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Gregory L. Tylka
Iowa State University, gltylka@iastate.edu

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SOYBEAN CYST NEMATODE - BIOLOGY MANAGEMENT

Gregory L. Tylka
Assistant Professor
Plant Nematologist
Iowa State University

Introduction

The soybean cyst nematode, *Heterodera glycines*, is a small, unsegmented plant-parasitic roundworm that attacks the roots of soybeans. While many plant-parasitic nematodes are believed to be endemic or native to the United States, the soybean cyst nematode was apparently introduced from Japan. Soybean cyst nematode was first discovered in the United States in 1954 in North Carolina. It has since spread to 25 additional states in the Southeast and Midwest. It was first discovered in Iowa in Winnebago County in 1978. The presence of soybean cyst nematode has been confirmed in 48 counties within Iowa (Figure 1) and it is suspected to be present in others as well.

Soybean cyst nematode has become one of the major factors limiting soybean production in Iowa. Of 879 grower-submitted soil samples tested for soybean cyst nematode by the Cooperative Extension Service at Iowa State University in 1989 and 1990, approximately 75% were found to be infested (Table 1).

Figure 1. Known distribution of soybean cyst nematode in Iowa as of October 31, 1990
Furthermore, nearly 75% of those soil samples which tested positive for the nematode had egg densities greater than 1,000 per 100 cc of soil. Research conducted in Iowa with susceptible varieties indicates that significant yield suppression occurs at population densities of 50 eggs per 100 cc of soil or lower.

Table 1. Distribution of results of soil samples tested for soybean cyst nematode by Iowa State University Cooperative Extension Service, 1989 - 1990.

<table>
<thead>
<tr>
<th>Eggs per 100 cc soil</th>
<th>1989</th>
<th>1990</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td># of samples</td>
<td>% of total</td>
</tr>
<tr>
<td>0</td>
<td>134</td>
<td>24.5</td>
</tr>
<tr>
<td>1 - 1,000</td>
<td>80</td>
<td>14.6</td>
</tr>
<tr>
<td>1,001 - 5,000</td>
<td>161</td>
<td>29.4</td>
</tr>
<tr>
<td>5,001 - 10,000</td>
<td>95</td>
<td>17.3</td>
</tr>
<tr>
<td>10,001 - 20,000</td>
<td>55</td>
<td>10.0</td>
</tr>
<tr>
<td>20,001 +</td>
<td>23</td>
<td>4.2</td>
</tr>
<tr>
<td></td>
<td>548</td>
<td>100.0</td>
</tr>
</tbody>
</table>

**Symptoms**

Symptoms of soybean cyst nematode damage can be classified into two categories, above-ground and below-ground. The above-ground symptoms may appear in circular or oblong patterns which vary in size or the symptoms may be more generalized across much or all of the field. When symptoms appear in a localized spot, the most severe damage usually occurs in the center of the spot. Above-ground symptoms often initially appear near a gate or entrance to a field where farm machinery enter or along a fence line where wind-blown soil tends to accumulate.

**Above-ground Symptoms**

The above-ground symptoms of soybean cyst nematode damage are not unique and often can be mistaken for damage due to compaction, iron deficiency chlorosis, other nutrient deficiencies, drought stress, herbicide injury, or other plant diseases. In many instances, injury due to soybean cyst nematode has probably gone undetected for several years because these nondescript symptoms were attributed to other causes.
The first obvious symptom of soybean cyst nematode injury to soybeans is the appearance of stunted, yellowed, less vigorous plants. Plants growing in heavily infested soils may remain stunted throughout the growing season. Additionally, rows of soybeans grown in infested land are often slow to close or fill in with foliage.

The yellowing of soybeans due to soybean cyst nematode damage is often confused with iron deficiency chlorosis. This is particularly true in areas with high pH soils where iron deficiency is a problem. However, there are differences between the symptoms of the two problems. Iron deficiency chlorosis symptoms will appear early in the growing season, usually in early June. Yellowing due to soybean cyst nematode damage will occur later in the season, usually in July and August. Furthermore, yellowing due to iron deficiency chlorosis primarily affects the areas between the veins of the upper leaves while soybean cyst nematode yellowing usually begins at the leaf margins of leaves over the entire plant. Iron deficiency chlorosis and soybean cyst nematode may occur in the same field with symptoms of both occurring on the same plant.

