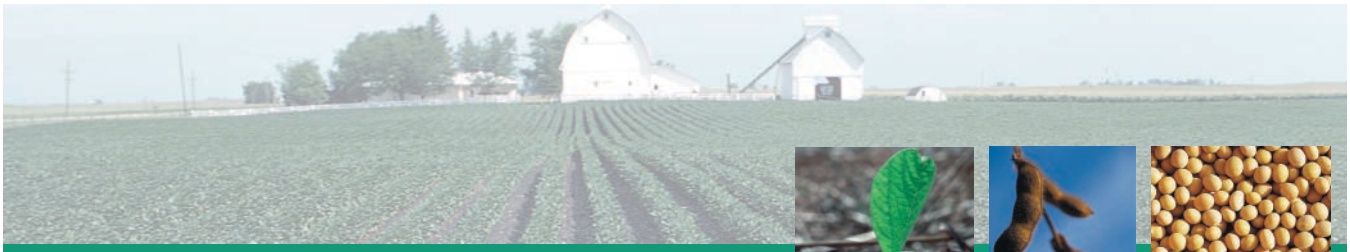

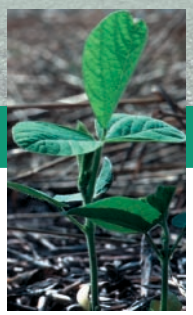

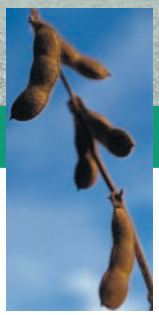

The Yields II Project: Research-Based Management Information

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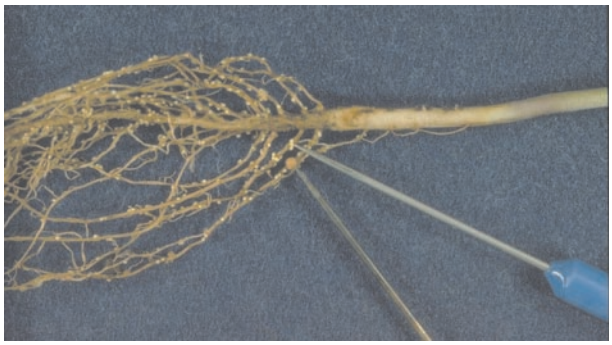
Double Trouble in a Dry Year: Herbicides and Soybean Cyst Nematode

Yields II research demonstrates that herbicide stress impacts soybean grain yield, especially in dry years. Varieties susceptible to soybean cyst nematode suffer the greatest yield losses. If possible, growers should avoid using contact herbicides in their SCN-infested fields, especially in a dry growing season.

Many university and industry studies have shown that soilborne pathogens, water stress, herbicide damage, and insect feeding all have the potential to decrease yield, depending on the timing and intensity of the stress that they cause. Typically, these studies examined one stress at a time. But in any given year, soybean is exposed to a variety of stresses that can interact to decrease yield potential. One aspect of the Yields II project was to examine how a combination of stresses caused by soybean cyst nematode (SCN) infestation, herbicide damage, and lack of available soil moisture interacted to decrease yield. The outcome was clear: herbicide damage in an SCN-infested field was double trouble for soybean producers, especially if it occurred in a dry growing season.

SCN is present in all major soybean-producing regions in the North America and can cause up to 30% yield loss without obvious aboveground symptoms. The pathogen invades young soybean roots, and females form feeding sites from which they removed nutrients from the plant. Besides tapping energy from the plant, these feeding sites may disturb normal root function, the most important of which is the transport of water to the leaves, stem, and pods. Because SCN is a soilborne pathogen, the only practical control measure available to soybean producers is to grow genetically resistant varieties. The importance of this aspect of SCN management also was emphasized by the results of the Yields II project.



Yellow soybean cyst nematode females on soybean roots (top pointer). The females are much smaller than the nitrogen-fixing nodule (bottom pointer). Photo courtesy of Iowa State University.

