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SUGAR BEET NEMATODE

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The sugar beet nematode, *Heterodera schachtii* is a major parasite of sugar beets. It causes serious stand and yield reductions wherever sugar beets are grown. It was first identified in 1859 on sugar beets near Halle, Germany, and was first observed in the United States as early as 1895. Today, *H. schachtii* is present in 17 states in the U. S., including Wyoming, and in 39 other sugar beet-growing countries throughout the world.

SYMPTOMS

Entire fields may be infested, or they may have one or more localized areas of infestation. Localized infestations may result in well-defined circular or oval areas where plant stands and growth are poor (Figure 1). Over time these areas usually become enlarged and spread out. *H. schachtii* can parasitize roots of plants of all ages. Seedlings may be severely injured or killed,

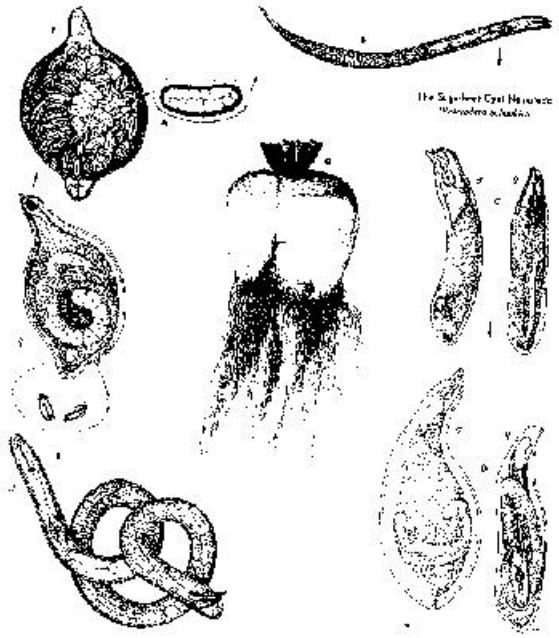
Figure 1. Sugar beet field with localized areas of poor growth, infested with Heterodera schachtii.

resulting in poor stands. However, the older the plant when attacked, the less damage will occur. Young plants attacked by *H. schachtii* may have elongated

Figure 2. Sugar beet plants parasitized by Heterodera schachtii. Note severe stunting and yellowing of diseased plants.

petioles and remain stunted until harvest. When infected, outer leaves of plants usually wilt during the hot period of the day or when soil moistur becomes limited. Leaves of parasitized plants also may have pronounced yellowing (Figure 2). Affected plants have small storage roots (Fig. 3) that are severely branched with excess fibrous roots often referred to as "bearded" or 'whiskered.' When older plants are attacked, symptoms are less noticeable.

Figure 3. Reduction in size of storage root of sugar beet due to heavy parasitism by Heterodera schachtii.



LIFE CYCLE

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H. schachtii is a parasitic roundworm. Its life cycle is shown in Figure 4 (A-F). Eggs and juveniles remain dormant and survive inside the cyst (F), which is the body of the dead female. When the root of a host plant contacts or grows near the cyst, and soil moisture is sufficient, root exudates stimulate juveniles to hatch and emerge from the cyst (A & B). Juveniles are attracted and migrate to the fibrous roots, infecting near the root tips (G). After entering the root, they migrate a short distance within the root cortex and begin developing into adults that become sedentary (C & D). After three additional molts, adult males emerge from the root (E) and enter the soil. After a fourth molt. the females become lemon-shaped (E) and can be seen as small white-yellow dots attached to fibrous roots (G). Males are attracted to the females where fertilization occurs. An average of 200 eggs are produced by one female, a few of which are laid outside the body in the soil. However, the majority of the eggs remain inside the female (F). At maturity, the female dies, and her body wall hardens and is transformed into a light brown to reddish brown cyst, completing the cycle. Cysts are barely visible to the naked eye. The cycle requires four to six weeks, depending on soil temperature. H. *schachtii* reproduces best between 70-80 degrees Fahrenheit but can reproduce between 50-90 degrees Fahrenheit. Three cycles have been reported to occur during the growing season in western Nebraska.

