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Corn Grain Yield Trends from 2012 to 2016: A 26-Year Long-Term Experiment

J. Rivera-Zayas
Kansas State University, johanie@ksu.edu

Charles Rice
Kansas State University, cwrice@ksu.edu

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Abstract

Long-term research trials provide an understanding of long-term effects on crop production. This long-term research studied the effect of conventional tillage (CT) and no-tillage (NT) systems. Factors of this 22-year study of corn (*Zea mays* L.) production also included the application of nitrogen (N) in the forms of ammonium nitrate and manure at rates of 150 lb/N/a. Corn grain yield trends during 2012 to 2016 were affected by the interaction between N source and year ($P < 0.05$). The interaction between tillage practices and N source and the overall interaction between the last 5 years did not yield performance ($P > 0.05$). Under the studied conditions the 75 lb/N/a as N fertilizer or manure achieved high corn yields.

Keywords

corn yield, nitrogen fertilizer, manure, till, no-till

Corn Grain Yield Trends from 2012 to 2016: A 26-Year Long-Term Experiment

J. Rivera-Zayas and C.W. Rice

Summary

Long-term research trials provide an understanding of long-term effects on crop production. This long-term research studied the effect of conventional tillage (CT) and no-tillage (NT) systems. Factors of this 22-year study of corn (*Zea mays L.*) production also included the application of nitrogen (N) in the forms of ammonium nitrate and manure at rates of 150 lb/N/a. Corn grain yield trends during 2012 to 2016 were affected by the interaction between N source and year ($P < 0.05$). The interaction between tillage practices and N source and the overall interaction between the last 5 years did not yield performance ($P > 0.05$). Under the studied conditions the 75 lb/N/a as N fertilizer or manure achieved high corn yields.

Introduction

During the 1960s the Green Revolution was able to increase crop yields while increasing the food supply to reach the demand capacity. Over the last decade, agricultural yields have increased but soil resources have been depleting as a result of intensive agricultural practices. At the same time the cost of N fertilizer, one of the main agricultural inputs for increasing yields, has increased. Currently, the agricultural sector faces the challenge of increasing production for meeting the demand for 9 billion people by 2050. Currently, farmers face the challenge of increasing crop yields while using more efficient practices regarding inputs and restoration of soils. The agricultural industry must identify agricultural practices for corn (*Zea mays L.*) that will achieve an increase in yields while maintaining or restoring soil and water resources on a long-term basis.

Agronomic practices such as N fertilization and soil management have a direct effect on crop yields. Studies have shown how tillage practices have a direct effect on soil physical properties and soil nutrient availability for crop growth (Young et al., 2009; Cook and Trlica, 2016). In the U.S. corn belt, the two most common soil management practices for corn production are conventional tillage (CT) and no-tillage (NT). Conservative soil management with the NT practice offers an increase in physical, chemical, and biological soil quality characteristics that leads to higher nutrient availability in soils. The benefits also represent an efficient use of inputs and lower environmental impact. Under CT practices, soil nutrient dynamics are more susceptible to losses in the environment by soil erosion, losses to the atmosphere, and leaching (Cook and Trlica, 2016; Fernández and Schaefer, 2012; Young et al., 2009).

Soil nutrient additions are usually met by mineral fertilizer or an organic source such as animal or vegetable manure. Mineral fertilizers tend to be immediately available for plant uptake, which are easily absorbed, therefore, resulting in higher crop yields. However, studies have shown how disproportionate use of mineral fertilizer may increase soil acidity and reduce soil microbial communities. Organic fertilizers, such as cattle manure (CM) may be more stable in soils, can increase soil organic content, and increase soil microbial diversity when compared to soils with the addition of mineral fertilizers (Wang et al., 2007; Li et al., 2015; Busari et al., 2016).

Previous results from the study showed minimum soil disturbance from the NT practice, nutrient stratification in soil layers from 0-15 in., and higher soil organic carbon retention (unpublished data). Overall, results from this 26-year long-term experiment support soil conservation practices as a management tool to achieve competitive yields. Corn yield trends from 2012 to 2016 validate the long-term effect of the most common agricultural practices in order to identify the most sustainable agricultural system.