Herbicide injury is a common concern of soybean growers because it is visible. Stress resulting from postapplication of herbicide products such as acifluorfen (Blazer) and imazethapyr (Pursuit) can stunt plant growth and decrease biomass. If the stress associated with foliar injury occurs early in soybean development, however, it may not affect grain yield if the plants can recover before flowering. Results of the Yields II project showed that rapid growth during flowering and pod set is essential for maximum yield because it is during these stages that seed numbers and yield potential are determined (see Yields II fact sheet, *Manage Soybean "By the Numbers" for Higher Yield*).

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 had been grown for several years and the soil was infested with SCN (per 100 cc of soil: 1,180 eggs in 2000; 3,250 eggs in 2001; and 7,503 eggs in 2002). The impact of this SCN infestation on the level of plant stress was determined by comparing the yield of SCN-resistant and SCN-susceptible varieties grown side by side. The SCN-resistant varieties were AG2201 and PS423N; SCN-susceptible varieties were AG2301 and AG2401. These four varieties were chosen because yield trials conducted at Iowa State University indicated no significant differences in yield between them when they were grown at SCN-free sites.

Four postemergence herbicide treatments were applied at the recommended growth stage (V4) and at the recommended application rates: acifluorfen (Blazer) at 0.17 lb a.i. per acre, imazethapyr (Pursuit) at 0.063 lb a.i. per acre, and glyphosate (Roundup) at 5 oz. a.i. per acre. The effect of these herbicides on plant growth and yield were tested against a weed-free check. Blazer and Pursuit were chosen because they have both been reported to cause visible crop injury sufficient to limit growth. Roundup was chosen because crop injury has not been observed when it is applied at recommended rates.

Soybean injury from postemergence application of Blazer.
Photo courtesy of Iowa State University.

Detailed measurements of leaf injury, plant growth, number of seeds per plant, seed size, leaf senescence, and soil moisture were taken during the season to document the level of plant stress and its impact on grain yield. Although the treatments were imposed in small experimental plots (approximately 400 ft^2), the relative yield losses provide a clear indication how these individual stresses combined to cause yield loss.

Soil moisture during the growing season

The relative level of moisture stress was measured during various soybean developmental stages by comparing the amount of rainfall that fell during the study period with the amount of water used by the crop (evaporation). If evaporation exceeded rainfall by less than 1 inch, for example, the crop experienced a "low" level of stress. A deficit of more than 5 inches during a given stage was considered a "high" level of stress. Table 1 shows that soybean in 2000 was exposed to a high level of moisture stress during pod development (R3–R5) and seed filling (R5–R7). A medium level of stress occurred during these stages in 2001. The 2002 growing season was the most favorable of the three in terms of soil moisture during the entire season.

Table 1. Relative moisture stress during development.

Year	V1–V5	R1–R3	R3–R5	R5–R7
2000	Low	Medium	High	High
2001	Low	Medium	Medium	Medium
2002	Low	Low	Low	Medium

Rainfall—Evaporative Demand (in.)	
X > –1	Low
–1 > X > –5	Medium
X < –5	High

Inadequate moisture compounds effects of SCN and herbicide damage on yield

Figure 1 summarizes the yield results. The highest yields were obtained in 2002, which was the year with the most favorable soil moisture. Note that the all four varieties yielded about the same in 2002 (statistically there was no difference), regardless of the herbicide treatment, or the resistance to SCN (S, susceptible; R, resistant). The two SCN-susceptible varieties yielded considerably less than their SCN-resistant counterparts in 2000 and 2001. This result is remarkable considering the level of SCN infestation increased over the course of this study and was greatest in 2002. Herbicide treatment only had a significant impact on yield in 2000, the driest year of the study, with the postemergence Blazer causing considerable leaf injury and stunted growth. SCN-resistant and -susceptible varieties were affected, but the yield loss

