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Host Suitability of Diverse Lines of *Phaseolus vulgaris* to Multiple Populations of *Heterodera glycines*

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Abstract: The host suitability of diverse races and gene pools of common bean (*Phaseolus vulgaris*) for multiple isolates of *Heterodera glycines* was studied. Twenty *P. vulgaris* genotypes, representing three of the six races within the two major germplasm pools, were tested in greenhouse experiments to determine their host suitability to five *H. glycines* isolates. *Phaseolus vulgaris* genotypes differed in their host suitability to different *H. glycines* isolates. While some common bean lines were excellent hosts for some *H. glycines* isolates, no common bean line was a good host for all isolates. Some bean lines from races Durango and Mesoamerica, representing the Middle America gene pool, were resistant to all five nematode isolates. Other lines, from both the Andean and Middle America gene pools, had differential responses for host suitability to the different isolates of *H. glycines*.
Key words: Common bean, *Heterodera glycines,* host suitability, *Phaseolus vulgaris,* race, resistance, soybean cyst nematode.

Soybean cyst nematode (*Heterodera glycines* Ichinohe) is the most destructive pathogen of soybean (*Glycine max* L. Merr.) in the world (Wrather et al., 2001). Among the 10 countries that produced nearly 98% of the world's soybean crop in 1998, *H. glycines* caused more yield loss (8,969,400 metric tons) than any other disease of soybean (Wrather et al., 2001). While soybean hectarage increased nearly 14% worldwide from 1994 to 1998, reported soybean yield loss due to *H. glycines* increased nearly 300% worldwide for the same period (Wrather et al., 1997; Wrather et al., 2001).

Heterodera glycines is believed to have been imported into the United States from Asia and was first discovered in 1954 in North Carolina (Noel, 1992). It has been reported from at least 26 U.S. states and in Canada, the People's Republic of China, Colombia, Indonesia, Japan, Korea, the former Soviet Union, Taiwan (Noel, 1992), Brazil (Mendes and Dickson, 1993), Argentina (Wrather et al., 2001), and Puerto Rico (Smith and Chavarria-Carvajal, 1999). Field population densities are quite variable and are highly affected by soil texture and soil moisture (Heatherly and Young, 1991; Koenning et al., 1988). Economic threshold levels for soybean also are related to soil texture (Schmitt et al., 1987) and can vary within a given field.

Noel et al. (1982) commented that most cultivars of common bean (*Phaseolus vulgaris* L.) were susceptible to *H. glycines.* Melton et al. (1985) used two *H. glycines* isolates and 21 snap bean cultivars to compare host suitability in common bean. A majority of the cultivars were equally or more susceptible to both isolates than was soybean 'Williams 79.' This finding indicated that some snap bean cultivars may be equal or better hosts than specific susceptible soybean cultivars. However, in one of two trials for each isolate, snap bean 'WIS (RRR) 36' was not different from resistant soybean 'Fayette' as a host.

The interaction between *H. glycines* and common bean has been studied and reported for only a limited number of bean genotypes. The focus has been mostly on snap bean and kidney bean (Abawi and Jacobsen, 1984), both of which are of Andean origin, and has involved only a limited number of *H. glycines* isolates. Knowledge of the diversity in *H. glycines* populations has increased, and in recent years *H. glycines* has increased its global presence. Also, U.S. soybean and common bean production areas overlap in Michigan, Illinois, Wisconsin, North Dakota, and possibly other production areas. Beans of non-Andean origin, as well as those of Andean origin, are grown in these production areas and there is little information on the host suitability of this broader range of bean diversity to *H. glycines.* There is an increased need to understand host suitability for *H. glycines* in terms of the broader diversity of common bean germplasm that is currently grown in many soybean production areas. Hence, the purpose of this research was to measure the host suitability of a greater diversity of common bean genotypes for a larger collection of *H. glycines* isolates.

