deltapine 3627					1	73	1	153	1	70			2	90	2	77
Deltapine 506			1	102	1	80					1	76			1	30
Douglas	1	67			2	134	1	108	2	70	1	101	3	108	2	95
E.H.J.U.-5					1	95	1	157	1	68			2	83	2	90
E.H.J.U.-1213					1	89	1	175	1	166			2	74	2	86
ESCO B-24			1	90	1	52					1	84			1	29
FFR 398	1	83			1	184	1	70	1	84	1	81	1	85	1	133
FFR 464	1	70			1	187	1	56	1	59	1	104	1	113	1	84
FFR 544	1	83			1	122	1	35	1	105	1	58	1	104	1	93
FFR 561			1	88	1	76					1	84			1	48
Hartz 6686	1	81			2	166	2	149	2	104	1	106	3	93	4	71
Hartz H7190	1	70			2	159	2	208	2	87			3	82	3	66
Hartz H7585					1	126	1	66	1	80			2	75	2	82
HB-J57-5			1	56	1	98					1	92			1	97

TABLE 1. Continued

Variety	Race 1		Race 2		Race 3		Race 4		Race 5		Race 6		Race 9		Race 14	
	No. test	Index	No. test	Index	No. test	Index	No. test	Index	No. test	Index	No. test	Index	No. test	Index	No. test	Index
Hutcheson	1	76			2	125	1	45	1	131	1	66	1	114	1	127
Hyperformer Brand 401	1	68			1	97	2	112	2	117	1	74	3	64	3	107
JMS 4982			1	36	1	31					1	66			1	39
KE 518					1	118	1	68	1	117			2	39	2	98
Lamar					1	52	1	86	1	84			2	59	2	54
Lee 74			1	100	1	100					1	100			1	57
Lee Nonod					1	66	1	167	1	40			2	89	2	90
M82-571206			1	77		45					1	77			1	34
M88-467128					1	43	1	75	1	77			2	53	2	61
M88-577321					1	99	1	79	1	60			2	61	2	83
Pershing			1	29	1	42					1	58			1	75
Pioneer Variety 9391					1	78	1	102	1	81			2	79	2	83
Pioneer Variety 9442	1	56			2	128	2	77	2	52	1	66	3	52	3	65
Pioneer Variety 9461					1	53	1	126	1	106			2	63	2	69
Pioneer Variety 9591					1	67	1	79	1	103			2	90	2	88
Pioneer Variety 9592					1	102	1	112	1	91			2	54	3	63
Pioneer Variety 9641	1	118			2	126	2	97	2	84	1	80	3	73	2	60
R1-11					1	119	1	88	1	133			2	37	2	54
RA 451			1	27	1	39					1	90			1	44
Rally					1	145	1	264	1	171			2	86	2	69
RVS 477					1	107	1	116	1	67			2	70	2	75
RVS 499					1	36	1	117	1	68			2	38	2	38
RVS 677					1	48	1	125	1	49			2	87	2	71
RVS 693B					1	66	1	95	1	83			2	79	2	55
RVS 699					1	84	1	165	1	116			2	104	2	79
RVS Cajan					1	79	1	102	1	59			2	60	2	55
S44-77	1	41			2	116	1	137	1	74	1	71	1	52	1	64
S53-34	1	61			2	94	1	42	1	111	1	84	1	49	1	60
S61-10	1	75			1	187	1	160	1	88	1	110	1	54	1	93
S69-96			1	35	1	78					1	104			1	53
Sharkey					1	74	1	118	1	65			2	92	1	99

