SCN Population Effects on SDS and Soybean Yield

Introduction

Soybean cyst nematode (SCN; *Heterodera glycines*) has long been the chief nemesis of soybean production in the U.S. This tiny worm-like parasite has now spread to practically all important soybean production areas of the U.S., and is reaching economic levels in more and more fields. SCN may decrease yields substantially without inducing obvious symptoms. In fact, studies have shown that in SCN-infested fields, yields can be reduced by over 30 percent without visible above-ground symptoms.

SCN Interaction with SDS

Several research studies have shown an association between SCN and sudden death syndrome (SDS; *Fusarium virguliforme*) in soybean, where SDS symptoms and subsequent yield loss tend to be worse in areas where SCN is also present. SCN increases the stress on the soybean plant, and also provides wounds through which the SDS pathogen may enter the roots. Recent research conducted in Wisconsin showed that infestations of SCN and SDS were not correlated; the presence of one in the soil did not increase the likelihood of the other also being present (Marburger et al., 2013). However, in instances where both were present, crop damage and yield loss tended to be worse.

Figure 1. Differences in SDS symptoms between soybean varieties in a research study near Decatur, MI; Aug. 17, 2012.

Genetic Resistance to SCN and SDS

The most important management tactic for both SCN and SDS is selection of resistant varieties. Researchers have identified a number of soybean lines that have the ability to resist nematode reproduction on their roots. Currently, there are three main sources for genetic resistance to SCN – PI88788, PI548402 (Peking), and PI437654 (Hartwig and CystX). The PI88788 source is used in the vast majority of existing SCN-resistant varieties marketed in the US. Only a small number of varieties currently use the PI548402 source, and even fewer use the PI437654 source.

Soybean varieties can show dramatic differences in tolerance to SDS infection with tolerance exhibited primarily as a reduction in symptom severity. For that reason, variety selection is a key management practice to reduce plant damage and yield loss due to SDS. To assist growers in choosing resistant varieties, Pioneer researchers rate products (1 to 9 scale; 9 = most tolerant) based on field trials at multiple test sites with known historical SDS occurrence.

SCN HG Types

SCN populations are genetically diverse and have historically been separated into races by their ability to reproduce on soybean tester lines. The most commonly used system separated SCN into 16 races. More recently, a new classification system called the HG Type test has been widely adopted. The HG Type test is similar to a SCN race test but includes only the seven sources of resistance in available SCN-resistant soybean varieties. Results are shown as a percentage, indicating how much the nematode population from a soil sample increased on each of the seven lines.

The HG Type test indicates which sources of resistance would be suited for the field being tested. For example, if an HG type contains the number 2, this indicates that PI88788 would not be an effective source of SCN resistance (Table 1).

Table 1. Indicator lines for HG Type classification of SCN.

	Indicator Line		Indicator Line
1	PI548402 (Peking)	5	PI209332
2	PI88788	6	PI89772
3	PI90763	7	PI548316
4	PI437654 (Hartwig)		

If a single genetic source of SCN resistance is used repeatedly, race shifts can occur in a field. For this reason, nematologists recommended rotating sources of resistance, in addition to crop rotation and other management practices.

Research Study

A three-year field research study was conducted as part of the DuPont Pioneer Crop Management Research Awards (CMRA) Program with Dr. Martin Chilvers of the Dept. of Plant, Soil, and Microbial Sciences, Michigan State University. The objectives of this study were to evaluate:

- Performance of Pioneer brand soybean varieties with differing levels of resistance to SCN and SDS
- The interaction between SCN and SDS in their effects on soybean yield.
- SCN reproduction on soybean varieties with different resistance sources.

Study Description

Research trials were conducted from 2011 through 2013 in a field near Decatur, MI with heavy SDS pressure and initially low to moderate SCN pressure. All soybean trials were conducted in the same 10-acre field and were established following a soy-corn rotation, except for the 2012 season in which they were conducted following a soy ('09) -corn ('10) -soy ('11) rotation. The trial in 2011 and 2012 was organized in a RCBD with five replicates. Each plot was 40 ft. long and trimmed to 34 ft. for harvest. Plots contained six rows in 15-inch spacing, with the center four used for rating and harvest. In 2013, the design was altered to four row plots at 30 inch spacing, planted at 17.5 ft. long.