Materials and Methods

A 2-year greenhouse study was conducted in Isabela, Puerto Rico, with a race 2 isolate of *H. glycines* from Puerto Rico. Also, a 1-year study was conducted in Jackson, Tennessee, with four *H. glycines* isolates (identified as races 2, 3, 5, and 14). The two race 2 isolates differed in that the Tennessee isolate had more reproduction on 'Peking' and less on 'PI 88788' (Table 1).

Nineteen bean genotypes representing three *P. vulgaris* races within the two major *P. vulgaris* gene pools were assayed in both studies. 'Montcalm,' 'Taylor Horticultural,' 'G122,' 'Contender,' 'Tendercrop,' 'RRR36,' and 'FR266' (race Nueva Granada) were selected from the Andean gene pool (Singh et al., 1991). 'Kodiak,' 'Burke,' 'Maverick,' 'Chase,' and 'Matterhorn' (race Durango), and 'Dorado,' 'Tio Canela 75,' 'G21212,' 'Porrillo Sintético,' 'Arroyo Loro,' 'PI

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TABLE 1. Comparison of female indices of two soybean cyst nematode (*Heterodera glycines*) race 2 isolates (from Isabela, Puerto Rico, and Jackson, TN) on the *H. glycines* race differential soybean lines.

Genotype	Population: Isabela[a]	Population: Jackson[a]
Pickett	68.2[b]	62.8
Peking	14.4	33.3
PI 88788	54.7	32.1
PI 90763	0.2	0.0
Lee[c]	694.0	78.0

[a] For the Isabela race test, Lee, Peking, and PI 90763 were replicated 19 times, Pickett 18 times, and PI 88788 17 times. Each replication of each differential was infested with 4,000 eggs. For the Jackson race test, all differentials were replicated 5 times and each replication of each differential was infested with 1,000 eggs.

[b] The mean number of cysts for each host differential was divided by the mean number of cysts for Lee and then multiplied by 100.

[c] Mean number of females on Lee.

203958,' and 'Cornell 2114-12' (race Mesoamerica) were selected from the Middle America gene pool (Singh et al., 1991). An additional Andean common bean, 'G19833' (race Nueva Granada), was assayed in the Tennessee study but not in the Puerto Rico study.

Host suitability of common bean for the Puerto Rico isolate of H. glycines: Nematode race categorization was determined per Riggs and Schmitt (1988), and host suitability categorizations were made as suggested by Schmitt and Shannon (1992) but with some modifications. Four seeds were planted in sterilized crushed gravel (40.1% gravel, 32% coarse and medium sand, 27.9% fine sand, very fine sand, silt, and clay; pH 7.8; 0% organic matter) in 7.5-cm-diam. (240-cm^3) clay pots. After emergence, stands were thinned to one healthy plant per pot. The potting medium was infested with 4,000 eggs and (or) juveniles pipeted just below the soil surface and near the roots of each plant soon after the cotyledons had separated (approximately 5 to 7 days after planting).

Approximately 2 weeks after infestation, a fertilizer solution (15% N, 13% P, 13% K, 0.02% B, 0.97% Cu, 0.15% Fe, 0.05% Mn, 0.0005% Mo, and 0.06% Zn) was lightly sprinkled on the foliage. The mean maximum and minimum temperatures were approximately 33 °C and 18 °C, respectively. The plants were grown 30 to 34 days after infestation in January/February 1999 and 35 to 40 days after infestation in January/February 2000. A longer growing period than the 30 days suggested by Schmitt and Shannon (1992) was necessary because of low night temperatures.

Root weight was estimated for each replication as fresh weight at the time cyst counts were taken and was measured after first removing all soil, cysts, and free water from roots. Hypocotyl tissue containing adventitious roots was included with the roots.

