University of Wisconsin · Agronomy Department
1575 Linden Drive · Madison, WI · 53706 · (608) 262-1390
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The Corn-Soybean Rotation X Tillage Interaction: No Tillage Required When Rotating

Joe Lauer, *Corn Agronomist*

The three pillars of conservation agriculture are no-till, residue retention and crop rotation. Corn yield increases 10 to 19% when rotated with soybean, while soybean yield increases 14 to 23% when rotated with corn (Lauer, 2012; Lauer, 2013). This rotation effect is even more dramatic in stressful years.

The rotation effect lasts at most two years and depends upon the length of the break between similar crops. When you have two or more break years, then the yield of second-year corn is 7 to 8% greater than continuous corn. If there is only one break year, then the yield of second-year corn equals continuous corn.

Tillage used to be about controlling weeds and preparing a seedbed. In a recent meta-analysis of 610 studies (Pittelkow et al., 2015) no-till reduced yield 5.7% (Figure 1), However, under certain conditions no-till can produce equivalent or greater yields than conventional tillage (rainfed in dry years = 7.3% increase in yield). Importantly, when no-till is combined with residue retention and crop rotation, its negative impacts are minimized.

In an Iowa study (Al-Kaisi et al., 2015), treatments involving tillage (no-tillage, NT; strip-tillage, ST; chisel plow, CP; deep rip, DR; and moldboard plow, MP) and three crop rotations of corn–soybean, C–S; corn–corn–soybean, C–C–S; and corn–corn, C–C. Yield and economic returns for the three rotations were as follow: C–S > C–C–S > C–C. Yield (11 to 28%) and economic penalty (5 to 16%) were greater with NT than conventional tillage in the northern locations (poorly-drained soils) than locations with well-drained soils.

So tillage is often not necessary in today's corn production systems, except in continuous corn. The question is, what is the magnitude of the crop rotation X tillage interaction on corn yield in Wisconsin?

A corn-soybean rotation X tillage study was begun in 1983 at Arlington, WI. The rotation treatments consist of continuous corn, continuous soybean, alternating corn and soybean, and five years of corn followed by five years of soybean. Every phase of these

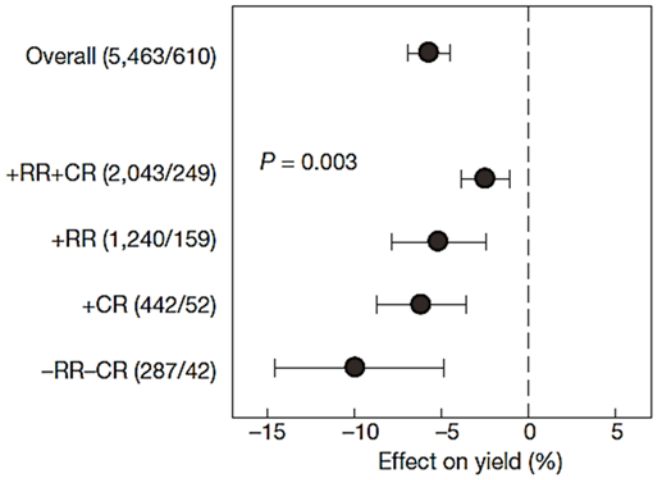

Fig. 1. Comparison of yield in no-till versus conventional tillage systems in the presence or absence of residue retention and crop rotation: +RR+CR (residue retention + crop rotation), +RR (residue retention), +CR (crop rotation), or –RR–CR (without residue retention or crop rotation). The number of observations and total number of studies included in each category are displayed in parentheses. Error bars represent 95% confidence intervals.

14 rotation treatments is grown every year. Two tillage treatments designated no-till (NT) and conventional-till (CT) have been practiced since 1987. No-till consists of one-pass with a 13-wave coulter, followed by trash whippers and then double disc seed openers. Conventional-till is fall chisel plow followed by two spring field-cultivator operations. The continuous corn and soybean plots have been in place 30 years. The results for 1993-2012 are shown in Figure 2 for corn and Figure 3 for soybean.

