

Soybean Cyst Nematode: Old Foe or New Nemesis?

Greg Tylka, Professor, Plant Pathology, Iowa State University

Introduction

The soybean cyst nematode, *Heterodera glycines*, is a very widespread, persistent, and yield-reducing pest in Iowa and much of the Midwest. The nematode is estimated to be in nearly 75% of the fields in Iowa (Workneh et al., 1999), and eggs within cysts (dead females) can remain viable for 10 or more years without a host crop (Inagaki and Tsutsumi, 1971). Yield loss can occur without obvious aboveground symptoms occurring (Wang et al., 2003).

Until 2005, it had been several years since widespread, devastating losses from SCN had occurred in Iowa. But this year, severe damage and yield loss from SCN was reported in widespread areas of the state, areas that experienced hot, dry growing conditions throughout most of the growing season. While this severe damage, and the accompanying serious yield losses, draw the attention to the potential for disaster in fields infested by the nematode under harsh environmental conditions, all soybean growers in the Midwest should be wary of this insidious pest. To that end, following is a review of the basic biology of and recommended management strategies for the soybean cyst nematode.

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. Consequently, two to four generations per growing season are possible in the Midwest. Worm-shaped soybean cyst nematode juveniles hatch from eggs in the soil when adequate temperature and moisture levels occur in the spring (Schmitt and Riggs, 1989). These juveniles are the only life stage of the nematode capable of infecting soybean roots. Hatched juveniles that do not penetrate host roots and begin feeding will die from starvation, predation, or parasitism within several days to a few weeks.

After penetrating the soybean roots, juveniles move through the root until they contact the vascular tissue. There they cease moving and begin to feed. As the nematodes feed and develop, they swell. Eventually the female nematodes become so swollen that they break out through the root tissue and are 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 on the root surface. After fertilization, males eventually die whereas 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 eventually will 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 or so 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 also will survive within the cysts for

many years (Inagaki and Tsutsumi, 1971).

Management of Soybean Cyst Nematode

For all practical purposes, soybean cyst nematode never can be eliminated from a field once it is present. However, there are things that can be done to manage the nematode in order to maximize soybean yields and minimize reproduction of the nematode. Effective management of soybean cyst nematode involves a three-prong approach of 1) scouting for early detection of infestations, followed by proper use of 2) resistant soybean varieties in rotation with 3) nonhost crops in infested fields. Also, a few soil-applied nematicides are available for management of the nematode, although the economics of field-wide application of such chemicals prohibitive for many growers.

Early detection

Because aboveground symptoms are not a reliable indicator of soybean cyst nematode damage (Wang et al., 2003), it is not possible to know if a field is infested with soybean cyst nematode just by looking at the tops of the plants. Many fields that are infested with the nematode, and in which yields are being significantly reduced, appear to be healthy based on the appearance of the tops of the plants. The lack of symptom occurrence and subsequent missed diagnosis are unfortunate because the key to effective management of the soybean cyst nematode is early detection, before large nematode population densities develop. The only reliable way to know if a field is infested with soybean cyst nematode is to either dig roots of soybean plants during the season and look for adult nematode females or take a soil sample and have it analyzed by a qualified laboratory.

Use of soybean cyst nematode-resistant soybean varieties

Resistant soybean varieties are the most effective tool available for managing soybean cyst nematode. By growing 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 on most resistant varieties.

There are hundreds of soybean varieties available with resistance to the soybean cyst nematode (Tylka, 2004). Currently, there are three main genetic sources for SCN resistance genes in commercial soybean varieties, namely three soybean breeding lines called PI 88788, Peking, and Hartwig, which is derived from PI 437654. Additionally, one variety with resistance genes from the breeding line PI 209332 is available. Each of these sources of resistance contains several genes that provide resistance to the nematode. Consequently, soybean varieties developed from the various sources of resistance may not all contain the same genes in the same combinations.

