

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

Mariana Del Corso, Bruno Figueiredo, and Bill Raun

Department of Plant and Soil Sciences, Oklahoma State University, 371 Agricultural Hall, Stillwater, OK – 74078 delcors@okstate.edu

Introduction

• Continuous use of organic and inorganic fertilizers can impact soil properties such as total nitrogen (TN), organic

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

Year	Trt —	N source	Rate	P source	Rate	K source	Rate
			kg ha⁻¹		kg ha⁻¹		kg ha

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.

Troatmont	2	Test	Ectimata		Maant	Standard
neatment	11	variable	Estimate	Ρη- ι	Mean	deviation
Manure Plot	1/	Intercept=0	42.6790	0.1072	6 48922	0.4003
Manure i lot	74	Slope=1	-0.0181	0.1656	0.4052a	
Check Plat	15	Intercept=0	39.8887	0.0245	5.822b	0 2005
CHECKTIOL	13	Slope=1	-0.0170	0.0489		0.2333
P Plot	15	Intercept=0	40.2083	0.0025	5 58/60	0 236
11100	12	Slope=1	-0.0173	0.0067	J.J0+0C	0.230
NP Plot	15	Intercept=0	39.8705	0.0035	5.1326d	0.2416
	15	Slope=1	-0.0173	0.0084		
NPK Plot	15	Intercept=0	64.6254	0.0002	5 058d	0.3399
	15	Slope=1	-0.0297	0.0004	J.0300	
NPKI Plat	1/	Intercept=0	53.2535	0.0843	5 /186/1c	0 5073
	17	Slope=1	-0.0238	0.1172	5.40040	0.3073
Source	DE	Type III SS	Mean	F Value	PR	> F
Jource		Type III 35	Square	i value	1 1\/	
Treatment	5	20.3067	4.0613	58.1600	<.0	0001
Year	14	5.1531	0.3680	5.2700	<.0	0001
	Treatment Manure Plot Check Plot P Plot NP Plot NPK Plot NPKL Plot Source Treatment Year	TreatmentnManure Plot14Check Plot15P Plot15NP Plot15NPK Plot15NPKL Plot14SourceDFTreatment5Year14	$\begin{tabular}{ c c c } \hline Treatment & n & $$Test$$ variable \\ \hline Manure Plot & 14 & $$Intercept=0$$ $$Slope=1$ \\ \hline Manure Plot & 15 & $$Intercept=0$$ $$Slope=1$ \\ \hline Check Plot & 15 & $$Intercept=0$$ $$Slope=1$ \\ \hline P Plot & 15 & $$Intercept=0$$ $$Slope=1$ \\ \hline NP Plot & 15 & $$Intercept=0$$ $$Slope=1$ \\ \hline NPK Plot & 15 & $$Intercept=0$$ $$Slope=1$ \\ \hline NPKL Plot & 14 & $$Intercept=0$$ $$Slope=1$ \\ \hline Source & DF & $$Type III $$S$ \\ \hline Treatment & 5 & $$20.3067$$ \\ \hline Year & 14 & $$5.1531$ \\ \hline \end{tabular}$	Treatment n Test variable Estimate Manure Plot 14 Intercept=0 42.6790 Manure Plot 14 Intercept=0 39.887 Check Plot 15 Intercept=0 39.887 P Plot 15 Intercept=0 40.2083 P Plot 15 Slope=1 -0.0173 NP Plot 15 Intercept=0 39.8705 NP Plot 15 Slope=1 -0.0173 NP K Plot 15 Intercept=0 39.8705 NPK Plot 15 Slope=1 -0.0173 NPK Plot 15 Intercept=0 39.8705 NPKL Plot 15 Slope=1 -0.0173 NPKL Plot 16 Slope=1 -0.0173 Source DF Intercept=0 53.2535 Slope=1 -0.0238 Slope=1 -0.0238 Source DF Type III SS Square Treatment 5 20.3067 4.0613 Year 1	Treatment n Test variable Estimate billing PR> t Manure Plot 14 Intercept=0 42.6790 0.1072 Manure Plot 14 Intercept=0 42.6790 0.1072 Check Plot 16 Intercept=0 39.887 0.0245 Check Plot 15 Intercept=0 39.887 0.0245 P Plot 15 Intercept=0 40.2083 0.0025 P Plot 15 Intercept=0 40.2083 0.0025 NP Plot 15 Intercept=0 39.8705 0.0035 NPK Plot 15 Intercept=0 39.8705 0.0035 NPK Plot 15 Intercept=0 64.6254 0.0002 NPK Plot 14 Slope=1 -0.0173 0.0044 NPKL Plot 14 Slope=1 -0.0173 0.0044 Slope=1 -0.0237 0.0044 -0.0237 0.0044 NPKL Plot 14 Slope=1 -0.0238 0.1172 Square	Treatment n Test variable Estimate slope PR> t Mean ⁺ Manure Plot 14 Intercepte 42.6790 0.1072 6.4892a Manure Plot 14 Intercepte 39.8887 0.0245 5.822b Check Plot 15 Intercepte 39.8887 0.0459 5.822b P Plot 15 Intercepte 40.2083 0.0025 5.846c NP Plot 15 Intercepte 39.8705 0.0035 5.1326d NP Plot 15 Intercepte 39.8705 0.0002 5.1326d NP Plot 15 Intercepte 39.8705 0.0035 5.1326d NPK Plot 15 Intercepte 64.6254 0.0002 5.0584d NPKL Plot 14 Intercepte 53.2535 0.0843 5.4864c Slope=1 -0.0238 0.1172 5.4864c 5.0584 5.4864c NPKL Plot 14 Slope=1 -0.0238 0.1172 5.4864c Square