The above-ground symptoms of soybean cyst nematode damage do not always occur consistently. Symptoms can range from severe to nonexistent. The intensity of the symptoms is influenced by the age and vigor of the soybean plants, the nematode population density in the soil, soil fertility and moisture levels, and other environmental conditions. Soybean cyst nematode damage is usually more severe in light, sandy soils but will occur in all types of soil.

One can not rely upon above-ground symptoms for identification of soybean cyst nematode infestations. If soybean yields in a particular field have decreased for no apparent reason or if soybean cyst nematode has been confirmed on nearby land, more thorough examination of plants for below-ground symptoms and a soil analysis are needed.

**Below-ground Symptoms**

Most below-ground symptoms of soybean cyst nematode injury are not unique. Roots infected with the nematode are dwarfed or stunted. Soybean cyst nematode also decreases the number of nitrogen-fixing nodules on the roots. Furthermore, infection of roots by soybean cyst nematode may make the roots more susceptible to infection by other soil-borne plant pathogens. It is often difficult to recognize roots as being stunted and having fewer nodules unless some noninfected soybean roots are also available for side-by-side comparison.

The only unique symptom of soybean cyst nematode infection is the presence of adult female nematodes and cysts on the soybean roots. Cysts appear as tiny, lemon-shaped objects which are
initially white but turn yellow, then tan to brown as they mature. Cysts can be seen with the unaided eye although observation with a magnifying glass is usually much easier. The cysts are about the size of a pinhead and are much smaller than nitrogen-fixing nodules. Roots must be carefully removed from the soil to observe the cysts on the roots, otherwise the cysts may become dislodged. Observation of cysts on the roots of infected soybean plants is the ONLY accurate way to diagnose soybean cyst nematode infestations in the field.

Life Cycle of Soybean Cyst Nematode

The soybean cyst nematode life cycle has three major stages: egg, juvenile, and adult. The life cycle can be completed in 24 to 30 days under optimum conditions in the summer. Vermiform or worm-shaped soybean cyst nematode juveniles hatch from eggs in the soil when adequate temperature and moisture levels occur in the spring. These juveniles are the only life stage of the nematode capable of infecting soybean roots.

After penetrating the soybean roots, juveniles move through the root cortex until they contact the vascular tissue. There they cease moving and begin to feed. In order to feed, the nematodes inject secretions which modify certain root cells and transform them into specialized feeding sites called syncytia.

As the nematodes feed they swell posteriorly and eventually the female nematode becomes so swollen that it breaks through the cortex of the root tissue and is exposed on the surface of the root. Male nematodes, which are not swollen as adults, migrate out of the roots into the soil and fertilize the lemon-shaped adult females. After fertilization, the males die and the females remain attached to the roots and continue to feed. The swollen females begin to produce eggs, initially in a mass or egg sac outside the body and later within the body cavity of the female. The entire body cavity of the adult female eventually becomes filled with eggs and the female dies. It is the egg-filled body of the dead female that is referred to as the cyst. Cysts will eventually dislodge from the roots and become free in the soil. The walls of the cyst become very tough and provide excellent protection for the 200 to 400 eggs contained within. Soybean cyst nematode eggs survive within the cyst until conditions become proper for hatching. Although many of the eggs may hatch within the first year, many will also survive within the cysts for many years.

Spread of Soybean Cyst Nematode

Soybean cyst nematode can move through the soil only a few inches per year on its own power. However, it can be spread great distances in a variety of ways. Generally, anything that moves even small amounts of soil is capable of disseminating soybean cyst nematode. Spread can occur by soil moved by farm machinery,
vehicles and tools, wind, water, animals, and farm workers. Seed-sized clumps of soil, called soil peds, often contaminate seed harvested from plants grown on infested land.

Soybean cyst nematode can be spread if this seed is planted in noninfested fields. There is even evidence that cysts of soybean cyst nematode can be spread by birds. Obviously, only some avenues of spread of this nematode can be prevented.

