Plant Pathology
Information Note

SOYBEAN NO. 6

MANAGEMENT OF SOYBEAN CYST NEMATODE

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INTRODUCTION

Soybean cyst nematode (SCN) is the most serious soybean disease problem in North Carolina. Since its discovery in North Carolina (and the United States) in 1954, it has spread to all counties in the Coastal Plain, Tidewater, and some Piedmont counties with large soybean acreages. Severe yield loss caused by this pest is especially common in sandy coastal plain soils. SCN, however, is not restricted to any soil type and often causes significant soybean yield losses which may go unnoticed. Soybean cyst nematode should be suspected as a possible production problem if any of the following apply: 1) irregular patches of stunted and/or yellow soybeans - an up-and-down pattern of soybean growth is common; 2) soybeans grown without rotation; 3) yields declining over several years; 4) detection of cysts on roots or a positive report on cyst nematode from the Plant Disease and Insect Clinic or the North Carolina Department of Agriculture, Nematode Advisory Service; and 5) failures in weed control (weed problems are frequently more severe in soybean-cyst-nematode-infested fields).

DIAGNOSIS

Diagnosis of cyst-nematode problems on soybean can be accomplished by several means. Generally, a soil sample must be processed in order to positively identify the nematode problem. If you suspect a nematode problem, take systematic (stratified) soil samples in the fall when nematode numbers are high. Pull 20 to 30 soil cores 6 to 8 inches deep from 4 to 5 acres. Send soil in a plastic bag and appropriate box (obtained from county Extension agent) along with the appropriate form and payment to the North Carolina Department of Agriculture, Agronomic Services, Nematode Advisory and Diagnostic Lab, 4300 Reedy Creek Road, Raleigh, NC 27607. If you know you have soybean cyst nematode, you

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may request an egg assay from the NCDA. Numbers of SCN eggs are more indicative of the severity of the problem, but egg assays may overlook other nematode problems. If you detect a problem during the growing season, plant and soil samples should be taken. Infected plants (stunted, but not dead) should be carefully dug from the soil. Small, white to yellow cysts (about the size of the head of a pin) on the root system indicate that cyst nematode is a problem. If you cannot identify cysts on roots, your county extension agent can assist you in identification, or forward the samples (soil and roots) to the Plant Disease & Insect Clinic or to the NCDA Nematode Advisory Service for diagnosis. Analysis of the soil and/or root sample for nematodes has the advantage that it may reveal other nematode or disease problems. Include an accurate crop history (including soybean varieties planted previously). Information about fertility, herbicides and cultural practices can also aid in diagnosis.

PATHOLOGY AND LIFE CYCLE

Nematodes are round worms which are generally microscopic. The Soybean Cyst Nematode is a parasite which can reproduce on only a few hosts, such as soybean and snap bean. SCN cannot reproduce on crops such as corn, cotton, peanut, tobacco or wheat. These crops are referred to as non-hosts. Eggs of soybean cyst nematodes are contained inside a cyst which is the body of an adult female. The eggs are dormant during the winter, but from April through June, eggs hatch and juvenile nematodes migrate through the soil. If the juveniles fail to locate roots of a host within a few weeks, they die. When soybeans are planted and start to germinate, roots exude substances which stimulate more hatch and attract juveniles to the root systems. Cyst juveniles penetrate the roots, migrating in the root until they locate a feeding site. This first event, penetration of the root system, may cause considerable damage to the soybean plant. As many as 10,000 cyst juveniles have been found in a single soybean root system as few as 10 days after planting. Nematode invasion of the root system frequently results in seedlings that are more susceptible to Phytophthora, Pythium, and Rhizoctonia root rots. Once the nematodes have established a feeding site in the root, they become stationary and induce nurse cells in the root. These nurse cells may prevent plant nutrients from reaching the shoots and leaves, sometimes causing nutrient deficiencies. More importantly, materials necessary for root growth are diverted to the nurse cells to feed the nematode. In high levels of infestation, the tap root may be killed, 4 or 5 inches below the soil surface. Since all secondary soybean roots come off the tap root, the soybean root system can be severely limited. The stunted root system may not be evident until the plants are under moisture and/or nutrient stress. Affected plants may show moisture stress even though soil moisture is adequate below the root system. When high levels of infection occur, nodulation of the soybean root system is inhibited, limiting the plant's ability to fix nitrogen. As a result, plants may be light green or yellow. After the nematodes have established a feeding site, the cyst juveniles molt three times in developing toward adulthood in soybean roots. The female becomes lemon-shaped and males migrate from the root to fertilize the female. The body of the female breaks through the root system and she is fertilized by the male. Eggs are produced by the cyst female and some are deposited in an egg mass outside the body of the female. These eggs, as well as eggs inside the female, will