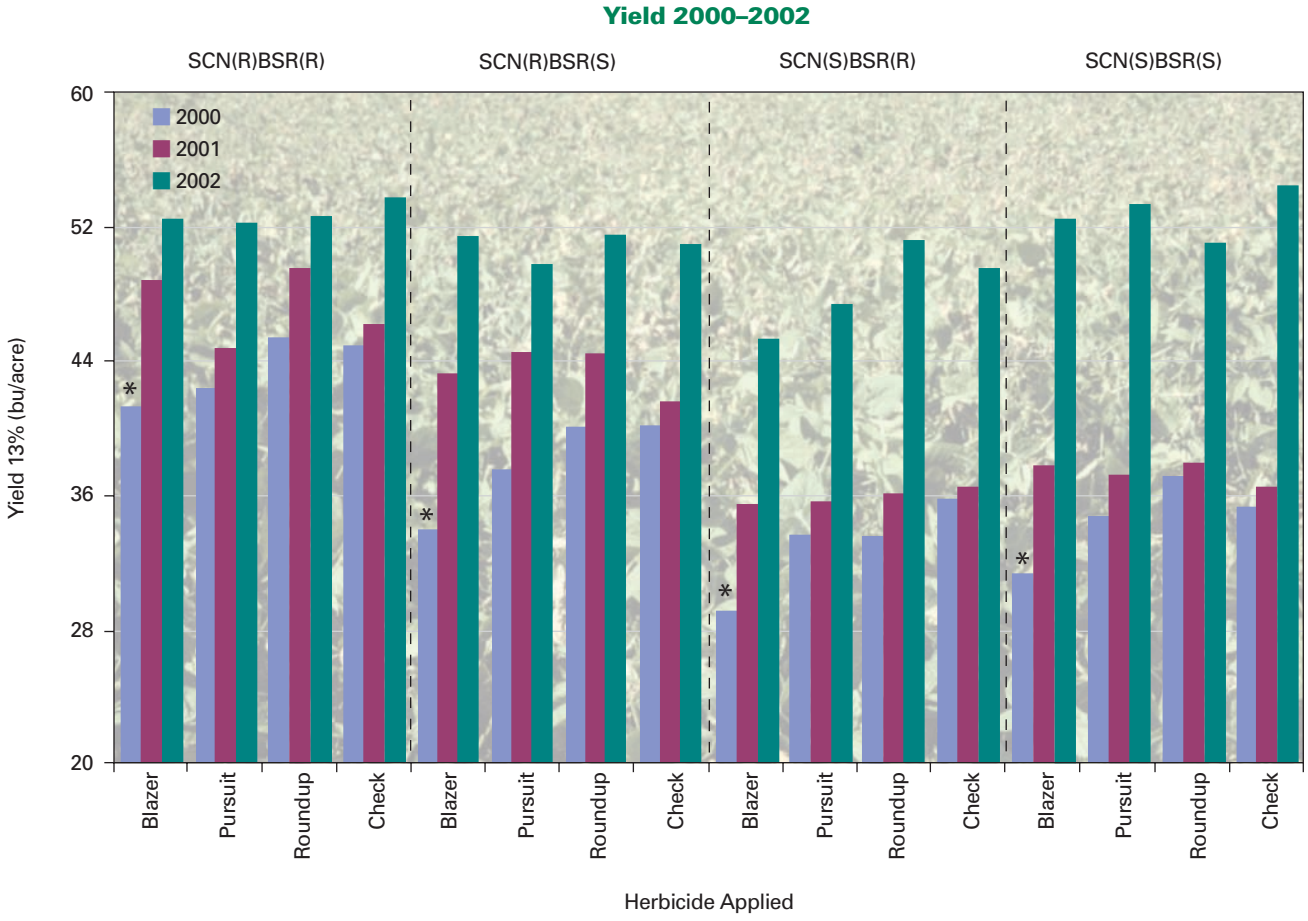


Figure 1. Yield of soybean treatments. SCN, soybean cyst nematode; BSR, brown stem rot; R, resistant; S, susceptible; * indicates yield is significantly different from the check.

was greater for the susceptible varieties. The lack of adequate moisture caused additional problems for soybean infested with SCN and injured by Blazer. These plants failed to recover rapid growth during flowering and pod set and suffered more rapid leaf senescence late in the season.

Why were SCN-susceptible varieties affected more by SCN and herbicides in the dry year (2000)? Our measurements of soil moisture indicated that SCN-susceptible varieties tended to rely on moisture in the upper-most soil layers. Negative plant response probably reflects a more shallow rooting system, which would make plants more vulnerable to SCN infection as well as more prone to water shortage as the soil dries. This pattern of soil moisture extraction is no problem in a year with adequate rainfall, such as 2002. But the combination of shallow roots and susceptibility to SCN may mean double trouble for soybean growers in their fields, especially with SCN egg counts on the rise.

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

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