ROTATIONAL EFFECTS ON SOYBEAN CYST NEMATODES

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Introduction

In 2002 we concluded a three-year study of the soybean cyst nematode (SCN), *Heterodera glycines*, in commercial soybean fields in Wisconsin. We studied 20 fields in 5 counties during at least one soybean crop plus one rotation crop. The fields were intensively sampled and each sampling location was georeferenced and data collected on multiple dates. Some of the conclusions of the study were:

1. Infested areas are not always located at equipment entry points into a field, demonstrating that SCN enters via wind or animals.
2. Average population densities of fewer than 1000 eggs/100 cm^3 soil are indicative of a patchy pattern of SCN in a field.
3. Sampling plans based on crop performance or SCN-induced symptoms such as delayed canopy closure are most likely to detect a SCN infestation.
4. SCN produce at least two generations of nematodes per soybean season in Wisconsin.
5. SCN reproduce on soybean cultivars designated as resistant to SCN, but to a lesser extent than on susceptible soybean cultivars.
6. Some SCN females continue to reproduce on root fragments in the soil after the canopy is dead and the beans harvested.
7. Estimates of overwinter survival based on the change in SCN population densities from October to the following May can be greater than 100% due to this phenomenon.
8. There is a yield advantage to planting SCN-resistant cultivars when egg densities at the time of planting exceed 500 cm^3 soil.
9. Cultivars designated as resistant to SCN do not achieve their full yield potential when egg densities at the time of planting exceed 10,000/100 cm^3 soil.
10. Growing soybeans in a soybean/corn rotation is highly likely to increase SCN population densities over time, even if SCN-resistant varieties are planted.

The most critical message for soybean growers is that once SCN enters a field, the problem is not likely to go away. Growers should remain vigilant in monitoring SCN population densities and develop an arsenal of tactics to maintain SCN at levels that won't impede soybean yield potential. The most crucial factor for achieving acceptable yield of any cultivar in an SCN-infested field is the amount of SCN inoculum (eggs) present at the time of planting. The initial egg density (Pi) is determined by the suitability of the previous soybean crop for nematode reproduction and the survival rate during the absence of a host.

Results and Discussion

Studies of the change in SCN population densities from the end of one soybean crop until the beginning of the next in a soybean/corn rotation were completed in 2002. Population densities of SCN were measured twice during the soybean year, twice during the corn rotation year, and in May of the second soybean crop for five fields in 1999-2001 and five fields in 2000-2002. All crops were planted, maintained, and harvested by the grower cooperator and sampled by us.

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Some were planted with an SCN-resistant cultivar, some with a susceptible cultivar, and some with both. The number of samples collected per field ranged from 25 to 110. Only those sampling points positive for SCN were used for data analysis. Egg counts from one sampling date to the next were compared using analysis of variance. For those fields where there was a statistically significant change using date as the variable, the change for each sampling location within a field was computed and then averaged for the field.

The impact of the soybean crop was measured by dividing SCN egg densities in October right after soybean harvest by the number present in May when soybean was planted. In some cases the increase was unrealistically high so a maximum value of 10.0 was assigned. For samples where the initial number was zero and the subsequent number was greater than zero, the value was set to 1.0.

The change in egg density during the rotation year was analyzed using date as the variable and when appropriate, the change for each sampling location within a field was computed and averaged. The impact of the corn rotation crop was measured by dividing SCN egg densities per 100 cm^3 soil at the time of planting the second soybean crop by egg densities at the end (October) of the first soybean crop.

Seven fields were positive for SCN in more than 10 sampling locations and were included in the analysis. Five of the seven fields showed an increase of SCN population densities during the soybean year (final /initial densities >1.0), including one field planted with only an SCN-resistant cultivar (Table 1). All but one of the fields showed a significant decline in SCN population densities by the time the next soybean crop was planted, but in only two fields was the decline sufficient to offset the increase that occurred during the soybean year. For example, in field 1, the SCN population increased by more than 4x in response to a resistant soybean cultivar and decreased about 2x during the nonhost portion of the rotation, leading to greater SCN pressure for the second soybean crop than the first. There was no yield depression due to SCN in this field, but there could be in the future if SCN continues to increase.

