Host Specificity and Morphometrics of Four Populations of *Heterodera glycines* (Nematoda: Heteroderidae)[1]

C. N. KOLIOPANOS AND A. C. TRIANTAPHYLLOU[2]

Abstract: Four populations of *Heterodera glycines* from four different states differed considerably in numbers of adult females developed on five resistant soybean cultivars, mungbean and lespedeza. Differences were observed also in body, tail and tail terminus lengths of second-stage larvae. No attempt was made to assign these populations to recognized races, and it is suggested that race designations should be applied only to representative samples of field populations and not to selected greenhouse populations or isolates. *Key Words:* Variation, Races.

The soybean cyst nematode, *Heterodera glycines*, is known to occur in Japan, China, Korea, U. S. A., Egypt, and South Africa. Extensive testing of nematode populations of different geographic origin on a number of differential hosts has established that physiological variation exists within this species (1, 2, 4, 5, 6, 7, 8). A special committee in the U. S. A. recently proposed the term "race" to designate the physiological variants within the species, and recognized four races (No. 1 to 4) from the U. S. A. on the basis of their ability to produce cysts on four soybean varieties (3).

The present study attempts to determine the extent and nature of variation within *H. glycines* by comparing four selected populations of this species from the U. S. A. on the basis of host specificity and morphometrics of second-stage larvae.

MATERIALS AND METHODS

Four populations of *H. glycines* originating from Wilmington, North Carolina (N. C.); Holland, Virginia (Va.); Lonoke, Arkansas (Ark.); and Jackson, Tennessee (Tenn.) were propagated on soybean [*Glycine max* (L.) Merr.] cultivar 'Lee'. They were tested for their relative ability to develop on the soybean cultivars 'Lee', 'Peking', 'Pickett', 'Dyer', 'Custer', soybean Plant Introduction 88788 ('PI 88788'), on mungbean (*Phaseolus aureus* Roxb.) cultivar 'Oklahoma 12', and on lespedeza (*Lespedeza stipulacea* Maxim.) cultivar 'Yadkin'. The nematode populations and the host plants were selected on the basis of previous information indicating or predicting striking differences in behavior and morphometrics.

Seven-day-old soybean and mungbean seedlings and 20-day-old lespedeza seedlings grown in a greenhouse at 25 C in 7.5-cm plastic pots filled with fine quartz sand were inoculated each with 100 freshly hatched larvae. Additional fluorescent and incandescent light was provided to extend the light period to 12 hr, and Hoagland's nutrient solution was added twice a week. Seventeen days after inoculation the roots were washed free of sand, stained for 1 min in boiling acid-fuchsin lactophenol, destained for 2 days in clear lactophenol, and examined microscopically for nematodes of all stages of development.

For the morphometric studies 20 brown cysts from each nematode population de-

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[2] Department of Plant Pathology and Department of Genetics, respectively, North Carolina State University, Raleigh, North Carolina, 27607. Present address of senior author: Benaki Phytopathological Institute, Kiphissia—Athens, Greece.

TABLE 1. Development of four populations of *Heterodera glycines* on various host plants.

Plant species or cultivar	Nematode population[a]							
	N. C.		Va.		Ark.		Tenn.	
	Adults	Larvae	Adults	Larvae	Adults	Larvae	Adults	Larvae
Soybean								
'Lee'	48	7	38	4	39	3	47	4
'Peking'	7	34	18	30	2	20	3	38
'Pickett'	3	37	23	8	3	23	6	24
'Dyer'	2	35	26	11	3	21	11	24
'Custer'	5	20	13	17	6	25	4	27
'PI 88788'	23	10	15	9	18	15	34	5
Mungbean								
'Oklahoma 12'	15	8	25	3	41	2	62	3
Lespedeza								
'Yadkin'	3	....	38	5	9	6	7	1

[a] Average of five replicate plants, each inoculated with 100 second-stage larvae.

veloped on 'Lee' soybean were individually crushed and two larvae picked at random from each cyst were relaxed by heat in water and mounted in 0.5% formaldehyde on glass slides.

