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No-Till Corn Yields More in the Good Years, Too

Introduction

A western Kentucky extension agent recently commented on the disappearance of no-till corn. No one is returning to the moldboard (or chisel) plow, but there is a lot of discing/vertical (minimum) tillage going on. Why might this be happening?

Testimonial evidence suggests that producers are using shallow surface tillage to improve weed (especially marestail) control, planter performance at higher planting speeds, and to both dry out and firm up the soil. More interesting was the comment that one of the main reasons for no-till management of corn, soil moisture conservation, was less of a consideration given the greater rainfall occurring in recent years. The implication of this statement was that no-tillage was less beneficial to corn yield in the 'good' years, when moisture was generally more adequate for corn production.

Information from a long-term research trial near Lexington indicates that the no-tillage corn yields are generally better than those for tilled corn, regardless the season. The 2012 production year was our latest very dry year. Yields were low, and no-till corn out-yielded tilled corn, as would be expected (Table 1), by an average of 12 bu/A. The last five years, 2015 through 2019, have been wetter, with seasonal rainfall ranging from about 32 (moderately dry) to about 52 (wet) inches (Table 1). Experiment average yield generally increases with the seasonal moisture (134 and 138 bu/A at 32 inches in 2016 and 2019; 158 bu/A at 41 inches in 2017), though not always consistently (160 and 175 bu/A at 50-52 inches in 2015 and 2018).

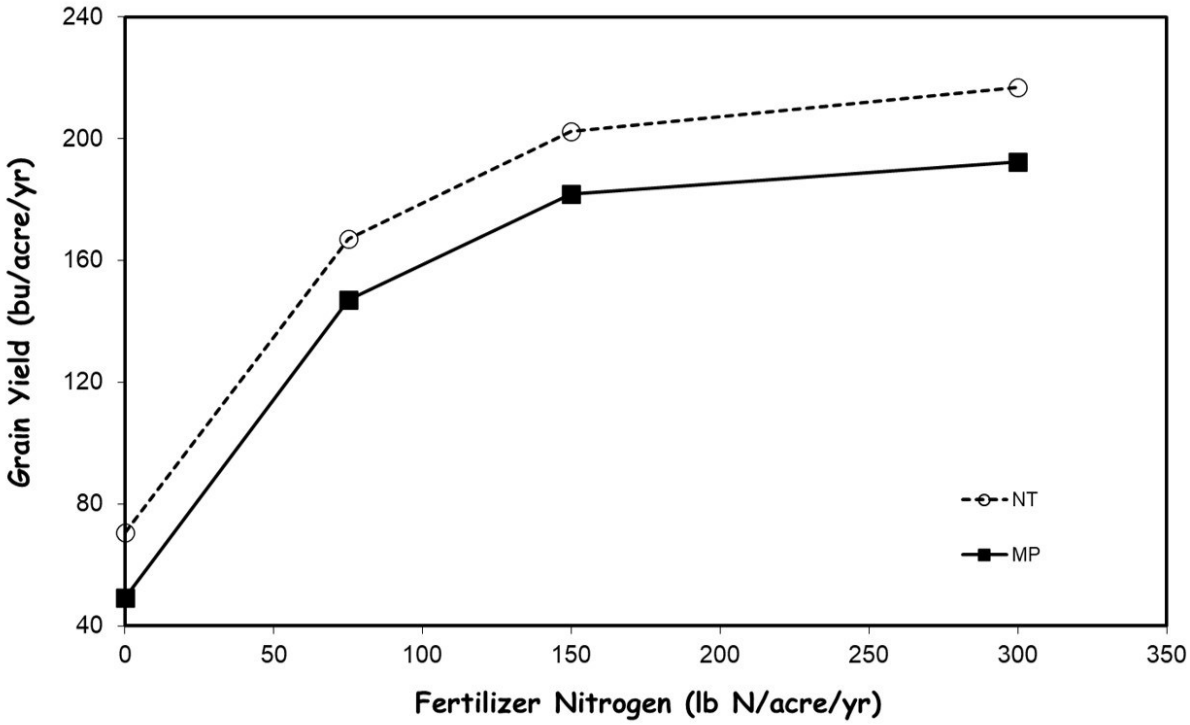
Table 1. Corn grain yield response to tillage, N rate, and seasonal rainfall: 2012, 2015-2019.

