Heterodera glycines race 2 and the yield of common bean in Puerto Rico[1,2]

James R. Smith[3]

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ABSTRACT

Heterodera glycines, a destructive pathogen of soybean (*Glycine max* L. Merr.), was recently discovered in Puerto Rico. Common bean (*Phaseolus vulgaris* L.) can also be a host for *H. glycines*, but there are no reports of the effect of *H. glycines* on seed yield of bean. The objective of this study was to determine the effect of the Puerto Rico race-2 population of *H. glycines* on yield components of common bean. Three resistant and three non-resistant bean lines were exposed to three infestation densities (0, 4,000, and 8,000 eggs and juveniles per pot) of *H. glycines* race 2. A factorial arrangement of lines and infestation densities was used in a randomized complete block design with six replications in a greenhouse in Isabela, Puerto Rico, in 2000. Data for seed number, pod number, and seed yield per plant were collected. *H. glycines* had no effect on any yield component. Observed differences in yield components were due to genotypic factors unrelated to *H. glycines*. Initial conclusions indicate that *H. glycines* will not affect yield of common bean in Puerto Rico. Follow-up studies of common bean and *H. glycines*, using course-textured soils, are recommended.

Key words: soybean cyst nematode, SCN, common bean

RESUMEN

La raza 2 de *Heterodera glycines* y el rendimiento de la habichuela común en Puerto Rico

Heterodera glycines, un patógeno destructivo de la soya (*Glycine max* L. Merr.), se descubrió recientemente en Puerto Rico. La habichuela común (*Phaseolus vulgaris* L.) también sirve como hospedero, pero todavía no se ha determinado el efecto de *H. glycines* en el rendimiento de este cultivo. El objetivo de este estudio fue determinar el efecto de la población raza 2 de *H. glycines*, que se descubrió en Puerto Rico, en el rendimiento de la habichuela común. Tres líneas resistentes y tres líneas sin resistencia se infestaron con tres niveles (0, 4,000, y 8,000 huevos y jóvenes por tiesto) de *H. glycines* raza 2. Se utilizó un arreglo factorial de líneas y niveles de infestación en un diseño de bloques completos aleatorizados con seis replicaciones. El estudio se realizó en un invernadero en Isabela, Puerto Rico, en 2000. Se recolectaron datos para el número de semillas, número de vainas, y el peso de semillas por planta. No se observó efecto de *H. glycines* sobre los componentes de rendimiento. Hubo diferencias entre las líneas para los

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[3]Research Geneticist, USDA-ARS, 141 Experiment Station Road, P.O. Box 345, Stoneville, MS 38776. E-mail: rsmith@ars.usda.gov.

componentes de rendimiento, pero estas diferencias se asociaron con factores genotípicos no relacionados con *H. glycines*. Se concluyó, tentativamente, que *H. glycines* no afectará el rendimiento de habichuela común en Puerto Rico. Sin embargo, se recomendaron estudios adicionales con *H. glycines* y habichuela común usando suelos de textura más gruesa.

INTRODUCTION

Soybean cyst nematode (SCN), *Heterodera glycines* Ichinohe, is one of the most destructive pathogens of soybean (*Glycine max* L. Merr.) in the world (Wrather et al., 2001). It has been reported to occur in at least 26 states of the United States, 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 Chavarría-Carvajal, 1999).

Common bean (*Phaseolus vulgaris* L.) can also serve as a host for SCN. Melton et al. (1985) used two SCN populations and 21 snap bean cultivars to compare host suitability of common bean. A majority of the cultivars were equally or more susceptible than soybean 'Williams 79' to both SCN populations. This susceptibility indicated that some snap beans may be hosts that are equal to or better than certain susceptible soybeans. However, snap bean 'WIS (RRR) 36' was not different from resistant soybean 'Fayette' in one out of two trials for each population. On the basis of the high level of resistance of WIS (RRR) 36 to both populations, resistance to SCN in snap bean appeared not to be race-specific.

However, Smith and Young (unpublished) evaluated the host suitability of 19 bean lines of diverse origin, representing both bean gene pools, for five SCN populations. They determined that whereas some lines were resistant to all five populations, other lines differentiated between populations, being resistant to some but susceptible to others. Bean line G122 was found to increase the Puerto Rico race-2 SCN population density over initial levels, while being resistant to SCN races 5 and 14.