RESULTS

Most of the nematodes in the susceptible soybean 'Lee' reached maturity but, with a few exceptions (Table 1) remained in the larval stages in the resistant cultivars. Most larvae from resistant hosts could not be sexed. They were vacuolated, structurally deteriorated, and many appeared to be dead. All four populations developed relatively well on the soybean line 'PI 88788', but only the Va. population produced a substantial number of adults on 'Peking', 'Pickett', 'Dyer' and 'Custer' soybeans. Mungbean was the best host for the Tenn. population and lespedeza was a good host only for the Va. population.

Recovering larval stages and males from root tissues is a very tedious procedure, thus counting females and cysts is the only practical means of evaluating field populations of *H. glycines*. For this reason, data of the development of adult females are presented separately in Fig. 1. All populations developed a few females on 'Peking', but only the Va. population developed a substantially high number of females on 'Peking' compared to 'Lee'. The Va. population also developed significantly higher numbers of females on 'Pickett', 'Dyer' and 'Custer' soybeans and on lespedeza. 'PI 88788' soybean supported moderate development of females of all four populations, but considerably higher numbers of females of the Tenn. population. Mungbean supported development of a small number of females of the N. C. population and a very high number of females of the Tenn. population.

In a morphometric comparison, second-stage larvae of the Ark. population were significantly longer (466 μ) than larvae of the other three populations, which averaged 443 μ (Table 2). Larval tail length varied from 47.5 μ in the Va. population to 52.8 μ in the N. C. population, with the Ark. and Tenn. populations being intermediate. Tail terminus length differed significantly at the 5% level among the four populations, with the Va. population having

