Population Characteristics of *Heterodera glycines* in Iowa

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ABSTRACT

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Four field populations and three populations of *Heterodera glycines* from single cysts were tested for ability to reproduce on six soybean differentials. The three populations from single cysts and one field population were classified as race 3. However, three field populations gave new patterns of response. After race identification of field population 2, cysts that developed on resistant cultivars were used to study changes in parasitism through selection on the resistant host from which they were obtained. The index of parasitism increased from 3.6 and 1.3 to 75.6 and 69.1 in two generations for larvae and eggs from cysts produced on resistant Pickett 71 and PI 88788, respectively. Four generations were required for larvae and eggs from cysts produced on resistant Peking and PI 90763 to increase their indexes of parasitism from 0.1 to 38.9 and 18.2, respectively. This study suggested that three groups of genes for parasitism on resistant cultivars are present in one field population and that the race status of the population may change in response to selection forces.

The potential impact of the soybean cyst nematode (*Heterodera glycines* Ichinohe) on soybean has long been recognized. Four races of the nematode are recognized by their ability to reproduce on three differential soybean *Glycine max* (L.) Merr. cultivars or breeding lines (2). Three groups of genes that condition parasitism by four races of the soybean cyst nematode have been analyzed (1,8). According to Triantaphyllou (8), race 1 has a high frequency of one group of genes that enables it to reproduce on PI 88788. Race 2 has a high frequency of two groups of genes for parasitism, one for PI 88788 and one for Pickett. Race 4 has three groups of genes for parasitism, one each for PI 88788, Pickett, and PI 90763. Race 3 has none of or so few of these genes for parasitism that it has an index of parasitism (IP) of <10 on any of the soybean differentials.

The objectives of the present study were to determine the race(s) of the soybean cyst nematode of four Iowa field populations, the race(s) of three populations from single cysts, and the potential for changes in the degree of parasitism through cyst selection on resistant hosts.

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MATERIALS AND METHODS

Cysts collected from four soybean fields (field populations 1, 2, 3, and 4) in Winnebago County, Iowa, were maintained and increased separately for one generation on Corsoy soybean. Cysts from each population were crushed by forcing them through an 80-mesh sieve, and the larvae and eggs obtained were used as inoculum. All experiments were done in the greenhouse with an ambient temperature of 25 ± 5 C. All plants were fertilized weekly with Hoagland Solution II.

Race identification of field populations. The ability of each population to develop viable cysts on one susceptible (Essex) and five differentially resistant (Peking, Pickett 71, PI 88788, PI 90763, and Bedford) soybean cultivars was determined. Each soybean differential was replicated 10 times for each population of soybean cyst nematodes. Each replication consisted of three germinated seeds planted in a 10-cm-diameter clay pot containing steam-sterilized sandy soil (86% sand, 11% silt, 3% clay, 2.5% organic matter, pH 7.0).

Twenty-five milliliters of water containing 2,000 second-stage larvae and 8,000 eggs was pipetted on the germinated seeds in each pot and covered lightly with soil. The soil and roots in each pot were processed 5 wk after inoculation. White females were collected on a 60-mesh sieve and counted.

The index of parasitism for each population was determined on each differential host. The index of parasitism (IP) is defined as the number of cysts that developed on a differential soybean cultivar, expressed as a percentage of the number developed on the susceptible cultivar Essex.

Race identification of populations from single cysts. Three single cysts were collected from field population 3 and increased four generations on Corsoy soybeans. Race identifications of the resulting population and of the field populations were conducted similarly except that five replications were used and the inoculum was 1,000 larvae and 4,000 eggs per pot.

Changes in parasitism. After race identification of population 2, larvae and eggs obtained from cysts produced on each differential host were used to determine their IP on the differential host from which they were obtained and on Essex.

There were three replications of each differential and susceptible host. Each experiment was repeated in the same manner, using the larvae and eggs obtained from cysts produced on the differential host to inoculate the same differential and Essex soybeans, until the IP was 10 or greater.

