

SUGAR BEET

in Idaho and Eastern Oregon

SAAD L. HAFE

NEMATODES THAT AFFECT SUGAR BEET production can seriously limit sugar beet production in Idaho and eastern Oregon. Over two dozen species of these microscopic, worm-like animals can cause severe damage to sugar beets world-wide, and sugar beet yield losses due to nematodes have been estimated between 10 and 80 percent. The severity of damage depends on the species of nematode present and population densities in the soil at time of planting. The most common sugar beet nematodes in Idaho and eastern Oregon are the sugar beet cyst nematode (*Heterodera schachtii*), root knot nematodes (*Meloidogyne hapla* and *M. chitwoodii*), and stubby root nematodes (*Paratrichodorus* or *Trichodorus* species). This bulletin covers the three most common sugar beet nematodes in Idaho and eastern Oregon, describes their life cycles and symptoms on sugar beet, outlines the potential economic impact on sugar beet production in the region, and suggests effective management strategies.

1. *Heterodera schachtii* Distribution and host range

The major nematode affecting sugar beet production in Idaho and eastern Oregon is the

sugar beet cyst nematode (SBCN). SBCN is distributed world-wide, wherever sugar beets are grown commercially. This nematode was detected in the United States in 1895. Today, SBCN is present in forty different countries and seventeen states in the United States, including Washington, Oregon, Utah, and Idaho.

In Idaho and eastern Oregon, more than half of the sugar beet acreage is infested with the sugar beet cyst nematode at a level that requires treatment for economically profitable yields. Cyst nematodes generally have limited host ranges compared to root knot nematodes or stem nematodes. However, in contrast, the sugar beet cyst nematode can parasitize a number of field crops and vegetables such as red table beet, broccoli, radish, Brussels sprouts, mustard, kohlrabi, and rapeseed, and weeds such as chickweed, nightshade, and goosefoot, among others (Table 1).

Sugar beet cyst nematodes move relatively short distances by themselves. However, with the unwitting help of humans, nematodes can be disseminated longer distances from field to field or from region to region. Cysts can be carried from infested areas to clean areas by

annual rate of decline of viable eggs and larvae in fields after removal of sugar beet or another host crop can vary from 40 to 50% (Table 2). The actual rate of decline depends on the type of soil, soil temperature, soil moisture, history of pesticide use (including herbicides), susceptibility and availability of host plants (including weeds), and the presence of predators and parasites.

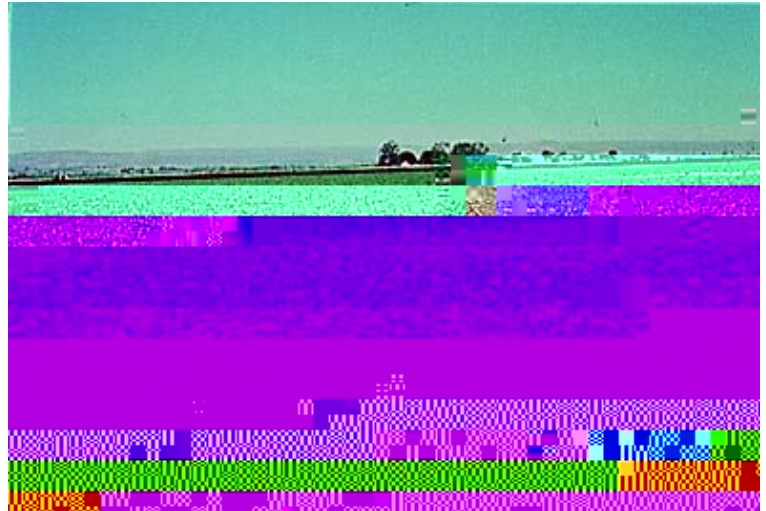
Symptoms of the sugar beet cyst nematode and impact on yield

General nematode injury begins in fields as small patches of poorly growing plants that can exhibit stunted growth, yellowing foliage, and other symptoms of nutrient deficiency (Figure 2). Infected plants may wilt on warm days, and wilting may persist even with adequate soil moisture. Small seedlings are especially susceptible to death in heavy infestations, and surviving beets are typically small with excessively hairy roots (Figure 3). If a plant is carefully removed from the soil, the small, white, lemon-shaped females and brown cysts may be seen on the beet roots. Yield reductions increase as infection severity increases. If the infestation is severe enough, entire seedling stands can be lost.

