ECONOMIC AND AGRONOMIC IMPLICATIONS
OF
GRAIN CROP ROTATION SYSTEMS

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Related Publications:

Adee, E.A., E.S. Oplinger, and C.R. Grau. 1994. Severity of Brown Stem Rot and Soybean Yield as Influenced by Tillage, Rotation Sequence, and Cultivar. J. Prod. Agric. (submitted).

Lund, M.G., P.R. Carter, and E.S. Oplinger. 1993. Tillage and crop rotation affect corn, soybean and winter wheat yields. J. Prod. Agric. 6:207-213.

Meese, B.G., P.R. Carter, E.S. Oplinger, and J.W. Pendleton. 1991. Corn/Soybean Rotation Effect as Influenced by Tillage, Nitrogen, and Hybrid/Cultiver. J. Prod. Agric. 4:74-80.

Research Summary:

Study I: Corn-Soybean Cropping Sequence Study

Greatest corn yields occurred the year following soybean in the rotation. Similar yields were found for annually rotated corn and for first year corn following five years of continuous soybean (Fig. 1). Corn yields decreased with additional years of continuous corn. In addition to the rotation x nitrogen fertilizer rate interaction (Fig. 1), a rotation x tillage system x hybrid interaction was observed (Fig. 2 and 3).

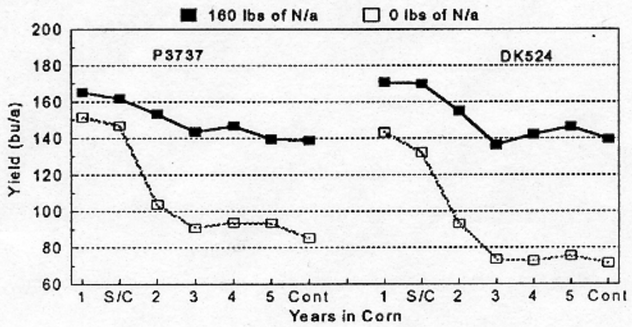

Fig. 1. Corn yield as influenced by years in corn, nitrogen fertilizer rate, and hybrid.

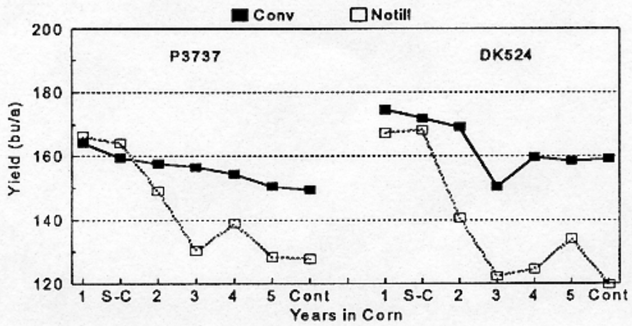

Fig. 2. Corn yield as influenced by years in corn, tillage system, and hybrid at 160 pounds of nitrogen fertilizer per acre.

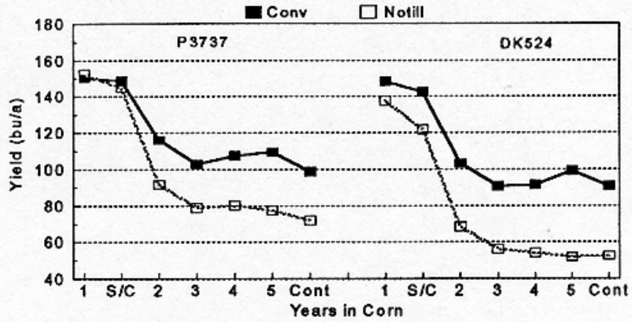

Fig. 3. Corn yield as influenced by years in corn, tillage system, and hybrid at 0 pounds of nitrogen fertilizer per acre.

The rate of yield loss with more than two years of continuous corn was reduced with the addition of nitrogen. Even with the high N rate, yields for continuous corn were lower than for first year corn (Fig. 2). These results agree with previous research which found 1) greater yields for first year corn than for continuous corn regardless of the amount of fertilizer N applied and 2) increased response to fertilizer N with additional years of continuous corn in the rotation.

Yields under conventional tillage and no-till were usually similar for first year corn following soybean for both hybrids. DeKalb DK524 had a greater average first year corn yield than P3737, although yields under no-till decrease more for DK524 than for P3737 with additional years of continuous corn (Figs. 2 and 3).

Soybean response to annual rotation with corn or monocropping was influence by year x rotation x cultivar and rotation x tillage system interactions. Yields for both cultivars were always greater for first year soybean than for annually rotated soybean. Although the yield response to additional years of consecutive soybean varied with cultivar, yields generally decrease with two or more years of consecutive soybean (Fig. 4).

