INTRODUCTION
In 1895 the sugarbeet cyst nematode (BCN), Heterodera schachtii, was first discovered in the U.S. in Utah and wasn’t identified in Michigan until 1948. BCN is responsible for ninety percent of all nematode related sugarbeet damage. In Michigan, this nematode is a key pest that can significantly lower sugarbeet yield and quality, especially for RWSA, RWST, and healthy storage of sugarbeets (healthy beet=good storage=good sugar extraction).

Random field surveys conducted by Michigan Sugar Company in 2012-2013 found thirty-one percent of the sampled sites had detectable levels of BCN (Figure 1). Research indicates heavily infested fields can suffer yield losses up to fifteen tons and reduced sugar with current prices placing these losses over $750 per acre. In fields with relatively low populations of BCN and no visible foliar symptoms, yield losses can range from two to four tons. Therefore, the estimate of the economic impact loss caused by BCN to the Michigan Sugar Cooperative is between five-ten million dollars per year.

WHAT IS BCN?
BCN, like all plant-parasitic nematodes, is a microscopic roundworm related to the animal parasitic roundworms that infect pets and livestock. BCN reproduces optimally between 70°F to 80°F, and is capable of producing two to three cycles in a season in Michigan and can be observed from about six weeks after planting until harvest.

The juvenile stage of the nematode is the infective stage of BCN which enters the sugarbeet root after hatching from an egg. The life cycle normally takes four to six weeks, depending upon soil temperatures. The juveniles infiltrate the sugarbeet roots and cause the development of specialized feeding cells in the vascular system of the roots. If the juveniles become males, they leave the root after feeding for a few days, move through the soil, and do not interpose further to the sugarbeet.

If the juveniles become females, they lose the ability to move and swell into white, lemon-shaped objects (Image 1). Females become too large to remain entirely implanted within the root. Their heads remain

Figure 1: Sugarbeet Cyst Nematode (BCN) and Soybean Cyst Nematode (SCN) Survey, 2012-2013.

Image 1: Sugarbeet Female Feeding On Root Hairs.
embedded while the rest of their bodies break out of the root. White females become yellow as they age and then turn brown after they die. The brown stage is the cyst for which the nematode is named. Each cyst can contain between 200-300 eggs under optimal field conditions.

It is important to note that, even in the presence of host plants, fifty percent of eggs remain dormant and will persist in the soil for long periods of time (up to ten years). BCN cysts, which contain eggs and/or juveniles, can remain viable in fields for several years. Rates of decline each year of populations in soils during rotations range from forty percent to sixty percent, however, they can survive for longer periods of time in fallowed soil. Survival and rate of decline is influenced by host suitability, geographic location, length of growing season, planting date, presence of weed hosts, and soil temperature.

**SAMPLING FOR BCN**

Current sugarbeet fields should be sampled in late summer (July-August) to properly diagnose BCN infestations. Because of the patchy nature of BCN, an adequate number of soil cores must be taken to minimize false negatives. It is recommended that twenty-five soil cores be taken per tested field. In order to take a representative and random sample from a field in a practical manner, the “Z” pattern is recommended to be used across the field. Samples can be taken with a soil sampling probe, trowel or shovel. Samples should be taken before any treatment decision is required and when soils are not excessively wet, dry or frozen. Samples should be taken from the root zone by removing the top two inches of soil and then sampling to a depth of twelve inches. Also, include sugarbeet root hairs with the samples.

The sample should be placed in a durable, moisture resistant sample bag. Keep the sample cool, ideally 50°F; do not leave in direct sunlight or car trunk, and deliver sample(s) to Michigan Sugar Company or send samples(s) to a diagnostic laboratory as soon as possible. Samples must be labeled with information (location, soil type, cropping history, current and anticipated crop, last nematicides used, etc.) which may aid in identification and diagnosis. **NOTE:** Approximately one quart of soil should be delivered to Michigan Sugar Company or to a diagnostic laboratory. Since nematodes are live organisms, **DO NOT** let samples dry out.

Above ground symptoms are rare, unless there is some environmental stress on the plants. Above ground symptoms caused by BCN feeding include wilted, yellowing of the leaves and under-developed beets, excessive fibrous roots (beard-like appearance) and/or beets with a forked appearance. Infection by BCN juveniles and the eruption from roots by the maturing females create openings in the root surface that can serve as entry points for other soil-borne sugarbeet pathogens such as Pythium, Rhizoctonia, and Phytophthora.

