Eight Nonhost Weed Species of *Heterodera glycines* in Iowa

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ABSTRACT

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The ability of the soybean cyst nematode (*Heterodera glycines*) to reproduce on eight weed species commonly occurring in Iowa was evaluated in greenhouse and field microplot experiments. Population densities of the nematode increased on *H. glycines*-susceptible soybean but not on *H. glycines*-resistant soybean, Canada thistle, cocklebur, eastern black nightshade, giant foxtail, lambsquarters, redroot pigweed, velvetleaf, and wild sunflower. All of the weeds evaluated were nonhosts of this *H. glycines* race 3 population.

The soybean cyst nematode (*Heterodera glycines* Ichinohe) is a serious pest of soybean (*Glycine max* (L.) Merr.) in many soybean-producing areas of the world. Since the initial report of its presence in North Carolina by Winstead et al (18), *H. glycines* has spread to most soybean production regions of the United States (7). This nematode has recently been reported as the most damaging soybean pathogen in the north-central United States (3), can cause substantial losses in heavily infested fields (6,13), and is rapidly becoming a major factor limiting soybean production in Iowa.

H. glycines is managed by reducing population densities below a level that causes crop damage and by preventing or minimizing increases in population densities. Specific control measures include use of resistant soybean cultivars, crop rotation with nonhost plants, and nematicides. Alternate planting of resistant and susceptible soybean cultivars and nonhost crops is recommended for managing *H. glycines* in Iowa (17). Weeds serving as hosts for the nematode may negate the effects of management strategies. Thus, effective control of any weed hosts will be essential for optimal management of the nematode.

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The status of many common weeds as hosts for *H. glycines* has been documented by Epps and Chambers (4) in Tennessee, Riggs and Hamblen (9–11) in Arkansas, and Smart (14,15) in Virginia. Most of the weed species evaluated are commonly found in the southern and southeastern United States. The capacity of *H. glycines* to reproduce on weeds commonly found in the north-central region requires further investigation. Canada thistle (*Cirsium arvense* (L.) Scop.), cocklebur (*Xanthium strumarium* L.), eastern black nightshade (*Solanum ptycanthum* Dunal ex DC.), field bindweed (*Convolvulus arvensis* L.), lambsquarters (*Chenopodium album* L.), redroot pigweed (*Amaranthus retroflexus* L.), velvetleaf (*Abutilon theophrasti* Medic.), and wild sunflower (*Helianthus annuus* L.) are common weeds that are widely distributed in corn and soybean production fields throughout the Midwest (5,8). Cocklebur and lambsquarters were found to be nonhosts for *H. glycines* by Riggs and Hamblen (10). Only recently, lambsquarters and redroot pigweed were reported as nonhosts for *H. glycines* race 5 (16). The research described herein was conducted to assess the *H. glycines* host status of weed species commonly occurring in corn and soybean fields in Iowa.

MATERIALS AND METHODS

Eight weed species representing six different plant families were evaluated for host status to *H. glycines* in greenhouse and microplot experiments. Weeds selected were Canada thistle, cocklebur, eastern black nightshade, giant foxtail (*Setaria faberi* Herrm.), lambsquarters, redroot pigweed, velvetleaf, and wild sunflower. The soybean cultivars Corsoy 79 and Bell were selected to represent susceptible and resistant control treatments, respectively. A population of *H. glycines* race 3 was cultured in the greenhouse on Corsoy 79 soybean for inoculum. Mature cysts collected from greenhouse cultures by elutriation (2) were used to infest soil at a density of 15 cysts per 100 cm^3 of soil for greenhouse experiments and four cysts per 100 cm^3 of soil for the field microplot study.

Greenhouse experiments. Seeds of soybean and all weed species except Canada thistle were germinated in vermiculite. Young rootstocks of Canada thistle were collected from the field and transplanted into 20-cm-diameter plastic pots and subcultured thereafter as needed. *H. glycines* cyst inoculum was thoroughly incorporated into a sterilized sand:soil (3:1) mixture that was potted into 55 20-cm-diameter plastic pots. A single 7- to 14-day-old seedling of each weed species or soybean cultivar was transplanted into the center of each pot. The pots were maintained at 27 ± 2 C under natural light conditions with supplementary incandescent light providing a minimum day length of 14 hr. The plants were watered as needed and fertilized with 200 ml of soluble nutrient solution (Liquid Peters 20-10-20) at 2 and 4 wk after transplanting to maintain vigorous plant growth. Six 2.5-cm-diameter, 15-cm-deep soil cores were arbitrarily collected from each pot at 0, 15, 30, 45, and 60 days, and 100 cm^3 aliquants of soil were processed by elutriation (2) to recover cysts. Cysts were collected on a 60-mesh (250-μm pore) sieve and crushed with a motorized pestle to release the eggs (1). Eggs were subsequently recovered on a 500-mesh (25-μm pore) sieve and counted by direct microscopic observation with a dissecting microscope at 24× magnification. A reproductive factor (Rf) was calculated for each treatment by dividing final egg population density by initial density.

The experiment was established in a randomized complete block design with five replications per plant species plus five control pots that were left fallow. The experiment was repeated once.

Numbers of *H. glycines* eggs at each sampling date and Rf were analyzed by analysis of variance (ANOVA), and means were separated with Fisher's protected least significant difference (LSD) test ($P = 0.05$) (12).