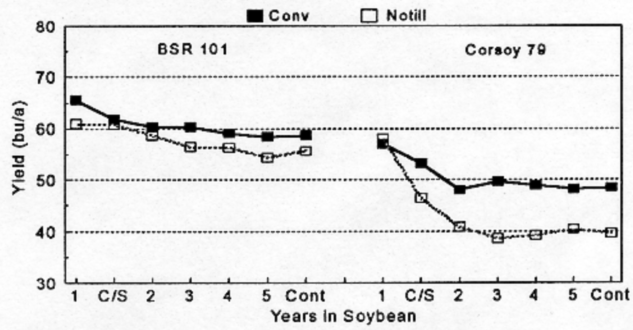

Fig. 4. Soybean yield as influenced by years in soybean, tillage system, and cultivar.

The brown stem rot susceptible cultivar (Corsoy 79) was more sensitive than the resistant cultivar (BSR 101) to annual rotation with corn and to consecutive years of soybean (Fig. 4). Yield decreases were in direct correlation to increase in BSR severity. Yields were 15 to 30 percent lower when a monocropping system was used with the susceptible cultivar (Fig. 5).

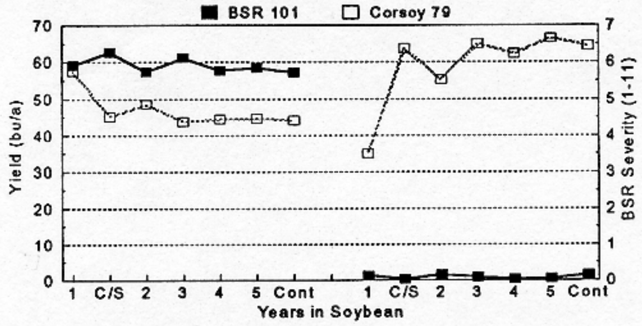

Fig. 5. Soybean yield and BSR severity as influenced by years in soybean and cultivar.

Yields in conventional tillage generally exceed those in no-till. Once again, the lower yields in no-till were related to increase in BSR severity (Fig. 6). The effect of tillage on BSR severity was more pronounce for the brown stem rot susceptible cultivar than for the resistant cultivar (Fig. 7).

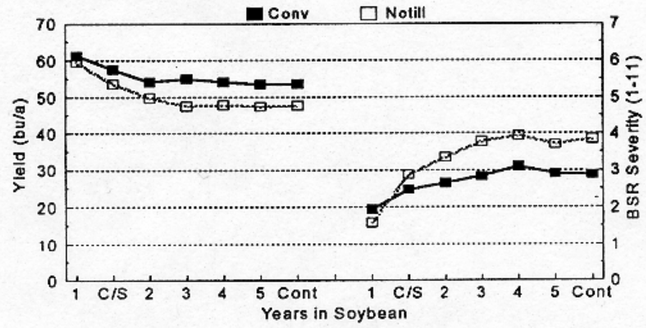

Fig. 6. Soybean yield and BSR severity as influenced by years in soybean and tillage system. Data are the average of the BSR resistant (BSR 101) and susceptible (Corsoy 79) cultivars.

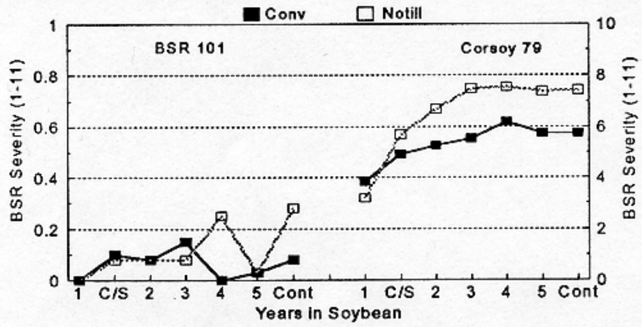

Fig. 7. BSR severity as influenced by years in soybean, tillage system, and cultivar.

The results of this study indicate several considerations that could be used by growers in the northern Corn Belt when developing corn and soybean cropping systems:

1. Corn and soybean must be rotated to obtain highest yields. For both crops, yield decreases occurred beyond the second year of monocropping.

2. Withholding corn for one year was sufficient to obtain the maximum "rotation effect", but for soybean, rotating for just one year was not enough to obtain maximum yield.

3. When the BSR was severe, the level of yield decrease for continuous soybean was doubled with the BSR susceptible cultivar as compared to the BSR resistant cultivar.

4. Corn hybrids varied in sensitivity to monocropping both under no-till and conventional tillage.

5. The relative sensitivity of corn and soybean to monocropping was similar when the least "monocropping sensitive" corn hybrid and BSR resistant soybean were compared.

6. For both corn and soybean, yield depressions under no-till and conventional tillage were less likely to occur when crops were rotated rather than grown continuously.