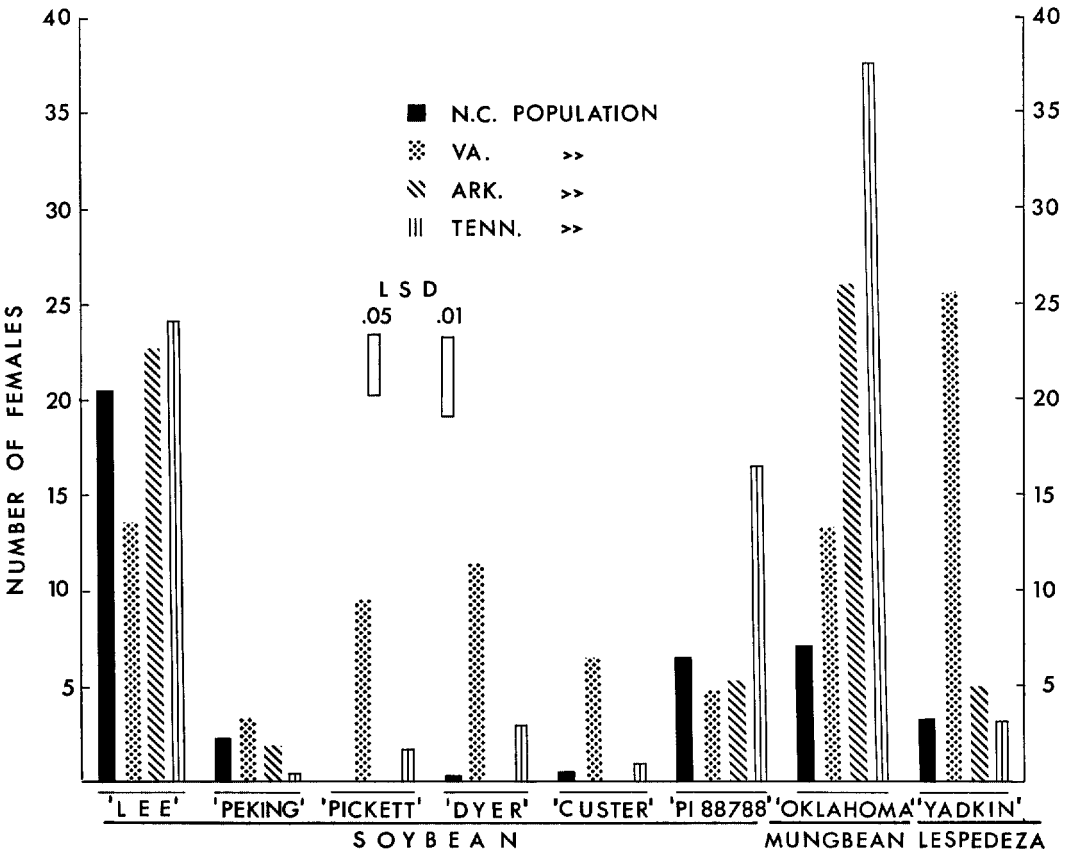

FIG. 1. Development of four populations of *Heterodera glycines* on various plant species or cultivars in greenhouse tests (means of five replicates).

the shortest and the N. C. the longest tail terminal.

DISCUSSION AND CONCLUSIONS

The various populations were differentiated from each other as follows: (i). The Va. population produced higher numbers of females on lespedeza and the resistant soybean cultivars 'Peking', 'Pickett', 'Dyer' and 'Custer' and the tail terminus length of its second-stage larvae was significantly shorter than that of all other populations; (ii). The Tenn. population produced a small number of females on 'Pickett' and higher numbers on 'PI 88788' and mungbean than any other population; (iii). The Ark. population did not develop on 'Pickett', 'Dyer' and 'Custer' but produced characteristically high numbers of females on mungbean. Larvae of this population were longer than those of all other populations; (iv). The N. C. population did not develop on 'Pickett' but, like the Tenn. population, produced a few females on 'Dyer' and 'Custer' soybeans. It also produced smaller numbers of females on mungbean than all other populations. Larvae of this population had greater tail length and tail terminus length than all other populations.

TABLE 2. Morphometric comparison of second-stage larvae of four populations of *Heterodera glycines*.[a]

Nematode population	Body length (μ)		Tail length (μ)		Tail terminus length (μ)	
	Range	Mean	Range	Mean	Range	Mean
N. C.	407–475	443	43–61	52.8	17.8–35.1	29.2
Va.	396–479	443	40–53	47.5	17.5–27.9	22.9
Ark.	435–530	466	45–56	50.4	24.0–35.2	27.8
Tenn.	410–483	443	42–57	48.4	19.9–31.1	25.8
LSD .05		8.2		1.4		1.2
.01		14.0		2.5		2.1

[a] Average of 40 measurements.

Some behavior differences were observed in these populations compared to previous reports. For example, adult females of the Tenn. population developed in greater numbers than those of the N. C. population on 'PI 88788' soybean, whereas, the reverse was true in previous tests with other populations of the same origin (6). Similarly, the N. C. population developed some females on 'Peking' but none on 'Pickett', whereas, it was previously found that the Wilmington, N. C. populations reproduce slightly better on 'Pickett' than on 'Peking', at least under field conditions. Such discrepancies in behavior can probably be attributed mainly to differences in the genetic constitutions of the particular populations tested, and in part, to the specific environmental conditions and the degree of accuracy of the tests.

The above basic differences observed among these four populations clearly confirm previous reports and observations indicating the extent of variation existing within this species. Assuming that differences in host specificity reflect inherent genetic differences, the data indicate that such differences are due to the presence or absence of certain genes in some populations and most often, to differences in gene frequencies. Since these populations were maintained under greenhouse conditions for more than 2 years prior to testing, they undoubtedly were adapted to these conditions. Therefore, the present gene frequencies do not represent exactly those of the original field populations and any attempt to assign these populations to recognized races of the nematode will not be justified. Race designations as recommended by the committee's report (3) should be applied to representative samples of field populations, before any artificial selection pressure has been exercised upon them.

The most important questions resulting from this study are: to what extent do differences in host specificity and morphometric characters represent truly genetic differences, and what is the role of the environment on the expression of these characters? An answer to these questions will provide information needed to assess the genetic status of the various recognized races and their stability or their response to environmental changes.

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