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Tolerance in Maturity Groups V–VIII Soybean Cultivars to *Heterodera glycines*[1]

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Abstract: Twenty-six susceptible and resistant soybean, *Glycine max*, cultivars in Maturity Groups V, VI, VII, and VIII were compared with Coker 156, Wright, and PI97100 for tolerance to *Heterodera glycines* races 3 and 14. Seed yields were compared in nematicide-treated (EDB, fenamiphos) and untreated plots at two *H. glycines*-infested locations over 3 years. Coker 488, DP 417, and NK S72-60 had the highest average tolerance indices ([yield in untreated plot ÷ yield in nematicide-treated plot] × 100) of the race 3-susceptible cultivars to races 3 and 14. Plant height and seed weight of untreated soybean plants were suppressed in race 3-infested soil, but only plant height was suppressed at the race 14-infested location. Several race 3-resistant and race 14-susceptible cultivars were moderately tolerant to race 14.
Key words: Heterodera glycines, soybean cyst nematode, *Glycine max,* susceptibility, resistance, tolerance, yield, soybean.

Tolerance to the soybean cyst nematode (SCN), *Heterodera glycines* Ichinohe, has been identified in soybean, *Glycine max* (L.) Merrill, and is considered to be an important trait for maximizing yields on SCN-infested land (1,2). Tolerance as used here indicates little suppression of yield by nematode parasitism, whereas intolerance denotes high suppression of yield (4). Resistance (suppression of nematode reproduction relative to a susceptible cultivar) characterizes suitability of a host for nematode reproduction.

Crop rotation and use of resistant cultivars are the principal strategies for management of SCN (9). The most effective rotation schemes involve a varying number of years of a nonhost crop, a resistant soybean cultivar, and a susceptible soybean cultivar. A tolerant susceptible cultivar, in addition to relieving the pressure for development of new races placed on a SCN population by a resistant cultivar, will be damaged less by the nematode than an intolerant susceptible cultivar.

The number of soybean cultivars available for use in a rotation program has greatly increased during the past few years. Since these cultivars may differ in their sensitivity to SCN parasitism, those with the highest levels of tolerance need to be identified for use in rotation programs to maximize yields on SCN-infested land. Information on tolerance of SCN-resistant cultivars for races to which they do not have resistance genes is needed to predict their performance in fields with different frequencies of SCN genotypes.

Our objective was to identify cultivars currently grown in the southeastern United States with levels of tolerance to SCN races 3 and 14 similar to, or greater than, Coker 156, Wright, and PI97100, which were previously found to possess the most tolerance of SCN-susceptible genotypes (1,2).

MATERIALS AND METHODS

Field experiments: Experiments were conducted from 1985 to 1987 at sites with natural infestations of *H. glycines* at the Plant Sciences Farm (race 3) near Athens, Georgia, and in a grower's field (race 14) near Waynesboro, Georgia. At Athens the soil was an Appling coarse sandy loam (70% sand, 19% silt, 11% clay; Typic Hapludult, clayey, kaolinitic, thermic) and at Waynesboro it was a Dothan sandy loam (85% sand, 12% silt, 3% clay; fine-loamy, siliceous, thermic Plinthic Paleudults).

The experimental areas were fertilized according to soil test analyses; rates varied from 0 to 31 kg/ha for P and from 0 to

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150 kg/ha for K. Trifluralin (0.56 kg a.i./ha) was applied preplant at Athens in 1985 and 1987 and at Waynesboro in 1987, alachlor (2.24 kg a.i./ha) was applied preemergence at Athens in 1985 and 1986, and pendimethalin (1.12 kg a.i./ha) was applied preplant at Waynesboro in 1985 and 1986. The following herbicides were applied postplant for weed control: a solution of bentazon (0.6 kg a.i./ha) and toxaphene (1.75 liter/ha) at Athens in 1985 and 1986, and imazaquin (0.14 kg a.i./ha) at Athens in 1987 and Waynesboro in 1986 and 1987. Insects were controlled at Waynesboro by an application of methomyl (0.75 kg a.i./ha) in 1986. Plots were irrigated (2.5 cm water per application) once in 1985 and four times in 1986 and 1987 at Athens. Plots at Waynesboro were not irrigated.

