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## **Tillage Study for Corn and Soybeans: Comparing Vertical, Deep, and No-Tillage**

*E.A. Adee*

### **Summary**

Trends from a tillage study conducted since 2011 are beginning to show that corn yields are greater when there is an occasional deep tillage. The yield of soybeans have not been affected significantly by tillage systems ranging from no-till to conventional tillage every year.

### **Introduction**

The need for tillage in corn and soybean production in the Kansas River Valley continues to be debated. The soils of the Kansas River Valley are highly variable, with much of the soil sandy to silty loam in texture. These soils tend to be relatively low in organic matter (< 2%) and susceptible to wind erosion. Although typically well drained, these soils can develop compaction layers under certain conditions. A tillage study was initiated in the fall of 2011 at the Kansas State University Kansas River Valley Experiment Field near Topeka to compare deep vs. shallow vs. no-tillage vs. deep tillage in alternate years. Corn and soybean crops are be rotated annually. This is intended to be a long-term study to determine if soil characteristics and yields change in response to a history of each tillage system.

### **Procedures**

A tillage study was laid out in the fall of 2011 in a field that had been planted with soybean. The tillage treatments were (1) no-tillage, (2) deep tillage in the fall and shallow tillage in the spring every year, (3) shallow tillage in the fall following both crops, and (4) deep tillage followed by a shallow tillage in the spring only after soybean, and shallow tillage in the fall after corn. In the fall of 2010, prior to the soybean crop, the entire field was subsoiled with a John Deere V-ripper. After soybean harvest, 30- × 100-ft individual plots were tilled with a Great Plains TurboMax vertical tillage tool at 3 in. deep or a John Deere V-ripper at 14 in. deep. Spring tillage was with a field cultivator. Starting in the fall of 2012 the treatments were with the TurboMax or a Great Plains Sub-soiler Inline Ripper SS0300. Spring tillage in 2013-2016 was with the TurboMax and a field cultivator in 2017 on the required treatments. Each tillage treatment had 4 replications.

Dry fertilizer (11-52-60 nitrogen (N), phosphorus (P), and potassium (K)) was applied to the entire field prior to fall tillage in 2012 and to the soybean stubble in 2013 and 2014. In fall of 2015 and 2016, 14-52-40-10 (N, P, K, and sulfur (S)) was applied to the soybean stubble prior to fall tillage. Nitrogen (150 lb in 2012 and 2013; and 180 lb in

2014, 2015, 2016, and 2017) was applied in March prior to corn planting. Corn hybrid Pioneer 1395 was planted at 30,600 seeds/a on April 12, 2012; P1498HR at 32,000 seeds/a on April 30, 2013; P1105 at 32,000 seeds/a on April 21, 2014, and April 14, 2015; P1257 at 32,000 seeds/a on April 12, 2016; and Midland 534 at 32,000 seed/a on April 24, 2017. Soybean variety Pioneer 93Y92 was planted at 155,000 seeds/a on May 14, 2012; P94Y01 3833 at 140,000 seeds/a on May 15, 2013; Asgrow 3833 at 140,000 seeds/a on May 21, 2014; Midland 3884NR2 with ILeVO seed treatment at 144,000 seeds/a on June 1, 2015; Stine 42RE02 with ILeVO seed treatment at 140,000 seeds/a on May 31, 2016; all in 30 inch rows. On May 26, 2017, Pioneer 39T67 with ILeVO seed treatment was planted at 140,000 seeds/a in 15 inch rows with a Kinze 3000 planter. Soybeans were planted after soybeans in the setup year.

Irrigation to meet evapotranspiration (ET) rates was started May 26 and concluded August 1 for corn and started July 5 and concluded August 23 for soybean in 2012. Irrigation for corn started June 24, 2013 and concluded August 1. Irrigation for soybeans in 2013 started June 30 and concluded September 8. Irrigation in 2014 started July 1 and ended August 16 for corn and started July 22 and ended August 22 for soybeans. In 2015, the first irrigation for both crops was June 23, and the last on August 24. The first irrigation on corn in 2016 was on June 20, and the last on August 4, while only the irrigation for soybean was on August 18. In 2017, the first and last irrigations on corn were June 13 and August 8, respectively, and July 16 and August 8, respectively, for soybeans. Two yields were taken from each plot from the middle 2 rows of planter passes. Corn was harvested on August 31, 2012; September 25, 2013; September 11, 2014; September 10, 2015; September 16, 2016; and September, 20, 2017. Soybeans were harvested on October 5, 2012; October 10, 2013; October 9, 2014; October 3, 2015; and October 17, 2016. Four 15-inch rows of soybeans were harvested for yield on October 17, 2017.

A preliminary comparison of the different tillage systems across both crops of the rotation was made by calculating gross income per acre. The gross income per acre was calculated by multiplying the average yield for each crop by the closing market price on January 3, 2016, \$3.51 and \$9.11/bu for corn and soybean, respectively, then dividing by 2 to get the average gross income per acre. Differences between cost of tillage operations and herbicide weed control were not factored in this preliminary comparison.

