

Data Sheets on Quarantine Pests

Heterodera glycines

IDENTITY

Name: *Heterodera glycines* Ichinohe

Taxonomic position: Nematoda: Tylenchida: Heteroderidae

Common names: Soybean cyst nematode (English)

Bayer computer code: HETDGL

EPPO A1 list: No. 167

HOSTS

Soyabean is the major economic host of *H. glycines*. Other cultivated hosts, mainly Fabaceae, are *Lespedeza* spp., *Lupinus albus*, *Penstemon* spp., *Phaseolus vulgaris*, *Vicia villosa*, *Vigna angularis* and *V. radiata*. Sugarbeet and tomatoes have been found to be experimental hosts (Miller, 1983). In general, *H. glycines* has a wide host range, mainly on weeds, of at least 23 families (e.g. Boraginaceae, Capparaceae, Caryophyllaceae, Chenopodiaceae, Brassicaceae, Lamiaceae, Fabaceae, Scrophulariaceae, Solanaceae). Typical weed hosts are *Cerastium holosteoides*, *Lamium amplexicaule* and *Stellaria media*. See Riggs & Hamblen (1962; 1966), Manuel *et al.* (1981), Riggs (1982).

GEOGRAPHICAL DISTRIBUTION

The first report of *H. glycines* was from Japan in 1916. Earlier observations date back to 1881. In 1938 the nematode was reported from Manchuria (then an independent state, now in China) and then from several other parts of Asia, including the Amur District in Russia. It was first detected in the USA in 1954 and subsequently found in many states (now 25) with the extension and intensification of soyabean cultivation. It is still a matter of debate whether *H. glycines* is indigenous to North America (Riggs, 1977; Norton, 1978; Noel, 1986).

EPPO region: Egypt, Russia (Amur District in the Far East only).

Asia: China (Hebei, Hubei, Heilongjiang, Henan, Jiangsu, Liaoning), Indonesia (Java only), Japan, Korea Democratic People's Republic, Korea Republic, Taiwan (unconfirmed), Russia (Far East).

Africa: Egypt.

North America: Canada (Ontario), USA (Alabama, Arkansas, Delaware, Florida, Georgia, Indiana, Illinois, Iowa, Kentucky, Louisiana, Maryland, Minnesota, Missouri, Mississippi, North Carolina, Ohio, Oklahoma, South Carolina, Tennessee, Texas, Virginia, Wisconsin; Burrows & Stone, 1985).

South America: Chile, Colombia, Ecuador. Unconfirmed reports from Argentina and Brazil (Goias, Minas Gerais, Matto Grosso do Sul, Matto Grosso).

EU: Absent.

BIOLOGY

H. glycines is a bisexual cyst-forming species. First-stage juveniles moult to second stage within the eggs and hatch under stimulation from exudates from host roots. They invade the root and begin feeding on a group of cells which become modified into a multinucleate syncytium. The female nematode remains at this feeding site as it develops through the vermiform juvenile stages into the swollen adult form. The swelling of the female disrupts the tissues of the host root and the body of the nematode finally protrudes from the surface. The males remain vermiform; they leave the root and are attracted towards the female, where copulation takes place. Eggs are formed within the female and some are laid into an egg sac or "gelatinous matrix". Males may sometimes be found in the gelatinous matrix. When the female dies the body becomes a hardened protective cyst enclosing the eggs.

In the field, there are three to five generations per year. Optimum development occurs at 23-28°C; development stops below 14°C and above 34°C (Riggs, 1982; Burrows & Stone, 1985). Survival of a small percentage of juveniles occurred after 6 months at -24°C (Slack & Hamblen, 1961). In the absence of a host, contents of cysts may remain viable in soil for 6-8 years (Slack *et al.*, 1972).

Riggs & Schmidt (1988) proposed a race system based on the reaction of four host differentials to attack by *H. glycines*. Sixteen such races can then be identified. Twelve are currently known from the USA and races 1, 3 and 5 are present in Japan (Ichinohe, 1988).

DETECTION AND IDENTIFICATION

Symptoms

Affected plants show stunting and discoloration (yellow dwarf disease). At low to moderate infestation levels, there is over-production of lateral roots. A low rate of nodulation may also be observed.

