Tillage Study for Corn and Soybean: Comparing Vertical, Deep, and No-Tillage

E.A. Adee

Summary

A tillage study comparing no-tillage, shallow tillage, and deep tillage in alternate or every year for corn and soybeans in annual rotation was conducted at Kansas River Valley Experiment Field for five years. 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. As the study progresses, the corn yields were increased with deep tillage occurring sometime in the cropping rotation.

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 River Valley Experiment Field near Topeka to compare deep vs. shallow vs. no-tillage vs. deep tillage in alternate years. Corn and soybean crops will 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. The fall of 2010, prior to the soybean crop, the entire field was subsoiled with a John Deere V-ripper. After soybean harvest, 30 ft × 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 done with a field cultivator. Starting in the fall of 2012, the treatments were tilled with the TurboMax vertical tillage tool or a Great Plains Sub-soiler Inline Ripper SS0300. Spring tillage in 2013-2015 was done with the TurboMax 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 185 lb in 2014, 2015, and 2016) 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 30,600 seeds/a on April 30, 2013; P1105 at 32,000 seeds/a on April 21, 2014, and April 14, 2015; and P1257 at 32,000 seeds/a on April 12, 2016. Soybean variety Pioneer 93Y92 was planted at 155,000 seeds/a on May 14, 2012; P94Y01 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; and Stine 42RE02 with ILeVO seed treatment at 140,000 seeds/a on May 31, 2016. 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 the only irrigation for soybean was on August 18. 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; and September 16, 2016. Soybeans were harvested on October 5, 2012; October 10, 2013; October 9, 2014; October 3, 2015; and October 17, 2016.

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 (Tables 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, 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 - 2016 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 -2016 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 four years, there was up to $20/a advantage of 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, and 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 2013-2016 at Kansas River Valley experiment fields

Tillage treatment	Corn yield					Average stand
	2013	2014	2015	2016	Average corn yield	2014 - 2016
	bu/a					Plants/a
No-tillage	221	243	205	183 b*	213	33,000
Fall subsoil/spring field cultivate	217	259	213	202 a	223	32,500
Fall vertical tillage	196	259	207	189 b	213	32,479
Fall subsoil after sb/vertical tillage after corn	219	256	214	195 a	221	32,125
Pr>F#	0.48	0.27	0.10	0.005	0.063	0.26

*Values followed by the same letter are not significantly different at Pr = 0.05.
#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 2013-2016 at Kansas River Valley experiment fields

Tillage treatment	Soybean yield 2013	2014	2015	2016	Average soybean yield
	---- bu/a ----				
No-tillage	62.4	52.8	69.7	80.2	66.3
Fall subsoil/spring field cultivate	64.3	54.6	73.1	76.1	67.0
Fall vertical tillage	64.4	55.5	72.8	78.6	67.8
Fall subsoil after sb/vertical tillage after corn	66.3	53.4	70.9	75.7	66.6
Pr>F	0.52	0.59	0.23	0.11	0.50

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* 2013	2014	2015	2016	Average gross income
	---- $/a ----				
No-tillage	672	667	677	686	676
Fall subsoil/spring field cultivate	674	703	707	701	697
Fall vertical tillage	637	709	695	690	686
Fall subsoil after sb/vertical tillage after corn	686	693	699	687	691

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