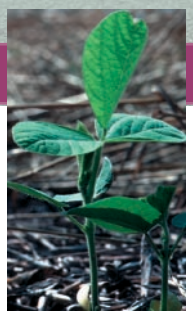
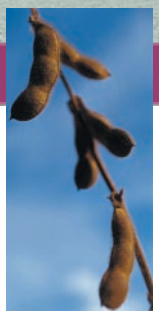




Mark E. Westgate, Kenneth A. Kaiser, Robert Horton, and Tyson E. Ochsner, Department of Agronomy; Gregory L. Tylka, Department of Plant Pathology; Kenneth A. Kaiser, Department of Agronomy; and William D. Batchelor, Department of Agricultural and Biosystems Engineering, Iowa State University, Ames

Adequate Rainfall Can Disguise Soybean Cyst Nematode-Problem Fields

It is tempting to assume that soybean cyst nematode (SCN) is not a problem or not present in high-yielding soybean fields. The results of the Yields II project, however, indicate that rain may disguise a developing SCN problem that manifests when it becomes more difficult for plants to extract moisture from the soil. Test for SCN in high-yield years and in high-yielding areas of fields so you are not surprised by SCN problems in dry years.

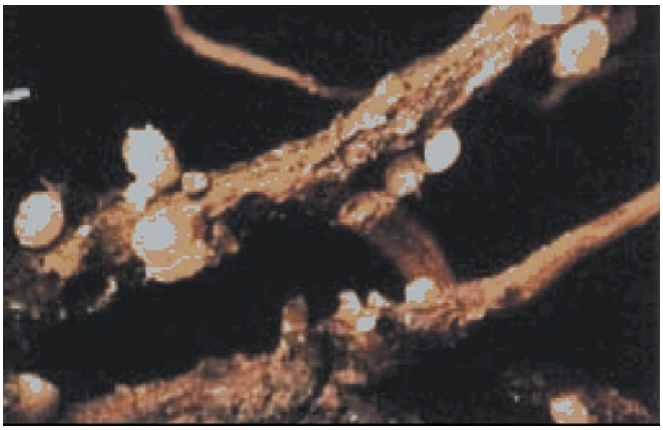
A central theme of the Yields II project was to demonstrate how the combination of stresses caused by soybean cyst nematode (SCN) infestation, herbicide damage, and water stress combine to decrease soybean yield. Field observations indicated that the presence of SCN in the field made stresses due to herbicide injury and lack of soil moisture much more of a problem for the soybean plant. This report focuses on the interaction between SCN and soil moisture and its impact on soybean yield.

SCN is a major concern for soybean growers because it is present in all major soybean-producing regions in North America and can cause up to 30% yield loss without severe aboveground symptoms. The pathogen invades young soybean roots and females form feeding sites from which they remove nutrients from the plant. Besides tapping energy from the plant, these feeding sites are thought to disturb normal root function. The most important of these functions is to transport water to the leaves, stem, and pods. Physiological studies have shown that the soybean root system is a relatively poor conductor of water, even under favorable growing conditions. If SCN infection is severe enough to disrupt water delivery to the shoot, then the plants are likely to suffer sooner when the soil starts to dry. The Yields II project revealed that herbicide injury, which generally would not affect yield, caused a significant yield loss when plants also were stressed by SCN infection and drying soil conditions (see Yields II fact sheet, *Double Trouble in a Dry Year: Herbicide and SCN*). When there is adequate soil moisture throughout the season, however, the symptoms of SCN infestation are not so obvious. It is tempting to assume that SCN is not a problem or not present in a high-yield field. But recent ISU research indicates that SCN egg counts can rise very quickly in fields considered presumably SCN-

free. The results of the Yields II project indicate that timely rains, although welcomed for their positive impact on yield, may disguise a developing SCN problem that occurs "out of nowhere" when it becomes more difficult for the plants to extract moisture from the soil.

Field trials examine stress interactions

Yields II researchers tested for interactions between stresses caused by SCN, herbicide, and lack of water in a 3-year study (2000–2002) in replicated trials located at the Bruner Farm near Ames, Iowa. This location was ideally suited for this research because soybean has been grown there for several years, and the soil is infested with SCN eggs. The levels of SCN increased dramatically during the study, from approximately 1,200 eggs/100 cc of soil in 2,000 to more than 7,500 eggs/100 cc of soil in 2002 (Figure 1).



Cysts formed on roots by female soybean cyst nematodes. Each cyst can contain hundreds of eggs. Photo courtesy of Iowa State University Extension.