Morphology

H. glycines belongs to a group of many similar species of *Heterodera*, and thus identification can require considerable experience. For reliable identification, at least cysts and eggs containing juveniles are necessary. Characters of the vulval cone of the cyst and, in the second stage juvenile, the length of stylet, tail and hyaline tail terminus, must be measured. The shape of the juvenile stylet knobs is an additional character (Table 1). Detailed and illustrated keys to the species of *Heterodera* are given by Mulvey & Golden (1983), Wouts (1985) and Golden (1986). For measurements see Table 1 and Burrows & Stone (1985). Taylor (1975), Hesling (1978), Graney & Miller (1982) and Mulvey & Golden (1983) give comparative measurements of related species. It should be noted that measurements may vary with hosts and geographical isolate.

Table 1. Measurements of *Heterodera glycines* (after Taylor, 1975 and Graney & Miller, 1982)

		Mean	Average range
Cysts			
Fenestra	length (μm)	55	(30-70)
	width (μm)	42	(25-60)
Vulval slit	length (μm)	53	(43-60)
Juveniles			
Body	length (μm)	440	(375-540)
Stylet	length (μm)	23	(22-24)
	subventral knobs	posteriorly sloping	
Tail	length (μm)	50	(40-61)
	length/anal width = c'	3.4	
	hyaline part (μm)	27	(20-30)
	length/width of hyaline part (μm) = h'	3.0	

Detection and inspection methods

In the field, cysts may be seen with the naked eye on host roots 4-6 weeks after planting, if the infestation is heavy.

Cysts may be extracted from soil, substrates or packing materials after suitable preparation, using the Fenwick can, the Schuiling centrifuge or other suitable techniques. Young females, males and second-stage juveniles may be extracted from fresh soil by sugar flotation techniques, and the motile males and juveniles may be found with Baermann funnel techniques and their modifications.

Additional differentiation between species using biological tests on suitable host plants may be useful, but can take 6-8 weeks. Mitochondrial DNA hybridization probes have been constructed to distinguish *H. glycines* from similar cyst nematodes. The procedures may be modified for routine diagnosis (Besal *et al.*, 1988).

MEANS OF MOVEMENT AND DISPERSAL

By itself, the nematode is completely sedentary apart from a small amount of independent movement (at most, a few centimetres) by juveniles and males. The durability of the cyst, however, allows considerable passive transport. Cysts with viable juveniles have been recovered from excrement of birds (Epps, 1971). International transport is most likely to occur with soil or growing medium attached to plants or seeds; *H. glycines* was shown to be viable for up to 8 months in soil particles mixed in with seed stocks (Epps, 1969). Nematodes can also be readily carried in the roots of infected plants.

PEST SIGNIFICANCE

Economic impact

H. glycines is a major pest of soyabeans in Asia and the USA. In Japan, yield loss was estimated to be 10-75% (Inagaki, 1977; Ichinohe, 1988), whereas in the USA Riggs (1977) calculated a loss of 85 million USD from five states only. In North Carolina (USA), *H. glycines* is also a pest on *Phaseolus vulgaris*. In Japan, it interacts with the fungus

Phialophora gregata on *Vigna angularis*. When the nematodes are controlled, the fungus causes no damage (Ichinohe, 1988).

Control

The nematodes can be controlled by the use of soil-applied nematicides or, more effectively, by nematicides in combination with long crop rotation and the use of resistant and susceptible cultivars in a flexible integrated plant production system. New resistant cultivars are being sought, since populations of resistance-breaking pathotypes are developing in the field.

Phytosanitary risk

EPPO (OEPP/EPPO, 1989) lists *H. glycines* as an A1 quarantine pest; CPPC, IAPSC and NAPPO also consider it of quarantine significance. Based on the distribution of *H. glycines* in Asia and the Americas and its wide host range, it must be assumed that this nematode could survive in the warmer and temperate areas of the EPPO region. However, *H. glycines* would only establish itself and become a pest of economic importance where the principal host, soybeans, are widely cultivated in close rotations or monoculture.

Although soybean has not in the past been a significant crop in the EPPO region, in 1984 the EPPO member countries together produced about 2% of the world output of soybeans. Bulgaria, France, Hungary, Italy, Morocco, Spain, Yugoslavia and states of the former USSR are now soybean producers (FAO, 1985), and there is every prospect that production will increase. This makes it particularly important to exclude soybean pests not yet introduced into the region.

PHYTOSANITARY MEASURES

Imports of soil and rooted plants with soil from countries where this nematode occurs should be restricted (OEPP/EPPO, 1990).