Small corn yield differences are observed in rotated corn (CS) and first-year (1C) corn following 5-years of soybean (Fig. 2). During the second-year of corn conventional tillage increased yield 5% over no-till (2C). Yield was 10 to 11% greater for conventional-till than for no-till as the number of continuous corn production years increased (3C, 4C, and 5C). So, tillage is not needed when corn is annually rotated with soybean. Tillage can make up some of the rotation

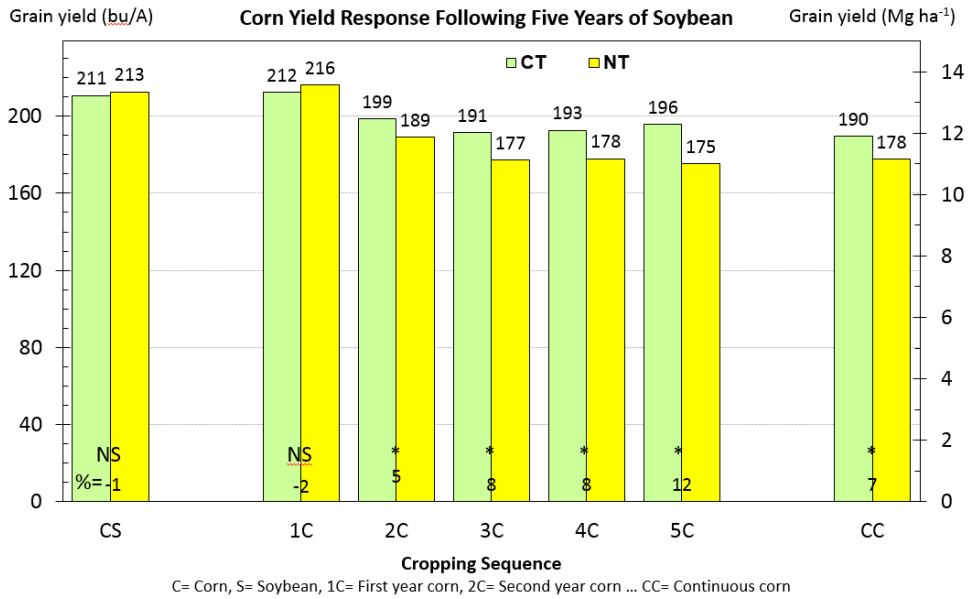

Fig 2. Corn yield response to rotation and tillage following five years of soybean during 1994 to 2013 at Arlington, WI. Asterisks indicate statistical differences at P<0.05. NS= non significant. Percentage values indicate relative differences between tillage systems for a phase in the rotation sequence.

effect over time in continuous corn, but it does not bring yield back to rotated corn yield levels.

The story is somewhat different for soybean. Grain yield is 3 to 5% greater in no-till than conventional tillage for rotated soybean (SC), first- (1S), second- (2S), third- (3S) and fourth-year (4S) soybean following five years of corn (Figure 3). There is no tillage effect as the number of years of continuous soybean production increases (5S and SS). So, tillage is not needed when soybean is annually rotated with corn.

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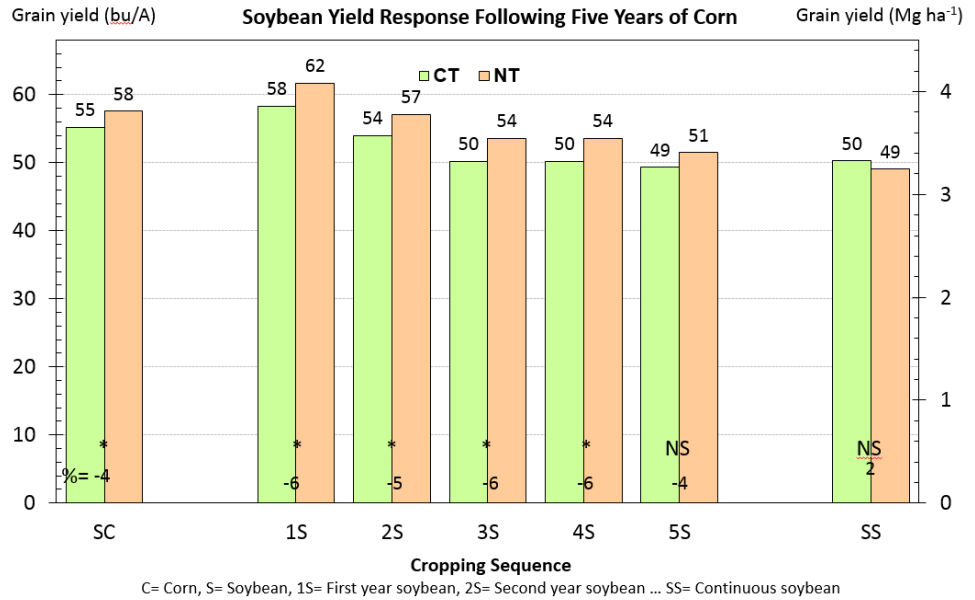

Fig. 3. Soybean yield response to rotation and tillage following five years of corn during 1994 to 2013 at Arlington, WI. Asterisks indicate statistical differences at P<0.05. NS= non significant. Percentage values indicate relative differences between tillage systems for a phase in the rotation sequence.