Tillage	N Rate	Corn Grain Yield (bu/A)						N RateYield
System	lb N/A	2012	2015	2016	2017	2018	2019	Ave (2015-19)
no-till	0	59	90	68	68	75	53	71
	75	77	173	156	152	191	163	167
	150	82	196	195	218	222	181	202
	300	79	200	208	236	245	195	217
no-till ave	---	74	165	157	168	184	148	
tilled	0	60	68	51	36	48	44	49
	75	53	174	119	142	174	127	147
	150	54	198	148	205	206	153	182
	300	36	196	157	206	242	161	192
tilled ave	---	50	155	119	147	167	121	
year ave		62	160	138	158	175	134	
		Total Season (April to September) Rainfall (inches)						
		19.6	51.5	31.7	41.0	50.2	31.7	

The data also clearly show that average no-till corn yield was superior to tilled corn yield in each one of those seasons (Table 1), averaging around 22 bu/A/yr and totaling over 100 bu/A over the 5-yr period.

The last (right-most) column is shown in Figure 1. When averaged across 2015-2019, no-tillage corn yields are consistently higher, regardless the N rate. The shape of these two responses also indicates that, on average, 150 lb N/A has not been enough to maximize grain yield. This is particularly evident in the data for wetter seasons in Table 1. In this study, on a well-drained soil, all the fertilizer N is applied soon after emergence. These results suggest that splitting the N application might have been beneficial, preventing some N loss and improving N use efficiency, especially in the seasons with substantially greater rainfall.

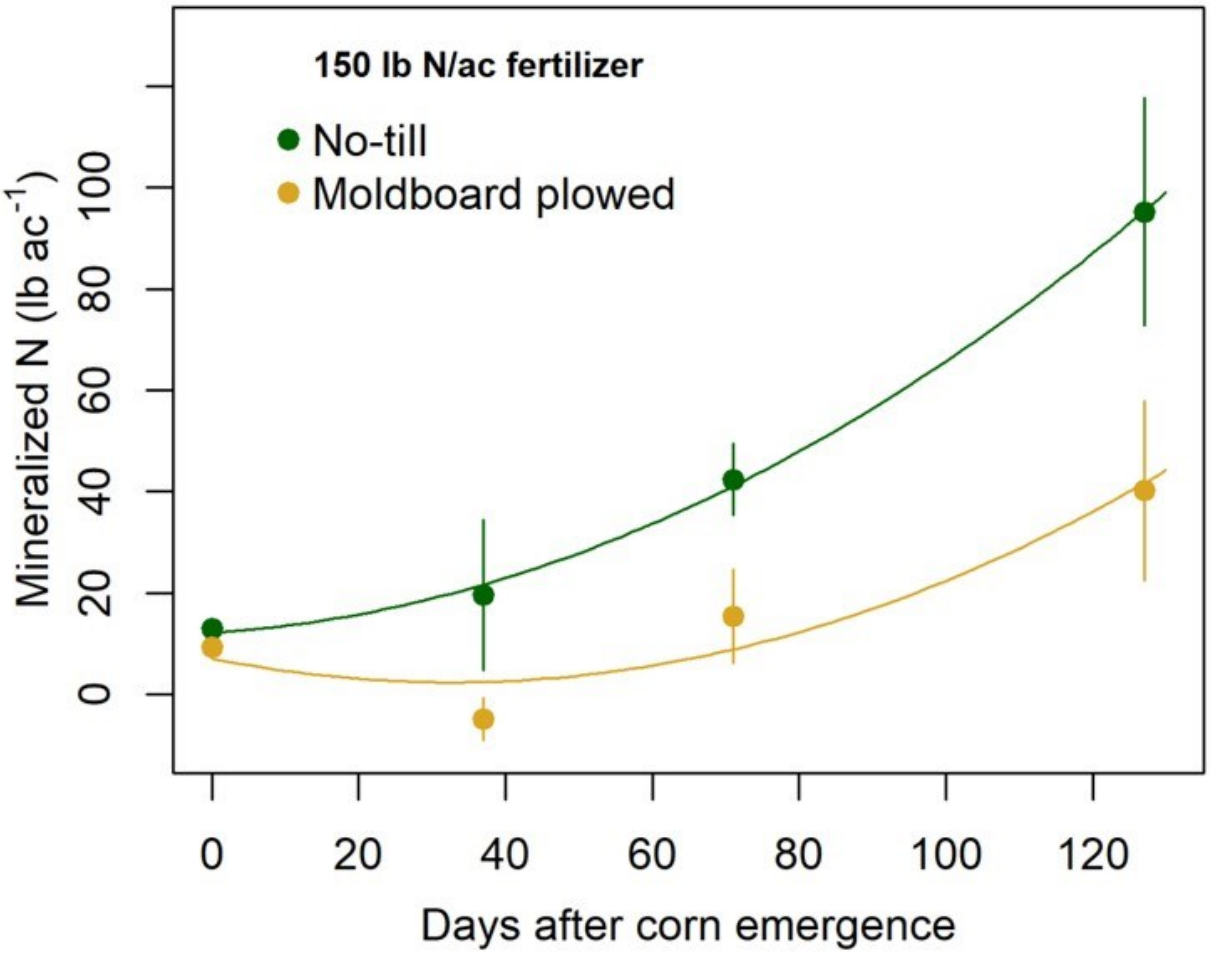
Figure 1. Average (2015-2019) corn grain yield response to fertilizer N rate.