A split-plot treatment design with a randomized complete block experimental design with 3–6 replications was used in all experiments. The main plots were soybean genotypes; subplots consisted of nematicides or no nematicides. Each subplot consisted of two rows, 4.3 m long and spaced 96 cm apart. A fumigant nematicide 1,2-dibromoethane (EDB), 54 kg a.i./ha (25 ml a.i./4.3 m row), was injected 20 cm deep 12.5 cm on each side of the seed furrow in the treated subplots at planting. Liquid fenamiphos, 6.7 kg a.i./ha (64 ml a.i./4.3 m row), was applied as a spray in a 20-cm band on the soil surface on both sides of the row at flowering to all EDB-treated plots for further suppression of the SCN population density (6). Plots were planted at a rate of 30–35 seeds/m. Planting dates were 24 May 1985, 14 May 1986, and 27 May 1987 in Athens and 13 June 1985, 30 June 1986, and 6 June 1987 in Waynesboro.

Data were collected from a 3.7-m section of plants after removing 0.6 m of plants from both ends of each plot at maturity. Seed yield was obtained by mechanically harvesting and weighing seed that had been air dried and adjusted to 13% moisture. Plant height was measured on three plants per plot at harvest.

Soil samples for nematode assays were taken from each replication of each experiment at planting in 1986 and 1987. Each sample consisted of 500 cm^3 soil collected from a composite of 15–20 2.5-cm-d cores taken 20–30 cm deep. Soil samples were also collected from the top 20 cm of soil (10 2.5-cm-d cores per row) of each untreated plot during September in 1986 and 1987. Nematodes (egg, cysts, and second-stage juveniles) were extracted as previously described (2). The predominant SCN race present in each field was determined by use of the standard soybean host differentials (8).

Soybean genotypes of Maturity Groups (MG) V, VI, VII, and VIII evaluated in these experiments are listed in Tables 1 and 2. The genotypes in MG V and VI were evaluated in a separate experiment from genotypes in MG VII and VIII. All genotypes except G80-1515 and PI97100 are cultivars. G80-1515 is a MG VII breeding line with resistance to SCN races 3 and 14 from the cross Pickett 71 × Bedford. PI97100 is a MG VII plant introduction from Korea that was previously shown to have the highest level of tolerance to SCN of tested soybean genotypes (1,2). For convenience, these genotypes will hereafter be collectively referred to as cultivars.

Greenhouse experiments: Soybean cultivars were planted in 474-ml styrofoam cups filled with SCN-infested soil obtained from fields at Athens and Waynesboro. Soil sources were handled as separate experiments. The cups were planted with five seeds and thinned to one plant per cup after 1 week. The experimental design was a randomized complete block with four replications. Cysts were collected after 38–42 days as previously described (2). Each experiment was repeated once.

Data analysis: Data were subjected to analysis of variance. Field experiments were combined over years, assuming years and replications to be random effects and cultivar and nematicides to be fixed effects. Nematode counts were transformed (log_{10} [n + 1]) before analysis and are presented as antilogs. A tolerance index (TI) was cal-

TABLE 1. Mean performance of 19 soybean cultivars grown with (+) and without (−) nematicide soil treatment in field plots infested with *Heterodera glycines* race 3 near Athens, Georgia, 1985–87.