SURVIVAL IN SOIL

Cysts, containing eggs and/or hatched juveniles, may remain viable in irrigated fields for several years (Figure 5). Annual rate of decline of cysts in soil during rotation is estimated at 40-60 percent. Cysts may survive even

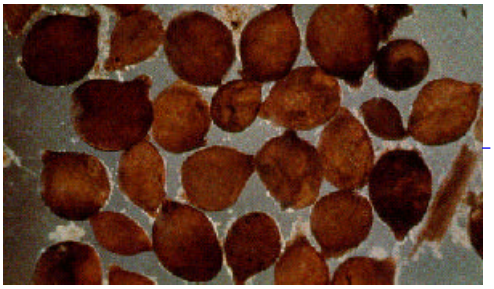

Figure 5. Cysts of Heterodera schachtii removed from sugar beet fields as seen under a microscope (35 magnifications).

longer in fallowed soil. Factors affecting survival or rate of decline include soil temperature, soil moisture, susceptibility of plants (including cultivated crops and weeds), soil type, and number of predators and parasites present. High soil populations of *H. schachtii have* been found in sugar beet fields in the sandy loam soils of Goshen County (134 eggs/cubic centimeter (cc) or 2,196/inch3 of soil), as well as in the heavier clay loam soils of Washakie County (200 eggs/cc or 3,277/inch3 of soil). Similar high populations occur in many areas of Nebraska supporting long-term sugar beet production.

HOST RANGE

Although in Wyoming *H. schachtii* presently causes economic losses only in sugar beets, it can attack over 200 plant species in 23 different plant families. Most hosts are found in the *Chenopodiaceae* family and the *Cruciferae* family. In addition to sugar beets, other host crops include turnip, kale, radish, spinach, broccoli, cabbage, cauliflower, tomatoes, brussels sprouts, table beets, kohlrabi, rhubarb, and other closely related crops. Crops that are host to *H. schachtii* should be avoided in fields where sugar beets are grown. Weed hosts include mustard, pigweed, lambsquarter, shepherdspurse, purslane, and other closely related weeds. Good weed control is crucial during rotation if minimum reduction of soil population of *H. schachtii* is to be obtained.

DISTRIBUTION AND SPREAD

Cysts can be found in the soil profile from the surface down to 24 inches. The greatest concentration is usually found in the root zone (2-10 inches). Spread of cysts may occur in many ways. Long-distance spread has most likely been from cysts in soil peds in unclean seed. Other means of spreading soil such as on machinery or animal hooves, can also result in the spread of *H. schachtii.* Short-distance spread occurs through irrigation water. 'This can occur throughout the canal system, as well as in surface water within a given field. Other means of spread include wind-blown soil and cysts, and cysts in feces of birds and other animals. Many of the cysts attached to roots are shaken off (with attached "tare' soil) during unloading at beet dumps. Therefore, tare soil from infested fields may have a high number of egg- filled cysts.

DAMAGE

Initial soil population density of approximately three eggs (range of two to four) and/or juveniles in 1 cubic centimeter of soil (49/cubic inch) may result in yield loss. The amount of damage is determined largely by the level of parasitism and the length of favorable environmental conditions. Damage to plants is greatest in a dry summer, when plants are stressed, following a wet spring, which is conducive to nematode infection. High soil populations of *H. schachtii* will eventually result in uneconomic production of sugar beets.

CONTROL

Sanitation - Tare soil should be used as fill in washes, barrow pits, etc., on the farm or taken to a sanitary landfill. Dumping tare soil into cultivated fields should be avoided because this can result in "hot spots" for the cyst nematode (Figure 4) and other sugar beet pathogens and pests for several years.

Rotation with non-host crops - The most effective method of control is the rotation out of sugar

beets with a non-host crop. In Wyoming, non-host crops include wheat, barley, corn, beans, and alfalfa. However, weed hosts must be controlled during the rotation. The number of years of rotation out of sugar beets to reduce the soil population of *H. schachtii* below a damaging level will depend on the initial density of cysts in the soil. Once the population density has been determined, the number of years a non-host crop must be grown to reduce the population below the two to four eggs or juveniles per cubic centimeter of dry soil can be estimated using the 40-60 percent estimated annual decline rate. However, the actual nematode soil population in a given field must be determined by a laboratory analysis. On the average, the economic threshold level in western Nebraska is 2.8 eggs or juveniles/cc or soil. The higher the sugar price and yield, as well as the lower the cost of control, the lower the economic threshold level will be. A rotation of three to five years is usually required.

