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

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Abstract

Trends from a tillage study conducted since 2011 have shown no clear differences between tillage systems for either corn or soybeans in lighter soils under irrigation. One out of seven years has shown a yield advantage for either corn or soybeans for any tillage system, which appears to be related to environmental conditions experienced during the season.

Keywords

vertical tillage, no-till, corn, soybeans, long-term tillage

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Summary

Trends from a tillage study conducted since 2011 have shown no clear differences between tillage systems for either corn or soybeans in lighter soils under irrigation. One out of seven years has shown a yield advantage for either corn or soybeans for any tillage system, which appears to be related to environmental conditions experienced during the season.

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 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 through fall of 2017, the treatments were conducted with the TurboMax or a Great Plains Sub-soiler Inline Ripper SS0300. Spring tillage in 2013–2016 was conducted with the TurboMax and a field cultivator in 2017 on the required treatments. Starting in the fall of 2017, the vertical tillage treatments were made using a Kuhn Krause Excelerator 8005. 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 the 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, 2017, and 2018) was applied in March prior to corn planting. Soybeans were planted after soybeans in the setup year. Planting, harvest, and irrigation information for the study are included in Table 1.

Irrigation was set to meet evapotranspiration (ET) rates. All corn was planted in 30-inch rows, as well as soybeans through 2016. Soybeans were planted in 15-inch rows in 2017 and 2018.

Results

Yields of corn or soybeans did not differ due to tillage in the setup year of the study (Table 2). The yields were respectable considering the extreme heat and drought experienced in 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 3 and 4). In 2014, the corn yields were very good and Sudden Death Syndrome lowered soybean yields, but there were no differences between tillage treatments (Tables 3 and 4). The cool and rainy start to the season in 2015 slowed corn growth and lowered yields, while the soybeans had very good yields (Tables 3 and 4). In 2016, which had extremes in soil moisture from dry to saturated, the deep tillage treatments yielded higher than the shallow tillage in corn, but not in soybeans. There were soil moisture extremes again in 2017, but a cooler August was very favorable for yields of both crops, with no differences between yields with the different tillage systems. The 2018 growing season started off very cool, but quickly had above-normal temperatures. The corn yields were very good, with no difference between tillage systems. The soybean yields were very good, with the highest being the more conventional annual tillage and the vertical tillage systems. Combining data from 2013–2018 for analysis showed corn yields are favored by deep tillage, and soybean yields a few bushels better with any kind of tillage in the system (Tables 3 and 4). Averages of stand counts taken at the V5 stage in the corn for 2014–2018 did not show any differences (Table 3). We anticipated that it will take several years for any characteristics of a given tillage system to build up to the point of influencing yields. However, with these soils and environments we haven't seen a consistent yield advantage for any tillage system.

Conclusions

The influence of tillage system on corn or soybean yield appears to be dependent on the year. A given set of environmental conditions may favor a specific system, but in Kansas the conditions can vary considerably each year. 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. Yield-limiting conditions may vary between fields based on soil type and environmental conditions during a season and over the long term.

Table 1. Cropping details for tillage study at Kansas River Valley Experiment Field, Topeka, KS

	2012		2013		2014		2015	
Crop:	Corn	Soybean	Corn	Soybean	Corn	Soybean	Corn	Soybean
Planting date:	12-Apr	14-May	30-Apr	15-May	21-Apr	21-May	14-Apr	1-Jun
Hybrid/variety:	Pioneer P1395	Pioneer P93Y92	Pioneer P1498 HR AQ	Pioneer P94Y01	Pioneer P1105AM	Asgrow 3833	Pioneer P1105AM	Midland 3884NR2 + ILeVO
Seeding rate:	30.6K	155K	30K	144K	32K	140K	31.7K	144K
Row spacing (inches):	30	30	30	30	30	30	30	30
Harvest date:	31-Aug	5-Oct	27-Sep	8-Oct	11-Sep	9-Oct	10-Sep	13-Oct
Irrigation (inches)								
May	0.77	0.77	0	0	0	0	0	0
June	4.25	0.73	1.58	1.58	0	0	1.58	0.74
July	4.63	4.19	3.51	3.51	4.74	1.55	2.29	0.74
August	0.73	4.66	0.77	2.27	2.19	2.19	2.87	2.87
September	0	0	0	2.18	0	0	0	0

	2016		2017		2018	
Crop:	Corn	Soybean	Corn	Soybean	Corn	Soybean
Planting date:	11-Apr	31-May	24-Apr	26-May	23-Apr	7-May
Hybrid/variety:	AgriGold 6538	Stine 42RE02	Midland 534	Pioneer P39T67 + ILeVO	Golden Harvest 11B63	Midland 4373 RR2
Seeding rate:	31.7K	140K	32K	140K	32K	140K
Row spacing (inches):	30	30	30	15	30	15
Harvest date:	19-Sep	17-Oct	20-Sep	17-Oct	31-Aug	17-Oct
Irrigation (inches)						
May	0	0	0	0	0	0
June	2.24	0.74	2.88	0.00	4.71	0
July	4.40	4.40	3.63	1.82	4.85	3.11
August	0.70	1.54	1.81	1.81	1.71	1.67
September	0	0	0	0	0	0

Table 2. 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	
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 3. Effects of tillage treatments on corn yields and plant stands in 2013–2018 at Kansas River Valley experiment fields

	Corn yield						Average corn yield	Average stand
	bu/a							Plants/a
Tillage treatment	2013	2014	2015	2016	2017	2018	2013–2018	2014–2018
No-tillage	221	243	205	183 b*	226	206	214 b	32,538
Fall subsoil/spring field cultivate	217	259	213	202 a	233	214	222 a	32,188
Fall vertical tillage	196	259	207	189 b	226	210	215 b	32,150
Fall subsoil after sb/vertical tillage after corn	219	256	214	195 a	234	209	224 a	31,788
Pr>F#	0.48	0.27	0.1	0.005	0.59	0.7	0.02	0.07

*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 4. Effects of tillage treatments on soybean yields in 2013–2018 at Kansas River Valley experiment fields

	Soybean yield						Average soybean yield
	bu/a						
Tillage treatment	2013	2014	2015	2016	2017	2018	2013–2018
No-tillage	62.4	52.8	69.7	80.2	67.4	69.3 ab*	66.9 c
Fall subsoil/spring field cultivate	64.3	54.6	73.1	76.1	72.8	74.9 a	69.3 a
Fall vertical tillage	64.4	55.5	72.8	78.6	68.1	75.0 a	69.1 ab
Fall subsoil after sb/vertical tillage after corn	66.3	53.4	70.9	75.7	70.1	66.6 b	67.2 bc
Pr>F#	0.52	0.59	0.23	0.11	0.098	0.03	0.035

*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.