Based on these results, a proposed three-year cropping system to maximize yields and minimize tillage would be a corn-corn-soybean rotation, using no-till for soybean and first year corn and conventional tillage for second year corn. However, corn and soybean producers seldom settle on a particular rotation for long-term periods. Rather, selection of crop sequences is usually a complicated annual process based on 1) current or anticipated crop prices , 2) changes in government programs, and 3) the previous year's growing conditions (which may influence water and/or nitrogen availability and herbicide carryover susceptibility of subsequent crops). We believe the results described should help growers with this yearly decision making effort by providing expected corn and soybean response for a range in crop history, tillage systems, nitrogen management, and hybrid/cultivar backgrounds to apply specific economic, environmental and government program scenarios.

Study II: Corn-Soybean-Wheat Cropping Sequence Study.

Crop rotations in which either corn or soybean are grown every third year may result in higher yields than annual rotated corn and soybean. The objective of this study was to determine relative corn and soybean response when grown in monoculture, corn-soybean, and corn-soybean-wheat rotations under conventional and no-tillage for two hybrids/cultivars.

Corn yields averaged 17 percent higher when grown following soybeans or wheat compared to continuous corn. Corn yields in corn-soybean, corn-soybean-wheat and corn-wheat-soybean sequences were similar (Fig. 8). Tillage did not influence corn yield when grown in rotations, but no-till yields were reduced by 19 percent in continuous corn.

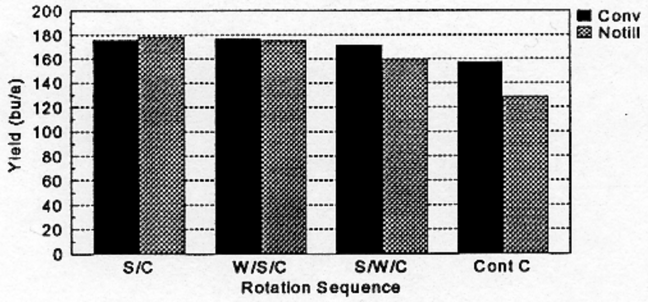

Fig. 8. Corn yield as influenced by rotation sequence and tillage.

Soybean yields were 19% greater following corn or wheat as compared to continuous soybean. Similar to corn, there was no yield benefit for soybean-corn-wheat or soybean-wheat-corn sequences as compared to the soybean-corn rotation (Fig. 9). When averaged over four years, soybean yields were consistently 2-4 bushels per acre higher under conventional tillage than when no-till was used.

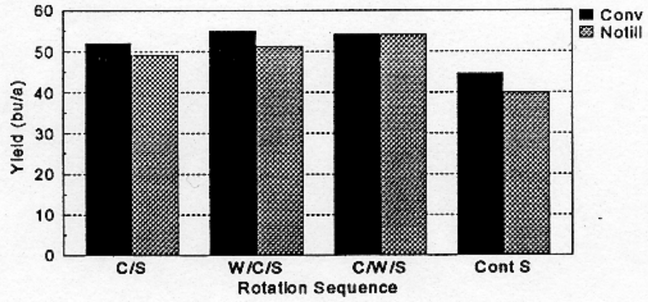

Fig. 9. Soybean yield as influenced by rotation sequence and tillage.

Wheat yields were very low across all cropping sequences and tillage systems (Fig. 10). The effect of tillage system varied with rotation sequence. While yield differences due to tillage were evident with C/S/W and continuous wheat, these difference were not consistent across the four year period. Overall, wheat yields across rotation sequences were similar.

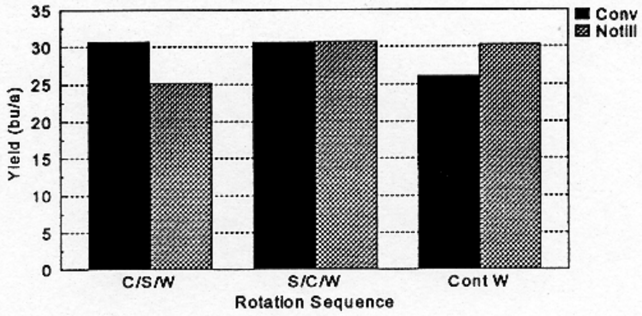

Fig. 10. Wheat yield as influenced by rotation sequence and tillage.

Three year results indicate that:

1. Corn and soybean yields and economic returns under no-till are more likely to be equal to those under conventional tillage when the crops are grown in a rotation.

2. Low wheat yields limit the profitability of three crop rotations involving corn, soybean, and wheat. Wheat yield reductions in this study are partially due to late planting. Initially, this date was during October after the corn and soybean harvest rather than the optimum planting date of mid-September. In 1992 and 1993, spring wheat was substituted for winter wheat.