

Total nitrogen (TN), organic carbon (OC), and soil pH, in a Long Term Continuous Winter Wheat (*Triticum Aestivum* L.) Experiment

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Introduction

- Continuous use of organic and inorganic fertilizers can impact soil properties such as total nitrogen (TN), organic carbon (OC), and soil pH.
- The relationship between SOC and TN can impact decomposition and mineralization rates.
- Main result of decomposition is the release of carbon (C) from soils to the atmosphere as carbon dioxide (CO₂).

Objective and Hypothesis

- The objective was to document changes in total nitrogen (TN), organic carbon (OC), and soil pH over 25 years.

Materials and Methods

- The Magruder plots evaluate the value of fertilizer in a long-term conventionally tilled winter wheat experiment that was started in 1892.
- 24 site-years comprehensively evaluated.
- Six unreplicated plots included cattle manure, inorganic phosphorus (P), nitrogen (N) and P, N,P, and potassium (K), and NPK+lime applied when soil pH dropped was below 5.5.
- Composite soil samples taken each year, 0-15cm, air-dried, ground to pass a 2mm sieve, and stored at room temperature, 25°C.
- TN and OC determined using a LECO dry combustion analyzer.
- Soil pH measured using an electronically with a 1:1 soil to deionized water solution.
- ANOVA was performed using years as replications and Duncan test for mean separation.