Moisture stress also varied each season. The relative soil moisture deficit was estimated by comparing the amount of rainfall that fell during the various plant growth stages with the amount of water used by the crop (evaporation). A deficit is registered when crop water use exceeds rainfall. The greatest moisture deficit occurred in 2000 when plants were developing pods and filling seed. A moderate level of stress occurred during these stages in 2001. The 2002 growing season was the most favorable because rainfall was sufficient to meet evaporative demand during the entire season.

Adequate soil moisture limited yield loss due to SCN

The impact of increasing the level of SCN infestation on grain yield was tested by growing SCN-resistant and SCN-susceptible varieties side by side in the field. The SCN-resistant varieties were AG2201 and PS423N; SCN-susceptible varieties were AG2301 and AG2401. The highest yields were obtained in the year with the most favorable soil moisture, 2002 (Figure 2, blue bars). All four varieties yielded about the same in 2002 (no statistical differences among varieties). The two SCN-susceptible varieties yielded considerably less than their SCN-resistant counterparts in 2000 and 2001.

This result was remarkable considering that the level of SCN infestation increased over the course of this study and was greatest in 2002. Apparently, maintaining adequate soil moisture during the season overcame the negative effects on SCN infection on the

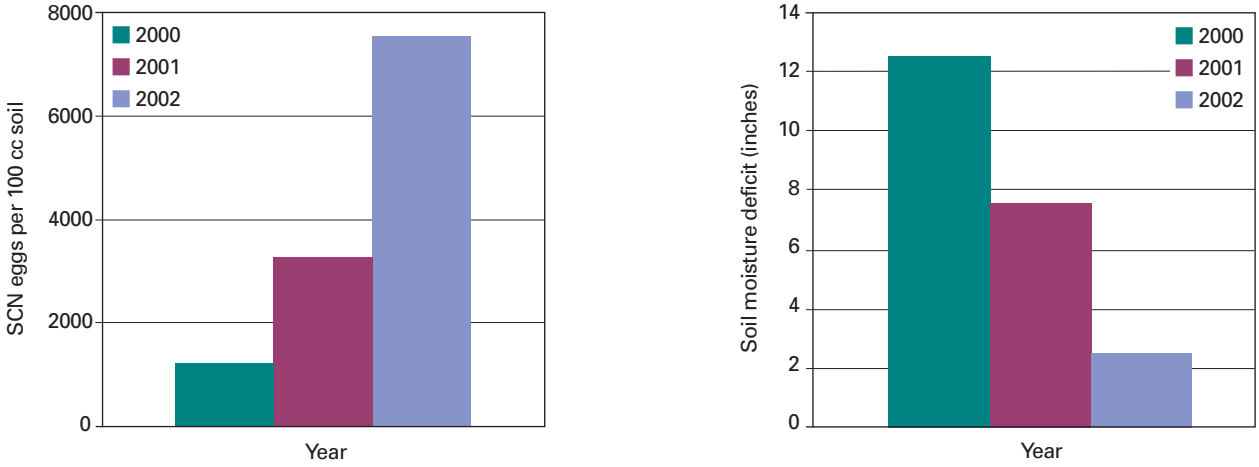


Figure 1. Spring SCN egg counts and seasonal moisture deficit for the Bruner Farm site in 2000, 2001, and 2002.

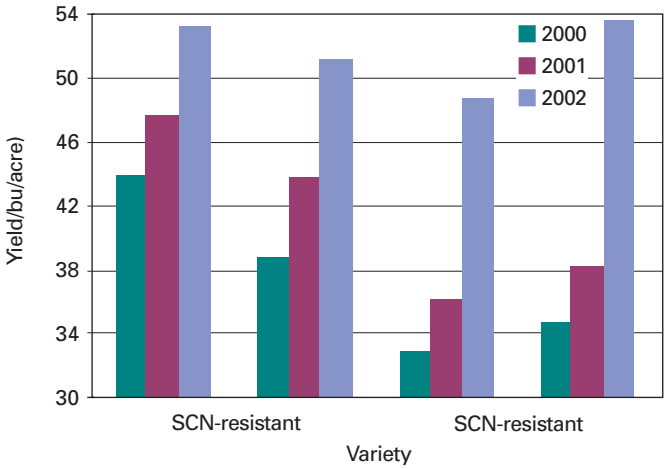


Figure 2. Yields of SCN-resistant and SCN-susceptible varieties grown at the Bruner Farm site infested with soybean cyst nematodes.

yield of susceptible cultivars. This Yields II result, however, is not all beneficial. The positive implication is that soybean susceptible to SCN can withstand infection by the pathogen if water can be readily extracted from the soil. The negative implication is that an SCN infestation could go unnoticed and population densities could continue to increase if soil moisture is sufficient to disguise its effects on root function and plant growth.