Table 1. *Seven case studies of the change in SCN population densities during the soybean year and during a soybean/corn rotation. At least 25 samples were collected per field, but only those locations positive for SCN were included in the averages presented. The fields were planted with cultivars resistant (res) or susceptible (sus) to SCN or both (res/sus) during the first soybean crop studied.*

Field	Years studied	Year in corn	# samples positive for SCN	Cultivar planted year 1	Average final vs initial SCN egg densities during soybean 1[a]	Average % remaining at start of soybean 2[b]
1	2000-02	2001	55	res	4.13	55%
2	2000-02	2001	39	res/sus	3.58	74%
3	2000-02	2001	13	res/sus	1.00	77%
4	2000-02	2001	19	sus	2.72	66%
5	1999-01	2000	49	res/sus	1.85	100%
6	1999-01	2000	55	res/sus	7.09	60%
7	1999-01	2000	13	res	1.00	79%

[a] A value of 1.0 indicates no change in SCN population densities. Values greater than 1.0 indicate an increase. Samples were collected at planting (initial) and harvest (final) of soybean.

[b] Percentage of the SCN present following soybean still in the field for the next soybean crop.

We also initiated studies using pea and soybean trap crops planted prior to the corn crop in a soybean/corn rotation. The sugarbeet cyst nematode, *Heterodera schachtii*, is managed very effectively in Europe using trap crops. A trap crop supports nematode infection but is harvested before the nematode can reproduce. In the absence of a suitable host, the hatched juvenile nematodes starve to death. Attempts in other states to use trap crops to elicit the hatch of SCN eggs have met with limited success (Chen et al., 2001). Our results to date show that pea is a better choice than soybean because it germinates at cooler temperatures. Once the corn germinates, hatch of SCN eggs appears to decrease appreciably, indicating that either the trap crop must be planted well in advance of the rotation crop or the trap crop should be the rotation crop.

Cultural tactics successful in accelerating the decline of other nematode pests include green manure cover crops that stimulate microbial antagonists of nematodes, crops that release nematode-suppressive compounds such as marigolds or *Brassica* spp., or the addition of fungal antagonists that attack cyst nematode eggs. These measures have not been studied in Wisconsin for the SCN, but appear to have potential based on research in Wisconsin (MacGuidwin et al., 2000) and elsewhere (Alexander and Waldenmaier, 2002) with the root lesion nematode, *Pratylenchus* spp.

Future Issues: Our data show an inverse relationship between numbers of SCN and root lesion nematodes in commercial soybean fields. Our hypothesis is that the presence of SCN depresses root lesion nematode densities because they are not as competitive as SCN for feeding sites on soybean roots. Anecdotal evidence is accumulating that root lesion nematodes are becoming more of problem in corn in soybean production areas. The relationship between the use of SCN-resistant cultivars and changes in SCN and root lesion population densities merits attention. Both soybean and corn are hosts for root lesion nematodes and no cultivars resistant to this nematode are available for either crop.

References

Alexander, S. A., and C. M. Waldenmaier. 2002. Suppression of Pratylenchus penetrans populations in potato and tomato using African marigolds. J. Nematol. 34:130-134.

Chen, S. Y., P. M. Porter, C. D. Reese, L. D. Klosser, and W. C. Steinstra. 2001. Evaluation of pea and soybeans as trap crops for managing *Heterodera glycines*. J. Nematol. 33:219-226.

MacGuidwin, A. E., A. Reid-Rice, I. Saeed, D. Sexson, J. Wyman, and T. Connell. 2001. Cover crops in potato production. Proc. WI Ann. Potato Meeting, 265-269.