Early planting - Planting early when soil temperatures are relatively cool (below 60 degrees Fahrenheit) greatly reduces damage from *H. schachtii.* Plants can better tolerate attack by *H. schachtii* at a later age. The younger the plant is when parasitism occurs, the greater the damage and loss will be. However, when seeding early, seed should be treated with one or more fungicides to protect seedlings from damping-off fungi.

Nematicides - Nematicides are commonly used to control *H. schachtii*, particularly in short rotations and when the cyst population is above the damage threshold level prior to planting sugar beets. Several nematicides and insecticide/nematicides are labeled for the control of *H. schachtii* on sugar beets. Nematicides that have proven effective in tests conducted in western Nebraska are given in Table 1.

In Wyoming, Temik is the most widely used chemical, partly because of its dual activity on both nematodes and insects. Temik, applied at the recommended rate of 27 lb/acre, inhibits the hatching of juveniles and disorients juveniles and adult males in the soil. When taken up by the plant, Temik becomes systemic and inhibits the development of *H. schachtii* after penetration into the sugar beet root. Temik is applied in a band at planting and incorporated into the soil. The label also allows an at-planting plus a post-plant sidedressing application. Counter is registered for suppression of the sugar beet nematode and is useful for low to moderate nematode populations.

Soil fumigants such as Telone II must be applied in either the fall or pre-plant during the early spring. Effectiveness of fumigants depends on the depth of application, soil temperature and moisture, soil type, compaction, and organic matter content. Telone II can be applied by chisel or moleboard plow. It is extremely important to seal the soil surface with presswheels following moleboard plow applicators. Fumigants are usually more effective, but are also more expensive than granular materials such as Temik and Counter when applied at recommended rates.

Trap crops - Several cultivars of "trap crops" (oil radish and yellow mustard) have been developed in Germany to control the sugar beet nematode. Cultivars of oil radish include "Pegletta," "Nemex,' and 'Adigio," and the white mustard "Maxi." Trap crops are planted in late summer or early fall following harvest of a rotation crop. In western Nebraska field tests, the best Toot growth of trap crops occurs from plantings made between June 1 and August 15. Roots of the trap crop mimic those of sugar beets or other host crops by stimulating cysts to hatch and attracting juveniles to the roots. After penetration, however, juveniles fail to develop into adults and reproduction does not occur. Trap crops, when used in conjunction with a non-host rotation crop, further lower the soil population of *H. schachtii* and reduce the need for nematicide in the following sugar beet crop.

Table 1. Nematicides and recommended rates for control of the sugar beet nematode.

Nematicide	Per Acre	Rate Per 1000 ft row
Telone II Soil Fumigant	12-15 gal	__
Temik 15G	27 lb	20 oz
Counter 15G (for suppression of moderate populations)	No more than 29 lb	18 oz
Counter 20G (for suppression of moderate populations)	No more than 19.6 lb	12 oz

The economics of using trap crops in existing cropping systems are currently being studied in sugar beet-growing areas of Wyoming. Tests are also being conducted in western Nebraska to determine optimum planting dates and effects on soil nematode population levels. Use of trap crops in controlling the sugar-beet nematode has proven promising in Idaho research, and similar results are anticipated in Nebraska and Wyoming. However, seed is not yet commercially available in the US.

Resistant sugar beet cultivars - Although research is being conducted toward the development of resistant cultivars, none are currently available.

Integrated control - A combination of disposal or proper handling of tare soil, rotation with nonhost crops, good weed control, and the possible fall planting of a trap crop will all reduce the soil population of *H. schachtii.* However, laboratory analysis of soil should be made to determine nematode density and when sugar beets can safely be planted. From the nematode analysis, a decision can be made as to whether control practice(s) are needed.

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