TABLE 1. Continued

Variety	Race 1		Race 2		Race 3		Race 4		Race 5		Race 6		Race 9		Race 14	
	No. test	Index	No. test	Index	No. test	Index	No. test	Index	No. test	Index	No. test	Index	No. test	Index	No. test	Index
Shenandoah			1	40	1	70					1	89			1	40
Spartan			1	47	1	107					1	78			1	47
Starr			1	47	1	96					1	78			1	55
Stevens	1	62	1	70	3	88	2	127	2	60	2	95	3	70	4	66
Terra-Vig 505					1	94	1	101	1	65			2	57	2	78
Terra-Vig 616					1	64	1	318	1	181			2	54	2	114
Tracy M			1	163	1	77					1	148			1	35
Twiggs	1	44			2	26	2	160	2	33	1	104	3	90	3	83
Wilstar 550			1	72	1	42					1	71			1	43
Wilstar 790			1	67	1	93					1	81			1	73
Yield King 499	1	94			1	150	1	128	1	88	1	111	1	56	1	99
Yield King Competitor	1	68			1	197	1	54	1	76	1	66	1	99	1	87
YK 503			1	61	1	57					1	46			1	51
Young			1	113	1	85					1	73			1	36

Indices are based on percentage of females produced on test host compared to Lee 74 or Lee (with race 14). Indices shown in table are means across 1–4 tests in 3 years as indicated.

TABLE 2. Indices indicating relative reproduction of eight races of *Heterodera glycines* on the moderately resistant soybean cultivars and lines tested in 1988–90.

Variety	Race 1		Race 2		Race 3		Race 4		Race 5		Race 6		Race 9		Race 14	
	No. test	Index	No. test	Index	No. test	Index	No. test	Index	No. test	Index	No. test	Index	No. test	Index	No. test	Index
A 6785			1	71	1	87					1	21			1	71
A 7986			1	15	1	152					1	73			1	61
Capehart EXP6836			1	18	1	143					1	62			1	49
Deltapine 417			1	22	1	93					1	33			1	74
Deltapine 566			1	85	1	18					1	90			1	69
E.H.J.U.-3					1	25	1	106	1	175			2	53	2	70
HB-R224	1	21			1	30	1	30	1	96	1	37	1	64	1	43
Johnson			1	19	1	120					1	63			1	53
Pioneer Variety 9691			1	52	1	30					1	14			1	51
Pioneer Variety 9791			1	23	1	185					1	84			1	59
RA 452			1	18	1	36					1	58			1	51
S48-84	1	37			1	58	1	101	1	40	1	32	1	21	1	63
Sampson			1	21	1	141					1	130			1	86
Sanaloma			1	24	1	77					1	95			2	110
Shiloh			1	59	1	14					1	29			1	31
YK 593			1	137	1	14					1	27			1	93
YK 707			1	20	1	11					1	28			1	13
YK 757			1	43	1	12					1	36			1	22

Indices are based on percentage of females produced on test host compared to Lee 74 or Lee (with race 14). Indices shown in table are means across 1–4 tests in 3 years as indicated.

TABLE 3. Indices indicating relative reproduction of eight races of *Heterodera glycines* on the resistant soybean cultivars and lines tested in 1988–90.

Variety	Race 1		Race 2		Race 3		Race 4		Race 5		Race 6		Race 9		Race 14	
	No. test	Index	No. test	Index	No. test	Index	No. test	Index	No. test	Index	No. test	Index	No. test	Index	No. test	Index
A 5403	1	15			2	5	2	68	2	110	1	24	3	26	3	12
A 5979	1	9			2	4	2	58	2	84	1	29	3	19	3	11
A 6297					1	4	1	34	1	91			2	18	2	20
AT 550	1	4	1	16	2	3	2	32	2	108	2	22	3	21	4	4
AT-685			1	9	1	8					1	12			1	5
AT 695					1	7	1	81	1	70			2	19	2	8
Avery					1	2	1	29	1	97			2	8	2	7
Bedford			1	35	1	0					1	17			1	4
Capehart 5646			1	35	1	4					1	25			1	32
Capehart/FFR 565	1	9			2	9	2	91	2	125	1	32	3	39	3	22
Capehart/FFR 606	1	7			2	4	2	106	2	64	1	25	3	33	3	16
Capehart/FFR 646					1	9	1	88	1	51			2	49	2	10
Centennial			1	63	1	1					1	17			1	68
Coker 355			1	62	1	1					1	15			1	24
Coker 368			1	26	1	0					1	19			1	19
Coker 485			1	90	1	0					1	12			1	93
Coker 6727			1	26	1	2					1	15			1	122
Coker 6738			1	36	1	0					1	16			1	107
Coker 6847			1	36	1	0	1	159	1	93	1	18	2	61	3	85
Coker 686			1	30	1	0					1	17			1	35
Coker 6955	1	13	1	67	3	0	2	72	2	79	2	28	3	55	4	64
Coker 6995	1	6	1	37	3	9	2	60	2	80	2	26	3	14	4	7
Cordell					1	0	1	11	1	2			2	13	2	49
D79-6162			1	91	1	0					1	32			1	44
Deltapine 415			1	78	1	3			1	19					1	96
Deltapine 726	1	48	1	82	3	0	2	73	2	44	2	41	3	67	4	73
E.H.J.U.-1P					1	6	1	105	1	80			2	34	2	11
E.H.J.U.-7					1	0	1	169	1	27			2	64	2	86