**POPULATION REDUCTION**

The number of BCN in a field can be greatly reduced through proper management, but it is impossible to eliminate BCN from your field once it has become established. With currently available management options, it is much easier to keep low numbers low than it is to try and drive high BCN numbers down.

If a BCN problem develops, it may be necessary to reduce the population density of the pest. This can be accomplished utilizing several tactics alone or in combination; these tactics include crop rotation, tolerant varieties, trap crops, and nematicides. The economic yield loss threshold is approximately one cyst/cm³ of soil or more acutely two to four nematode eggs/cm³ of soil.

**MANAGEMENT**

- **BCN Tolerant Varieties:** Use of a tolerant variety in fields heavily infested in BCN has increased yields by fifteen tons per acre when compared to non-tolerant varieties. It should be noted that BCN will develop and reproduce on these tolerant varieties but poorly. Growers should use these varieties prudently as overuse may lead to a shift resistance to BCN. These varieties are very susceptible to Cercospora and Rhizoctonia and fungicides should be used appropriately.

- **Rotation with Non-Host Crops:** planting crops like small grains, corn, soybeans or alfalfa will reduce soil populations through natural decline.

- **Weed Control:** control weeds that can be a host to BCN like common lambsquarters, shepherd's purse,
pigweed, chickweed, dock, purslane, and other closely related weeds.

- **Trap crops**: A trap crop is one that attracts nematodes but often does not allow them to successfully develop, thus reducing population densities up to eighty to ninety percent. Oilseed radish has been used successfully as a trap crop for BCN; however, only a few cultivars of oilseed radish can be used for this purpose: Defender, Image, and Colonel. Seeding rates range from 10-20 pounds per acre and apply 80-90 pounds of Nitrogen when planting radish after wheat. Radish needs about 60 days of growth to be effective in reducing BCN numbers. Pile Drive and Ground Hog are excellent hosts for BCN and should **NEVER** be used as trap crops (Graph 1).

**SPREAD**

BCN is a soilborne pest that can move about one inch each year on its own. However, anything that can move soil can move nematodes. Although we can do little to control movement by windblown soil or flooding, we can prevent movement into fields by soil attached to equipment. Thoroughly clean equipment, this is especially true for used equipment bought or rented from cyst-infested areas before taking it to a non-infested field.

Ideally, tare soil should not be returned to a sugarbeet field, or at least be only returned to fields that are already known to be infested. Composting tare soil before returning it to clean fields should eliminate nematodes that survive in sugarbeet tare dirt.

**OTHER PRODUCTS**

Currently there is ongoing research evaluating potential new products that may be helpful in the control of BCN. These products include seed treatments, foliar applied plant health promoters and soil applied nematicides. There will be a new seed treatment option that contains a Pasteuria spp. that is tentatively going to be released in 2015. Clariva (Pasteuria spp.) is an endospore-forming, bacterial parasite that will infect BCN, thus reducing BCN populations in the soil. Research will be done in 2014 to look at this biological nematicide, therefore, seeing how this seed treatment will fit into Michigan Sugar Company’s BCN management program.

**Graph 1**: Comparison of Oilseed Radishes and How BCN Reproduce on These Cultivars.

<table>
<thead>
<tr>
<th>BCN Susceptible</th>
<th>Pile Driver</th>
<th>Ground Hog</th>
<th>Toro</th>
<th>Respect</th>
<th>FumaRad</th>
<th>Defender</th>
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</thead>
<tbody>
<tr>
<td>Eggs and J.S.</td>
<td>16860</td>
<td>7280</td>
<td>3950</td>
<td>620</td>
<td>50</td>
<td>25</td>
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SUMMARY

BCN is a very serious pest of sugarbeets. Management of cyst nematodes typically requires an integrated approach in which routine soil sampling is an integral component. All growing and potential sugarbeet fields should be monitored and sampled for BCN. Fields should be sampled in late summer when sugarbeets are actively growing. Multiple control strategies should be implemented if BCN is found. This would include lengthening crop rotation, utilizing trap crops, and utilizing tolerant BCN varieties.

BCN should be monitored closely since they are typically a major limiting factor. Fields should be sampled and samples submitted to Michigan Sugar Company or to a Diagnostic Service Laboratory. For 2014, Michigan Sugar Company will again pay the analysis and shipping costs for Growers who would like to participate in this free program.

To get an accurate test result, the sample(s) should arrive at Michigan Sugar Company or to a Diagnostic Service Laboratory as soon as possible, therefore, a courier service is recommended. For free shipping and analysis, drop off the soil sample(s) including root hairs to Michigan Sugar Company’s Agricultural offices (e.g. Sebewaing, Caro, Croswell, and Bay City).