All of these sources of resistance to the soybean cyst nematode allow limited reproduction of only a few of the nematodes. Limited reproduction by a few nematodes on a resistant soybean variety does not pose a problem in a single growing season. However, if soybean varieties containing the same source of resistance are grown repeatedly for many years, there is the potential for build-up of a population of nematodes that readily reproduce on that source of resistance. Thus, use of resistant soybean varieties, particularly any single soybean cyst nematode-resistant variety, should not be considered the sole solution for managing the nematode. Instead, Iowa State University recommends growing nonhost crops, such as corn, in conjunction with soybean varieties with different sources of resistance in a crop rotation scheme to discourage the build-up of nematode

populations that reproduce readily on resistant soybean varieties (Tylka, 2003). If growers cannot utilize soybean varieties with different sources of resistance to the nematode in successive soybean crops, they should try to grow different resistant varieties derived from the common source of soybean cyst nematode resistance, PI 88788 (Niblack, 2005).

Furthermore, Iowa State University recommends that a susceptible soybean variety be grown once after all types of available resistance have been used to offset the effect of growing the resistant soybean varieties (Tylka, 2003). But before doing so, growers are cautioned to sample fields to confirm that population densities of the nematode are relatively low. Following is a recommended six-year rotation scheme using different types or sources of soybean resistance in conjunction with susceptible soybean varieties and nonhost crops for integrated management of soybean cyst nematode.

- 1st year - nonhost crop
- 2nd year - resistant soybean
- 3rd year - nonhost crop
- 4th year - resistant soybean different than that used in 2nd year
- 5th year - nonhost crop
- 6th year - high-yielding, susceptible soybean

Use of nonhost crops

Soybean cyst nematode is an obligate parasite. The nematode is unable to mature and reproduce in the absence of host roots. Consequently, soybean cyst nematode population densities decline during any year that nonhost crops are grown. Alfalfa, corn, and oats are common nonhost crops grown in Iowa, and soybean cyst nematode densities decline similarly when these three crops are grown in infested fields. Soybean cyst nematode population densities generally decline from 10 to 50% during a year that a nonhost crop is grown, but the magnitude of decline is unpredictable because the change in population density varies from year to year and is greatly influenced by environmental conditions.

Summary

Soybean cyst nematode always will be a major threat to soybean production in Iowa because the nematode survives for many years in infested soils, causes significant reductions in soybean yields at relatively low population densities, and reproduces to high population densities very quickly. However, an integrated management program can effectively prevent increases in soybean cyst nematode population densities and maintain profitable soybean yields in fields infested with the pest. Such a management program must include scouting for early detection of soybean cyst nematode infestations followed by rapid implementation of a thorough crop rotation program including nonhost crops and resistant soybean varieties.

Literature cited

Inagaki, H., and M. Tsutsumi. 1971. Survival of the soybean cyst nematode, *Heterodera glycines* Ichinohe (Tylenchida: Heteroderidae) under certain storing conditions. *Applied Entomology and Zoology* 6:156-162.

- Niblack, T. L. 2005. Soybean cyst nematode management reconsidered. *Plant Disease* 89: 1020-1026.
- Schmitt, D.P., and R.D. Riggs. 1989. Population dynamics and management of *Heterodera glycines*. *Agricultural Zoology Reviews* 3:253-269.
- Tylka, G.L. 2003. Iowa State University Plant Disease Clinic soybean cyst nematode management recommendations. Iowa State University Cooperative Extension Service, Publication IPM-63, 2 pp.
- Tylka, G.L. 2004. Soybean cyst nematode-resistant soybean varieties for Iowa. Iowa State University Extension publication Pm 1649. 20 pp.
- Wang, J., Niblack, T.L., Tremain, J.A., Wiebold, W.J., Tylka, G.L., Marett, C.C., Noel, G.R., Myers, O., and M.E. Schmidt. 2003. Soybean cyst nematode reduces soybean yield without causing obvious aboveground symptoms. *Plant Disease* 87:623-628.
- Workneh, F., Tylka, G.L., Yang, X.B., Faghihi, J. and J.M. Ferris. 1999. Regional assessment of soybean brown stem rot, *Phytophthora sojae*, and *Heterodera glycines* using area-frame sampling: prevalence and effects of tillage. *Phytopathology* 89:204-211.