Five soybean genotypes, 'Lee' (susceptible), 'Franklin' (resistance to *H. glycines* derived from Peking), 'Linford' (resistance derived from PI 88788), 'Hartwig' (resistance derived from 'PI 437654' and Peking), and PI 437654, were included in the common bean assay for comparative purposes. Peking is resistant to races 1, 3, 5, 6, 7, 8, 10, and 15. PI 88788 is resistant to races 3, 6, 8, 9, 10, 12, 13, and 14. PI 437654 has been described as resistant to all known U.S. races and biotypes (Anand, 1991). In addition, the soybean race differentials ('Pickett,' Peking, PI 88788, and 'PI 90763') were grown in separate race tests both years. Seed for each soybean genotype was obtained from the U.S. Department of Agriculture Soybean Germplasm Collection in Urbana, Illinois, and then increased.

A randomized complete block design with four replications, containing both soybean and common bean, was used. Analysis of variance was conducted for cyst count and root weight. Protected LSDs ($P = 0.05$) were calculated to compare genotypic means. Correlation coefficients were calculated between cyst count and root weight. Missing values (one for Tendercrop and one for Arroyo Loro in 1999; one for Franklin, one for FR266, two for Hartwig, and two for Cornell 2114-12 in 2000) were estimated by covariance analysis (except in the case of Hartwig, where "0" was used for cyst count). Analysis of variance, Pearson correlations, and covariance analyses were performed using "Statistix for Windows" (Analytical Software, Tallahassee, FL).

Host suitability of common bean for four Tennessee isolates of H. glycines: The Tennessee race 2 isolate actually originated in North Carolina, but other Tennessee isolates (races 3, 5, and 14) originated in Tennessee (Young, 1990). Each common bean genotype was grown in 8-cm-diam. pots filled with a sterile 3:1 masonry sand: silt loam soil (30% sand, 63% silt, 7% clay; pH 6.0; < 2% organic matter) mixture that had been infested with 1,000 eggs of the selected isolate per pot at the time of planting. One plant was grown per pot (replication), and each genotype had up to seven replications. Plants were grown for approximately 35 days in a greenhouse at 26 ± 3 °C, after which the root ball was removed from each pot and gently crumbled to remove soil from roots. Roots were visually rated for nematode infection according to a scale of 1 = 0 to 5, 2 = 6 to 10, 3 = 11 to 20, 4 = 21 to 40, and 5 = >40 for *H. glycines* females on the roots of each plant. A mean rating was calculated for each genotype: rating = $\sum$ (rating category × no. plants receiving rating)/ total no. plants. A standard error was calculated for each mean. Protected LSDs ($P = 0.05$) were calculated from one-way ANOVAs using genotypes with standard errors >0. Genotypes with a standard error of zero were not used in the analysis because of the assumption of homogeneous variances required for ANOVA. However, the resulting LSDs are conservative for comparisons involving the genotypes with zero sampling variance. Average sample sizes of 6.4, 6.6, 6.6, and 6.8 were used to calculate average LSDs for the isolates of races 2, 3, 5, and 14, respectively. Actual LSDs for a given comparison may vary slightly due to unbalanced data. Reaction of the genotypes to each nematode isolate was evaluated separately. Soybean cultivars ('Hutcheson,' 'Centennial,' 'Bedford,' and Hartwig) with known reactions to each isolate were grown as controls. Common bean response was compared to the known controls for determining host suitability.

Results and Discussion

Host suitability of common bean for the Puerto Rico isolate of H. glycines: The number of cysts was different (P = 0.01) between years (combined ANOVA not shown). There were many more cysts produced in 1999 (mean = 105) than in 2000 (means = 36) (data not shown). These differences were likely due to night temperature differences between 1999 and 2000. Mean low temperatures for the 2 years were very similar (18.2 °C and 17.2 °C, respectively), but 2000 had 8 nights with temperatures of 15.6 °C or less (4 consecutive nights), while 1999 had only 1 night as low as 15.6 °C. Alston and Schmitt (1988) found that egg hatch in *H. glycines* did not occur at constant temperatures of 16 °C or lower. They observed hatch at 20 °C and optimum hatch at 24 °C. While the below-threshold hatch temperatures for the current experiment were not constant, the repeated temperature fluctuations involving below-threshold temperatures likely reduced hatch. The consecutive 4-night period of below-threshold temperatures (15.6, 15.0, 13.3, and 13.9 °C) occurred 7 to 8 days after infestation in 2000. The only below-threshold temperature (15.6 °C) in 1999 occurred 24 days after infestation, which was well after expected hatch.

