HOST SUITABILITY OF PIGEON PEA FOR HETERODERA GLYCINES RACE 2

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ABSTRACT

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Soybean cyst nematode, *Heterodera glycines*, was recently discovered in Puerto Rico. Pigeon pea is a major crop in Puerto Rico, but little is known concerning the host suitability of pigeon pea for *H. glycines*. The purpose of this research was to increase the understanding of the host suitability of pigeon pea for *H. glycines*. Ten pigeon pea cvs. were evaluated in three assays (two field and one greenhouse) for host suitability to the Isabela, Puerto Rico race-2 population of *H. glycines*. The field assays, a one-replication potted trial and a two-replication plot trial, were done in a *H. glycines*-infested "Coto" clay soil. The greenhouse assay had six replications and used artificially infested crushed gravel as the potting medium. A few white females were observed on roots of pigeon pea cvs. I-8-3-2, I-13, Cortada, and II-56 in the infested field assays, but none were observed on cvs. PR-147, I-58-3, Blanco de Yauco, Guerrero, I-8-3-1, and Kaki. No *H. glycines* females were recovered on any pigeon pea cv. in the greenhouse assay. These data indicate that four cultivars are highly resistant, whereas the other six may be immune. Additional studies with other cvs. and races are necessary to fully understand the host suitability of pigeon pea for *H. glycines*.

Key words: Cajanus cajan, *Heterodera glycines*, host suitability.

RESUMEN

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El nematodo de los quistes de la soja, *Heterodera glycines*, se ha descubierto recientemente en Puerto Rico. *Cajanus cajan* es un cultivo importante en Puerto Rico aunque se sabe poco de la compatibilidad de este cultivo a *H. glycines*. El objetivo de esta investigación fue incrementar el conocimiento sobre la compatibilidad de *C. cajan* a *H. glyciynes*. Se evaluó la compatibilidad de diez cultivares de *C. cajan* a la población de *H. glycines* Isabela, Puerto Rico raza—2 en tres experimentos (uno de invernadero y dos de campo). Los experimentos de campo, ensayo en contenedor con una repetición y ensayo en microparcelas con dos repeticiones, se hicieron en un suelo arcilloso tipo "Coto" infestado con *H. glycines*. El experimento en invernadero se realizó en contenedores con grava triturada como sustrato y constó de seis repeticiones. Se observaron unas pocas hembras blancas en las raíces de los cultivares de *C. cajan* I-8-3-2, I-13, Cortada y II-56 en los experimentos de campo, pero no se observó ninguna hembra en los cultivares PR-147, I-58-3, Blanco de Yauco, Guerrero, I-8-3-1 ni en Kaki. No se recuperó ninguna hembra de *H. glycines* de ninguno de los cultivares de *C. cajan* en el experimento realizado en el invernadero. Estos datos indican que cuatro de los cultivares de *C. cajan* son altamente resistentes al nematodo mientras que los otros seis pudieran ser inmunes. Se necesita realizar estudios adicionales con otros cultivares y razas para entender mejor la compatibilidad de *C. cajan* a *H. glycines*.

Palabras clave: Cajanus cajan, *Heterodera glycines*, compatibilidad.

INTRODUCTION

Soybean cyst nematode (*Heterodera glycines* Ichinohe) is the most destructive pathogen of soybean (*Glycine max* L. Merr.) in the world, and caused a yield loss of 8,969,400 metric tons to soybean in 1998 (Wrather *et al.*, 2001). Other plant species, such as lespedeza (*Kummerowia stipulacea* and *K. striata*), hemp sesbania (*Sesbania macrocarpa*), henbit deadnettle (*Lamium amplexicaule*), adzuki bean (*Vigna angularis* (Willd.) W. F. Wright), mung bean (*Phaseolus aureus*) (Epps and Chambers, 1966), and common bean (*Phaseolus vulgaris* L.) (Melton *et al.*, 1985), can also be good hosts.