BIBLIOGRAPHY

- Besal, E.A.; Powers, T.A.; Radice, A.D.; Sandal, L.J. (1988) A DNA hybridization probe for detection of soybean cyst nematode. *Phytopathology* **78**, 1136-1139.
- Burrows, P.R.; Stone, A.R. (1985) *Heterodera glycines*. *CIH Descriptions of Plant-Parasitic Nematodes* No. 118. CAB International, Wallingford, UK.
- Epps, J.M. (1969) Survival of the soybean cyst nematode in seed stocks. *Plant Disease Reporter* **53**, 403-405.
- Epps, J.M. (1971) Recovery of soybean cyst nematode *Heterodera glycines* from digestive tract of birds. *Journal of Nematology* **3**, 417-419.
- FAO (1985) *FAO production yearbook 1984*. FAO, Rome, Italy.
- Golden, A.M. (1986) Morphology and identification of cyst nematodes. In: *Cyst nematodes* (Ed. by Lamberti, F.; Taylor, C.E.), pp. 23-45. Plenum Press, New York, USA.
- Graney, L.S.O.; Miller, L.I. (1982) Comparative morphological studies of *Heterodera schachtii* and *H. glycines*. In: *Nematology in the Southern Region of the United States* (Ed. by Riggs, R.D.), pp. 96-107. Southern Cooperative Series Research Bulletin No. 276.
- Hesling, J.J. (1978) Cyst nematodes: morphology and identification of *Heterodera*, *Globodera* and *Punctodera*. In: *Plant nematology* (Ed. by Southey, J.F.), pp. 125-155. HMSO, London, UK.
- Ichinohe, M. (1988) Current research on the major nematode problems in Japan. *Journal of Nematology* **20**, 184-190.
- Inagaki, H. (1977) Soybean nematodes. *Technical Bulletin*, ASPAC Food & Fertilizer Technology Center, Taiwan No. 31, 17 pp.
- Manuel, J.S.; Bendixen, L.E.; Riedel, R.M. (1981) Weed hosts of *Heterodera glycines*: the soybean cyst nematode. *Ohio Agricultural Research and Development Center Research Bulletin* No. 1138.

- Miller, L.I. (1983) Diversity of selected taxa of *Globodera* and *Heterodera* and their interspecific hybrids. In: *Concepts in nematode systematics* (Ed. by Stone, A.R.; Platt, H.M.; Khalil, L.F.), pp. 207-220. Academic Press, London, UK.
- Mulvey, R.H.; Golden, A.M. (1983) An illustrated key to the cyst-forming genera and species of Heteroderidae in the Western Hemisphere with species morphometrics and distribution. *Journal of Nematology* **15**, 1-59.
- Noel, G.R. (1986) The soybean cyst nematode. In: *Cyst nematodes* (Ed. by Lamberti, F.; Taylor, C.E.), pp. 257-268. Plenum Press, New York, USA.
- Norton, D.C. (1978) *Ecology of plant-parasitic nematodes*. Wiley, New York, Etats-Unis.
- OEPP/EPPO (1989) Fiches informatives sur les organismes de quarantaine No. 167, *Heterodera glycines*. *Bulletin OEPP/EPPO Bulletin* **19**, 683-688.
- OEPP/EPPO (1990) Exigences spécifiques de quarantaine. *Document technique de l'OEPP n° 1008*.
- Riggs, R.D. (1977) Worldwide distribution of soybean cyst nematode and its economic importance. *Journal of Nematology* **9**, 34-39.
- Riggs, R.D. (1982) Cyst nematodes in the Southern USA. In: *Nematology in the Southern Region of the United States* (Ed. by Riggs, R.D.), pp. 77-95. *Cooperative Series Research Bulletin* No. 276.
- Riggs, R.D.; Hamblen, M.L. (1962) Soybean cyst nematode host studies in the family Fabaceae. *Arkansas Agricultural Experiment Station Report Series* No. 110.
- Riggs, R.D.; Hamblen, M.L. (1966) Further studies on the host range of the soybean cyst nematode. *Arkansas Agricultural Experiment Station Report Series* No. 118.
- Riggs, R.D.; Schmitt, D.P. (1988) Complete characterization of the race scheme of *Heterodera glycines*. *Journal of Nematology* **20**, 392-395.
- Slack, D.A.; Hamblen, M.L. (1961) The effect of various factors on larvae emergence from cysts of *Heterodera glycines*. *Phytopathology* **51**, 350-355.
- Slack, D.A.; Riggs, R.D.; Hamblen, M.L. (1972) The effect of various factors and moisture on the survival of *Heterodera glycines* in the absence of a host. *Journal of Nematology* **4**, 263-266.
- Taylor, A.L. (1975) Identification of soybean cyst nematodes for regulatory purposes. *Proceedings, Soil and Crop Science Society of Florida* **34**, 200-206.
- Wouts, W.M. (1985) Phylogenetic classification of the family Heteroderidae. *Systematic Parasitology* **7**, 295-328.