MANAGEMENT of Sugar Beet Nematodes

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In Idaho and eastern Oregon, the sugar beet cyst nematode (SBCN), *Heterodera schachtii*, is an important pest that can limit sugar beet production. This nematode is widely distributed in sugar growing regions and can cause up to 80 percent yield loss. The amount of yield loss caused by SBCN depends on the initial nematode population density, distribution within the field, general soil and climatic conditions that influence growth of the host plant, and nematode survival and reproduction rate. More than half of the sugar beet acreage in Idaho and eastern Oregon is infested with levels of SBCN that without special management prevent profitable production. In the past, growers typically chose between long rotations using nonhost crops or applying expensive nematicides. Both of these options have limited benefits. A third option is to plant green manure trap crops in nematode-infested fields.

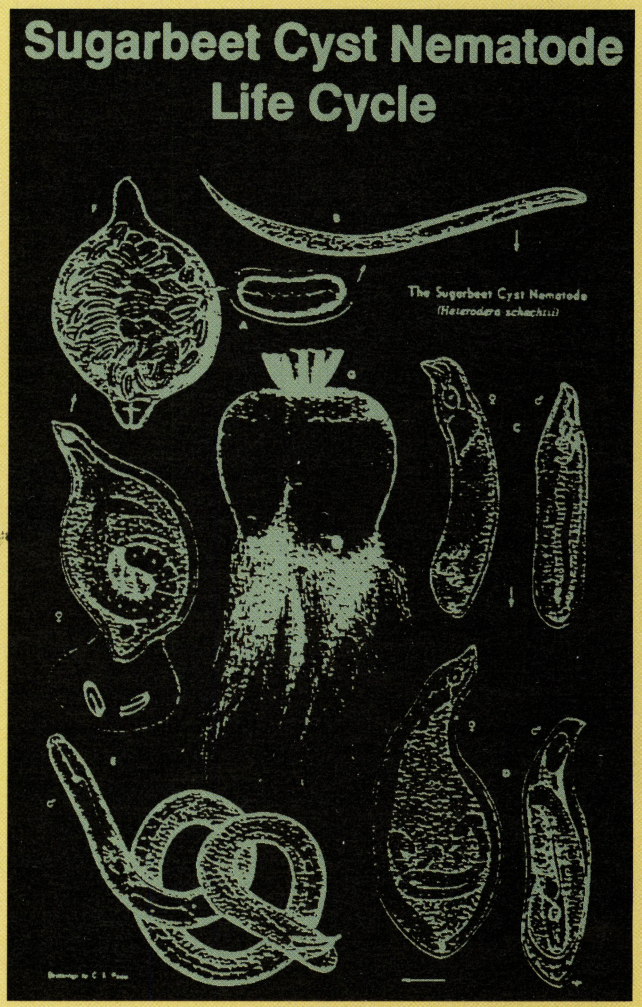

Figure 1.
Life cycle of the sugar beet cyst nematode.

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Figure 2.
Appearance of oil radish and white mustard green manure trap crops after approximately 8 weeks growth.

'Adagio' was used. Green manure trap crops are presently used on about 110,000 hectares (250,000 acres) in Germany.

In addition to reducing soil densities of SBCN, other benefits of using green manure trap crops include increased yields of subsequent sugar beet crops (Table 1), improved soil tilth and water holding capacity, reduced nitrogen leaching into groundwater, weed suppression, reduced soil erosion by wind and water, and potential suppression of seedling diseases.