In addition to reducing the total number of cysts produced, the low night temperatures of 2000 also appeared to have lengthened the time necessary for cyst development. The experiment was conducted in more days in 2000 than in 1999 because the females needed more developmental time to reach maturation.

Genotypes responded differently to year effects, as indicated by significant genotype × year interactions (P = 0.05) for number of cysts. Some genotypes (e.g., soybean PI 437654 and Hartwig and common bean Dorado, G21212, and Contender) were stable over years, while others (e.g., soybean Lee, Linford, and Franklin and common bean FR266, Arroyo Loro, and Kodiak) were not (Table 2). The most stable genotypes tended to be those with poor host suitability, while the least stable genotypes tended to be those with good host suitability. Contender was exceptional in that it supported a similarly high number of cysts in both years (Table 2).

A large difference (P = 0.001) between 1999 and 2000 also was observed for mean root weight (2.8 g vs. 5.8 g, respectively). This was likely due to the longer growing period in 2000 (35 to 40 days) than in 1999 (30 to 35 days). However, there was no difference between years for root weight among soybean when it was analyzed separately.

The genotype × year interaction was significant (P = 0.0001) for mean root weight. Again, there was no interaction among soybean when it was analyzed separately. Soybean root weight tended to be stable across years, but this was true for only some bean genotypes (Table 2). Other bean genotypes (Taylor Horticultural,

Table 2. Mean number of cysts and root weights of 19 common bean (*Phaseolus vulgaris* L.) and 5 soybean (*Glycine max* L. Merr.) genotypes grown in clay pots infested with a *Heterodera glycines* race 2 isolate in a greenhouse in Isabela, Puerto Rico, in 1999 and 2000.

Genotype	Cysts 1999	Cysts 2000	Root weight 1999	Root weight 2000
	no. plant^{-1}		g plant^{-1}	
Lee[a]	570.5	108.5	2.07	2.50
Linford[a]	334.5	40.8	1.69	1.93
G122	322.0	159.3	2.07	4.79
Franklin[a]	172.5	21.0	3.19	2.99
Tendercrop	176.8	50.8	3.47	5.87
Maverick	128.3	44.8	4.68	8.93
FR266	122.5	31.5	4.53	3.96
Cornell 2114-12	101.8	71.8	3.17	9.14
Contender	94.5	104.8	2.56	5.97
Arroyo Loro	79.8	21.5	1.68	2.45
Kodiak	74.3	18.5	3.26	11.31
Taylor Horticultural	50.3	23.5	2.68	12.34
RRR36	41.8	19.3	3.03	3.47
Matterhorn	47.5	13.5	2.78	5.83
PI 203958	39.3	30.3	1.75	8.24
Chase	39.3	23.5	3.37	5.03
Porrillo Sintético	35.8	13.8	1.61	6.70
Montcalm	25.0	18.5	3.87	9.00
Burke	19.8	4.8	3.71	8.19
Dorado	16.0	13.8	3.01	4.14
Tio Canela 75	14.5	6.8	2.45	3.24
G21212	11.5	15.5	2.69	7.56
PI 437654[a]	0	0	1.47	1.54
Hartwig[a]	0	0	2.76	3.67
LSD1 (0.05)[b]	153.9	33.3	1.34	3.41
LSD2 (0.05)	166.7	36.0	1.45	3.70
LSD3 (0.05)	179.0	38.7	1.56	3.97
LSD4 (0.05)		43.0		4.42
LSD5 (0.05)		43.5		4.46
LSD6 (0.05)		47.5		4.88
LSD7 (0.05)		40.9		4.19

[a] Soybean. All other genotypes are bean.