Cultivar†	Seed yield (kg/ha) −	Seed yield (kg/ha) +	Tolerance index‡ (%)	Plant height (cm) −	Plant height (cm) +	Seed weight (g/100 seed) −	Seed weight (g/100 seed) +
			Maturity Group V or VI				
Coker 156	1,904	2,476*	77	60	66*	12.3	12.7*
DP 105	1,513	2,161*	72	56	63*	13.2	14.2*
DP 246	1,246	2,196*	56	50	58*	11.6	12.4*
DP 345	1,229	1,978*	62	57	64*	13.1	13.9*
DP 506	1,851	2,422*	76	68	73*	12.8	13.4*
Duocrop	1,470	2,431*	60	73	94*	15.7	17.0*
Centennial§	2,062	2,257	93	68	71	13.0	13.5*
LSD (0.05)‖	537		15	9		1.3	
			Maturity Group VII or VIII				
Wright	1,448	2,320*	65	64	74*	13.4	14.1*
Braxton	1,004	1,776*	56	62	75*	15.0	15.6*
Cobb	910	1,822*	50	66	82*	11.4	12.5*
Coker 237	642	1,623*	40	48	64*	12.5	14.5*
Coker 488	1,328	2,010*	67	70	82*	14.1	15.1*
DP 417	1,243	1,784*	71	77	91*	13.8	15.2*
GaSoy 17	1,164	1,871*	62	63	76*	12.7	13.4*
NK S72-60	1,524	2,044*	75	71	75	13.6	14.1
PI97100	1,101	1,461*	76	93	107*	13.3	13.5
Gordon§	1,747	1,995	88	74	76	11.9	11.8
Kirby§	2,003	2,299	87	76	78	12.7	12.7
Thomas§	1,923	2,139	90	68	70	15.4	15.6
LSD (0.05)‖	613		18	12		1.6	

* Significant difference between nematicide treated vs. untreated within a cultivar ($P = 0.05$).
† DP = Deltapine; NK = Northrup King; PI = plant introduction.
‡ Tolerance index = (yield of untreated ÷ yield of treated) × 100.
§ Race 3 resistant.
‖ For comparison of all means in a column.

culated for each cultivar as (seed yield in untreated subplot ÷ seed yield in nematicide-treated subplot) × 100.

Results and Discussion

In the present study Coker 156 had the highest TI (77%) for race 3 (Table 1) and the second highest TI (64%) for race 14 (Table 2) of the susceptible cultivars. It previously was reported to have moderate tolerance to races 3 and 14 (1,2,7). Coker 156 had a higher ($P = 0.05$) TI and seed yield in untreated plots than DP 246, an intolerant cultivar, at Athens and a higher ($P = 0.05$) seed yield than DP 246 at Waynesboro. Of the six MG V–VI, SCN-susceptible cultivars DP 105 and DP 506 had TI > 70% and DP 506 had a comparable seed yield to Coker 156 in untreated plots (Table 1). Of the race 3-susceptible cultivars grown in a race 14-infested field, only DP 345 had a TI equal to, or greater than, Coker 156 (Table 2). DP 345 had a lower TI (62%) and seed yield (1,229 kg/ha) in untreated plots than Coker 156 on race 3 soil (Table 1) and therefore did not express similar levels of tolerance to both races.

The three MG VI race 3-resistant cultivars—Centennial, RA680, and Twiggs—had a TI similar to Coker 156 when grown in a race 14-infested field (Table 2). These three cultivars appeared equally as susceptible to race 14 as the race 3-susceptible cultivars in both the field (Table 3) and greenhouse (Table 4). At Athens, race 3-resistant Centennial was the highest yielding MG V–VI cultivar in untreated plots (2,062 kg/ha) and had the highest TI (93%) (Table 1).

Growth of all MG V–VI cultivars was suppressed ($P = 0.05$) in untreated relative

TABLE 2. Mean performance of 26 soybean cultivars grown with (+) and without (−) nematicide soil treatment in field plots infested with *Heterodera glycines* race 14 near Waynesboro, Georgia, 1985–87.