2. Root knot nematode (*Meloidogyne hapla* and *M. chitwoodi*)

Distribution and host range

Although there are several species of root knot nematode in this region, the two most common on sugar beet in Idaho and eastern Oregon are the Northern root knot nematode (*M. hapla*) and the Columbia root knot nematode (*M. chitwoodi*). The Northern root



2. Sugar beet plants showing symptoms of root knot nematode infestation, including stunted growth and yellowing foliage.

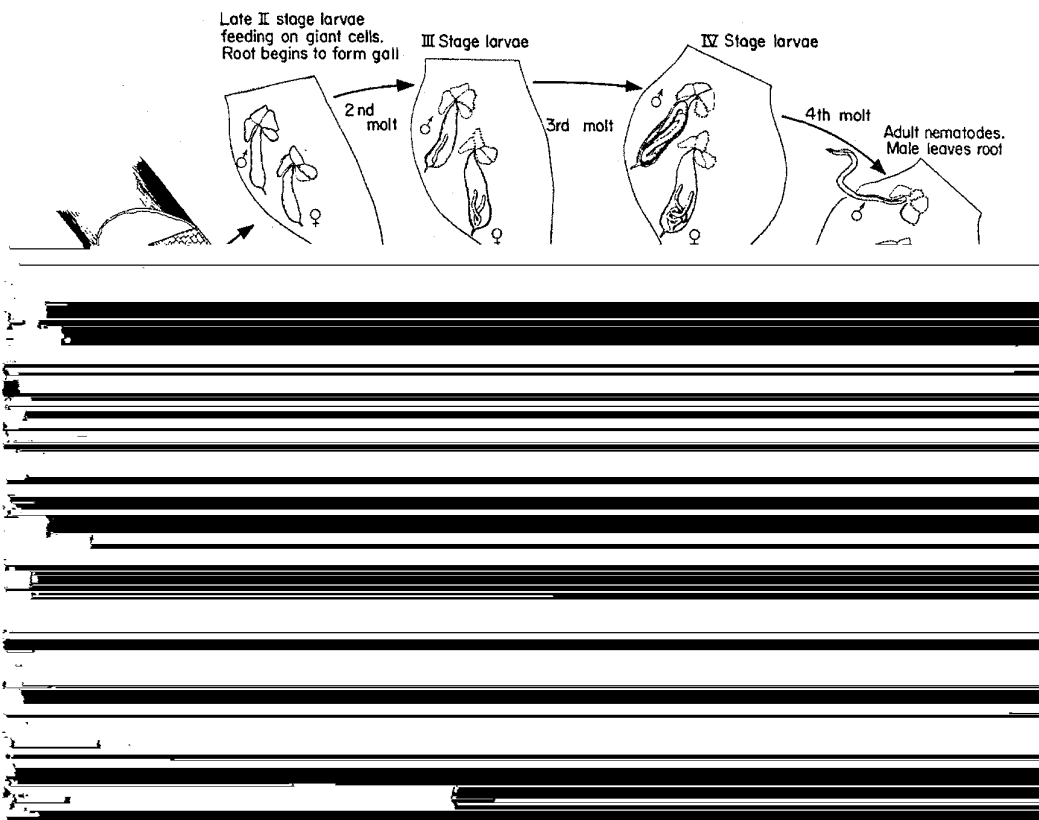


3. A sugar beet root showing a large, white, lemon-shaped female nematode and several brown cysts attached to it.



knot nematode is distributed in sugar beet production areas throughout the northern and southern United States, and the Columbia root knot nematode is found in the Columbia River Basin in Washington, Oregon, and in Idaho, northern California, and parts of Nevada. Both species can attack sugar beets, but neither species is as economically damaging as other root knot nematode species reported in Europe or as the sugar beet cyst nematode. However, reports of Northern root knot nematode damage on sugar beets have increased during the past several years, particularly in eastern Idaho and Washington state.

The host range of root knot nematodes is wide. They attack potatoes, alfalfa (*M. hapla*),



invade sugar beet roots. They mature to adults within the sugar beet root in as few as 20–25 days. Like SBCN, female root knot nematodes become sedentary as they mature. The root knot nematode female swells into a sack-like shape and lays 50–1,000 eggs in a gelatinous matrix outside her body. Unlike sugar beet cyst nematode eggs, root knot nematode eggs hatch readily, without the stimulus of root exudates. Depending on climatic conditions (soil temperature), several generations can occur in one growing season. Root knot nematodes survive winters as eggs or as second-stage juveniles in soil or in plant tissue.