Four Pioneer brand soybean varieties with differing SCN resistance sources and SDS resistance were compared in 2011 and 2012, with two more varieties added in 2013 (Table 2).

Table 2. SCN resistance source and SDS resistance ratings of Pioneer brand soybean varieties used in the trial.

Variety/ Brand*	Years Used	SCN Resistance	SDS Resistance
92Y53 (RR)	2011-2013	Peking	6
92Y51 (RR)	2011-2013	PI88788	6
92M82 (RR)	2011-2013	None	3
92Y91 (RR)	2011-2013	None	5
93Y20 (RR)	2013	PI88788	7
92M75 (RR)	2013	Peking	5

An SCN HG Type test determined the presence of SCN type 2.5.7 (PI88788; PI209332; PI548316) at the trial location.

Measurements

SDS symptoms were rated using the standard university rating system of disease incidence (DI) on a 0-100% scale and 1-9 disease severity (DS) scale to derive the disease severity index (DSI), where DSI = (DS/9) x DI. Soil samples were collected just after planting and harvest each year for SCN quantifications. Foliar SDS development was monitored throughout the season with reported ratings taking place at or around R6 growth stage as symptoms peaked.

Results

1. What were the dynamics of the SCN populations across years?

SCN populations in the soil were generally low in the research field at the inception of the study in spring of 2011 (Figure 2). In all three years of the study, an increase in SCN numbers during the growing season was associated with soybean varieties with no SCN resistance. The most dramatic increase in SCN numbers occurred in the first year (2011) of the trial, where the initial SCN numbers were on average only 614 eggs + juveniles per 100cc of soil. At the beginning of the 2012 and 2013 seasons, there were on average 8,024 and 8,064 eggs + juveniles per 100cc of soil, respectively. This demonstrates the potential for relatively low SCN numbers to rapidly increase under favorable conditions.

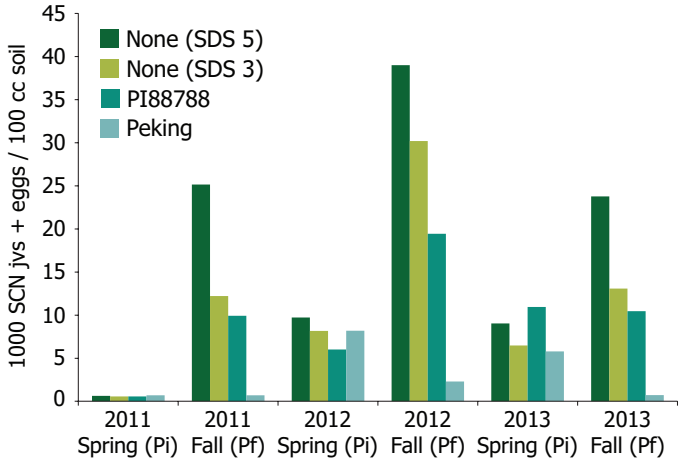

Figure 2. Soybean cyst nematode juvenile + egg counts for the beginning and end of each season.

2. What was the efficacy of PI88788 and Peking SCN resistance sources in managing SCN?

In a lab test, the SCN population was found to be type HG 2.5.7, indicating that SCN had broken resistance to the PI88788 resistance source. The HG type test results were reflected in SCN reproduction in the field. Although PI88788 resulted in a lower SCN reproduction compared to varieties with no resistance source, reproduction on PI88788 was much higher than SCN reproduction on the Peking resistance source (Table 3). The Peking resistance source resulted in no net increase of SCN numbers in 2011 (Pf/Pi = 1.01) and even reduced the moderate to high SCN numbers in 2012 and 2013 with Pf/Pi ratios of 0.03 to 0.28 across years and varieties.

Table 3. Soybean cyst nematode reproduction ratio (Pf/Pi) associated with soybean varieties in 2011, 2012, and 2013.