Cultivar†	Seed yield (kg/ha) −	Seed yield (kg/ha) +	Tolerance index‡ (%)	Plant height (cm) −	Plant height (cm) +	Seed weight (g/100 seed) −	Seed weight (g/100 seed) +
			Maturity Group V or VI				
Coker 156	1,203	1,879*	64	48	61*	12.2	12.4
DP 105	954	1,726*	54	48	66*	14.0	14.8*
DP 246	872	1,606*	52	48	54*	11.0	11.0
DP 345	1,445	1,956*	75	59	68*	13.9	13.4
DP 506	1,129	2,064*	54	59	78*	12.5	12.6
Duocrop	909	1,571*	57	66	82*	14.1	14.5
Centennial§	1,359	1,948*	70	56	71*	12.4	12.4
Coker RA680§	1,404	2,041*	69	64	74*	13.1	12.9
Twiggs§	1,353	2,067*	65	54	67*	12.7	12.9
Leflore‖	1,861	2,287*	81	62	70*	12.0	12.0
LSD (0.05)¶	310		14	8		0.9	
			Maturity Group VII or VIII				
Wright	1,215	1,982*	61	62	71*	12.7	12.6
Braxton	992	1,790*	55	58	70*	14.7	15.2
Cobb	1,003	1,650*	61	64	72*	11.5	11.5
Coker 237	686	1,625*	42	50	60*	12.9	12.7
NK S72-60	1,604	2,045*	79	69	77*	12.8	12.8
PI97100	964	1,493*	65	84	94*	11.9	12.3
Coker 488	1,236	1,968*	63	70	84*	13.5	13.5
DP 417	1,221	1,961*	62	70	78*	13.4	13.1
GaSoy 17	854	1,747*	49	57	70*	12.6	12.4
Gordon§	1,376	1,945*	71	66	75*	10.8	10.9
Hartz 7126§	1,409	1,890*	75	68	79*	11.8	12.2
Kirby§	1,330	2,039*	65	61	71*	12.9	12.5
Coker 317§	1,284	1,894*	68	66	75*	12.7	12.3
Coker 368§	1,571	2,220*	71	73	85*	12.0	12.2
Thomas§	1,577	2,095*	75	62	68*	13.9	14.0
G80-1515‖	2,053	2,345*	88	71	71	10.6	10.1
LSD (0.05)¶	237		14	3		1.4	

* Significant difference between nematicide treated vs. untreated within a cultivar ($P = 0.05$).
† DP = Deltapine; NK = Northrup King; PI = plant introduction; G = Georgia breeding line.
‡ Tolerance index = (yield of untreated ÷ yield of treated) × 100.
§ Race 3 resistant.
‖ Race 3 and 14 (breeder's race 4) resistant.
¶ For comparison of all means in a column.

to nematicide-treated plots except Centennial in Athens (Table 1). Seed weight was greater ($P = 0.05$) in the treated plots of all cultivars. SCN appeared to affect the soybean plant during vegetative development and during the seed-filling period at this location. In untreated plots at Waynesboro, Leflore (resistant to races 3 and 14) was higher ($P = 0.50$) in yield than all other cultivars (Table 2). Growth of all cultivars was suppressed ($P = 0.05$) in untreated plots, whereas seed weight of only DP 105 was suppressed (Table 2). The greatest impact of SCN on the soybean plant at the Waynesboro site was early in the growing season during vegetative growth rather than later during seed fill.

Of the cultivars in MG VII–VIII, Wright and PI97100 had been reported previously to be moderately tolerant and tolerant, respectively (1,2,7). Wright and PI97100 had higher ($P = 0.05$) TI and seed yield in untreated plots than Coker 237, an intolerant cultivar, in race 14 soil (Table 2). Also, Wright and PI97100 had higher ($P = 0.05$) TI than Coker 237 in race 3 soil (Table 1). Of the race 3-susceptible cultivars, Coker 488, DP 417, and NK S72-60 had a higher TI than Wright to race 3 (Table 1) and none were equal to PI97100 (76%). Only

TABLE 3. September population densities of *Heterodera glycines* race 14 on different soybean cultivars from untreated plots near Waynesboro, Georgia, 1986–87.

