Sugarbeet Cyst Nematode Not Detected in the Red River Valley of Minnesota and North Dakota

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ABSTRACT

A survey was conducted in 2001 to determine if sugarbeet cyst nematode (*Heterodera schachtii* Schmidt) and soybean cyst nematode (*Heterodera glycines* Ichinohe) were present in the Red River Valley of Minnesota and North Dakota. A total of 303 soil samples were collected from 101 locations in nine Minnesota counties and six North Dakota counties. Samples were processed for cyst nematode eggs and second-stage juveniles. No sugarbeet cyst nematode or soybean cyst nematode was detected in samples. A species of *Cactodera*, however, was found in a sample collected in Clay County, MN. The nematode completed its life cycle in sugarbeet, but reproduction was poor. Attempts to determine its host range and to increase populations for further identification and description were unsuccessful. Since the populations did not increase on sugarbeet, the *Cactodera* population probably has no or little pathogenicity to sugarbeet.

Sugarbeet cyst nematode (*Heterodera schachtii* Schmidt) has been a major problem for more than 150 years in many sugarbeet (*Beta vulgaris* L.)-growing regions, especially in Europe when grown in short rotation (Muller, 1999). Sugarbeet is a major cash crop grown in the Red River Valley (RRV) in Minnesota and North Dakota. *Heterodera schachtii* was confirmed in sugarbeet fields in 1976 in Manitoba, Canada in the RRV, and by 1988 this nematode had infested most sugarbeet-growing areas in Manitoba (Nyegaard and Holen, 1990). In a survey conducted in 1988 the nematode was not detected in the southern region of the RRV (Nyegaard and Holen, 1990).

In recent years, hectarage of canola (*Brassica napus* L.), a host of *H. schachtii*, has increased in the southern region of the RRV (USDA

NASS, 2003). Even though the presence of *H. schachtii* has not been confirmed in Minnesota or North Dakota and sugarbeet production no longer occurs in the RRV in Canada, canola is not recommended for the sugarbeet rotation in the region, primarily because of its susceptibility to *H. schachtii* (Baltensperger *et al.*, 2000). Because of the increased production of canola, some sugarbeet and canola growers are concerned about presence of this nematode in sugarbeet fields in Minnesota and North Dakota.

Soybean [*Glycine max* (L.) Merr.] production has also increased in the southern region of the RRV (USDA NASS, 2003). While not a host to *H. schachtii*, soybean is a host to the soybean cyst nematode (*Heterodera glycines* Ichinihe). The soybean cyst nematode was first documented in Minnesota in 1978 (MacDonald *et al.*, 1980), and has since spread from southern Minnesota northward as soybean cropping frequency and acreage increased (Chen *et al.*, 2001). The soybean cyst nematode was detected in North Dakota in 2003 (Bradley *et al.*, 2004) and Ottertail County in the RRV in Minnesota in 2004 (S. Chen, unpublished).

The soybean cyst nematode and the sugarbeet cyst nematode have similar morphology and life cycles (Burrows and Stone, 1985; Franklin, 1972). Developmental stages of both nematodes include the egg, four juvenile stages, and adult female and male. The second-stage juvenile (J2) hatches from the egg, and acts as the infective stage by penetrating plant roots. After penetrating the root, the nematode establishes a feeding site in the host plant vascular tissue where it becomes sedentary, enlarges to become sausage-shaped, and molts three times before becoming an adult. The adult female is lemon-shaped and, when fully developed, is visible without magnification on the root surface. The adult male undergoes a metamorphosis during the last molt to become a slender, motile worm. The male stops feeding, exits the root and mates with females. Reproduction of both species is amphimictic.

The objective of this research was to survey soil from representative sugarbeet, canola and soybean production fields in the RRV of Minnesota and North Dakota for the presence of sugarbeet and soybean cyst nematodes.

MATERIALS AND METHODS

Soil samples were collected in May, June, and July 2001 from sugarbeet and canola fields and from sugarbeet piling stations in the region of the RRV south of the Canadian border. The production fields sampled were identified by sugarbeet and canola producers in conjunction with sugarbeet company representatives and the researchers.

Some sampled fields had areas of poor sugarbeet growth, possibly due to the presence of the sugarbeet cyst nematode. In addition, some sampled fields were from sites where tare soil had been spread. Tare soil, a combination of dislodged plant parts and soil adhering to harvested sugarbeet roots, is dislodged when roots are mechanically piled at a receiving (piling) station. This waste material is returned to the producer before leaving the piling station; it typically contains tare soil remnants of previous loads of sugarbeet roots delivered by other producers. All locations sampled were identified by area in the field, section, township and county, as well as by a grower/cooperator. A total of 303 soil samples were obtained from 101 locations (Table 1), with three soil samples obtained at each location. When the sample location was a production field, each soil sample analyzed was a composite of 20 soil cores collected from a radius of approximately 8 m, or area of approximately 200 m^2. These soil cores were 2.0 cm in diameter and taken to a depth of 20 cm.

Of the 101 locations, 22 were from sugarbeet piling stations (Table 1). Of the remaining 79 location, 63 had a history of sugarbeets sown within the previous 10 years, and 31 had a history of canola sown within the previous 10 years. Seventeen locations had a history of both sugarbeet and canola production within the previous 10 years. Forty locations had a history of receiving tare soils. Forty-nine locations included soybean in the rotation in the previous 10 years (Table 1).

