# Impact of *F. virguliforme* and *H. glycines* on Soybean

**L. F. Brzostowski[1], W. T. Schapaugh, Jr.[1], C. R. Little[2], T. C. Todd[2]**
**[1]Department of Agronomy, [2]Department of Plant Pathology, Kansas State University**

## INTRODUCTION

*Fusarium virguliforme*, the soilborne fungus which causes sudden death syndrome of soybean (SDS), and *Heterodera glycines* Ichinohe, soybean cyst nematode (SCN), are two economically important pathogens of soybean in the Midwest (Roy et al, 1997). The two pathogens are often found together in soybean (*Glycine max* (L.) Merr.) fields suggesting that there is a possible interaction between them.

## OBJECTIVES

- Evaluate relationships between populations of SCN and *F. virguliforme* and the development of SDS.
- Characterize the response of soybean genotypes to SDS and SCN.

## MATERIALS AND METHODS

**Experimental design:** In 2008 and 2009, four replications of four soybean genotypes selected to encompass resistance and susceptibility to SDS and SCN were planted in eight row plots at seven environments in Manhattan, Morganville, Rossville, and Topeka in a randomized complete block design (Table 1).

Table 1. SDS ratings and SCN Female indices of soybean genotypes from the KSU 2007 Soybean Performance Test. Genotypes were selected prior to the 2008 growing season.

| | | SCN Female Index† | |
|---|---|---|---|
| Genotype | SDS Rating‡ | Race 3 | Race 4 |
| COM1 | 1.0 | 8 | 13 |
| COM2 | 1.7 | 22 | 92 |
| COM3 | 4.3 | 23 | 32 |
| KS3406RR | 4.7 | 74 | 118 |
| LSD (0.05) | 1.0 | 29 | 44 |

†SDS rating, where 1=no disease and 5=premature plant death during early pod fill.
‡SCN female index (FI), where the FI=(mean # of cysts on a variety/mean number of cysts on a suceptible check) x 100. A low FI (<10) indicates the SCN population was not able to reproduce on the differential line, and a high FI indicates the SCN population was able to reproduce well.

a

b

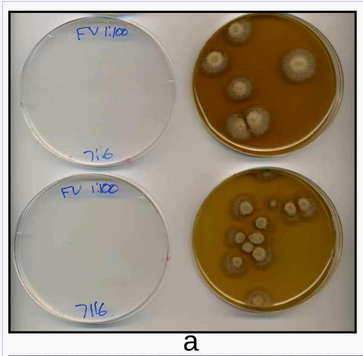
Fig. 1a. Soil sampling. b. Grinding roots.

**Pathogen quantification:** Soil samples were collected at planting, harvest, and midseason on a per plot basis (Fig. 1a). Prior to harvest, taproot samples were collected and ground to pass through a 0.5 mm screen (Fig 1b). Soil and root populations of *F. virguliforme* were determined on modified Nash and Snyder (MNS) media as colony forming units/gram soil (cfu/g) (Fig. 2a). SCN was quantified using a sieve technique and reported as eggs and J2/100 cc soil (Fig. 2b).

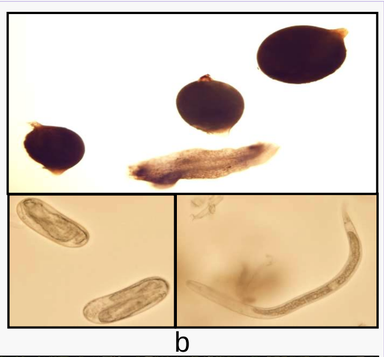
**Disease ratings:** Once SDS symptoms began to develop, SDS disease ratings were taken per plot every other week and the area under the disease progress curve calculated (AUDPC) (Fig. 2c) (Shaner and Finney, 1977).

**Harvest notes:** Height, maturity, and lodging was recorded and plots were harvested for seed yield.

**Statistical analysis:** Data was subjected to analysis using SAS Proc GLM and Proc CORR procedures.



a



b

c

Fig. 2a. *F. virguliforme* colonies on MNS media b. SCN female cysts, J2 juvenile, egg (clockwise from top center) c. SDS foliar symptoms in field

## RESULTS

There were significant differences observed between environments for all measured variables (Table 2). There were significant differences seen between genotypes with yield, *F. virguliforme* population at planting, *F. virguliforme* root population, SCN population at harvest, and AUDPC. A genotype by interaction was observed with yield, *F. virguliforme* population at harvest, SCN population at midseason and harvest, and AUDPC.