	Eggs/500 cm³ soil		Juveniles/100 cm³ soil	
Cultivar†	1986	1987	1986	1987
Maturity Group V or VI				
Coker 156	3,432 a	691 ab	4 a	7 bc
DP 105	1,635 a	404 ab	7 a	17 ab
DP 246	755 a	604 ab	7 a	21 ab
DP 345	1,994 a	501 ab	4 a	12 a–c
DP 506	3,355 a	610 ab	2 a	24 a
Duocrop	3,535 a	1,038 a	5 a	14 a–c
Centennial‡	3,082 a	576 ab	2 a	20 ab
Coker RA680‡	4,349 a	702 ab	4 a	15 a–c
Twiggs‡	3,160 a	264 ab	5 a	4 cd
Leflore§	108 b	152 b	0 b	<1 d
Maturity Group VII or VIII				
Wright	1,124 ab	445 a	13 a–c	3 a
Braxton	1,870 ab	397 a	10 a–d	5 a
Cobb	1,193 ab	710 a	20 a	3 a
Coker 237	3,419 a	712 a	2 de	4 a
NK S72-60	760 b	702 a	1 e	4 a
PI97100	860 b	431 a	5 b–e	4 a
Coker 488	1,481 ab	375 a	8 a–d	3 a
DP 417	1,679 ab	564 a	5 b–e	5 a
GaSoy 17	1,037 ab	681 a	16 ab	6 a
Gordon‡	797 b	593 a	9 a–d	6 a
Hartz 7126‡	996 ab	520 a	3 c–e	2 a
Kirby‡	1,041 ab	284 a	8 a–d	3 a
Coker 317‡	2,637 ab	657 a	5 b–e	2 a
Coker 368‡	1,300 ab	546 a	7 a–d	2 a
Thomas‡	898 b	530 a	6 a–e	4 a
G80-1515§	148 c	22 b	1 e	1 a

Means followed by the same letter within a maturity grouping are not significantly different based on LSD ($P = 0.05$) performed on $\log_{10}$ (n + 1) transformed data.
† DP = Deltapine; NK = Northrup King; PI = plant introduction; G = Georgia breeding line.
‡ Race 3 resistant.
§ Races 3 and 14 (breeder's race 4) resistant.

TABLE 4. Number of cysts of *Heterodera glycines* race 14 (Waynesboro) on 26 soybean cultivars in two greenhouse experiments.

Cultivar†	Experiment 1	Experiment 2
Maturity Group V or VI		
DP 506	1,776 a	1,479 a
DP 105	1,480 ab	1,058 a
Coker 156	1,420 ab	1,081 a
DP 345	1,255 ab	1,512 a
DP 246	1,113 ab	1,351 a
Centennial‡	2,216 a	1,211 a
Coker RA680‡	2,097 a	1,070 a
Twiggs‡	1,203 ab	894 a
Duocrop	681 b	958 a
Leflore§	56 c	13 b
Maturity Group VII or VIII		
Wright	2,898 a	1,253 a–c
Braxton	2,444 a	1,232 a–c
Cobb	2,294 ab	1,494 a
PI97100	1,772 a–c	1,489 a
Coker 237	1,594 a–c	681 c
Coker 488	1,516 a–c	1,366 ab
GaSoy 17	1,495 a–c	837 a–c
DP 417	1,144 a–c	1,102 a–c
NK S72-60	902 bc	798 a–c
Coker 317‡	2,898 a	1,135 a–c
Hartz 7126‡	1,943 a–c	1,194 a–c
Thomas‡	1,867 a–c	981 a–c
Coker 368‡	1,810 a–c	1,293 a–c
Gordon‡	1,626 a–c	829 a–c
Kirby‡	857 c	744 bc
G80-1515§	163 d	225 d

Means followed by the same letter within a maturity grouping are not significantly different based on LSD ($P = 0.05$) performed on $\log_{10}$ (n + 1) transformed data.
† DP = Deltapine; NK = Northrup King; PI = plant introduction; G = Georgia breeding line.
‡ Race 3 resistant.
§ Races 3 and 14 (breeder's race 4) resistant.