Symptoms of root knot nematodes and impact on yield

Several factors influence the severity of damage caused by root knot nematodes. High population densities and warm soil temperatures at time of sugarbeet planting can lead to severely damaged seedlings. Damage includes stunting and sometimes plant death. More typical symptoms, usually not seen until later in the growing season, are similar to those caused by the sugar beet cyst nematode. These symptoms include stunting, yellowing of foliage, wilting in the presence of adequate soil moisture (particularly on warm days), or general nutrient and micronutrient deficiencies. In a severely infested field, galls may form on lateral roots and sometimes on main tap roots (Figure 5). Severely infected and galled plants may also suffer from secondary pathogens that cause roots to begin to rot in the field, making harvest difficult and increasing losses.

Generally, the northern root knot nematode causes more damage on sugar beets



5. *Trichodorus* and *Paratrichodorus* (Stubby root nematodes)

than the Columbia root knot nematode. Yield reductions induced by root knot nematodes can range from slight to more than 50 percent, with 25 percent reductions commonly reported. Total losses can potentially occur in severely infested fields. Damage from the northern root knot nematode may be most severe following alfalfa hay crops and during years with warm spring temperatures. Cooler seasons may delay infection and less injury may occur.

3. *Trichodorus* and *Paratrichodorus* (Stubby root nematodes)

Distribution and host range

Stubby root nematodes are found in sandy, moist, cool soils. Until recently, problems with stubby root nematodes on sugar beets have been



confined to parts of Europe and California. Problems with stubby root nematodes have now been consistently documented in eastern Idaho for several years. Stubby root nematodes apparently have a wide host range that includes cereal crops and potatoes.

Life cycle and survival of stubby root nematodes

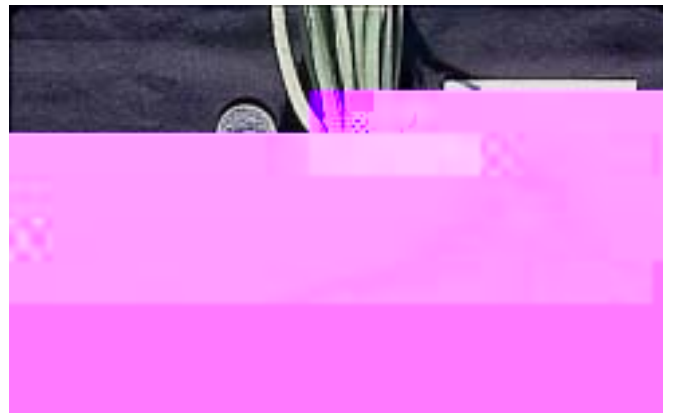
Stubby root nematodes are migratory ectoparasites. That is, during each stage of their life cycle, stubby root nematodes are mobile and they feed on the outside of roots. They are very mobile in the soil, and they often travel long vertical distances. Eggs are laid in soil, where all stages of the life cycle occur. The life cycle is relatively simple because all four larval stages outside the egg resemble the adult stage, except larvae are smaller. Because several generations can be produced within a year, large populations of stubby root nematodes can develop quickly. Their numbers can also decline rapidly after the crop is removed, so sampling at peak population times is critical to determine their population density more accurately. They may survive cold winters by migrating below the frost line and under going dormancy.

Symptoms of stubby root nematodes and impact on yield

Stubby root nematodes feed on main tap roots and lateral root tips, causing swollen, stubby-ended root tips (Figure 6). Root tips are often killed by these nematodes, and surviving roots become branched (forked) and distorted (Figure 7). Plants are seldom killed by this nematode. Damage by stubby root nematodes is greater in wet seasons. Above ground symptoms caused by the stubby root nematode resemble symptoms of other nematodes and can include poor growth, yellowing, and stunting.



6. u u u - ,
w .



7. u u
u .

Prevention

Preventing nematode infestations is the most economical method of managing them, and several ways of preventing nematode infestations exist.

- *Composting tare dirt before returning it to clean fields should eliminate nematodes that survive in sugar beet tare dirt.

- *Avoid moving soil from infested fields to clean fields with farm machinery.



*Avoid using contaminated irrigation water (e.g., irrigation waste water).

*Composting fresh manure fertilizer from feed lots (where livestock were grazing in infested fields) before applying to fields should eliminate surviving nematodes.

*Avoid moving livestock from infested fields to clean fields.

*Plant seed free of plant debris and soil that may harbor nematodes.