develop into second-stage juveniles which will hatch and re-infect the soybean plant. Females will generally mature (start producing eggs) in 21 to 28 days. After 30-40 days, yellow cysts become brown as the female dies and becomes detached from the root system. The dead female body is the cyst stage which may contain 25 to 200 eggs. Many of these eggs in the cyst will remain dormant until the following spring. The life cycle continues with 2 to 5 generations per year. The number of generations (and the amount of infection next year) is largely determined by two factors: 1) the length of the growing season which is primarily related to the soybean maturity group - a later maturity group will result in more generations and a higher population density next year, and 2) the environment during the growing season - very hot weather tends to limit reproduction, whereas cool to moderate conditions with adequate moisture tend to enhance reproduction. When the adult female dies, nurse cells in the root atrophy and die, providing an excellent avenue for various fungi to invade and further compromise the soybean root system. Southern stem blight, Phytophthora root rot, Pythium root rot and Cylindrocladium black root rot (red crown rot) are commonly associated with cyst nematode.

POPULATION CHANGES

The population density of soybean cyst nematode is relatively static during winter and early spring, but is changing constantly through the soybean growing season. Eggs are dormant until March or April when juveniles start to hatch. Hatching accelerates in May and June. Juveniles must penetrate soybean root systems within a few weeks in order to survive. If soybean planting is delayed to mid- to late-June the preplant nematode density may be cut in half. Once soybeans are planted, the population starts to build up again until soil temperatures become very high in July or August. Reproduction resumes in September through October with the onset of cooler weather.

The soybean maturity group largely determines the amount of reproduction in the fall. Group IV or V soybean varieties mature in September and October, whereas a group VII or VIII will not mature until late October or November. Late maturing soybean varieties allow for an extra generation of cyst nematode to develop, which generally doubles or triples the population density of this nematode. The early infection of soybean root systems by SCN causes the most serious damage to the root system. In the first 2-4 weeks after planting, 30 to 50% of the soybean plant's yield potential is determined. Thus, the primary determinant of soybean yield is the initial population density (or preplant population density) of this pest at planting. Later infections may cause additional yield loss and provide a reservoir for this pest to survive to infest the next soybean crop. These aspects of life cycle determine the tactics we use to manage this pest. The key to management of this plant parasite consists of limiting reproduction of SCN such that the cyst nematode population density (the number of eggs present at the beginning of the season) is minimized. This goal is accomplished by a long term (2-4 years) strategy aimed at minimizing reproduction of this pest.

RACES OF SOYBEAN CYST NEMATODE

Field populations of SCN are characterized as races 1 through 16. A race of cyst nematode is an indication of a field populations' ability to reproduce on selected soybean host differentials (a set of varieties or breeding lines). Knowing the race of cyst nematode in a given field can assist the grower in making decisions about which resistant varieties should be utilized. For example, if a field has race 1 or 3, then selection of a variety resistant to these races would be the appropriate choice. Centennial and Forrest are two examples of soybean varieties that are resistant to races 1 and 3. Centennial or Forrest, however, are susceptible to races 2 and 4. Unfortunately, many growers have relied on resistant varieties as a sole means of controlling this pest. Continued use of one resistant variety generally results in a change in the nematode population's ability to attack "resistant varieties", referred to as a race shift. If the grower starts with race 1 and grows the variety Forrest for 3 to 5 years, the population may shift from race 1 to race 2 or 4. Thus, the grower needs to know the race of cyst nematode present in addition to the population density. The Nematode Advisory Service (NCDA) will perform race determinations on a limited number of samples. Samples for race determinations should include soil and roots taken from several locations in a field. Assays to ascertain the race of cyst nematode need to be taken during late summer before the nematodes enter a dormant state. The Nematode Advisory Service may not designate the race, but will tell you which resistant varieties are appropriate to your situation. A new soybean variety, Hartwig, is apparently resistant to all races of SCN. Hartwig, however, does not have the yield potential of the older resistant varieties, so the variety resistant to the specific race present is still a desirable option for many growers.

MANAGEMENT

Management of SCN requires the development of both long- and short-term strategies which promote soybean health and minimize reproduction by this pest. Elimination of other production limitations should take first priority, however. Good soil fertility and elimination of compaction problems can be especially helpful since these problems can compound the damage caused by this nematode.

