Eight Nonhost Weed Species of Heterodera glycines in Iowa

A. T. S. Wong
G. L. Tylka
Iowa State University, gltylka@iastate.edu

Follow this and additional works at: http://lib.dr.iastate.edu/plantpath_pubs

Part of the Agricultural Science Commons, Agriculture Commons, Plant Breeding and Genetics Commons, Plant Pathology Commons, and the Weed Science Commons

The complete bibliographic information for this item can be found at http://lib.dr.iastate.edu/plantpath_pubs/175. For information on how to cite this item, please visit http://lib.dr.iastate.edu/howtocite.html.
Eight Nonhost Weed Species of *Heterodera glycines* in Iowa

A. T. S. WONG, Former Graduate Research Assistant, and G. L. TYLKA, Assistant Professor, Department of Plant Pathology, 351 Bessey Hall, Iowa State University, Ames 50011

**ABSTRACT**


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.

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 annus* 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 3 (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 supplemental 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$^3$ aliquots 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 24X 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.

---


---


Portion of an M.S. thesis submitted for fulfillment of graduate degree requirements.

Accepted for publication 23 December 1993.
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 cm³ aliquots 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 experiments; 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 cm³ 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 cm³ 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 cm³ 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 cm³ 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 than in *H. glycines*-resistant soybean, and weed treatments, which were 5.7, significantly higher than those for all other treatments, which were 0.5 or lower.

**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.

**ACKNOWLEDGMENTS**

We thank Charlie Block, Jim Gregory, Richard Pope, and Art Wagner for providing weed seeds, advice, and assistance on weed germination, and Jim Belyea, David Sib, and Ronald Walcott for technical assistance. This research was supported in part by state and Hatch funds and by a grant from the Iowa Soybean Promotion Board.

**LITERATURE CITED**

Identification of New Races of *Puccinia graminis* f. sp. *avenae*

D. E. HARDER, Agriculture Canada Research Station, 195 Dafoe Road, Winnipeg, Manitoba, R3T 2M9

**ABSTRACT**


Twenty-two new races of *Puccinia graminis* f. sp. *avenae* were identified from field collections made in Canada since 1985 or from 1,500 isolates held in storage since 1953 at the Agriculture Canada Research Station in Winnipeg. The stored isolates, previously identified by older differentials, were originally described. The new races are available upon request.

Additional keywords: oat stem rust, physiologic specialization

A revised nomenclature (NA) for races of *Puccinia graminis* Pers.:Pers. f. sp. *avenae* Eriks. & E. Hen. in North America was introduced in 1979 (9). Thirty races, using 10 backcrossed single-gene oat (*Avena sativa* L.) lines as differentials, were originally described. Martens (7) added 22 new races, bringing the number to 52 known NA races in North America.

Approximately 1,500 isolates of *P. g. avenae* have been stored at the Agriculture Canada Research Station in Winnipeg, beginning in 1953. These were obtained mainly from field and nursery collections from across Canada as well as greenhouse isolates. The greenhouse isolates had been labeled with coded designations, which in all cases could not be traced as to their origin. In most cases, they would have been derived as single-pustule isolates from field collections or from various greenhouse studies. Collections to 1963 were identified by race numbers based on the differential host set of Stakman et al (12) and continued by Bailey (1) and Newton and Johnston (11). The collections were identified as C-races beginning in 1965 (8) and as NA races after 1978 (9).

A project was initiated in 1988 to rejuvenate all isolates of *P. g. avenae* held in storage at Winnipeg and reidentify them using the NA nomenclature system (9). This paper reports new virulence combinations that were identified in this study and from more recent field collections in Canada.

**MATERIALS AND METHODS**

The collections of *P. g. avenae* were stored as urediniospores in vacuum-dried, sealed ampules at 5 C or as fresh urediniospores frozen at -75 C. The vacuum-dried samples were removed from storage, the vacuum seal was broken, and the urediniospores were allowed to rehydrate at room temperature for several hours. Frozen samples were heat-shocked in a water bath at 45 C for 10 min prior to inoculation. urediniospores were then applied with a sterile spattula to seedling leaves of a susceptible cultivar (Victory or Makuru) that had been moistened with water containing five drops per liter of Tween 20. After inoculation, the plants were incubated overnight at 18 C air temperature in a dew chamber (Percival Model I60-D), then placed on greenhouse benches with 6 hr per day of supplemental fluorescent lighting. Pots containing the seedlings were covered with a plastic chimney to prevent contamination. Where viability of the original collections was low, a second increase of inoculum on the susceptible hosts was performed as above. The genotypes used for race differentiation were backcross lines of *A. sativa* cv. Rodney-O with the single genes *Pgl*1, *Pgl*2, *Pgl*3, *Pgl*4, *Pgl*8, *Pgl*9, *Pgl*13, *Pgl*15, *Pgl*16, and *Pgf* for stem rust resistance. The PI and RL numbers of the differentials were listed by Martens et al (9). The differentials were planted as a set, six to eight plants per entry, in 20 X 24 X 6 cm fiber trays. Seedling leaves were inoculated by being brushed with the inoculum increase plants and then were incubated in a dew chamber as above. Infection types were scored 14 days after inoculation. All work was performed during the winter months when greenhouse temperatures remained below 22 C.

Virulence combinations that were not previously published (7,9) were given preliminary NA designations, reisolated, and verified by repeated tests. During the course of the study, some erratic reactions by the line with gene *Pg*4 were noted. A new source of seed with *Pg*4 was obtained from A. P. Roelfs (Cereal Rust Laboratory, St. Paul, MN) to ensure conformity with the differentials used there. All newly identified isolates were retested with this source of *Pg*4.

**RESULTS AND DISCUSSION**

Twenty-two new races, NA53 through NA74, were identified (Table 1). The geographic origin and year of first isolation are given in Table 1. The identity of the host genotype(s) from which the isolates were obtained in most cases was not known. Seven of the races reacted with mesothetic infection types on the gene *Pg*3 differential (Table 1). The effectiveness of gene *Pg*3 is environmentally sensitive (7), and lines with this gene could be interpreted as resistant or susceptible, depending on conditions prevailing at the time of identification. Thus, NA54 could possibly be identified as NA26, NA58 as NA55, NA59 as NA10, NA60 as NA8, NA62 as NA61, NA69 as NA11, and NA70 as NA56.

Race NA55 was identified several times in collections from Ontario in 1984 (3) but has not been observed since. Race NA55 is unique in its virulence to gene *Pgl*16. This resistance gene was isolated from an accession of the tetraploid species *A. barbata* Brot. (2), originally collected in Israel. Because gene *Pgl*16 has not been used in commercial production anywhere in North America, it presumably has not influenced North American populations of *P. g. avenae*. However, virulence to "new" resistance...