[b] LSD1—For all comparisons in 1999 except those involving Tendercrop and Arroyo Loro. Also, for all comparisons in 2000 except those involving Franklin, Hartwig, Cornell 2114-12, and FR266.

LSD2—For all comparisons in 1999 involving Tendercrop and Arroyo Loro, but excluding comparisons between Tendercrop with Arroyo Loro. Also, for all comparisons in 2000 involving Franklin and FR266, but excluding comparisons among Franklin, Hartwig, Cornell 2114-12, and FR266.

LSD3—For comparisons in 1999 between Tendercrop and Arroyo Loro. Also, for comparisons in 2000 between Franklin and FR266.

LSD4—For comparisons in 2000 between Franklin and Hartwig, or for comparisons between FR266 and Cornell 2114-12, or for comparisons between Franklin and FR266.

LSD5—For comparisons in 2000 between FR266 and Hartwig.

LSD6—For comparisons in 2000 between Hartwig and Cornell 2114-12.

LSD7—For comparisons in 2000 between Hartwig and any genotype, but excluding Franklin, Cornell 2114-12, and FR266. Also, for comparisons in 2000 between Cornell 2114-12 and any genotype, but excluding Hartwig, Franklin, and FR266.

PI 203958, and Porrillo Sintético) had large increases in root weight in 2000 vs. 1999 (Table 2).

Because cyst count was lower in 2000 than in 1999 and because root weights were higher in 2000 than in 1999, one might expect an overall negative correlation between root weight and cyst count. However, the estimated correlation ($r = -0.14$), which included both common bean and soybean data, was not significant ($P = 0.05$).

The data also were analyzed as cysts per gram root and $\log_{10}$ (cysts/gram root +1), but these analyses were no more elucidating than analyses of raw data. The $\log_{10}$ (cysts/gram root +1) transformation normalized the data, but year and genotype × year effects ($P = 0.05$) still were present.

Because the 1999 and 2000 results were different for nematode reproduction and root weight, the data for each year are presented separately (Table 2). All common bean genotypes supported nematode reproduction in both years. In 1999, common bean G122 averaged more cysts per root (322.0) than all other common bean genotypes, except Tendercrop (176.8). In 2000, G122 averaged more cysts per root (159.3) than all other common bean genotypes. G122 produced significantly fewer cysts than soybean Lee in 1999 (322.0 vs. 570.5, respectively) but produced significantly more cysts in 2000 (159.3 vs. 108.5, respectively). G122 was not different from soybean genotypes Linford and Franklin for cyst production in 1999 (322.0 vs. 334.5 and 172.5, respectively), whereas in 2000 G122 was higher than both (159.3 vs. 40.8 and 21.0, respectively). G122 appears to be a highly suitable host for the race 2 Puerto Rico isolate of *H. glycines.*

On the basis of the definitions for genotype resistance developed by Schmitt and Shannon (1992), only soybean Hartwig and PI 437654 and common bean Tio Canela 75 and Burke were resistant in both years. Common bean Dorado, Taylor Horticultural, Matterhorn, RRR36, PI 203958, Chase, Porrillo Sintético, Montcalm, and G21212 were resistant in 1999 and moderately resistant in 2000. Soybean Franklin and common bean FR266, Arroyo Loro, and Kodiak were moderately resistant in both years, whereas common bean Maverick was moderately resistant in 1999 and moderately susceptible in 2000. Common bean Cornell 2114-12 and Contender were moderately resistant in 1999 and susceptible in 2000. Common bean Tendercrop and soybean Linford were moderately susceptible in both years, whereas common bean G122 was moderately susceptible in 1999 and fully susceptible in 2000. These ratings are all relative to soybean Lee, and their respective stabilities or instabilities were very much influenced by Lee. For example, Contender's stability for number of cysts over years already has been noted, but its instability (moderately resistant in 1999 and susceptible in 2000) here is a direct function of the yearly differences of Lee.