Procedures

Data were based on the results of a long-term experiment established in 1990 at the North Farm of Kansas State University in Manhattan, KS (39° 12' 42"N, 96° 35' 39"W). The soil is a moderately well-drained Kennebec silt loam (fine-silty, mixed, superactive mesic Cumulic Hapludoll); main chemical properties are shown in Table 1. The local average annual precipitation is 31.5 in. and the annual mean temperature is 51.8°F.

Corn (*Zea mays L.*) was grown continuously on the site from 1990 to present. The tillage practices were CT with a chisel plow and offset disc, and NT with zero soil disturbance. The N treatments were 75 lb/N/a as ammonium nitrate (LF), 75 lb/N/a as composted cattle manure (LM), 150 lb/N/a as ammonium nitrate (HF), 150 lb/N/a as composted cattle manure (HM), and a control (CO) treatment. The CM application rates were calculated assuming that 100% of the NH_4^+-N was available immediately after applied and approximately 35% of the organic N was mineralized the first years following application. Fertilizer N application was during spring before the corn was planted and manure was broadcast applied.

The experiment was arranged in split-plot randomized blocks with four replications. The experimental design is a split-split plot with four blocks, tillage as the whole plot and N source as the split-plot. Data were analyzed with a PROC GLIMMIX with repeated measurements over time procedure of SAS 9.4 (SAS Institute Inc., Cary, NC). The model included the effects of tillage, fertilizers, and their interaction; which were considered random. Significant differences were studied with a LSMEANS with Tukey at a $P < 0.05$.

Results

The interaction between N source and year significantly affected corn grain yields ($P < 0.05$). Harvest yield from 2013 and 2016 showed the higher yields. Lower grain yields from 2016 were from the CO with 121 bu/a; followed by an average of 176 bu/a between the other treatments (Figure 1). Yields were lower for all treatments ($P < 0.05$) during 2012 with an average of 77 bu/a. The LF treatment showed significant higher yields during 2013, 2014, and 2016 with 157, 134, and 183 bu/a, respectively. There was not a significant difference ($P < 0.05$) between the LF and HF with yields during 2013 and 2016 of 158 and 176, bu/a, respectively. The LM showed higher yields during 2013, 2014, and 2016 with 157, 135, and 172 bu/a, respectively. Additionally, fertilizer treatments of LM and HM were not significant. Higher yields were recorded for HM during 2013, 2014, and 2016 with 155, 150, and 181 bu/a, respectively.

Overall, there was no difference between grain yields during 2013, 2014, and 2016 for the LF, LM, and HM treatments; this also includes the 2013 and 2016 HF treatments. Lower yields during 2012 and 2015 may be a result of weather conditions such as drought.

References

Cook, R. L., and Trlica, A. 2016. Tillage and fertilizer effects on crop yield and soil properties over 45 years in Southern Illinois. *Agronomy Journal*, *108*(1), 415–426. http://doi.org/10.2134/agronj2015.0397

Fernández, F. G., and Schaefer, D. 2012. Assessment of soil phosphorus and potassium following real time kinematic-guided broadcast and deep-band placement in strip-till and no-till. *Soil Science Society of America Journal*, *76*(3), 1090–1099. http://doi.org/10.2136/sssaj2011.0352

Li, J., J.M. Cooper, Z. Lina, Y. Lia, X. Yanga, B. Zhao (2015). "Soil microbial community structure and function are significantly affected by long-term organic and mineral fertilization regimes in the North China Plain." Applied Soil Ecology 96: 75-87.

Wang, X.B., D.X. Cai, W.B. Hoogmoed, O. Oenema, and U.D. Perdok. 2007. Developments in conservation tillage in rainfed regions of North China. Soil and Tillage Research, 93, 239–250.

Young, R. R., Wilson, B., Harden, S., Bernardi, A. 2009. Accumulation of soil carbon under zero tillage cropping and perennial vegetation on the Liverpool Plains, eastern Australia. *Australian Journal of Soil Research*, *47*(3), 273. http://doi.org/10.1071/SR08104

Table 1. Soil chemical characteristics of 0 to 2 in. soil layer of conventional tillage and no-tillage plots

Tillage	pH	Bray-P	Potassium	CEC*	Sand	Silt	Clay
		----------- ppm	----------	cmolc kg^{-1}	----------------	g kg^{-1}	---------------
CT	6.2	55	371	17.1	100	700	200
NT	5.8	55	318	18.4	120	680	200

*CEC = cation exchange capacity.