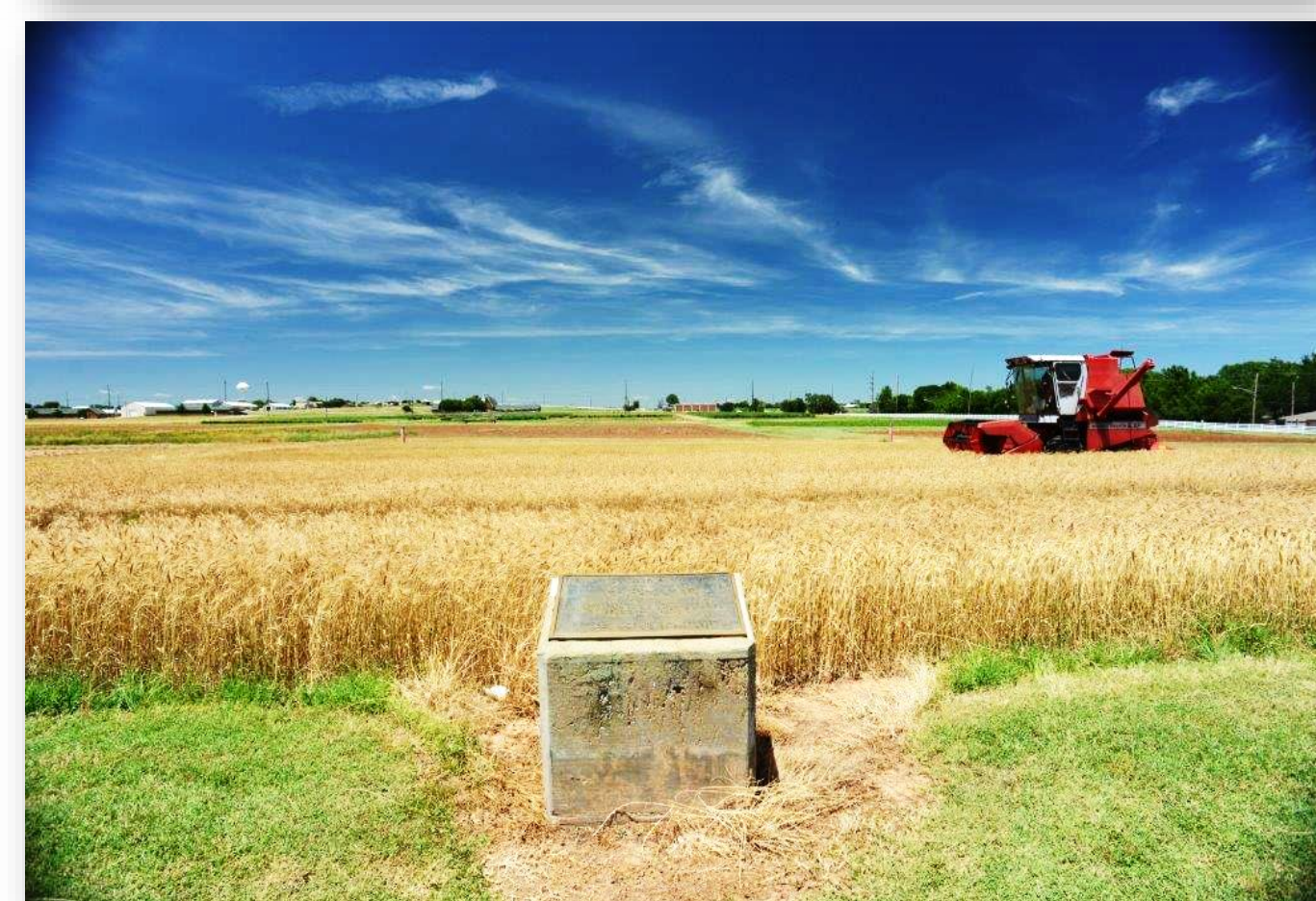


Figure 1: The Magruder plot in 1947 and 2010.

Table 1: Treatment structure with source of fertilizer and rate, Magruder Plots, OK 1991-2015.

Year	Trt	N source		P source		K source	
		Rate	Rate	Rate	Rate	Rate	Rate
1991-2003	1	Manure‡	269	-	0	-	0
	2	-	0	-	0	-	0
	3	-	0	TSP	34	-	0
	4	NH ₄ NO ₃	67	TSP	34	Potash	34
	5	NH ₄ NO ₃	67	TSP	34	Potash	34
	6†	NH ₄ NO ₃	67	TSP	34	Potash	34
2003-2016	1	Manure‡	269	-	0	-	0
	2	-	0	-	0	-	0
	3	-	0	TSP	34	-	0
	4	Urea	67	TSP	34	Potash	34
	5	Urea	67	TSP	34	Potash	34
	6†	Urea	67	TSP	34	Potash	34

‡ Manure was applied in 1991, 1995, 1999, 2003, 2007, and 2015.
† Lime was applied in 2009, TSP – triple super phosphate.

Results

Table 2. Linear regression between treatments for Total Nitrogen (TN), test for intercept=0 and slope=1 (PR>t,0.05) and ANOVA evaluating treatments using years as replications, Duncans mean separation procedure (PR>F,0.05) 1990-2015, Stillwater, OK.

Treatment	n	Test variable	Estimate	PR> t	Mean†	Standard deviation
Manure Plot	14	Intercept=0	-0.4949	0.9531	1.0964a	0.1240
		Slope=1	0.0008	0.8501		
Check Plot	15	Intercept=0	12.1107	0.0263	0.904c	0.0943
		Slope=1	-0.0056	0.0374		
P Plot	15	Intercept=0	2.7598	0.5916	0.9273c	0.0827
		Slope=1	-0.0009	0.7208		
NP Plot	15	Intercept=0	-5.2590	0.3991	1.04b	0.1039
		Slope=1	0.0031	0.3154		
NPK Plot	15	Intercept=0	0.3886	0.9493	1.0386b	0.0972
		Slope=1	0.0003	0.9152		
NPKL Plot	14	Intercept=0	-2.4270	0.7480	1.0542ab	0.1200
		Slope=1	0.0017	0.6455		
Source	DF	Type III SS	Mean Square	F Value	PR> F	
Treatment	5	0.4594	0.0918	21.4500	<.0001	
Year	14	0.6016	0.0429	10.0300	<.0001	

† Means followed by the same letter are not significantly different.

Table 3. Linear regression analysis between treatments for Organic Carbon (OC), test for intercept=0 and slope=1 (PR>t,0.05) and ANOVA evaluating treatments using years as replications, Duncans mean separation procedure (PR>F,0.05) 1990-2015, Stillwater, OK.