NK S76-60 had a higher seed yield in untreated plots than Wright.

In the race 14-infested field, where Wright had a TI of 61%, NK S72-60 had a greater ($P = 0.05$) TI (79%) (Table 2). NK S72-60 also averaged 32% higher than Wright in seed yield in the untreated plot. There was a consistent ranking of the MG VII–VIII race 3-susceptible cultivars for TI across races 3 and 14 (Tables 1, 2).

The six race 3-resistant, race 14-susceptible cultivars had TI equal to or greater than Wright and PI97100 at Waynesboro (Table 2). Coker 368 and Thomas averaged 30% higher in yield than Wright in untreated plots. These race 3-resistant cultivars supported reproduction of race 14 similar to that of the race 3-susceptible cultivars in the field (Table 3) and greenhouse (Table 4). G80-1515, which was higher ($P = 0.05$) in yield than all other MG VII–VIII cultivars (Table 2), suppressed nematode reproduction in the field (Table 3) and greenhouse (Table 4).

At Athens both plant height and seed weight were suppressed in untreated plots for each of the MG VII–VIII cultivars except for the most tolerant cultivars, PI97100 and NK S72-60, and the race 3-resistant cultivars (Table 1). In Waynes-

TABLE 5. September population densities of *Heterodera glycines* race 3 on different soybean cultivars from untreated plots near Athens, Georgia, 1986–87.

Cultivar†	Eggs/500 cm³ soil 1986	Eggs/500 cm³ soil 1987	Juveniles/100 cm³ soil 1986	Juveniles/100 cm³ soil 1987
Maturity Group V or VI				
Coker 156	10,222 a	2,727 a	7 a	26 a
DP 105	5,543 a	2,442 a	6 a	31 a
DP 246	7,261 a	2,082 a	10 a	28 a
DP 345	5,357 a	3,177 a	7 a	22 ab
DP 506	6,990 a	2,725 a	9 a	28 a
Duocrop	8,078 a	3,285 a	13 a	38 a
Centennial‡	1,676 b	1,125 b	<1 b	8 b
Maturity Group VII or VIII				
Wright	19,049 a	2,494 a	5 a	18 b–d
Braxton	28,018 a	2,005 a	8 a	20 a–d
Cobb	30,452 a	3,341 a	12 a	22 a–d
Coker 237	16,903 a	3,014 a	4 a	39 ab
Coker 488	17,325 a	2,648 a	5 a	34 a–c
DP 417	26,618 a	2,498 a	8 a	29 a–c
GaSoy 17	15,339 a	2,707 a	18 a	16 cd
NK S72-60	14,527 a	3,286 a	11 a	41 a
PI97100	13,883 a	2,445 a	5 a	26 a–c
Gordon‡	1,199 b	1,068 b	<1 b	10 de
Kirby‡	93 c	909 b	0 b	4 f
Thomas‡	183 bc	821 b	<1 b	5 ef

Means followed by the same letter within a maturity grouping are not significantly different based on LSD ($P = 0.05$) performed on $\log_{10}$ (n + 1) transformed data.
† DP = Deltapine; NK = Northrup King; PI = plant introduction.
‡ Race 3 resistant.

TABLE 6. Number of cysts of *Heterodera glycines* race 3 (Athens) on 19 soybean cultivars in two greenhouse experiments.