Rapid root growth promotes SCN reproduction

The lack of yield loss associated with the high level of SCN infestation in 2002 does not mean the susceptible plants were free of SCN actively feeding on their roots. Results of a root grafting experiment indicate the opposite, although the experiment was originally intended to test whether roots or the plant shoot is responsible for resistance to SCN infection. Figure 3 shows how grafted plants with resistant roots or resistant shoots were prepared. These "hybrid" plants were grown in the presence of SCN eggs as were their ungrafted and self-grafted controls. After the female nematodes had enough time to infect the roots, develop, mate, and produce eggs, the numbers of SCN females that formed on the roots were determined.

The results of grafting showed that roots of susceptible plants were larger (in weight) than those of resistant plants (Figure 4). Grafted plants that had shoots from susceptible plants were usually larger than those with shoots from resistant plants, regardless of the root source. Thus, the shoot apparently determined the root biomass potential of the grafted plants; susceptible plants were in no way inferior to the resistant plants in terms of their capacity for root or shoot growth.

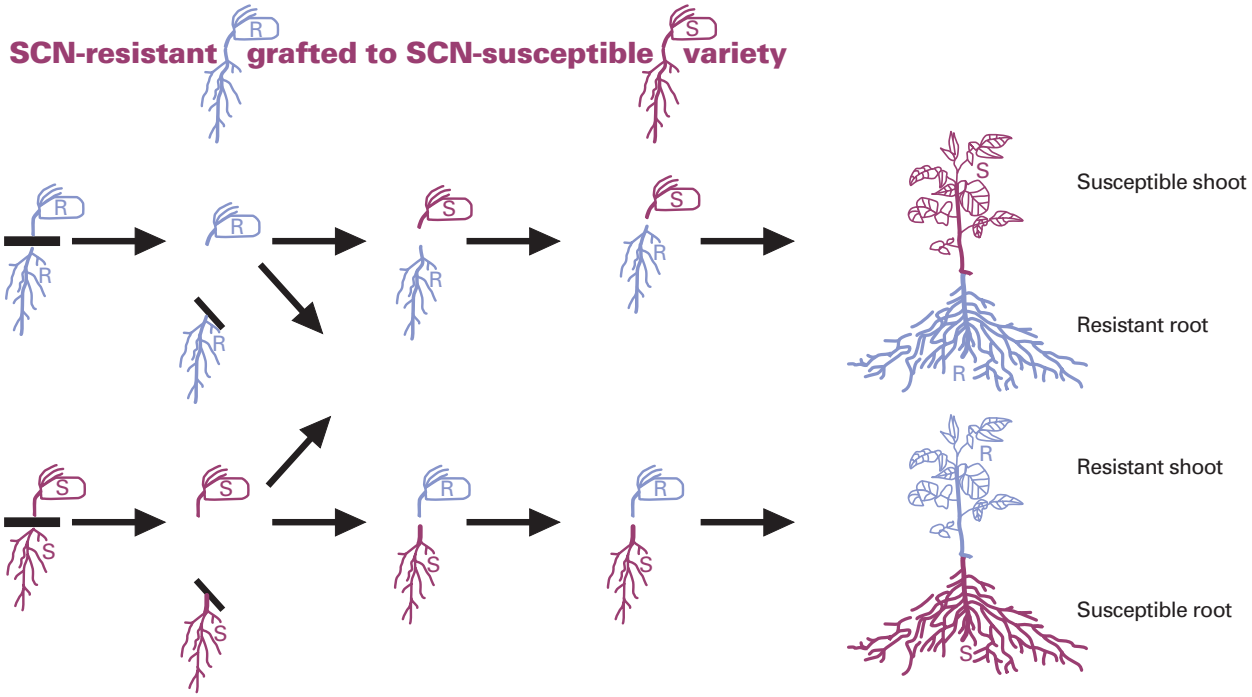


Figure 3. Reciprocal grafts between SCN-resistant and SCN-susceptible varieties were made to create 'hybrid' plants having susceptible shoots on resistant roots, or resistant shoots on susceptible roots.