Soil samples were stored at 4^{o}C and processed within 2 months. To determine the presence of *H. schachtii*, each soil sample was thoroughly mixed, and a subsample of 100 cm^3 of soil was processed using a hand-decanting method. The soil was placed in a 1-liter beaker containing 500 ml of water for at least 30 minutes and stirred with a spoon, if necessary, to break soil aggregates. The soil suspension was washed into a 2-liter bucket and after a few seconds, was poured through an 850-µm-aperture sieve "nested" on a 250-µm-aperture sieve. The bucket was refilled with a strong jet of water and the suspension was poured on the sieves. This procedure was repeated at least three times for each soil sample. Equipment was thoroughly washed to avoid any cross contamination among samples. Cysts, debris, and soil particles on the 250-µm-aperture sieve were collected, and cysts were separated by centrifugation in 76% (w/v) sucrose solution at 1,500g. Eggs were released from the cysts by breaking the cysts in a 40-ml glass tissue grinder by pushing the pestle straight to the bottom of the mortar (Fisher Scientific, Pittsburgh, PA). The egg suspension was poured through a 70-µm-aperture sieve nested onto a 25-µm-sieve. This grinding process was repeated until all materials in the mortar passed through the space between the pestle and mortar. Eggs were washed from the bottom sieve

Table 1. Locations where soil samples were collected in 2001 for cyst nematode determination. Emphasis in selecting field locations was based primarily on previous sugarbeet and canola cropping history.

			Cropping history†				
State	County	Locations samples‡	Sugar-beet	Canola	Soybean	Tare soil	Piling station§
MN	Clay	3	2	0	2	1	1
	Kittson	17	11	14	6	3	1
	Marshall	11	6	3	6	6	3
	Polk	10	7	3	7	7	3
	Norman	5	2	0	2	1	3
	Pennington	1	0	1	0	0	0
	Red Lake	3	2	1	2	0	0
	Wilkin	9	6	0	6	2	3
	Traverse	2	2	0	2	0	0
ND	Pembina	10	4	5	2	3	3
	Grand Forks	10	8	1	4	9	0
	Walsh	9	6	1	1	4	3
	Trail	3	2	0	2	2	1
	Cass	2	1	1	2	1	0
	Richland	6	4	1	5	1	1
Total		101	63	31	49	40	22

† Number of fields where sugarbeet, canola, or soybean was grown, or where tare soil was applied, within the previous 10 years.
‡ Three soil samples were taken from each of the 101 locations: 22 were piling stations and 79 were fields.
§ Soil samples obtained directly from sugarbeet piling stations.

and counted from an aliquot of 1 to 10 cm^3 out of 50 cm^3 of egg suspension. Another subsample of 50 cm^3 soil from each sample was processed to collect J2 of the cyst nematodes using a sugar-flotation and centrifugation technique (Jenkins, 1964) and number of J2 were counted.

When nematode eggs or J2 were found, the nematode was identified based on morphology of various developmental stages (*e.g.*, Baldwin and Mundo-Ocampo, 1991; Mulvey and Golden, 1983; Wouts and Baldwin, 1998). To determine host range, bioassays were conducted by growing plants in the soil in clay pots that were maintained at 20-30^{o}C in the greenhouse. Crops commonly grown in the RRV and other potential hosts (see Results Section) were included. The roots were examined for females (cysts) developed on the roots five weeks or longer after planting (see Results Section).

RESULTS AND DISCUSSION

No sugarbeet cyst nematode or soybean cyst nematode was detected in the 303 soil samples analyzed. At one location in Clay County, MN, however, a sample originally collected from a sugarbeet field had a high nematode egg count (4,075 eggs/100 cm^3 soil). Based on the cysts and juveniles from the soil, the nematode was identified as *Cactodera*. The soil was first bioassayed with sugarbeet and soybean by growing each of them in the soil in 15-cm-diameter pots. The roots were examined for females five weeks after planting. While no female was observed on soybean, approximately 20 white females were observed on the roots of five sugarbeet plants, and the nematodes produced 0 to approximately 30 eggs per female. However, no female was observed again on the roots of sugarbeet, which were subsequently grown in the soil for a year and sampled periodically. The bioassay suggests sugarbeet is a poor host of the nematode. The soil in the soybean pot was used for further bioassay of other crops as potential hosts, including canola, wheat (*Triticum aestivum* L.), barley (*Hordeum vulgare* L.), corn (*Zea mays* L), sorghum (*Sorghum bicolor* L.), and rye (*Solanum melongena* L.), which are common crops in the RRV, as well as eggplant (*Solanum melongena* L.), tomato (*Solanum lycopersicum* L. var. *lycopersicum*), and cactus (scientific species name not determined), which have been reported as hosts of some *Cactodera* species. The plants were grown in 10-cm clay pots at different times and the roots were examined one to two months after planting. No mature females were observed on any of these crops. Further examination of the morphology based on the cysts from the soil and the nematodes developed from the sugarbeet roots demonstrated that the nematode did not fit any reported species and was

probably a new species. Further attempts to recover this nematode from the same field, however, were negative. Since the host of the nematode is unknown, attempts to increase the population on plant species were unsuccessful, and further description of the species was not possible.

This survey targeted land with a high potential for the presence of the sugarbeet cyst nematode. Results from this survey suggest that the sugarbeet nematode, *H. schachtii*, is not currently present in the areas sampled in the RRV in North Dakota and Minnesota. However, possibility of the presence of the nematode in the RRV cannot be ruled out due to the limited number of samples examined and the large geographic area. It is necessary to continue monitoring any potential infestation on the nematode in the region.

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