Cultivar†	Experiment 1	Experiment 2
Maturity Group V or VI		
DP 345	136 a	206 ab
Duocrop	95 a	121 a–c
Coker 156	81 a	19 c
DP 105	73 a	404 a
DP 246	71 a	265 ab
DP 506	54 a	177 ab
Centennial‡	81 a	47 bc
Maturity Group VII or VIII		
Ransom	270 a	143 ab
Dowling	267 a	130 ab
PI97100	232 a	215 ab
Wright	221 a	233 ab
Cobb	204 a	204 ab
Coker 237	152 a	289 a
Coker 488	152 a	212 ab
GaSoy 17	150 a	127 ab
DP 417	123 ab	105 ab
NK S72-60	121 ab	200 ab
Braxton	109 ab	186 ab
Kirby‡	29 bc	68 a–c
Gordon‡	29 bc	21 c
Thomas‡	19 c	56 bc

Means followed by the same letter within a maturity grouping are not significantly different based on LSD ($P = 0.05$) performed on $\log_{10}$ (n + 1) transformed data.
† DP = Deltapine; NK = Northrup King; PI = plant introduction.
‡ Race 3 resistant.

boro only plant height was suppressed (Table 2).

Average preplant SCN population densities were higher in Athens (9,975 eggs, 23 juveniles) than in Waynesboro (3,411 eggs, 6 juveniles) and these population density differences continued throughout the growing season (Tables 3, 5). Races 3 and 14 appeared to differ in their damage potential on the soybean genotypes. Yields of all cultivars were higher ($P = 0.05$) in nematicide-treated than in the untreated plots in the race 14-infested fields (Table 2). However, yields of only the susceptible cultivars were increased ($P = 0.05$) in the nematicide-treated plots in race 3-infested fields (Table 1).

We have identified three SCN-susceptible cultivars—Coker 488, DP 417, and NK S72-60—with moderate tolerance to races 3 and 14 (similar to Wright in SCN tolerance). These cultivars would be useful in rotation with nonhost crops and SCN-resistant cultivars to manage SCN. When used in rotation they should be exposed to lower nematode population densities than in the present study and yield would be expected to be higher than reported here. Previous research showed tolerance to be highly dependent on initial SCN population densities (3). NK S72-60 appears to possess equal or greater tolerance than PI97100. Even though NK S72-60 (parentage = Ransom × Pickett 71) has one race 3-resistant parent (Pickett 71), these resistance genes (either some or all) do not appear to be present in NK S72-60, since it supported race 3 reproduction both in the field (Table 5) and greenhouse (Table 6). NK S72-60 was also superior in yield to PI97100, averaging 52% higher in untreated plots at Athens and Waynesboro and 38% higher in treated plots than PI97100 (Tables 1, 2). This cultivar should be of value as a parent in a breeding program to increase the level of tolerance in soybean to SCN.

The race 3-resistant cultivars were all equal or superior to Wright in tolerance to race 14. With the current data it is impossible to determine whether this is actual tolerance or partial resistance to a mixed (races 3 and 14) SCN population. In the future it would be desirable to determine if race 3-resistant cultivars, such as Thomas and Coker 368, show tolerance to other non-race 3 SCN populations to which they do not possess genes for resistance.

It should be noted that our data indicate that tolerance is not a replacement for resistance in a SCN management scheme. In both Athens and Waynesboro the highest yielding cultivars in untreated plots were resistant to the predominant race present in each field. Furthermore, resistant cultivars suppress nematode reproduction, which results in a low initial SCN population the following season. Tolerance does have utility in reducing selection pressure on SCN imposed by the resistant cultivar while reducing the risk of yield loss in a field with a low SCN population.

The mechanism(s) by which soybean plants are able to tolerate nematode damage is not well understood, although a recent rhizotron study indicates compensatory root growth was an important characteristic of SCN tolerance in Wright soybean (5). It would be useful to study the root response of the tolerant genotypes identified in this study to determine whether compensatory root growth is a general mechanism of tolerance. A recent report (7) indicates that tolerance can be enhanced in soybean through breeding. Improving the level of tolerance in soybean will increase the acceptance of tolerance as a SCN management strategy.

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