Some authors have noted the potential for SCN-induced yield reduction in common bean. Noel et al. (1982) observed chlorotic and stunted snap bean plants ('Blue Lake') in a commercial production field in Mason County, Illinois, and attributed the symptoms, which were similar to those caused by *H. glycines* on soybean, to SCN (race 3). The authors cautioned that SCN had the potential to negatively impact bean production.

Other authors have concluded that the risk for SCN-induced yield reduction is minimal. Abawi and Jacobsen (1984) estimated the effect of SCN (race 3) on yield of the dry bean cultivar California Light Red Kidney by measuring dry weights of six-week-old plants grown in the greenhouse. Plant dry weights did not differ at infestation densities of 0, 3, 6, 12, 24, and 48 eggs and juveniles per cm^3 of soil, but did differ for susceptible 'Amsoy 71' soybean. Although no seed yield estimates were made, these data indicated that SCN might not reduce yield of dry bean grown in a greenhouse, as it did with soybean. Abawi et al. (1994) later concluded that SCN does not usually reduce growth or yield of beans, even at very high populations. This conclusion may be based on Abawi and Jacobsen's (1984) greenhouse work, as there is still a lack of SCN-related yield data for field grown common bean. At present, there are no published data of any kind demonstrating the effect of SCN on seed yield of common bean.

Part of the problem in making such a determination is that it can be difficult to maintain sufficient densities of SCN in fine-textured soils (Heatherly and Young, 1991). Smith (unpublished) conducted a field study in a "Coto" clay (Typic Hapludox; 61% clay, 31% sand, and 7.9% silt) in Isabela, Puerto Rico, to determine the effect of SCN on seed yield. The study was inconclusive because of very low and sporadic levels of SCN infestation. Repeated attempts to increase SCN density and uniformity, using susceptible 'Lee' soybean, were unsuccessful.

Because SCN was recently discovered in Puerto Rico (Smith and Chavarría-Carvajal, 1999) and because initial investigations showed that some Andean beans were good hosts to SCN (Smith and Young, unpublished), a study was needed to evaluate the effect of the Isabela race-2 population of SCN on seed yield of common bean. Hence, the purpose of this research was to determine the effect of the Puerto Rico race-2 SCN population on the seed yield of common bean lines differing in their resistance/susceptibility to the above mentioned population.

MATERIALS AND METHODS

Six bean lines representing the two major *P. vulgaris* gene pools were used in a greenhouse study conducted in 2000 in Isabela, Puerto Rico. 'Taylor Horticultural', G122, 'Tendercrop', and 'RRR36' (race Nueva Granada) were selected from the Andean gene pool (Singh et al., 1991) and 'Burke' and 'Maverick' (race Durango) were selected from the Middle America gene pool. The snap bean (RRR36 and Tendercrop), pinto (Maverick and Burke), and cranberry (G122 and Taylor Horticulture) market classes were represented. The two representatives within each market class differed for host susceptibility to the Puerto Rico race-2 population of SCN. Taylor Horticultural, RRR36, and Burke are resistant, whereas G122 and Tendercrop are susceptible, and Maverick is intermediate (Smith and Young, unpublished).

Three infestation densities (0, 4,000, and 8,000 eggs and juveniles per pot) were employed as outlined by Schmitt and Shannon (1992), but with the following modifications: four seeds were planted in each pot and thinned to one healthy plant. The potting medium (70 to 80% sphagnum peat, perlite, dolomitic limestone, and gypsum) was infested soon after the cotyledons had separated (approximately 5 to 7 days after planting) by using a pipette and applying the appropriate density of eggs and juveniles just below the soil surface and near the roots of each plant.

The mean maximum/minimum greenhouse temperatures were 33 and 18° C, respectively. Each four-liter pot received 15 ml of a slow-release fertilizer (14% N, 6.1% P, and 11.6% K) at the time of planting and was subsequently fertilized with 120 ml of a nutrient solution (20% N, 8.7% P, 16.6% K, 0.0251% Mg, 0.02% B, 0.05% Cu, 0.1% Fe, 0.05% Mn, 0.001% Mo, and 0.05% Zn) at 2, 3, and 5 wk after planting. Plants were grown to maturity before counting the number of pods and seeds per plant and weighing the dried seeds per plant.

Each pot contained one plant and was considered a single replication. The experimental design was a factorial arrangement of treatments in a randomized complete block design. Each combination of line and egg concentration was replicated six times. Effects were considered fixed. Analysis of variance was conducted for seed and pod number and seed yield, and was performed by using "Statistix for Windows" (Analytical Software, Tallahassee, FL).[4] An LSD (0.05) was calculated for each yield variable.

