Sugar Beet nematodes in Idaho and Eastern Oregon

Saad L. Hafez

Nematodes that parasitize sugar beets 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. chitwoodi*), 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. Sugar beet cyst nematode, *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

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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.

Figure 6. Stubby root nematodes cause stubby-ended, swollen tips.

Figure 7. Forked, distorted root symptons caused by a stubby root nematode infection.

General Sugar Beet Nematode Management

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 cm^3 soil. Controlling host weeds (Table 1) in rotation crops is essential to achieve the best SBCN reduction.

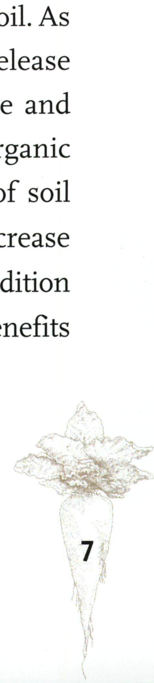
Crop rotation can have limited success, however, when the nematode pest has a relatively wide host range, as in root knot nematodes and stubby root nematodes. Small grains followed by clean fall fallow reduces population levels of root knot nematodes, particularly the northern root knot nematode. Corn,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

Early 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 manure.

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.

Resistant cultivars

Although researchers have identified sources of SBCN resistance in sugar beets, agronomically acceptable cultivars are currently not available. Several sugar beet hybrids have been evaluated for SBCN resistance in greenhouse tests, and most of the hybrids that were tested significantly reduced SBCN populations compared to the susceptible varieties Mono Hy RH 83 and WS-PM-9. Cultivars that are resistant to root knot nematodes or stubby root nematodes are not available.

Nematode resistant trap crops

Trap (catch) crops such as SBCN-resistant varieties of oil radish (*Raphanus sativus* spp. *Oleifera*) and white mustard (*Sinapis alba*) have been specially developed for SBCN management. As the trap crop develops in SBCN-infested soil, it triggers the nematode eggs to hatch, but the newly hatched juveniles are unable to develop into reproductive adults. The nematode population density in the soil is reduced and conditions are again favorable for sugar beet production. Trap crops can be planted in early spring or late summer. They are often planted after small grain harvests (between the last week in July and the last week in August). A minimum of eight weeks growth is required to achieve the best SBCN population reduction. Details on the effectiveness and cultural management of trap crops can be found in the CIS publication, "Cultural Management of Green Manure Trap Crops in Sugar Beet Rotations for Sugar Beet Cyst Nematode Management." (University of Idaho CIS 1071).

Chemical control

Severe nematode infestations may require the use of nematicides. Because nematicide registrations may change, growers should consult the most recent Pacific Northwest Disease Control Handbook for current recommendations. Following are some tips to optimize effectiveness of chemical applications.

- Use only labeled chemicals and recommended rates.
- Carefully calibrate and maintain machinery to avoid over or under application.
- Apply the chemicals only when soil conditions (moisture, temperature, and preparation) are suitable.
- Treat the ends of fields, even if they will not be planted, to avoid re-contamination.
- Implement and maintain an effective weed control program.
- Avoid bringing nematode-contaminated equipment into treated fields.
- Irrigation should follow application as soon as possible when using systemic nematicides.

Management Decisions Based on Economic Thresholds

Economic thresholds for nematode pests

The economic injury level of a particular pest is the "break-even" population density level, when the cost of pest management at this 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

Soil and root sampling is critical to determine if a nematode pest is present and to find out its population density. If economic threshold levels are known, as in the case for the sugar beet cyst nematode, the population density can be determined for any field, and management programs based on economic thresholds can be developed. If the economic threshold level of a nematode species is not known, a management program based on the presence of the nematode or past diagnosed problems with the nematode (or both) can be implemented. The bulletin, "Sampling Procedure to Diagnose Nematode Infestations" (University of Idaho CIS 1056), provides detailed information on a soil sampling procedure. Good sampling procedures are essential for proper diagnoses and making for effective management decisions.

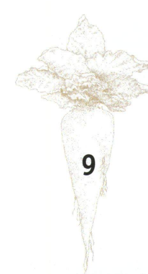


Table 1. Partial list of hosts of the sugar beet cyst nematode.

Field crops and vegetables	Weeds	Ornamental plants
Wild beet	Broadleaf dock	Candy tuft
Red table beet	Cattle spinach	Nasturtium
Sugar beet	Chickweeds	Carnation
Swiss chard	*common*	Arache
Leaf Beat	*mouseear*	
Spinach	Goosefoot	
Horseradish	*common lambsquarter*	
Common mustard	*Russian thistle*	
Kohlrabi	Knot weeds	
Rutabaga	*prostrate knotweed*	
Rape or coleseed	Mustards	
Turnip	*blue mustard*	
Broccoli	*field pennycress or fanweed*	
Brussel sprouts	*flixweed or tansy mustard*	
Cabbage	*shepards purse*	
Cauliflower	*tumble mustard*	
Radish	*wild mustard*	
Dill	Nightshades	
Kale	*cutleaf nightshade*	
Rhubarb	Pigweeds	
	smooth pigweed	
	redroot pigweed	
	protrate pigweed	
	tumble pig weed	
	Pokeweed	
	Purslane	

Table 2. Illustration of the potential effect of rotation with nonhost crops for up to 7 years on sugar beet cyst nematode populations. In this example, a hypothetical field has an initial nematode population of 15 viable eggs and larvae per 1 cm3 soil in Year 0 (the year sugar beet or another host was planted). A 40% rate of decline is calculated for each subsequent year that nonhosts are planted.

Year after a sugar beet crop	Estimated number of viable eggs + larvae remaining per 1 cm3 soil
0	15.0
1	9.0
2	5.4
3	3.2
4	1.9
5	1.2
6	0.7
7	0.4

Suggested reading

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 E. Duff, eds. American Phytopathological Society, APS Press: St. Paul.

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