Management decisions based on SBCN economic threshold levels

Green manure trap crops (Figure 2) can effectively manage SBCN. Special varieties of SBCN-resistant oil radish (*Raphanus sativus* spp. *oleifera*) and white mustard (*Sinapis alba*) have been developed for enhanced SBCN management. When these trap crops are grown in nematode-infested soil, chemical root exudates trigger hatching of nematode eggs, but the larvae that emerge are unable to develop into reproductive females. Nematode population densities then decline, and conditions are again more favorable for sugar beet production. In field experiments conducted from 1992 to 1997 in Parma, Idaho, use of green manure trap crops consistently reduced population densities of SBCN by six- to eight-fold. Average SBCN population reductions were 84 percent to 92 percent (Table 1). Field validation trials conducted in northwestern Wyoming showed similar results. Sugar beet cyst nematode population reductions of 19 percent to 69 percent were reported in commercial fields when oil radish

The *economic threshold* is the pest population density when action should be taken to prevent the population from reaching the economic injury level. The *economic injury level* is reached when pest damage equals the cost of pest management. In Idaho, economic thresholds for SBCN vary by production region. The Treasure Valley has a longer growing season than the Magic Valley, and SBCN can therefore potentially produce more generations. The threshold level is two eggs and larvae per cm^3 soil for the Treasure Valley, and 3 eggs and larvae per cm^3 soil for the Magic Valley. The difference is due to slightly warmer temperatures and therefore potentially more generations in the Treasure Valley as compared to the Magic Valley.

To determine if treatment based on economic threshold levels is necessary, the number of viable eggs and larvae of SBCN per cm^3 soil must be determined. If the number of eggs and larvae per cm^3 soil in a field exceeds economic threshold levels,

Table 1. Sugar beet yield increase (1992–96) and nematode decline (1992–93) due to green manure trap crops planted in late summer at the University of Idaho Parma Research & Extension Center (Parma, Idaho).

Green manure trap crop (prior to sugarbeet)	Root yield (T/A)	% yield increase (over fallow)	% reduction in nematode population*
Radish (Adagio)	31.3	24.7	92
Mustard (Metex)	30.5	21.5	84
Fallow	25.1	–	41

*Initial population (Pi) was assessed before planting green manure trap crops; final population (Pf) was assessed before planting subsequent sugar beet crop. % Reduction = [(Pi – Pf)/Pi]*100.

nematode management is recommended. When soil is analyzed by the University of Idaho Nematology Laboratory in Parma, Idaho, the information returned to the grower is the number of viable *cysts* (not eggs and larvae) per 500 cm^3 soil. Other nematology laboratories may report SBCN populations in other terms, such as the number of cysts per 100 cm^3 soil. Regardless of the amount of soil reported in laboratory analyses, the value should be converted to the number of viable *eggs and larvae per 1 cm3 soil.* To convert number of viable cysts in a known quantity of soil to the number of viable eggs and larvae in 1 cm^3 soil, note that one cyst can contain as many as 500 viable eggs and larvae, and then use the following conversion factor:

(cysts/γ cm^3 soil) (500 eggs and larvae/cyst)

or,

eggs and larvae/1 cm^3 soil = (cysts 500/γ cm^3 soil)

where γ is the amount of soil a particular nematode diagnostic laboratory reports to growers. After determining the number of viable eggs and larvae per 1 cm^3 soil, a management decision based on the economic threshold level can be made. For example, suppose a grower in the Treasure Valley of Idaho sends soil samples from an SBCN-infested field for nematode analysis. The nematology laboratory reports that the farmer has an SBCN population level of 15 viable cysts per 500 cm^3 soil. Using the above conversion factor, the farmer calculates the number of viable eggs and larvae per 1 cm^3 soil:

Example:

eggs and larvae/1 cm^3 soil = (15x 500)/500 cm^3 soil

eggs and larvae/1 cm^3 soil = 15

The farmer realizes he is above the SBCN economic threshold level for the Treasure Valley, and decides to take management action.

If the management decision includes planting nonhost crops (including nonhost green manure trap crops) for a number of years, the grower can use the following formula to estimate future SBCN population levels for any number of consecutive years when no SBCN hosts will be grown:

(number of viable eggs and larvae/1 cm^3 soil) ´ $(0.6)^n$

where *n* is the number of consecutive years when nonhost crops will be grown. About 60 percent of the number of viable eggs and larvae remain viable each year in the absence of a host plant. The factor 0.6 represents the 60 percent of eggs and larvae that remain viable. Table 2 demonstrates the use of this formula to estimate the number of viable eggs and larvae for seven consecutive years of planting nonhost crops, based on our example above of 15 viable eggs and larvae per 1 cm^3 soil in the year beets are grown.