Management of Soybean Cyst Nematode

For all practical purposes, soybean cyst nematode can never be eliminated from land once it is present. However, there are things that can be done to manage the nematode in order to maximize yields and minimize reproduction of the nematode. Management practices for soybean cyst nematode fall into five categories.

1. Maintenance of plant health

Plants that have adequate moisture and fertility are better able to withstand infection by soybean cyst nematode. Consequently, maintaining proper soil fertility and pH levels in land infested with soybean cyst nematode is more critical to maximizing yield than when land is noninfested. It is also important to control other plant diseases as well as insect and weed pests because they also weaken the plants and make them more susceptible to the yield suppressing effect of the nematode.

2. Sanitation

Common sense sanitation practices can be very effective in preventing or delaying the spread of soybean cyst nematode to noninfested land. If only certain fields on a farm are infested, planting and cultivating of infested land should be done only after noninfested fields have been worked. Equipment should be thoroughly cleaned with high pressure water or steam, if available, after working in infested fields.

Additionally, one should not use seed grown on infested land for planting unless the seed has been properly cleaned. Soybean cyst nematode may be spread in the seed-sized soil peds associated with the seed.

3. Host resistance

Resistant soybean varieties are the most effective tool available for management of soybean cyst nematode. By planting resistant soybeans in infested soil, reproduction of the nematode is suppressed. Most soybean cyst nematode juveniles will be unable to feed and reproduce on the roots of resistant varieties, but a few nematodes will survive and reproduce. Currently, resistant varieties in general yield slightly less than susceptible varieties.
on some noninfested land but yield significantly better in fields infested with soybean cyst nematode. The performance of resistant varieties on noninfested land is constantly being improved. In the past, there were no resistant varieties available for Iowa, but in recent years several public and private varieties have been released.

4. Crop rotation

While use of resistant varieties is the most effective management strategy for soybean cyst nematode, RESISTANT VARIETIES SHOULD NEVER BE PLANTED YEAR AFTER YEAR. If resistant varieties are planted for several years in a row, eventually a population (or race) of soybean cyst nematode will develop which is capable of reproducing on the resistant variety. Consequently, resistant varieties should be incorporated into a crop rotation scheme which includes nonhost crops and susceptible soybeans. This will prevent the build-up of soybean cyst nematode populations which are capable of reproducing on the available resistant varieties. The ultimate goal of the crop rotation program is to maintain the effectiveness of the available resistance for as long as possible and to lower nematode population levels enough to obtain acceptable yields when susceptible soybeans are again planted in the infested field. Examples of two crop rotation schemes for fields with low and moderate soybean cyst nematode levels are as follows:

<table>
<thead>
<tr>
<th>3-year rotation</th>
<th>4-year rotation</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>(low nematode level)</strong></td>
<td><strong>(moderate nematode level)</strong></td>
</tr>
<tr>
<td>1st - Nonhost</td>
<td>1st - Nonhost</td>
</tr>
<tr>
<td>2nd - Resistant soybean</td>
<td>2nd - Resistant soybean</td>
</tr>
<tr>
<td>3rd - Susceptible soybean</td>
<td>3rd - Nonhost</td>
</tr>
<tr>
<td></td>
<td>4th - Susceptible soybean</td>
</tr>
</tbody>
</table>

Crops which are not hosts to soybean cyst nematode include corn, alfalfa, and small grains. Growers should consult county extension personnel or seed company representatives for information on suitable resistant soybean varieties or to further discuss effective crop rotation schemes.

5. Nematicides

There are several nematicides which are labeled for use against soybean cyst nematode. Generally these materials do not give season long control. When applied at planting, the effect of the nematicides may last long enough to provide an economic yield benefit. By the end of the growing season, however, soybean cyst nematode numbers may be as high or higher than at planting. No nematicide will kill all soybean cyst nematodes in the soil.

The performance of the nematicide will depend on soil conditions, temperatures, and rainfall. A yield benefit is not
guaranteed and nematicides are expensive. Consequently, growers are advised to consider economics and environmental and personal health concerns before applying nematicides for management of soybean cyst nematode.