The most suitable common bean host (G122) came from the Andean gene pool (race Nueva Granada). Snap bean Contender and Tendercrop (also race Nueva Granada) were moderately suitable hosts. However, not all Andean genotypes were good hosts, as Montcalm, Taylor Horticultural, RRR36, and FR266 (also race Nueva Granada) all were rated as resistant or moderately resistant. Common bean genotypes Dorado, Tio Canela 75, G21212, Porrillo Sintético, Burke, and Matterhorn had the least potential for being suitable hosts and all came from the Middle America gene pool (race Mesoamerica for the former four and Durango for the latter two). However, Middle America genotypes Cornell 2114-12 and Maverick showed some potential for host suitability.

Host suitability of common bean for four Tennessee isolates of H. glycines: An interaction for *H. glycines* race resistance/susceptibility was observed for several common bean genotypes (Table 3). G122, which was susceptible to the Puerto Rico race 2 isolate (Table 2), appeared to be less susceptible to the Tennessee race 2 isolate (Table 3) but highly susceptible to the Tennessee race 3 isolate and resistant to the isolates of races 5 and 14 from Tennessee (Table 3). Matterhorn and Tio Canela 75 seemed more susceptible to the Tennessee race 2 isolate (Table 3) than to the Puerto Rico race 2 isolate (Table 2). However, both genotypes were resistant to Tennessee isolates of 3, 5, and 14. Maverick and G19833 appeared moderately susceptible to the Tennessee race 2 but resistant to the race 14. On the other hand, Tendercrop appeared moderately susceptible to the race 3 and resistant to the race 14. No common bean genotype had a score greater than 1.7 to the race 14 (all were resistant), while at least one genotype had a score of 3.0 or greater to the races 2, 3, and 5. Dorado, Burke, Porrillo Sintético, Chase, Kodiak, Arroyo Loro, and Cornell 2114-12 (all from the Middle America gene pool) had scores of less than 2.0 for all Tennessee isolates (they appear to be resistant to all four Tennessee isolates). Cornell 2114-12 and Contender appeared to be less suitable hosts to the Tennessee race-2 population than to the Puerto Rico race-2 population. Hence, common bean genotypes differed in their host suitability to different isolates of *H. glycines.*

Common bean genotypes, like soybean genotypes, differed in their host suitability to different *H. glycines* isolates. While no common bean genotype was a suitable host for all *H. glycines* isolates tested, specific genotypes from both the Andean gene pool (G122, G19833, Contender, Taylor Horticultural, and Tendercrop) and the Middle America gene pool (Maverick, Matterhorn, Cornell 2114-12, and Tio Canela 75) were suitable hosts for some *H. glycines* isolates. Common bean genotypes Dorado, Burke, Porrillo Sintético, and Chase, from the Middle America gene pool, had high levels of resistance to all five isolates of *H. glycines.*

Certain common bean genotypes may pose more of a

TABLE 3. Mean ratings[a] and standard errors for 20 common bean (*Phaseolus vulgaris* L.) and four soybean (*Glycine max* L. Merr.) genotypes grown in soil infested with each of four races of soybean cyst nematode (*Heterodera glycines*) in a greenhouse in Jackson, Tennessee, in 1999/2000.