Table 2. The estimated effect of planting non-host crops for seven consecutive years on the sugar beet cyst nematode population. The example assumes an initial nematode population of 15 viable cysts per 500 cm^3 soil containing 500 eggs/cyst (= 15 viable eggs and larvae per 1 cm^3 soil) in Year 0 (the year sugar beet or another host was planted).

Year after a sugar beet crop (Year *n*)	Calculation: Number of viable eggs + larvae/1 cm^3 soil x $(0.6)^n$	Estimated number of viable eggs + larvae remaining per 1 cm^3 soil
0	15 x $(0.6)^0$	15.0
1	15 x $(0.6)^1$	9.0
2	15 x $(0.6)^2$	5.4
3	15 x $(0.6)^3$	3.2
4	15 x $(0.6)^4$	1.9
5	15 x $(0.6)^5$	1.2
6	15 x $(0.6)^6$	0.7
7	15 x $(0.6)^7$	0.4

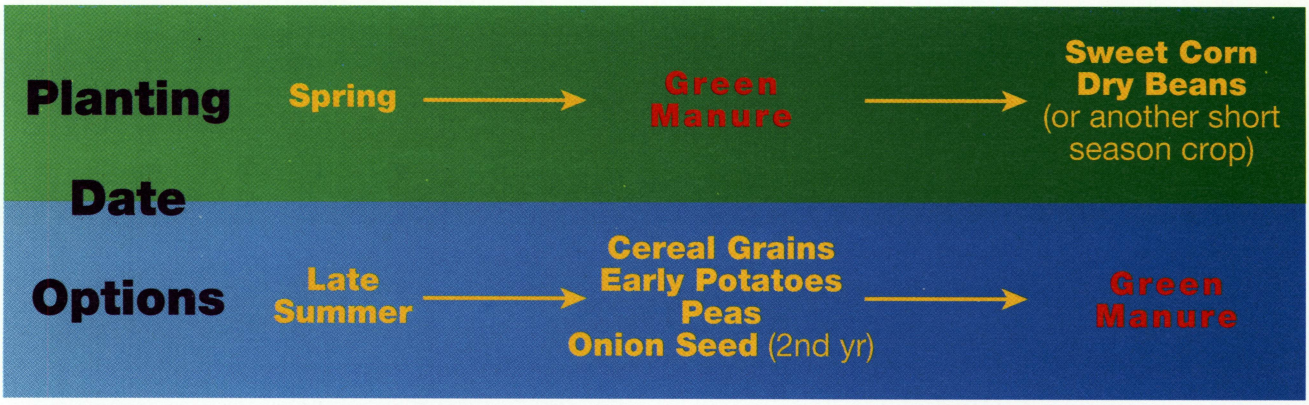

Figure 3.
Green manure planting date options (spring or late summer) for managing sugar beet nematodes.

Green manure trap crop management strategies

To effectively reduce nematode populations, green manure trap crops require at least eight weeks growth. Trap crops can be planted either in early spring or late summer. Often, the trap crop can be conveniently planted after the grain harvest. If this practice is chosen, planting date for the trap crop is usually between the last week in July and the last week in August.

Green manure trap crops should be managed as carefully as main crops to obtain maximum benefits. The following factors should be considered in managing the green manure trap crops: (1) planting date, (2) field preparation, (3) fertilization, (4) green manure variety, seeding rate, and sowing options, (5) irrigation, (6) weed control, and (7) incorporation of trap crop residues as green manure.