Variety/ Brand*	SCN Resistance	Pf/Pi**		
		2011	2012	2013
92Y91 (RR)	None	39.8	4.0	2.8 a
92M82 (RR)	None	22.0	3.7	2.7 a
92Y51 (RR)	PI88788	17.2	3.2	1.2 ab
92Y53 (RR)	Peking	1.0	0.28	0.14 b
93Y20 (RR)	PI88788	-	-	2.2 a
92M75 (RR)	Peking	-	-	0.03 b

*** Values with a column followed by the same letter are not significantly different at α = 0.05.*

3. Did increased SCN pressure from low to moderate-high result in an increase in SDS disease severity?

The SDS pressure at the field location was very high when first observed in 2009, with a 50% yield loss reported by the producer. The initial SCN pressure at the field location was significantly lower in 2011 compared to 2012 and 2013; however, no apparent increase in severity of SDS symptoms was noted between years. Soybean varieties with Peking SCN resistance developed the least amount of foliar SDS symptoms (Table 4). Varieties with PI88788 resistance sources developed intermediate levels of foliar SDS symptoms while those with no SCN resistance developed the greatest SDS symptoms. The comparison of Pioneer varieties 92Y91 and 92M75 in 2013 clearly shows the importance of SCN resistance in managing SDS. Both varieties are rated a 5 for SDS (moderate resistance) but 92M75 has Peking SCN resistance and had greatly reduced levels of SDS compared to 92Y91, which has no SCN resistance.

Table 4. Soybean varieties and SDS disease index by year.

Variety/ Brand*	SCN / SDS Resistance	SDS Disease Index**		
		2011	2012	2013
92Y91 (RR)	None / 5	50.5 b	50.9 b	49.8 a
92M82 (RR)	None / 3	98.0 a	76.3 a	75.6 a
92Y51 (RR)	PI88788 / 6	0.7 c	9.8 c	23.8 b
92Y53 (RR)	Peking / 6	0.9 c	0.0 c	0.0 d
93Y20 (RR)	PI88788 / 7	-	-	5.0 c
92M75 (RR)	Peking / 5	-	-	0.3 d

*** Values with a column followed by the same letter are not significantly different at α = 0.05.*

4. What was the effect of intense SDS and SCN pressure on soybean yield?

Despite supplemental overhead irrigation, yields of some varieties were very low due to the heavy SDS disease and SCN pressure. Pioneer varieties 92Y53 and 92M75, which have Peking SCN resistance and moderate resistance to SDS, outperformed all other varieties, including those with PI88788 SCN resistance (Table 5). Pioneer 92M82, which has no SCN resistance and low resistance to SDS, was the lowest-yielding variety in all three years of the study. Pioneer 92Y91, which also has no SCN resistance but has moderate resistance to SDS, yielded significantly better than 92M82, but still far less than the other varieties.

Table 5. Grain yield of soybean varieties by year.

Variety/ Brand*	SCN / SDS Resistance	Yield**		
		2011	2012	2013
		bu/acre		
92Y91 (RR)	None / 5	25.1	12.7 c	25.2 c
92M82 (RR)	None / 3	12.0	5.8 d	12.8 d
92Y51 (RR)	PI88788 / 6	43.4	31.0 b	38.3 b
92Y53 (RR)	Peking / 6	48.9	44.3 a	56.9 a
93Y20 (RR)	PI88788 / 7	-	-	37.1 b
92M75 (RR)	Peking / 5	-	-	56.2 a

** Values with a column followed by the same letter are not significantly different at α = 0.05.

Overall, results of this study showed that SCN management is a critical component of reducing symptoms and yield loss associated with SDS. Varieties with the appropriate SCN resistance source for the races present in the field (Peking, in this case) and moderate to high genetic resistance to SDS. Knowing the SCN population type and matching the correct genetic resistance can help reduce SDS and SCN injury.

Reference and Acknowledgements

Marburger, D., S. Conley, and J. Gaska. 2013. The Relationship Between the Causal Agent of SDS and SCN in Wisconsin. Univ. of Wisconsin Extension.

www.coolbean.info/library/documents/SCN_SDS_2013_FINAL.pdf

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* All Pioneer products are varieties unless designated with LL, in which case some are brands.

RR - Contains the Roundup Ready® gene.
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