TABLE 3. Continued

Variety	Race 1		Race 2		Race 3		Race 4		Race 5		Race 6		Race 9		Race 14	
	No. test	Index	No. test	Index	No. test	Index	No. test	Index	No. test	Index	No. test	Index	No. test	Index	No. test	Index
E.H.J.U.-11					1	1	1	56	1	73			2	9	2	2
Epps			1	50	1	1					1	13			1	11
Forrest			1	54	1	0					1	10			1	58
Gordon			1	20	1	3					1	14			1	38
Hartz 5164			1	95	1	1					1	14			1	9
Hartz 5171			1	103	1	0					1	14			1	82
Hartz 5370			1	93	1	1	1	71	1	30	1	13	2	45	3	51
Hartz 6130			1	18	1	0					1	15			1	4
Hartz 6200	1	22	1	38	2	0	2	107	2	14	2	24	3	43	4	59
Hartz 6385			1	40	1	0					1	32			1	71
Hartz 7110			1	25	1	0					1	21			1	113
Hartz 7126			1	25	2	3	1	48	1	107	1	34	2	62	3	83
Hartz H4464					1	0	1	48	1	61			2	32	2	48
Hartz H5240	1	45			2	1	2	93	2	61	1	49	3	69	3	111
Hartz H6372			1	43	1	1					1	21			1	52
Hartz H6570	1	5			2	1	2	50	2	74	1	23	3	26	3	6
HSC-B2J			1	37	1	1					1	13			1	124
HSC-Baldwin			1	37	1	1					1	23			1	111
Jeff			1	54	2	1					1	23			1	17
JMS 5484			1	55	1	0					1	32			1	112
KE 648					1	4	1	42	1	94			2	15	2	4
Leflore			1	73	1	1					1	19			1	8
Lloyd			1	63	1	2					1	10			1	0
M82-572403			1	48	1	1					1	24			1	105
M82-722611			1	50	1	6					1	74			1	62
Narow			1	70	1	2					1	15			1	96
Nathan			1	36	1	4					1	27			1	16
Pharoah					1	1	1	63	1	46			2	59	2	53

TABLE 3. Continued

Variety	Race 1		Race 2		Race 3		Race 4		Race 5		Race 6		Race 9		Race 14	
	No. test	Index	No. test	Index	No. test	Index	No. test	Index	No. test	Index	No. test	Index	No. test	Index	No. test	Index
PI 437654					1	0	1	0	1	0			2	0	2	0
Pioneer Variety 9531	1	13			2	4	2	82	2	102	1	23	3	11	3	7
Pioneer Variety 9581			1	78	2	0	1	66	1	34	1	10	2	62	2	23
Pioneer Variety 9582					1	2	1	43	1	121			2	19	2	10
Pioneer Variety 9711					1	1	1	178	1	85			2	75	2	68
Pioneer Variety 9751					1	1	1	109	1	58			2	57	2	59
RA 606			1	83	1	9					1	40			1	57
RA 680			1	31	1	0					1	21			1	46
RVS 593					1	4	1	264	1	159			2	61	2	82
RVS 757					1	5	1	98	1	76			2	18	2	13
S59-19			1	54	1	8					1	15			1	25
S64-23	1	12			2	2	2	80	2	106	1	18	3	12	3	6
S69-54	1	39	1	45	3	0	2	158	2	43	2	37	3	62	4	64
Stonewall					1	2	1	230	1	86			2	94	2	74
Terra-Vig 626					1	5	1	68	1	39			2	41	2	21
Thomas					1	1	1	133	1	124			2	51	2	76
TN 5-85					1	1	1	84	1	49			2	51	2	60
TN-4-86					1	3	1	71	1	71			2	16	2	4
TV 515			1	54	1	0									1	54
TV 553			1	62	1	1					1	16			1	29
TV 6260	1	18			1	8	1	78	1	81	1	48	1	25	1	13
Walters	1	42	1	39	2	2	1	122	1	68	2	33	1	91	2	95
YK 577			1	87	1	0					1	9			1	61
YK 613			1	51	1	7					1	25			1	89
YK 696			1	38	1	1					1	28			1	94