Table 1. Average number of cysts produced and index of parasitism of *Heterodera glycines* on six soybean differentials[a]

Nematode population	Soybean cultivar[b]						
	Pickett 71	Peking	PI 88788	PI 90763	Bedford	Essex	Race
Field							
1	126	1	137	7	355	2,595	
IP[c]	4.9	0.1	5.3	0.3	13.7		3 (?)
2	57	1	20	2	69	1,601	
IP	3.6	0.1	1.3	0.1	4.3		3
3	16	2	35	6	243	1,515	
IP	1.1	0.1	2.3	0.4	16		3 (?)
4	19	5	23	8	224	2,087	
IP	0.9	0.2	1.1	0.4	10.7		3 (?)
Single cyst							
1	13	0	5	1	26	1,021	
IP	1.3	0	0.5	0.1	3		3
2	9	1	6	0	18	925	
IP	1	0.1	0.7	0	2		3
3	10	0	21	0	36	709	
IP	1.4	0	3	0	5.1		3

[a] 2,000 larvae and 8,000 eggs were used for each field population replicate, and 1,000 larvae and 4,000 eggs were used for each single-cyst population replicate.
[b] Average number of cysts from 10 replicates for field populations and five replicates for single cysts, each replicate consisting of three plants per pot.
[c] IP = index of parasitism; the number of cysts developed on a differential cultivar expressed as a percentage of the number developed on the susceptible cultivar Essex.

RESULTS

Field population 2 and the three populations from single cysts from field population 3 had an IP < 10 on all differential hosts (Table 1). Therefore, these four populations can be classified as race 3. Field populations 1, 3, and 4 had an IP > 10 on Bedford, a cultivar resistant to races 1, 3, and 4 (3), and < 10 on Pickett 71, Peking, PI 88788, and PI 90763.