Although prevention is the most economical means of managing nematodes, management decisions are often made after a nematode problem is diagnosed. The most effective management programs integrate various proven methods, and usually involve a combination of cultural practices, use of resistant cultivars (when available), nematode resistant trap crops, and chemical control.

Cultural practices

Damage from plant parasitic nematodes can be reduced by employing a combination of various crop management practices such as crop rotation, weed control, early planting, use of organic manure, and proper fertilization.

Crop rotation.

Crop rotation is effective when the nematode has a relatively narrow host range, such as SBCN. Crop rotation is the easiest and cheapest method of manipulating SBCN populations, and rotating sugar beets with nonhost crops such as grain, corn, onion, potato, alfalfa, mint, or bean for various lengths of time (depending on the severity of infestation) should reduce SBCN populations. Table 2 illustrates the possible effect of rotation with nonhost crops for up to 7 years in a

hypothetical field that has an initial SBCN population of 15 viable eggs and larvae per cm³ soil. Controlling host weeds (Table 1) in rotation crops is essential to achieve the best SBCN reduction.

Crop rotation can have limited success, however, when the nematode pest has a relatively wide host range, as in root knot nematodes and stubby root nematodes. Small grains followed by clean fall fallow reduces population levels of root knot nematodes, particularly the northern root knot nematode. Corn, when grown for two consecutive years, has reportedly reduced northern root knot nematode populations sufficiently to obtain higher sugar beet yields.

Earl planting (escape).

Planting sugar beet as early as possible when soil temperatures are low (50-55F) should help the crop become established and escape economic damage before the rate of nematode hatching, movement, and invasion increases as soil temperature increases. Well-established sugar beet plants can withstand later attack by nematodes.

Organic man re.

Using organic manure (from non-infested fields) may help to reduce nematode populations by enhancing the activity of nematode-destroying organisms in the soil. As organic manure crops degrade, they release high concentrations of carbon disulfide and toxic acids that can kill nematodes. Organic manure improves physical properties of soil that may enhance plant growth and increase plant tolerance to nematode infection. Addition of organic manure to achieve desirable benefits is a long-term process.



Proper fertilization.

Proper fertilization and good nutritional status of sugar beet plants should help reduce the impact of nematode damage. Applying higher amounts of fertilizer may lower crop losses from light nematode infestations. Severity of nematode damage is more pronounced under stressful field conditions.



population density exactly equals the increased crop return. *Economic thresholds* are defined as the pest population levels at which management action should be taken to avoid reaching the economic injury level. Economic thresholds of nematodes often vary from region to region. For example, the economic threshold for the sugar beet cyst nematode in the Magic Valley of southern Idaho is three eggs and larvae per 1 cubic centimeter (cc) soil. In the Treasure Valley region of southwestern Idaho, where the growing season is slightly longer than the Magic Valley, the economic threshold for the sugar beet cyst nematode is two eggs and larvae per 1 cc soil. Economic threshold levels of the Northern root knot nematode or stubby root nematodes are currently unknown for sugar beet. Consequently, management decisions for these nematodes are often based on the presence of the nematode and previous problems rather than economic threshold levels.

Soil sampling

nemxDs TDb6pmic ,027iticalromsamppmP1pFagion



1.	u	.						
W		u						
		u u						
u		w						
w		common mouseear						
		common lambsquarter						
	u	Russian thistle						
		w						
u		prostrate knotweed						
	u							
u		blue mustard						
		field pennycress or fanweed						
u	u	flixweed or tansy mustard						
		shepards purse						
u	w	tumble mustard						
		wild mustard						
		cutleaf nightshade						
u		w						
		smooth pigweed						
		redroot pigweed						
		prostrate pigweed						
		tumble pig weed						
		w						
	u							
2.	u	w	u	7	u	15		
	u				u			
		1	3	0	(	u		40%
	u		u	u				

	1	3	+
0			15.0
1			9.0
2			5.4
3			3.2
4			1.9
5			1.2
6			0.7
7			0.4





Hafez, Saad L. *Cultural Management of Green Manure Trap Crops in Sugar Beet Rotations for Sugar Beet Cyst Nematode Management*. University of Idaho CIS 1071.

Hafez, Saad L. *Sampling procedure to diagnose nematode infestations*. University of Idaho CIS 1056.

Steele, A. E. 1986. Nematode parasites of sugar beet. Pages 33-36 In: *Compendium of Beet Diseases and Insects*. Whitney, E.D and James USociety, EAPS Press: S. Pagul

w u u - , , 8
w . . - u u , . u ,
- , , w, 83844.
u - - , , ,
u - , u w .