**Table 2.** ANOVA table of p values among variables.

| | | Variable | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | *F. virguliforme* population | | | | SCN Population | | | |
| Source | d.f. | Yield | Planting | Midseason | Harvest | Root | Planting | Midseason | Harvest | AUDPC |
| Environment | 6 | **<.01**** | 0.06 | **<.01**** | **<.01**** | **<.01**** | **<.01**** | **0.01**** | **<.01**** | **<.01**** |
| Genotype | 3 | **<.01**** | 0.12 | 0.54 | 0.55 | 0.10 | 0.89 | 0.22 | 0.08 | **<.01**** |
| Gen x Env§ | 18 | **0.02*** | 0.55 | 0.17 | 0.10 | 0.73 | 0.26 | 0.12 | **0.01*** | **<.01**** |

*Significant at p=0.05, **Significant at p=0.01

Yields were significantly different across and within locations among genotypes. Genotypes resistant to SDS generally yielded higher (Fig. 2).

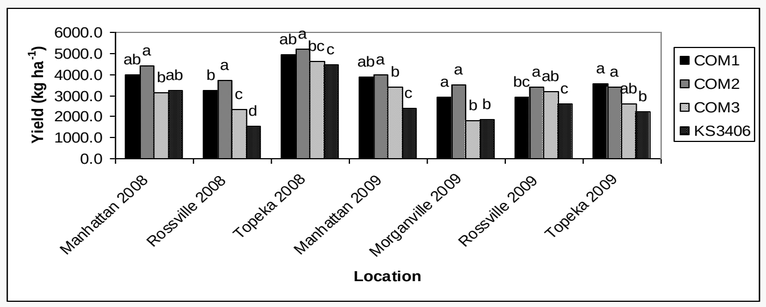



**Fig. 2.** Yields at all environments separated by genotype.

Yield was negatively correlated to *F. virguliforme* population at planting and AUDPC (Table 3, Figure 3). SCN at planting was positively correlated to *F. virguliforme* soil populations (Table 3). AUDPC was positively correlated to *F. virguliforme* soil populations at planting and midseason and SCN population at planting.

**Table 3.** Pearson's correlation coefficients for variables.

| | | Variable | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | *F. virguliforme* populations | | | | SCN populations | | | |
| | Variable | Yield | Planting | Midseason | Harvest | Root | Planting | Midseason | Harvest | AUDPC |
| *F. virguliforme* | Yield | | **-0.42*** | -0.19 | -0.11 | -0.30 | -0.23 | 0.07 | 0.14 | **-0.76**** |
| | Planting | | | **0.54**** | **0.46*** | -0.01 | **0.51**** | 0.18 | -0.02 | **0.61**** |
| | Midseason | | | | **0.91**** | **-0.43*** | **0.51**** | 0.34 | 0.15 | **0.40*** |
| | Harvest | | | | | -0.24 | **0.46*** | 0.28 | 0.10 | 0.32 |
| | Root | | | | | | -0.02 | -0.27 | -0.24 | 0.06 |
| SCN | Planting | | | | | | | **0.45*** | 0.19 | **0.40*** |
| | Midseason | | | | | | | | **0.67**** | -0.06 |
| | Harvest | | | | | | | | | -0.05 |
| | AUDPC | | | | | | | | | |

*Significant at p=0.05, **Significant at p=0.01

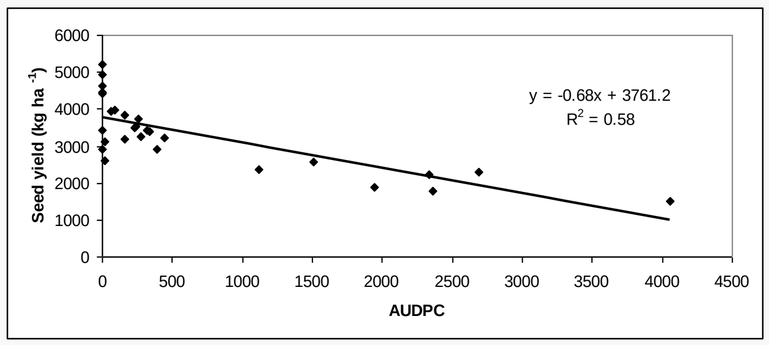



**Fig. 3**. Average seed yield of each genotype at each environment versus AUDPC.

## CONCLUSIONS

AUDPC was positively correlated to *F. virguliforme* soil populations at planting and midseason and SCN population at planting.

As disease pressure increased, the performance of resistant genotypes increased compared to susceptible genotypes.

Genetic resistance to SDS and SCN is important in protecting yields in fields with a history of the two diseases.

## REFERENCES

Roy, K. W., Hershman, D. E., Rupe, J. C, and Abney, T. S. 1997. Sudden death syndrome of soybean. Plant Disease 81(10):1100-1111.

Shaner, G. and Finney, R. E. 1977. The effect of nitrogen fertilization on the expression of slow-mildewing resistance in Knox wheat. Phytopathology:67:1183-1186.

## ACKNOWLEDGMENTS

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