RESULTS AND DISCUSSION

Analysis of variance indicated that infestation density had no effect on the number of seeds and pods produced or on the weight of seeds per plant (ANOVAs not shown). There was no interaction between line and infestation density for any yield variable. However, there were significant line differences for each yield variable (Table 1).

Yield variable means for each line over all infestation levels are presented in Table 1. Although RRR36 and Tendercrop were classified as "resistant" and "susceptible", respectively, to race 2 SCN (Smith and Young, unpublished), the level of race 2 SCN in the current study had no apparent yield effect on either snap bean. And the seed yield per plant did not differ between them (Table 1). Likewise, SCN infestation level did not affect the seed yield of the two pintos, although Maverick yielded slightly higher than "resistant" Burke (Table 1). Cranberries Taylor Horticultural and G122 did not differ for seed yield per plant (Table 1), although G122 is "susceptible" and Taylor Horticultural is "resistant" to race 2 SCN (Smith and Young, unpublished). This finding

[4]Trade names in this publication are used only to provide specific information. Mention of a trade name does not constitute warranty of equipment or materials, nor is this mention a statement of preference over other equipment or materials.

TABLE 1.—*SCN rating, market class, mean number of seed per plant, mean number of pods per plant, and mean weight of seed per plant of six common bean lines grown in a greenhouse in Isabela, Puerto Rico, in 2000 after infestation with three densities[1] of race 2 SCN.*

Line	SCN rating[2]	Market class	Seed	Pod	Mean weight
			mean no./plant		g/plant
RRR36	R	snap	221.3	47.7	47.9
Tendercrop	S	snap	157.9	32.7	42.7
Burke	R	pinto	132.1	31.4	49.4
Maverick	I	pinto	143.1	34.7	57.8
Taylor Horticultural	R	cranberry	98.6	22.1	46.0
G122	S	cranberry	119.4	29.3	40.1
LSD (0.05)			19.5	4.5	7.9
Infestation density			NS[3]	NS	NS
Genotype X infestation density			NS	NS	NS

[1]Infestation densities per pot were 0, 4,000, and 8,000 eggs and juveniles.
[2]SCN (soybean cyst nematode) ratings were previously determined by Smith and Young (unpublished) as: R = resistant, I = intermediate, and S = susceptible.
[3]NS = not significant at P = 0.05.

is impressive considering that G122 is capable of augmenting an initial inoculum level of 4,000 eggs to 38,491 eggs in approximately 37 days (Smith and Young, unpublished). Boerma and Hussey (1984) applied the terms "resistance" (low nematode reproduction), "susceptibility" (high nematode reproduction), "tolerance" (little suppression of yield), and "intolerance" (high suppression of yield) to soybean. On the basis of these definitions, G122 might be considered susceptible and tolerant.

Abawi and Jacobsen (1984) found no difference in plant weights of 36-day-old bean plants among initial rates of 0, 12, 24, and 48 eggs and juveniles per cm^3 of soil for bean cultivar California Light Red Kidney. The equivalent initial concentrations of eggs and juveniles per cm^3 used in the current experiment were 0, 17 (for the 4,000-egg level) and 33 (for the 8,000-egg level). Although only the current experiment had seed yield data, both experiments demonstrated a lack of yield suppression in beans due to SCN. Abawi and Jacobsen (1984) used race 3, and the current experiment used race 2. It seems appropriate to at least tentatively concur with Abawi et al. (1994) that SCN does not usually reduce bean yield, even at very high populations. However, it must be acknowledged that yield data for bean in the presence of SCN are still lacking for field-grown beans.

An issue that has not been adequately investigated in either greenhouse yield study is the effect of soil texture, which has been shown to affect SCN-related yield loss in soybean. Koenning et al. (1988) found that the percentage of sand in an SCN-infested fine sandy-loam soil was negatively correlated with soybean yield. Heatherly and Young (1991) found that SCN caused a greater yield reduction in soybean in an infested silt loam soil than in an infested clay soil. The same principles may apply to SCN-related yield loss in common bean. Course-textured soils may pose a greater risk for yield loss due to SCN than heavier fine-textured soils. Noel et al. (1982) observed SCN damage in a field containing dune sand and sandy-loam soils, whereas Abawi and Jacobsen (1984) used a Drummer silty clay loam soil and observed no loss in bean productivity due to SCN. The peat medium used in the current yield study may have been a factor in not observing an SCN yield response, as it lacks some of the stress properties (e.g., drought proneness) that course-textured soils possess.

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