Field microplot experiment. A field experiment was conducted in 1992 at the Iowa State University Hinds Research Farm in Ames to confirm results obtained in the greenhouse experiments. Prior to the initiation of the microplot experiment, sampling of the site revealed no detectable densities of *H. glycines*. Microplots were constructed of 75-cm-diameter, 91-cm-deep fiberglass cylinders, buried approximately 70 cm into the soil. Each microplot was artificially infested by manually incorporating a suspension of cysts approximately 46 cm deep into the soil. Following incorporation of inoculum, each microplot was planted with five 7- to 14-day-old seedlings of the weed species or soybean cultivars used in the greenhouse experiments. Canada thistle was not used in the field microplot experiment because of its perennial growth habit. Seedlings of the same weed species or soybean cultivar planted within each microplot were planted around the microplot as border plants to simulate field conditions. Fifty microplots were used; five replications were planted with each plant species and five microplots were left fallow. All treatments were arranged in a randomized complete block design. Volunteer weeds that germinated within the microplots were removed by hand periodically. All microplots were irrigated immediately after transplanting and then four times thereafter for the first month only.

Soil samples consisting of eight cores (2.5 cm in diameter, 20 cm deep) were collected arbitrarily from each microplot at 0, 2, and 4 wk after transplanting, then at intervals of 30 days throughout the growing season from 2 June to 30 October. *H. glycines* eggs were extracted from 100 cm^3 aliquants of soil from each soil sample by elutriation and counted, Rf values were calculated, and data were analyzed as described for the greenhouse experiments.

RESULTS

Greenhouse experiments. Nearly identical results were obtained from the two greenhouse studies; data presented are from the second greenhouse experiment. At the beginning of the experiment, egg densities ranged from 1,080 to 1,780 eggs per 100 cm^3 of soil (Table 1). Throughout the 60-day period, population densities of *H. glycines* eggs gradually decreased in all treatments except for the *H. glycines*-susceptible soybean treatment. Egg population densities for the *H. glycines*-susceptible soybean treatment increased at each sampling date after 30 days and reached a density of 8,005 eggs per 100 cm^3 at the end of the experiment, which was significantly greater than egg densities in the fallow, *H. glycines*-resistant soybean, and weed treatments, which averaged 518 eggs per 100 cm^3 of soil. There were no significant differences in *H. glycines* egg population densities at harvest among the weeds, *H. glycines*-resistant soybean, and fallow (Table 1). The Rf value for the susceptible soybean treatment was 5.7, significantly higher than those for all other treatments, which were 0.5 or lower.

Field microplot experiment. The overall average initial population density of *H. glycines* in the microplot soil was 280 eggs per 100 cm^3 of soil. Numbers of *H. glycines* eggs generally decreased for all treatments except for the *H. glycines*-susceptible soybean during the growing season, and population densities of the nematode were significantly greater in the *H. glycines*-susceptible soybean treatment relative to the other treatments beginning 30 days after planting and persisting through harvest (*data not shown*). No significant differences were detected in *H. glycines* egg population densities among fallow, *H. glycines*-resistant soybean, and weed treatments at the end of the season. The Rf value of 441.2 for *H. glycines*-susceptible soybean treatment was the highest; the fallow, *H. glycines*-resistant soybean, and weed treatments had Rf values of 1.0 or lower that did not differ significantly from each other.

Table 1. Effects of eight weed species, two soybean cultivars, and fallow on soil population densities and reproduction of *Heterodera glycines* race 3 in a greenhouse experiment

Treatment	Eggs/100 cm^3 soil[y]					
	Pi	Day 15	Day 30	Day 45	Pf	Rf
Fallow	1,780	1,460	1,510	905 ab	735 b	0.5 b
Soybean cv. Bell	1,620	1,580	990	375 c	455 b	0.3 b
Soybean cv. Corsoy 79	1,585	1,410	985	1,260 a	8,005 a	5.7 a
Canada thistle	1,690	1,085	965	705 bc	560 b	0.3 b
Cocklebur	1,615	1,610	970	465 c	460 b	0.3 b
Eastern black nightshade	1,600	1,160	725	510 c	500 b	0.3 b
Giant foxtail	1,430	1,275	895	650 bc	415 b	0.3 b
Lambsquarters	1,610	1,590	1,335	710 bc	580 b	0.4 b
Redroot pigweed	1,145	755	800	575 bc	565 b	0.5 b
Velvetleaf	1,080	1,075	1,060	545 bc	330 b	0.3 b
Wild sunflower	1,385	1,075	535	550 bc	575 b	0.4 b
ANOVA results[z]	NS	NS	NS	**	**	**

[y] Data are means of five replications per treatment. Column means followed by the same letter are not significantly different according to analysis of variance and Fisher's LSD ($P = 0.05$). Pi = initial *H. glycines* egg population density, Pf = *H. glycines* egg population density at 60 days, Rf = Pf/Pi.

[z] NS = not significant ($P > 0.05$), ** = significant at $P \leq 0.01$.

DISCUSSION

Our results indicate that Canada thistle, cocklebur, eastern black nightshade, giant foxtail, lambsquarters, redroot pigweed, velvetleaf, and wild sunflower are nonhosts of *H. glycines* race 3. These results confirm earlier reports that cocklebur, lambsquarters, and redroot pigweed are nonhosts for *H. glycines* (10,16). Although the eight weed species we evaluated were found to be nonhosts of *H. glycines*, other weeds commonly found in Iowa could support *H. glycines* reproduction. Only the most prevalent weeds in this region were tested in this study. Numerous weed species prevalent in other regions support *H. glycines* populations (4,9–11,14,15). Hence, growers must be aware of the potential for *H. glycines* reproduction on weeds and should implement aggressive weed management strategies as part of their overall crop management program.

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