The nematode has been found in many countries of the world (Noel, 1992; Mendes and Dickson, 1993) and was reported to cause significant yield loss to soybean in five of the top ten soybean-producing countries of the world (Wrather *et al.*, 2001). In 1998, *H. glycines* was discovered in Puerto Rico (Smith and Chavarría-Carvajal, 1999), the first report of *H. glycines* in the Caribbean.

Pigeon pea (*Cajanus cajan* (L.) Millsp.), an important source of protein for over a billion people in the world, was grown on approximately 4.6 million hectares in 1996 (Anon., 2001). Pigeon pea is the most widely cultivated edible legume in Puerto Rico, where 454 T of fresh pigeon pea was produced in 1995-96 (Semidey and Bosques-Vega, 1999). Although pigeon pea is grown in Africa, Latin America, and the Caribbean, approximately 82% of world production in 1996 was in India (Anon., 2001). India produced approximately 3.1 million T of pigeon pea during the 1998-99 crop season (Gupta, 2000) and over five million T of soybean in 1998 (Wrather *et al.*, 2001). The areas of production of the two crops overlapped (Wrather *et al.*, 2001; Gupta, 2000). *H. glycines* has not been found in India, but past records of spread indicate that it likely will be in the future.

The host suitability of pigeon pea for *H. glycines* is uncertain. Riggs and Hamblen (1962) reported three unnamed pigeon pea genotypes to be immune to race 3 (R. D. Riggs, pers. comm., 2002) of *H. glycines.* Miller (1974) tested 12 *H. glycines* isolates from eight states on 'Norman' pigeon pea and found no reproduction by five isolates, low reproduction by 3 isolates, medium reproduction by two isolates, and high reproduction by two isolates. Hence, the potential impact of *H. glycines* on pigeon pea production in India, the Caribbean, and other parts of the world could be great, depending on specific population-cultivar interactions.

Increased information on the host suitability of pigeon pea for *H. glycines* is important for continued sustainable production of pigeon pea and to determine if alternate management practices may be required in the future. The objective of this research was to evaluate the host suitability of ten pigeon pea cvs. for the race-2 population of *H. glycines* present in Isabela, Puerto Rico.

MATERIALS AND METHODS

1998 Field Assays

Ten pigeon pea cvs. (I-8-3-2, PR-147, I-58-3, Blanco de Yauco, I-13, Cortada, Guerrero, II-56, I-8-3-1, and Kaki) were grown in a race-2 infested field soil (Smith and Chavarría-Carvajal, 1999) in Isabela, Puerto Rico in 1998. The soil was a "Coto" clay (Tropeptic Haplorthox; clayey, kaolinitic, isohyperthermic; 31% sand, 7.9% silt, and 61.1% clay).

Two field assays were conducted. In the first, plants were grown in 7.5-cm diam clay pots placed directly on the soil surface in the field. Four seeds of each of the ten cultivars were planted per pot on 21 April 1998 and thinned to one healthy plant after emergence. Each cv. was in one pot. In addition, four pots (replications) each were planted with soybeans 'Lee,' 'Franklin,' and 'Linford' for comparison purposes. Lee is susceptible to *H. glycines,* whereas Franklin and Linford are resistant to some races of *H. glycines* and susceptible to others. Franklin derives its resistance from 'Peking' (Bernard and Shannon, 1980), whereas Linford derives its resistance from 'PI 88788' (Bernard and Noel, 1991). On 26 May 1998, 35 days after planting, soil was gently washed from the roots of each plant and the females were counted on the roots of each plant without magnification.

The second field assay involved growing the ten pigeon pea cvs. directly in the field in 1 m plots. Each cv., replicated twice, was planted in rows 91 cm apart on 21 April 1998. Lee, Franklin, and Linford were planted in adjacent single-replicate plots of 15 cm for comparison. On 6 July 1998, 76 days after planting, roots of all plants were dug up and the number of females from each plot was counted on all applicable roots without using magnification. The number of plants per plot varied and, as the roots in each plot were intertwined, individual plant counts were not made.