Indices are based on percentage of females produced on test host compared to Lee 74 or Lee (with race 14). Indices shown in table are means across 1–4 tests in 3 years as indicated.

indices low enough to be rated moderately resistant (Tables 2, 3). Eighty-one of the cultivars and lines tested were resistant to race 3 (Table 3), and 10 were moderately resistant (Tables 2, 3). Only one line was resistant to race 4 (Table 3), and one cultivar was moderately resistant (Table 3). One cultivar and one line were resistant to race 5 (Table 3), and one cultivar was moderately resistant (Table 3). One cultivar was resistant to race 6 (Table 3), whereas 41 were moderately resistant (Tables 2, 3). Two cultivars and one line were resistant to race 9 (Table 3), and 15 cultivars and lines were moderately resistant (Tables 2, 3). In four tests, 17 cultivars and lines were resistant to race 14 (Table 3), and 19 others were moderately resistant (Tables 2, 3).

Discussion

By far the largest percentage of resistant cultivars or lines of those tested against a particular race was to race 3. All cultivars and lines that were resistant to races 1, 2, 4, 5, 6, 9, or 14 were also resistant to race 3. That was not true of those with moderate resistance. The second highest percentage resistant plants was against race 14, whereas in a previous report the second highest percentage was against race 1 (2). Few cultivars and lines with resistance to races 2, 4, or 5 were found, as has been true in earlier tests (2). The cultivars Bragg and Braxton appeared to have moderate resistance to race 2, but in previous tests they were both susceptible (2). The low numbers of nematodes maturing on these cultivars may be attributable to a high level of root penetration and tissue damage.

In 1990, the cultivars and lines were tested against two isolates each of races 9 and 14. In some cases, a cultivar was resistant to one isolate and moderately resistant or susceptible to the other. This difference in reaction may be an indication of the differences in the gene pool of the nematode isolates, even though both were the same race according to the differentials.

Sixty-five of the cultivars and lines reported in the present study had been tested earlier and were reported in a previous report (2). There are differences in the susceptibility ratings in a few instances. For example A7986 is reported to be moderately resistant to race 2, whereas in 1988 it was reported to be susceptible. As indicated earlier, there were differences in the ratings of Bragg and Braxton against race 2. These discrepancies may be the result of differences in the race 2 isolates, just as was indicated for the race 9 and 14 isolates in 1990. These variations in rating of the same variety with two isolates of the same SCN race emphasize the need to use the same isolate for test purposes as much as possible. Also the race differentials (1) should be planted with every cultivar test to confirm the test SCN race.

Results of cultivar tests have demonstrated that some level of resistance to the commonly found races of SCN is available. In some cases few cultivars are available and in some cases the level of resistance was not high. The resistant cultivars should be planted judiciously, as needed, but not continuously.

Literature Cited

1. Riggs, R. D., and D. P. Schmitt. 1988. Complete characterization of the race scheme for *Heterodera glycines*. Journal of Nematology 20:390–395.

2. Riggs, R. D., M. L. Hamblen, and L. Rakes. 1988. Resistance in commercial soybean cultivars in six races of *Heterodera glycines* and *Meloidogyne incognita*. Supplement to the Journal of Nematology 20: 70–76.

3. Schmitt, D. P., and R. D. Riggs. 1989. Population dynamics and management of *Heterodera glycines*. Pp. 253–267 *in* G. E. Russell, ed. Agricultural zoology reviews, vol. 3. Winborne: Intercept.