- 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 (CO_2) .

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 longterm 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.

	1	Manure‡	269	-	0	-	0
	2	-	0	-	0	-	0
1991-2003	3	-	0	TSP	34	-	0
	4	NH_4NO_3	67	TSP	34	Potash	34
	5	NH_4NO_4	67	TSP	34	Potash	34
	6†	NH_4NO_5	67	TSP	34	Potash	34
	1	Manure‡	269	-	0	-	0
	2	-	0	-	0	-	0
2003-2016	3	-	0	TSP	34	-	0
2005-2010	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	
Manura Dlat	1 /	Intercept=0	-0.4949	0.9531	1.00642	0 12/0	
Manure Piot	14	Slope=1	0.0008	0.8501	1.0904a	0.1240	
Chack Plat	15	Intercept=0	12.1107	0.0263	0.004c	0 00/2	
CHECK FIOL	CT.	Slope=1	-0.0056	0.0374	0.9040	0.0943	
P Plot	15	Intercept=0	2.7598	0.5916	0 92730	0.0827	
FFIOL	13	Slope=1	-0.0009	0.7208	0.92730		
	15	Intercept=0	-5.2590	0.3991	1 0/b	0.1039	
	L)	Slope=1	0.0031	0.3154	1.040		
NDK Plat	15	Intercept=0	0.3886	0.9493	1 0386h	0 0072	
ΝΓΚΓΙΟΙ	13	Slope=1	0.0003	0.9152	1.03860	0.0972	
NPKI Plat	1/	Intercept=0	-2.4270	0.7480	1 05/2ab	0 1200	
NERIOL	14	Slope=1	0.0017	0.6455	1.034280	0.1200	
Source			Mean	F Value	DR	 >\ []	
Juice			Square	i value	ΓN	∕ Γ	
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 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.

Trootmont	n	Test	Ectimato	DD> +	Moon	Standard	
Iteatinent	11	variable	LStimate		IVICALI	deviation	
Manure Plot	lot 1/		-14.7955	0.7709	2 1260	0 7296	
Manule Flot	14	Slope=1	0.0085	0.7389	2.1200	0.7290	
Check Plat	15	Intercept=0	6.1479	0.7933	1 0766d	0 3770	
CHECKFIOL	13	Slope=1	-0.0025	0.8288	1.07000	0.3770	
D Plot	15	Intercept=0	-12.0359	0.6223	1 20/IEd	0 30/8	
11100	13	Slope=1	0.0066	0.5882	1.20400	0.3340	
NP Plot	15	Intercept=0	-76.3918	0.1738	2 2606hc	0 9385	
	10	Slope=1	0.0393	0.1622	2.200000	0.5505	
NPK Plot	15	Intercept=0	-24.0798	0.6219	2 4586ah	0 7892	
NI KI IOU		Slope=1	0.0132	0.5872	2.430000	0.7052	
NPKI Plat	11	Intercept=0	-47.0810	0.2052	2 58132	0 6119	
	74	Slope=1 0.024	0.0249	0.1817	2.30134	0.0115	
Source	DF	Type III SS	Mean	F Value	PR	> F	
	Ы		Square				
Treatment	5	31.5455	6.3091	54.7200	<.0	001	
Year	14	34.7608	2.4829	21.5300	<.0	001	



[†] 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
Manuro Plot	17	Intercept=0	-2.7442	0.9631	0 21282	0 8765
Manule Flot	14	Slope=1	0.0060	0.8392	9.3120d	0.8705
Chack Plat	15	Intercept=0	118.1658	0.0029	6 7506d	0.7320
CHECKFIOL	T	Slope=1	-0.0556	0.0044	0.75000	
P Plot	15	Intercept=0	106.1994	0.0196	7 12060	0 792/
FFIOL	10	Slope=1	Slope=1 -0.0494 0.0	0.0276	7.10000	0.7324
NP Plot	15	Intercept=0	-8.9663	0.8189	8 3013h	0 6320
	13	Slope=1	0.0086	0.6602	0.30130	0.0320
			c = 20 c c			

⁺ 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.

Figure 1: The Magruder plot in 1947 and 2010.



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