1999 Greenhouse Assay

Heterodera glycines reproductive potential was determined in a greenhouse test as suggested by Schmitt and Shannon (1992), but with some modifications. Four seeds per pot were planted in crushed gravel (40.1% gravel, 32% coarse and medium sand, 27.9% fine sand, very fine sand, silt, and clay) in 250 cm^3 polystyrene foam pots with perforations in the bottom. After emergence, stands were thinned to one healthy plant per pot. The ten pigeon pea cvs. used in the field tests, along with the soybean cyst nematode differential genotypes ('Pickett,' Peking, 'PI 90763,' and PI 88788) and Lee soybean, were planted on 31 December 1998 in a greenhouse in Isabela, Puerto Rico. The pigeon pea pots were arranged in a randomized complete block design (RCBD) with six replications, whereas the soybean differentials were planted adjacent to the pigeon pea assay in a RCBD with four replications. Eggs and juveniles were extracted for infestation from mature white females harvested from the roots of Lee soybean grown in the race-2 infested Isabela soil. The potting medium was infested on 11 January 1999 by using a pipette to apply 4,000 eggs and juveniles just below the soil surface and near the roots of each plant. Approximately two 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 sprinkled lightly on the foliage. The mean maximum and minimum greenhouse temperatures for the duration of the experiment were approximately 33°C and 18°C, respectively. The plants were grown 30-32 days after infestation, after which each plant was processed as described by Schmitt and Shannon (1992). The crushed gravel was gently washed from the roots. Females were then dislodged from the roots using a high-pressure stream of water. Dislodged females were caught on a 250-µm pore sieve and then rinsed into a petri dish, where females were counted for each plant without magnification. Female indices (FI) were calculated for each genotype by dividing the mean number of females per genotype by the mean number of females on Lee and then multiplying by 100.

RESULTS

1998 Field Assays

A total of 64 and 16 cysts were found on four potted-plants and four field-dug plants, respectively, of Lee (Table 1). These counts represent single-plant averages of 16 and 4, respectively. The number of cysts on Lee per 100 cm^3 of soil in the potted assay was estimated to be four. Female counts on Linford and Franklin were lower

Table 1. Total number of females of *H. glycines* on ten pigeon pea and three soybean cultivars grown in an infested Coto clay soil in Isabela, Puerto Rico in 1998.

	Field-potted plants		Field-dug plants	
Genotype	no. females	no. plants	no. females	no. plants
Lee[x]	64	4	16	4
Franklin[x]	14	4	0	6
Linford[x]	25	4	1	5
I-8-3-2	—	—	3	45
PR-147	—	—	0	48
I-58-3	—	—	0	52
Blanco de Yauco	0	1	0	35
I-13	0	1	2	24
Cortada	1	1	0	36
Guerrero	—	—	0	58
II-56	3	1	1	61
I-8-3-1	0	1	0	31
Kaki	0	1	0	49

[x]Soybean. All other cultivars are pigeon pea.

than those on Lee (Table 1). No females were recovered from Franklin in the field-dug assay, whereas 14 were recovered in the potted assay. Females were recovered from Lee and Linford in both field assays. Soybean female counts in the pots were higher than those from field-dug plants.

In the potted-pigeon pea assay, one female was found on a root of Cortada and three were found on a root of II-56 (Table 1). No females were recovered from potted-plants of Blanco de Yauco, I-13, I-8-3-1, and Kaki, while no potted plants survived from I-8-3-2, PR-147, I-58-3, and Guerrero (Table 1).

In the field-dug pigeon pea assay, three females were found on roots from 45 plants of I-8-3-2 (Table 1). Two females were found on roots of 24 plants of I-13 and one female was found on the roots of 61 plants of II-56 (Table 1). No females were found on multiple plants of PR-147, I-58-3, Blanco de Yauco, Cortada, Guerrero, I-8-3-1, and Kaki.