Planting date (southern Idaho)

To achieve the best results, green manure trap crops should be planted as early as possible either in spring (first two weeks of March) or late summer (last week of July to second week of August). Figure 3 summarizes planting date options. Short season crops such as sweet corn or beans can be preceded in early spring with a green manure trap crop. Early maturing crops such as grain, early potatoes, peas, or the second year of onion seed can be followed by a green manure trap crop planted in late summer. An eight to ten week growing period with soil temperatures above 60° F is critical for effective nematode control. With the advent of oil radish varieties that mature earlier, length of the necessary growing period may be shortened in the near future.

Field preparation

To obtain best results if the green manure trap crop follows a cereal crop, the field should be prepared by removing the straw by baling, burning residue, or chopping as short as possible and incorporating into the soil immediately after harvest. If time permits, irrigating should help germinate volunteer grain and weeds. Controlling the volunteers and weeds should also help achieve best nematode control. Soil should be loosened deep enough to allow dense root penetration and optimal aeration for egg hatching. This can be achieved by discing two to three times. Standard seedbed preparation is recommended.

Fertilization

Better nematode control will also be obtained when a minimum of 50 lbs of nitrogen per acre is applied to the green manure. This rate is recommended because nitrogen aids in the decomposition of straw and enhances green manure establishment.

Green manure variety, seeding rate, and sowing options

Choosing the appropriate variety of green manure is important because the level of resistance to the sugar beet cyst nematode varies among the different varieties of oil radish and white mustard. Different cultivars of green manure trap crops have

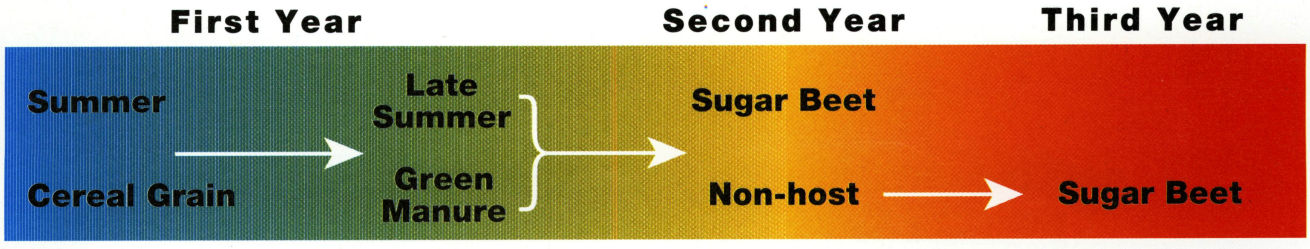

Figure 4.
Fitting late summer-planted green manure trap crops into a sugar beet rotation program.

different levels of resistance, though none has 100 percent resistance or immunity. Recommended varieties include oil radish 'Adagio' and white mustard 'Metex'. Oil radish 'Colonel' and white mustard 'Concerta' are two additional promising varieties that are currently under evaluation in Idaho. The recommended seeding rate is 25 pounds per acre. A dense seeding rate is needed because it reduces weed populations and increases nematode egg hatch. Sowing options include using a grain drill and packer and planting at a _–1 inch depth or using a fertilizer spreader. If the seed is mixed with the fertilizer in a fan spreader truck, a light harrowing would be necessary to cover the seed.

Irrigation

Adequate soil moisture is important for nematode egg hatching and green manure trap crop root establishment. Good irrigation practices will also help maintain good aeration in the soil, another factor that is important in stimulating egg hatch and seed germination. The number of irrigation events depends on the soil type and profile, but a minimum of four irrigation events is usually recommended. Avoid over-watering.

Weed control

To enhance weed control, irrigation (followed by discing) before planting the green manure trap crop is recommended if time permits. Other tactics include a dense green manure crop planting rate and the use of labeled herbicides. Treflan is a herbicide that can be used as a pre-plant application for broadleaf weeds and grasses, including grains. Assure 2 or Poast can be applied post-plant, and are effective against grasses (including grains). Herbicides should be used according to the labeled recommendations.