## Results

Yields of corn or soybeans did not differ due to tillage in the setup year of the study (Table 1). The yields were respectable considering the extreme heat and drought experienced this growing season. The growing conditions were better in 2013, resulting in higher yields in both corn and soybeans, but no significant differences between tillage treatments (Table 2 and 3). In 2014, the corn yields were very good and Sudden Death Syndrome lowered soybean yields, but there were no differences between tillage treatments (Tables 2 and 3). The cool and rainy start to the season in 2015 slowed corn growth and lowered yields, while the soybeans had very good yields (Tables 2 and 3). In 2016 and 2017, corn and soybean had very good yields, the deep tillage treatments yielded higher than the shallow tillage in the corn, but not in the soybeans. In the corn, there had been a trend with the yield data that was becoming closer to being significantly different as the years progressed, as indicated by the  $Pr > F$  value that was

decreasing. Combining data from 2013–2017 for analysis showed corn yields are favored by deep tillage, but soybean yields are not affected by tillage system (Tables 2 and 3). Averages of stand counts taken at the V5 stage in the corn for 2014–2017 did not show any differences (Table 2). We anticipate that it will take several years for any characteristics of a given tillage system to build up to the point of influencing yields.

Comparing the average gross income per acre across both crops showed that different systems had the higher income within a given year. This varying response is probably due to the environmental conditions experienced prior to or during each growing season. However, when averaged across the five years, there was up to \$20/a advantage for the systems that included deep tillage vs. the no-tillage or shallow tillage only systems.

## Conclusions

While the influence of tillage system on corn yield appears to be increasing with time, soybean yields appear to perform equally well with any of the systems. Numerous other factors need to be considered when comparing tillage systems, such as soil erosion, water conservation, weed control options (becoming more challenging with herbicide-resistant weeds), labor, equipment costs, and time available to conduct field work. Identifying the yield-limiting conditions may vary between fields based on soil type and environmental conditions during a season and over the long term.

**Table 1. Effects of tillage treatments on corn and soybean yields in 2012 at Kansas River Valley experiment fields**

Tillage treatment	Corn yield	Soybean yield
	bu/a	bu/a
No-tillage	196	59.9
Fall subsoil/spring field cultivate	202	55.5
Fall vertical tillage	198	57.9
Pr>F*	0.64	0.14

\*The lower the Pr>F value, the greater probability that there is a significant difference between yields.

**Table 2. Effects of tillage treatments on corn yields and plant stands in 2013–2017 at Kansas River Valley experiment fields**

Tillage treatment	Corn yield					Average corn yield	Average stand 2013–2017
	2013	2014	2015	2016	2017		
	----- bu/a -----						plants/a
No-tillage	221	243	205	183 b*	226	216 bc	32,406
Fall subsoil/spring field cultivate	217	259	213	202 a	233	225 a	31,844
Fall vertical tillage	196	259	207	189 b	226	215 c	31,797
Fall subsoil after soybean/vertical tillage after corn	219	256	214	195 a	234	224 ab	31,406
Pr>F <sup>#</sup>	0.48	0.27	0.10	0.005	0.59	0.03	0.11

\*Values followed by the same letter are not significantly different at Pr = 0.05.

<sup>#</sup>The lower the Pr>F value, the greater probability that there is a significant difference between yields.

**Table 3. Effects of tillage treatments on soybean yields in 2013–2017 at Kansas River Valley experiment fields**

Tillage treatment	Soybean yield					Average soybean yield
	2013	2014	2015	2016	2017	
	----- bu/a -----					
No-tillage	62.4	52.8	69.7	80.2	67.4	66.5
Fall subsoil/spring field cultivate	64.3	54.6	73.1	76.1	72.8	68.9
Fall vertical tillage	64.4	55.5	72.8	78.6	68.1	67.9
Fall subsoil after soybean/vertical tillage after corn	66.3	53.4	70.9	75.7	70.1	67.3
Pr>F <sup>#</sup>	0.52	0.59	0.23	0.11	0.098	0.34

<sup>#</sup>The lower the Pr>F value, the greater probability that there is a significant difference between yields.

**Table 4. Income return comparison of tillage systems for corn/soybean rotation at Kansas River Valley experiment fields**

Tillage treatment	Average gross income from corn and soybean crops*					Average gross income
	2013	2014	2015	2016	2017	
	----- \$/a -----					
No-tillage	672	667	677	686	704	682
Fall subsoil/spring field cultivate	674	703	707	701	741	709
Fall vertical tillage	637	709	695	690	707	687
Fall subsoil after soybean/vertical tillage after corn	686	693	699	687	730	700

\*Gross income = ((average corn yield × \$3.51 + average soybean yield × \$9.11)/2) (Closing grain price January 3, 2016, Cargill, Topeka, KS).