Treatment	n	Test variable	Estimate	PR> t	Mean†	Standard deviation
Manure Plot	14	Intercept=0	-2.7442	0.9631	9.3128a	0.8765
		Slope=1	0.0060	0.8392		
Check Plot	15	Intercept=0	118.1658	0.0029	6.7506d	0.7320
		Slope=1	-0.0556	0.0044		
P Plot	15	Intercept=0	106.1994	0.0196	7.1806c	0.7924
		Slope=1	-0.0494	0.0276		
NP Plot	15	Intercept=0	-8.9663	0.8189	8.3013b	0.6320
		Slope=1	0.0086	0.6602		
NPK Plot	15	Intercept=0	67.2050	0.0575	8.5433b	0.5892
		Slope=1	-0.0293	0.0920		
NPKL Plot	14	Intercept=0	46.6313	0.3931	9.3123a	0.8661
		Slope=1	-0.0187	0.4899		
Source	DF	Type III SS	Mean Square	F Value	PR> F	
Treatment	5	80.9850	16.1970	47.9100	<.0001	
Year	14	23.4838	1.6774	4.9600	<.0001	

† Means followed by the same letter are not significantly different.

Table 4. Linear regression analysis between treatments for soil pH, test for intercept=0 and slope=1 (PR>t,0.05) and ANOVA evaluating treatments using years as replications, Duncans mean separation procedure (PR>F,0.05) 1990-2015, Stillwater, OK.

Treatment	n	Test variable	Estimate	PR> t	Mean†	Standard deviation
Manure Plot	14	Intercept=0	42.6790	0.1072	6.4892a	0.4003
		Slope=1	-0.0181	0.1656		
Check Plot	15	Intercept=0	39.8887	0.0245	5.822b	0.2995
		Slope=1	-0.0170	0.0489		
P Plot	15	Intercept=0	40.2083	0.0025	5.5846c	0.236
		Slope=1	-0.0173	0.0067		
NP Plot	15	Intercept=0	39.8705	0.0035	5.1326d	0.2416
		Slope=1	-0.0173	0.0084		
NPK Plot	15	Intercept=0	64.6254	0.0002	5.058d	0.3399
		Slope=1	-0.0297	0.0004		
NPKL Plot	14	Intercept=0	53.2535	0.0843	5.4864c	0.5073
		Slope=1	-0.0238	0.1172		
Source	DF	Type III SS	Mean Square	F Value	PR> F	
Treatment	5	20.3067	4.0613	58.1600	<.0001	
Year	14	5.1531	0.3680	5.2700	<.0001	

† Means followed by the same letter are not significantly different.

Table 5. Linear regression analysis between treatments for grain yield, testing the intercept=0 and slope=1 (PR>t,0.05) and ANOVA evaluating treatments using years as replications, Duncans mean separation procedure (PR>F,0.05) 1990-2015, Stillwater, OK.

Treatment	n	Test variable	Estimate	PR> t	Mean	Standard deviation
Manure Plot	14	Intercept=0	-14.7955	0.7709	2.126c	0.7296
		Slope=1	0.0085	0.7389		
Check Plot	15	Intercept=0	6.1479	0.7933	1.0766d	0.3770
		Slope=1	-0.0025	0.8288		
P Plot	15	Intercept=0	-12.0359	0.6223	1.2046d	0.3948
		Slope=1	0.0066	0.5882		
NP Plot	15	Intercept=0	-76.3918	0.1738	2.2606bc	0.9385
		Slope=1	0.0393	0.1622		
NPK Plot	15	Intercept=0	-24.0798	0.6219	2.4586ab	0.7892
		Slope=1	0.0132	0.5872		
NPKL Plot	14	Intercept=0	-47.0810	0.2052	2.5813a	0.6119
		Slope=1	0.0249	0.1817		
Source	DF	Type III SS	Mean Square	F Value	PR> F	
Treatment	5	31.5455	6.3091	54.7200	<.0001	
Year	14	34.7608	2.4829	21.5300	<.0001	

† Means followed by the same letter are not significantly different.

Conclusion

- Manure application resulted in the highest means for TN, OC.
- Soil pH: Manure (every 4 years) pH above 6.0.
- Nitrogen fertilizer did not change TN and SOC.
- Nitrogen fertilizer decreased soil pH.
- Check plot with no nutrients applied continues to produce yields > 1.1 Mg/ha after 114 years of cultivation.

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