Incorporation of green manure

To prevent seed production, it may be necessary to mow at pod formation stage (when plants are about 12 inches in height). During this period, it is important to prevent moisture loss. To incorporate, the green manure should be first chopped, turned, and then plowed under to mix the green foliage and the roots with the soil. Discing two to three times, plowing, ripping, and harrowing are recommended.

Fitting trap crops into your crop rotation scheme

Deciding when to plant a green manure trap crop, in late summer or early spring, depends on your rotation program and on the availability of irrigation water. Figure 4 diagrams how green manure trap crops planted in late summer can be incorporated into current rotation programs, and Figure 5 provides examples as to how current rotations can accommodate green manure crops planted in the spring.

Late summer-planted oil radish can be followed by beets the next spring, but an additional season with a non-host rotation crop such as winter wheat, onion, potato, corn, or beans will provide a higher level of nematode control. This practice further reduces nematode populations, and increases the potential for a better crop of sugar beets the following year.

To most effectively reduce sugar beet cyst nematodes, green manure crops require eight to ten weeks of growth with soil temperatures above 60°F. This long growing period may be difficult to achieve when frost is expected. Oil radish tolerates frost as low as 22°F, while mustard cannot withstand frosts

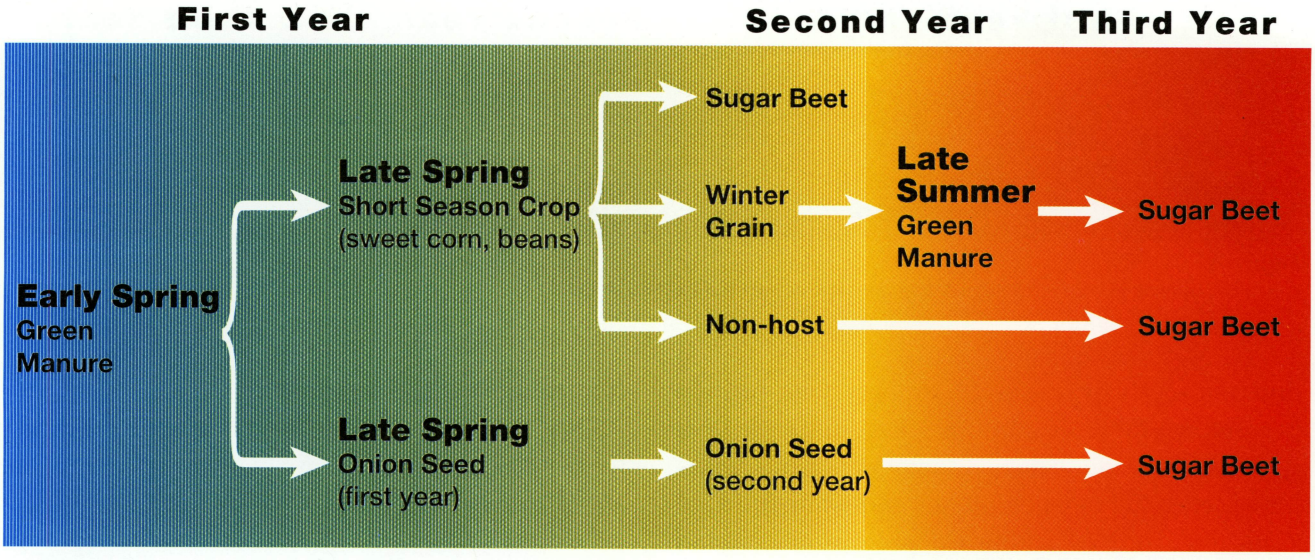

Figure 5.
Fitting spring-planted green manure trap crops into a sugar beet rotation program.

below 26°F. However, such concerns may be alleviated for late summer-planted green manure trap crops as faster growing varieties become available.

What to avoid in managing green manure crops

To achieve the best nematode control with green manure trap crops, the following factors should be avoided:

- Planting late.
- Poor seedbed preparation (e.g. leaving straw or stubble on the soil surface).
- Over-watering and under-fertilizing.
- Weeds and volunteer grain.
- Inadequate seeding rate.

About the author

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