Rotation. Crop rotation is an effective means of managing SCN. Planting a nonhost crop such as corn, tobacco, peanut, cotton or grain sorghum for one year can significantly reduce the SCN population. Two years of a nonhost may be necessary to reduce the SCN densities to levels which will cause no damage, especially in sandy soils. Soybean is more tolerant of SCN in heavier soils than in sandy soils, thus growing soybeans every third year may be the best option on light land; whereas, growing soybeans every other year on heavier land may be an economical solution. Some damage from SCN, will generally occur in rotations of less than 3 years (soybean grown every third year), but it may be at tolerable levels. Rotation is recommended even if resistant varieties are used. Table 1 shows rotations of resistant and susceptible varieties that have proved useful if followed rigorously. The rationale behind this scheme is that resistant varieties will suppress or hold the population density of cyst nematodes at low levels so that the susceptible variety can

be grown every third or fourth year. The inclusion of a nonhost as frequently as possible will reduce the nematode population density and delay the shift to a race which cannot be controlled by a resistant variety, thus prolonging the use of the resistant variety. In situations where resistant varieties are not available, rotations in Table 2 should be considered. In general, the longer the interval between soybean crops, the higher the soybean yield. If a rotation shorter than 3 years (soybean grown every third year) is used, growers should use a maturity group V or earlier soybean variety. Early maturing varieties will not affect yield loss in the current year, but will result in lower population densities in subsequent years, and thus higher soybean yields.

Cultural practices. Various cultural practices can impact cyst nematodes and soybean yield loss. Damage caused to soybean by SCN tends to be greater in early planted soybean than in late planted soybean since the population density declines from April to June. Yields of late-planted soybean, however, tend to be somewhat lower than those planted early. Growers can take advantage of this fact by planting the land most subject to damage by SCN last. No-till farming practices also can impact the soybean cyst nematode. Research conducted in North Carolina has shown that cyst densities are suppressed after 3 years of no-till. The use of no-till resulted in a 5% increase in soybean yield in an SCN-infested field as long as weeds could be adequately controlled.

Chemical control. Several nematicides are labeled for use on soybean. The high rates required for control of soybean cyst nematode combined with the low price of soybean, however, has generally resulted in negative economic returns for growers. For these reasons, currently available nematicides are not generally recommended for control of SCN on soybean.

Resistant varieties. When available, resistant varieties are an economical means of managing SCN. Resistant varieties, however, are not a cure-all. The resistant variety must be matched to the race of SCN to which it is resistant and then used judiciously. Seed companies and the North Carolina Cooperative Extension Service publish information on soybean varieties and relative resistance or tolerance to various nematode species and races. Currently, SCN resistant varieties fall into several categories: resistant to races 1 and 3, resistant to race 3, resistant to races 3 and 4 (3, 9, and 14 by the new scheme), or resistant to all races (Hartwig). Many of the cultivars resistant to race 3 may also be resistant to race 1, and some cultivars resistant to races 3 and 4 may also be resistant to race 1 and partially resistant to race 2. When practical, resistant varieties should still be grown in a rotation with nonhosts and/or susceptible varieties.

Resistant cultivars that limit reproduction of SCN are still attacked by this nematode. A resistant cultivar may still be damaged by SCN, if it follows a susceptible crop, but will still out-perform a susceptible variety. Secondly, the more frequently a resistant cultivar is grown, the sooner a race shift will occur to end the usefulness of this resistant cultivar (this may or may not be the case with Hartwig). Lastly, although many of the new resistant varieties have good yield potential, frequently a susceptible cultivar will outyield a resistant cultivar provided the nematode preplant population density has been reduced. A highly

resistant soybean variety will suppress the nematode population density such that a susceptible cultivar could be grown in rotation with it. Varieties resistant or tolerant to SCN are available. There is, however, a distinction between a resistant variety and a tolerant variety. Resistant varieties "resist reproduction by SCN" and thereby limit damage caused by this pathogen. Tolerant varieties "do not resist SCN reproduction". Nematode reproduction is unrestricted on most tolerant varieties, but yield of tolerant varieties are less affected by the nematodes than are susceptible varieties. Tolerant varieties may be an option if the race of SCN present cannot be controlled by a resistant variety. Tolerance of some soybean varieties has been noted, but has not been adequately evaluated in North Carolina.

Table 1. Suggested rotations for managing soybean cyst nematode with resistant varieties.

Year 1	Year 2	Year 3	Year 4	Year 5
PREFERRED				
Non-host	Resistant variety	Non-host	Susceptible variety	Repeat Cycle
OPTIONAL				
Non-host	Resistant variety	Susceptible variety	Repeat cycle	

Table 2. Suggested rotations for managing soybean cyst nematode without resistant varieties.

Year 1	Year 2	Year 3	Year 4	Year 5	Year 6
PREFERRED					
Non-host	Non-host	Soybean	Repeat cycle		
OPTIONAL					
Non-host	Soybean Group V or earlier	Non-host	Soybean Group V or earlier	Non-host	Repeat cycle

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