The degree of parasitism of *H. glycines*

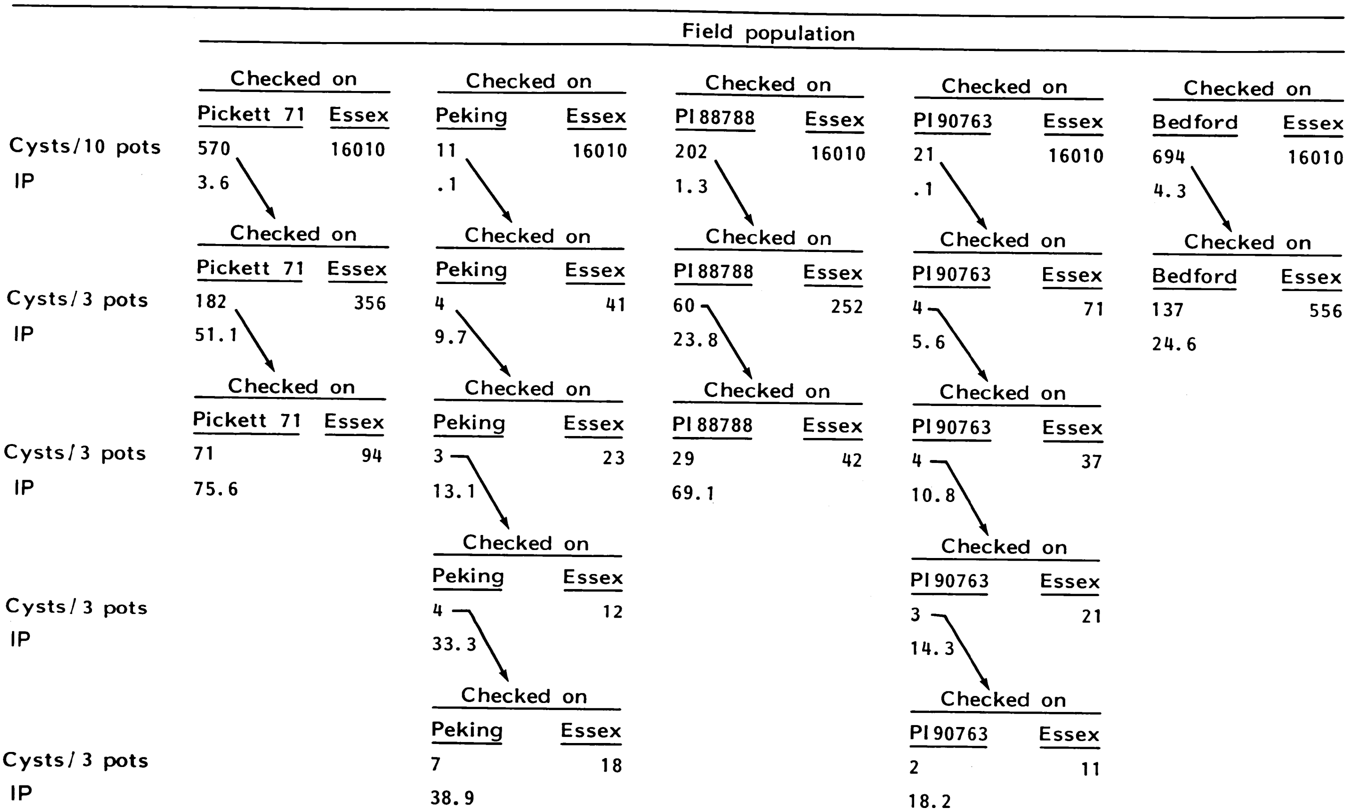

Fig. 1. Changes in the index of parasitism (IP) of field population 2 of *Heterodera glycines* through propagation on five resistant soybean cultivars. Arrows indicate the larvae and eggs obtained from cysts in a resistant cultivar used as inoculum for that cultivar and susceptible cultivar Essex.

populations from population 2 changed through selection on resistant hosts. The IP of larvae and eggs from cysts produced on Pickett 71 and PI 88788 increased from 3.6 and 1.3 to 75.6 and 69.1, respectively, in two generations (Fig. 1). The IP of larvae and eggs from cysts produced on Peking and PI 90763 increased from 0.1 to 38.9 and 18.2 in four generations.

DISCUSSION

Field populations 1, 3, and 4 showed a combination of responses to six soybean differentials that is not shown by any of the four recognized races of *H. glycines*. These populations exhibited an IP >10 on Bedford and <10 on Pickett 71, Peking, PI 88788, and PI 90763. Changes in parasitism of *H. glycines* in response to resistant cultivars under field and greenhouse conditions (4–8) and increases in degrees of parasitism of *H. glycines* race 1 through selection on resistant hosts have been reported (8). Although the numbers of cysts developed on resistant hosts were well below 10% of the susceptible Essex, the increase in IP through selection on resistant hosts indicates that the three groups of genes responsible for parasitism of *H. glycines* are present in Iowa field population 2.

Rapid changes in degree of parasitism of *H. glycines* populations through selection on resistant hosts and identification of several populations of this species with responses differing from the four previously known races tend to diminish the significance of the race concept of *H. glycines*. Any given resistant cultivar will react to a given population of *H. glycines*, not on the basis of the race of most of the individuals in that particular population, but on the basis of the type and frequency of genes for parasitism in that population (7,8). For example, cultivars with resistance genes similar to those of Peking and PI 90763 probably will hold their resistance to Iowa field population 2 longer than those with resistance genes similar to those of Pickett 71, PI 88788, and Bedford.

Changes in an IP are likely to be slower under field conditions than under controlled conditions where only host-selected cysts were used as sources of inoculum for the next generation. When a resistant cultivar is planted in an infested field, two important factors will act in favor of that cultivar. First, the numbers of host-selected cysts will be small and it will take time for them to increase to a level that can cause measurable damage; second, the males of previous generations with no genes for parasitism of resistant cultivars usually are capable of developing on resistant soybeans and mating with selected females (8). As a result, the selection pressure of resistant cultivars is minimized and the buildup of nematodes with genes for parasitism is rather slow. The use of the race concept in *H. glycines* will be useful only when it is based on the frequency of genes for parasitism in a population and allows prediction of the behavior of *H. glycines* against the major cultivars of soybeans.

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