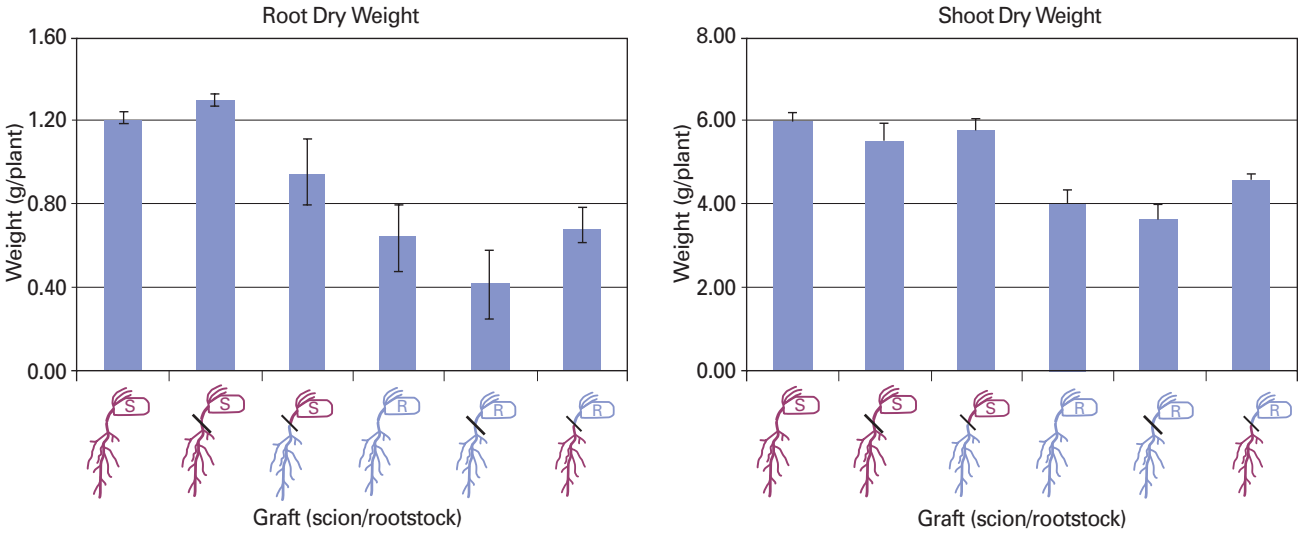


Figure 4. Root and shoot weight of control and grafted plants having shoots (scion) or roots (rootstock) resistant or susceptible to soybean cyst nematodes.

Inspection of roots for the presence of SCN females indicated that the root was the primary source of resistance to SCN. Very few cysts developed on roots that came from a resistant variety, regardless of whether the root was grafted to a shoot from a susceptible variety or from a resistant variety (Figure 5). This result confirms field observations that SCN egg counts in the soil decrease where resistant varieties are grown.

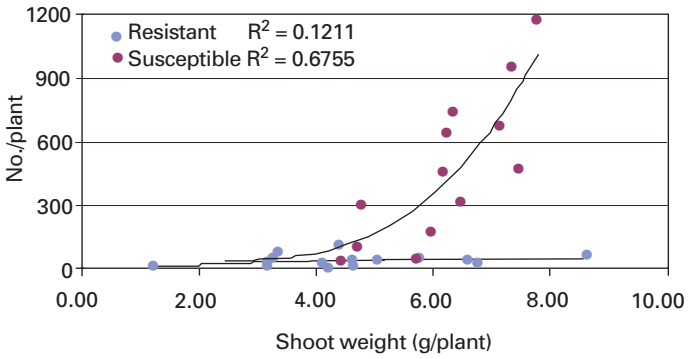


Figure 5. Number of adult female SCN cysts on resistant (●) and susceptible (●) roots. Note that number of cysts on susceptible roots increases with shoot growth.

Analysis of the grafted plants with susceptible roots also revealed that SCN reproduction was far more successful on roots that were growing rapidly. This result implies that field conditions favoring rapid plant growth and, therefore, high yield promote SCN reproduction and an increase in egg count. Therefore, the high yields achieved by the SCN-susceptible varieties in 2002 may disguise a growing SCN population in these fields and a potential for even greater yield loss during drier years that may follow. To avoid damage by SCN in a dry year, growers should test for SCN even in high-yield years and in the high-yielding areas of fields.

Page 1 photos courtesy of the USDA Natural Resources Conservation Service (NRCS).

Edited by Julie Todd, Department of Entomology, Iowa State University.

Designed by Donna Halloum, Creative Services, Instructional Technology Center, Iowa State University.

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