So, what (other than the simple fact of tillage) has caused this yield pattern? Clearly, the combined biological, chemical and physical properties resulting from no-tillage soil management, the overall "soil health", has resulted in a more productive soil. The soil is resilient to changing weather. But what are some possible reasons for this greater production resilience?

In 2018 at this site, in the plots receiving 150 lb N/A, encased soil cores were isolated from fertilizer N application, but left in the plots to assess seasonal release of N from organic matter (mineralization). Figure 2 shows that the no-till soil exhibited much greater ability to sustain N mineralization. Tillage, any tillage, causes soil organic matter to be lost. No-tillage results in organic matter retention for the greatest length of time possible for a given soil. The organic N associated with that organic matter then becomes available the next season when soils warm and the soil organisms commence mineralization. The mineralized N is then available to sustain corn N nutrition, regardless the fertilizer N rate.

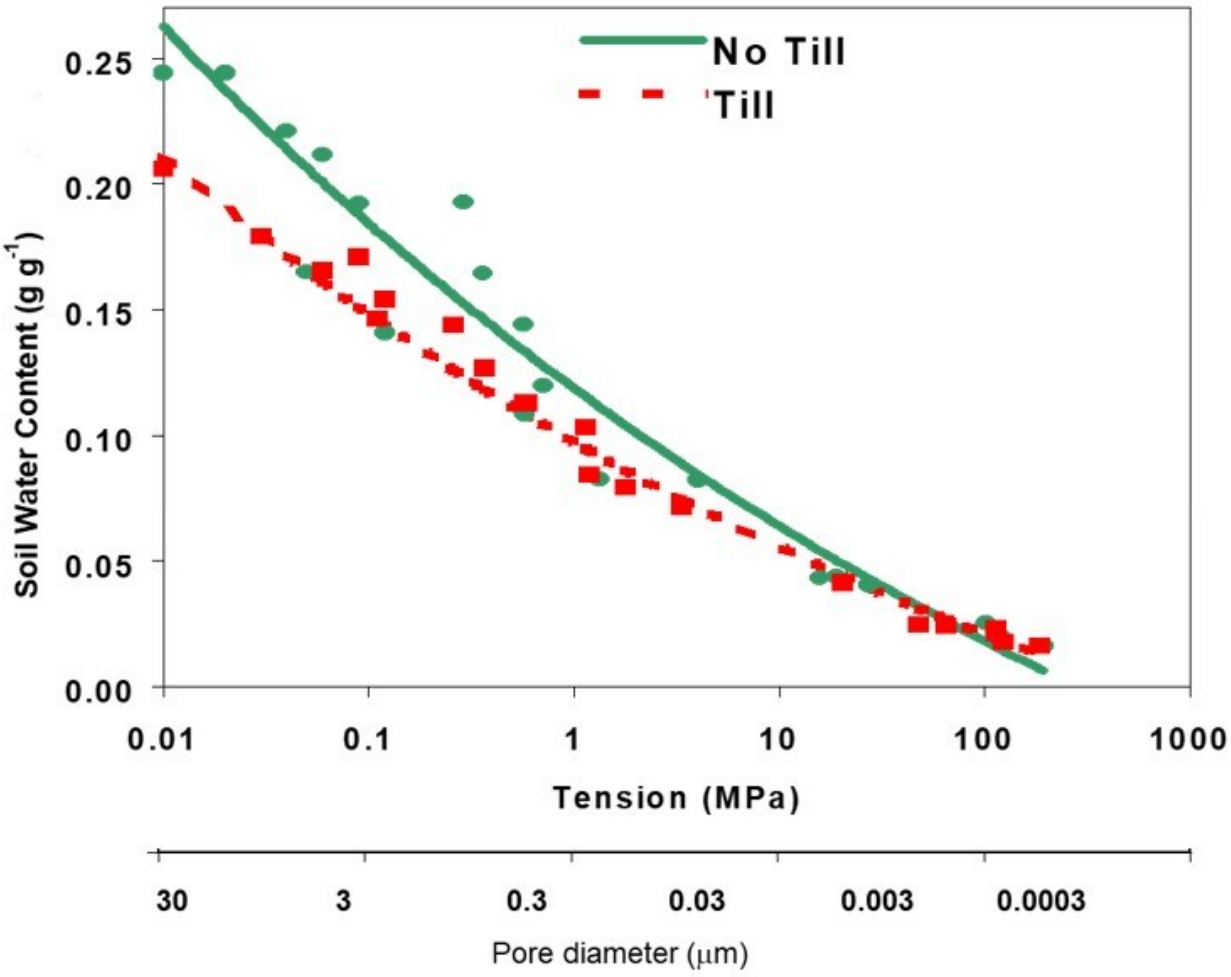
Figure 2. Soil N released from organic matter.



Other measurements, at another long-term tillage trial near Princeton, found that no-till surface soils have greater porosity (Figure 3). At field capacity (along the left edge of Figure 3), the larger pores, at low retention energy (tension), are holding the most water after a recent rainfall event. As the soil continues to dry, whether by evaporation off the soil surface or by crop transpiration of water, the soil's water retention energy/tension rises and the pores still holding water become ever smaller and smaller. When extremely dry, there is little difference between a no-till soil and the same soil after tillage – water retention depends upon soil texture (the relative proportions of sand, silt and clay), not soil structure. Tillage destroys soil structure, especially the larger pores, collapsing the green curve into the red curve. Less water is stored in the tilled soil after every rainfall event. What does that mean? The corn growing over the no-till soil has more plant-available water while awaiting the next rainfall – and short drought periods occur even in otherwise "well-watered" seasons.

We used to think that the no-till water conservation advantage, caused by the reduced evaporation of water from under the existing crop residues, persisted only until the crop canopy was completely formed. This data illustrates a mechanism that causes greater soil surface water retention the entire growing season – at least until the structure that supports that greater porosity is destroyed by minimum/surface tillage. Eliminate tillage, get a better soil that will maximize corn yield.

Figure 3. Soil water content as related to the energy of water retention (tension)/soil pore size.



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