Table 2. Analysis of variance for the factors tillage, treatment, and year for a significant level of *P* < 0.05

Factor	*P*-value
Tillage	0.1249
Treatment	<.0001
Tillage × Treatment	0.8486
Year	<.0001
Tillage × Year	0.7241
Treatment × Year	0.0015
Tillage × Treatment × Year	0.9252

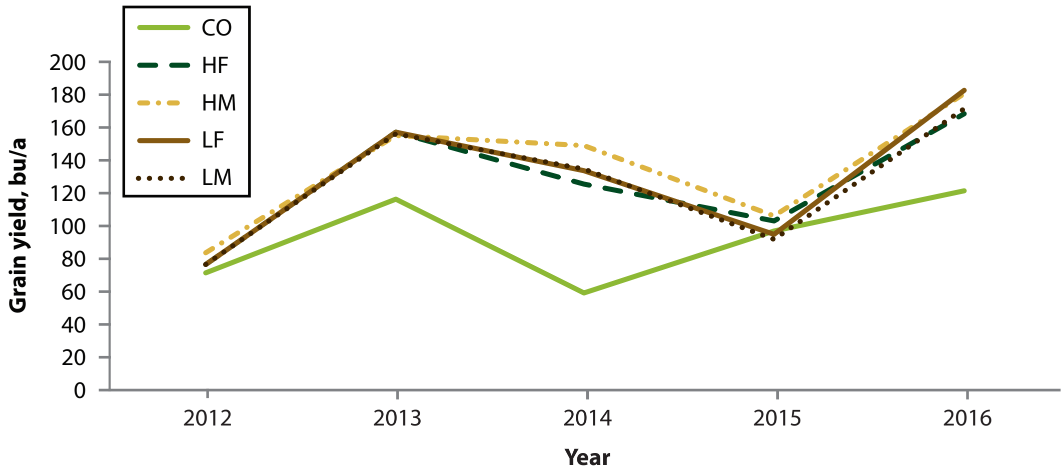

Figure 1. Effect of nutrient source over grain yield trends from 2012 to 2016 (*P* < 0.05). CO = control treatment, HF = 150 lb/N/a as ammonium nitrate, HM = 150 lb/N/a as composted manure, LF = ammonium, and LM = 75 lb/N/a as composted manure.

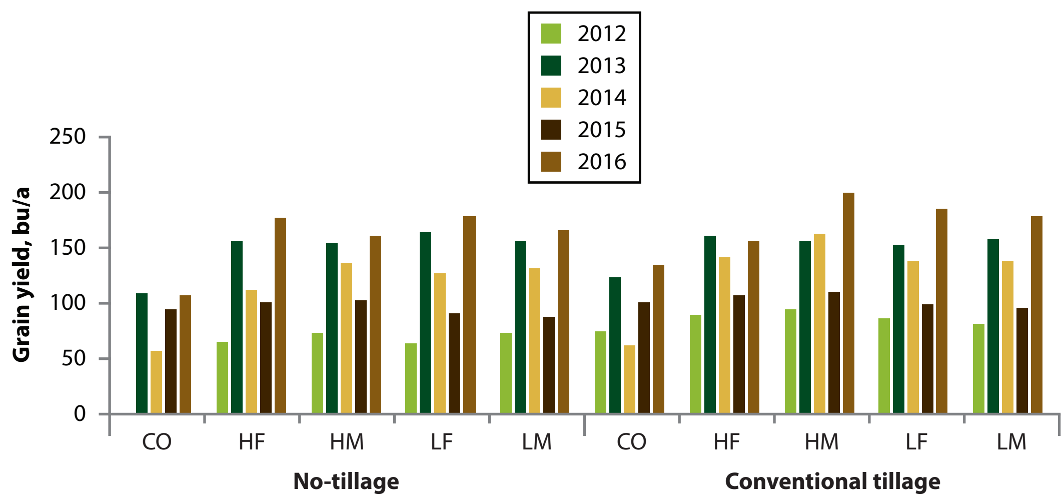

Figure 2. Grain yields trends from 2012 to 2016 as an effect of tillage practice and nutrient source (*P* > 0.05). CO = control treatment, HF = 150 lb/N/a as ammonium nitrate, HM = 150 lb/N/a as composted manure, LF = ammonium, and LM = 75 lb/N/a as composted manure.