	Soybean cyst nematode isolates							
	Race 2		Race 3		Race 5		Race 14	
Genotype	Rating[a]	S.E.	Rating[a]	S.E.	Rating[a]	S.E.	Rating[a]	S.E.
G122	3.0	0.31	4.9	0.14	1.4	0.20	1.1	0.14
Tendercrop	2.2	0.38	3.0	0.22	2.4	0.25	1.7	0.29
Maverick	3.0	0.22	1.6	0.30	1.0	0.00	1.3	0.19
FR266	2.0	0.31	2.0	0.36	1.3	0.19	1.0	0.00
Cornell 2114-12	1.6	0.20	1.4	0.30	1.0	0.00	1.0	0.00
Contender	2.1	0.34	2.6	0.30	2.1	0.34	1.3	0.19
Arroyo Loro	1.8	0.17	1.7	0.34	1.3	0.21	1.3	0.19
Kodiak	1.9	0.14	1.6	0.30	1.1	0.14	1.0	0.00
Taylor Horticultural	2.7	0.21	1.4	0.20	3.3	0.29	1.1	0.14
Matterhorn	3.7	0.19	1.6	0.30	1.1	0.14	1.0	0.00
RRR 36	2.2	0.38	1.2	0.17	1.0	0.00	1.0	0.00
Chase	1.7	0.29	1.3	0.21	1.7	0.29	1.0	0.00
PI 203958	2.4	0.25	1.7	0.34	2.1	0.26	1.0	0.00
Porrillo Sintético	1.3	0.34	1.8	0.40	1.0	0.00	1.3	0.21
Montcalm	1.7	0.19	1.3	0.19	2.7	0.29	1.1	0.14
G19833	3.7	0.21	2.0	0.31	2.8	0.31	1.2	0.17
Burke	1.7	0.29	1.0	0.00	1.6	0.30	1.1	0.14
Dorado	1.4	0.19	1.1	0.14	1.0	0.00	1.0	0.00
Tio Canela 75	2.9	0.26	1.6	0.30	1.3	0.21	1.1	0.14
G21212	2.3	0.19	1.1	0.14	1.0	0.00	1.0	0.00
Hutcheson[b]	4.8	0.15	3.8	0.20	4.8	0.16	4.6	0.20
Centennial[b]	4.0	0.24	1.0	0.00	2.3	0.47	4.1	0.26
Bedford[b]	3.7	0.22	1.3	0.19	5.0	0.00	1.7	0.31
Hartwig[b]	1.0	0.00	1.0	0.00	1.0	0.00	1.0	0.00
LSD (0.05)[c]	0.7		0.7		0.8		0.6	

[a] Ratings are: 1 = 0 to 5 cysts per plant, 2 = 6 to 10 cysts per plant, 3 = 11 to 20 cysts per plant, 4 = 21 to 40 cysts per plant; 5 = >40 cysts per plant.

[b] Soybean. All other genotypes are bean. Hutcheson is considered susceptible to races 2, 3, 5, and 14. Centennial is resistant to race 3 and susceptible to races 2, 5, and 14. Bedford is resistant to races 3 and 14 and susceptible to races 2 and 5. Hartwig is resistant to races 2, 3, 5, and 14.

[c] LSDs calculated from ANOVA using genotypes with standard errors >0. Average sample sizes of 6.4, 6.6, 6.6, and 6.8 were used in LSD calculations for races 2, 3, 5, and 14, respectively. These are average LSDs. Actual LSDs for specific comparisons may vary slightly due to unbalanced data.

risk to agriculture than others when grown in the presence of *H. glycines*. Arroyo Loro, which might typically be grown by farmers in Puerto Rico, likely will not increase reproductive densities or suffer any yield reduction. The same can be said for dry bean lines that farmers may grow in other areas of the Caribbean or Central America (Dorado, Tio Canela 75, G21212, and Porrillo Sintético). Dry bean (Montcalm, Burke, Chase, and Kodiak) and snap bean (RRR 36 and FR266) produced by U.S. farmers likely will not suffer any yield reduction or substantially increase reproductive densities above initial levels. Snap bean Contender and Tendercrop and dry bean Maverick, Matterhorn, and Taylor Horticultural may be more likely to increase reproductive densities of some populations, but their potential for *H. glycines*-reduced yields is uncertain. G122, a germplasm line known for its resistance to white mold (Miklas et al., 1999) and tolerance to heat stress (Shonnard and Gepts, 1994), very likely will increase reproductive densities over initial levels of specific populations of *H. glycines*. The likelihood of plant breeders transferring susceptibility to *H. glycines* from G122 along with tolerance to biotic and abiotic stresses is unknown, but should be monitored.

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