Of the pigeon pea genotypes that had surviving plants in both trials, females were recovered only from II-56 in both trials. Only one female was recovered from Cortada in the potted trial, and none in the field-dug trial. I-13 had none in the potted trial and two in the field-dug trial. Blanco de Yauco, I-8-3-1, and Kaki had no females in either assay.

1999 Greenhouse Assay

The mean female count for Lee was 734.5 in the potted greenhouse assay (Table 2). The combined indices for the *H. glycines* differentials indicated that this was a race-2 population, as had been described previously (Smith and Chavarría-Carvajal,

Table 2. Mean number of females of *H. glycines* and female indices of ten pigeon pea and five soybean genotypes grown in crushed gravel in pots in a greenhouse in Isabela, Puerto Rico in 1999.

Genotype	Mean female count[y]	Index[z]
Lee[x]	734.5	100
Pickett[x]	593.0	80.7
Peking[x]	92.3	12.6
PI 90763[x]	2.0	0.3
PI 88788[x]	280.0	38.1
I-8-3-2	0	0
PR-147	0	0
I-58-3	0	0
Blanco de Yauco	0	0
I-13	0	0
Cortada	0	0
Guerrero	0	0
II-56	0	0
I-8-3-1	0	0
Kaki	0	0

[x]Soybean. All other genotypes are pigeon pea.
[y]Means of Lee, Pickett, Peking, and PI 90763 were based on four replications. The mean of PI 88788 was based on two replications. Means of all pigeon pea genotypes were based on six replications.
[z]The mean number of females for each genotype was divided by the mean number of females on Lee and then multiplied by 100.

1999). The high female counts on Lee and the *H. glycines*-susceptible differentials indicated the potential for high female counts on susceptible genotypes in this assay. Yet, no females were found on any pigeon pea genotype (Table 2).

DISCUSSION

At the time of the field assays, it was not known if *H. glycines* required more, less, or the same duration of time to complete a generation on pigeon pea as it did on soybean. Four to six weeks after infestation, Riggs and Hamblen (1962) recovered females from several soybean genotypes, but recovered none from three pigeon pea genotypes. Miller (1974) recovered females from Norman pigeon pea after growing for six weeks in infested soil. The field data from the current study indicate that *H. glycines* is capable of completing a generation in 35 days on pigeon pea, as it can on soybean.

Of the ten pigeon pea cvs. evaluated, only roots of I-8-3-2, I-13, Cortada, and II-56 supported any *H. glycines* reproduction. A very small number of females was found on these genotypes, but only in the field assays. I-13 and Cortada likely differed in their field assay results (Table 1) due to low and sporadic levels of natural infestation.

Although inoculum densities were substantially higher and more uniform for the greenhouse assays, no females were observed on any pigeon pea cv. in this assay. Obvious differences between the field and greenhouse assays were: differences in day length (field assays occurred in spring/summer, whereas the greenhouse assay occurred in winter; both with natural light), differences in root media (field assays used a Coto clay, whereas the greenhouse assay used crushed gravel), and differences in temperatures (the typical mean maximum/minimum temperatures for the field assays during that time of year would have been 30°/20°C, respectively (Goyal and Gonzalez, 1989), whereas the greenhouse mean maximum/minimum temperatures were 33°/18°C, respectively). In terms of the above three differences, photoperiod-sensitive soybean supported nematode reproduction under both photoperiods, in both root media, and under both temperature regimes. Hence, it is not clear why females were observed on some pigeon pea cvs. under low infestation density, while none were observed on pigeon pea under high infestation density. However, it was clear that susceptible soybean was a much better host than any pigeon pea cv. under all assay conditions employed in these experiments.

Although host suitability of pigeon pea may vary for *H. glycines* (Miller, 1974), data from the current experiment indicate that I-8-3-2, I-13, Cortada, and II-56 are highly resistant, and the other pigeon pea cvs. may be immune. Although additional studies are needed with other populations to verify these initial findings, the current data indicate that these pigeon pea cvs. will not suffer any yield loss due to *H. glycines* race 2 in Puerto Rico.

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