INFLUENCE OF NITROGEN RATE APPLICATION ON SOIL FERTILITY IN FOUR LONG TERM EXPERIMENTS SITES

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INTRODUCTION

Two major determinants of soil fertility are Soil Organic Carbon (SOC) and Total Nitrogen (TN). These two parameters play an important role in soil fertility management (He et al., 2015; Dai and al., 2022). Fertilization can impact soil productivity by changing the soil's physical, chemical, and microbiological properties (Dong et al., 2014; Herencia et al., 2011). Nitrogen is a fundamental macronutrient that affects plant development. Its application is indeed vital for crop growth, yield, and grain quality. Many long-term studies have been conducted to study the effect of Nitrogen application on soil proprieties. This study focused on Nitrogen fertilization's effect on SOC and TC in four separate long-term sites.

METHODOLOGY

Experiments sites: The four long-term sites were in four different locations in Oklahoma State: Stillwater (STW), Lahoma (LAH), Perkins (PRK), and Carl Blackwell Lake (LCB), established respectively in 1968, 1970, 1998, and 2002. All the sites are characterized by no-tilling and continuous wheat monoculture.

Table 1: Experiment's sites characteristics

	STW	LCB	LAH	PRK
Soil classification	Fine-silty, mixed, thermic, udic paleustoll	Fine-silty, mixed, thermic, cumulic haplustoll	Fine-silty, mixed, superactive, thermic, Udic Arguistoll	Fine-silty, mixed, thermic, Ultic haplustalfs
Location: Longitude latitude	36°7’7’’ N 97°5’30’’W	36°8'22.97"N 97°16'56.53"W	36°23’ 13’’N 98°60’29’’W	35° 59’ 39.12’’N 97° 02’ 31.83’’W
Year established	1968	2002	1970	1998
No till establishment	2010	2007	2010	2005

Experiments designs:

For all the experiments sites, the experiment design is a randomized complete blocks design with one fixed factor: Nitrogen fertilization rate. STW and LCB had four replications. As for LAH and PRK sites, the number of replications was three.

Table 2: N rate applied and replications number for the four sites studied

	STW	LCB	LAH	PRK
N treatments (lbs/ac) Urea	0 40 80 120	0 45 90 135	0 20 40 60 80 100	0 50 100 150
Replications number	4	4	3	3

Soils sampling and analysis:

Soil samples (0.15 m depth) were collected after harvesting in 2020. In each plot, the soil was collected from twenty points randomly and mixed into one composite sample. Soil total organic carbon and nitrogen were determined by high temperature combustion using a LECO Truspec CN analyzer.

Statistical analysis:

The results obtained from the different analyses were processed and analyzed using Microsoft Excel 2010 (graphing) and SPSS Statistics 20 (ANOVA test and simple linear regression).

RESULTS AND DISCUSSION

Total Organic Carbon:

Figure 1 shows that STW, LAH, and PRK fluctuate similarly. By increasing the N Rate, the TOC values raised then fell and eventually increase. However, when raising the N rate at the LCB site , we see an elevation in TOC percentage followed by a reduction.

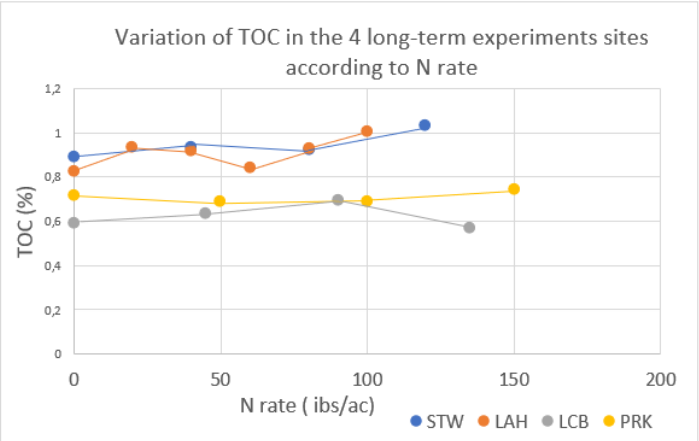

Figure 1: TOC variation according to N rate in the sites studied

The highest TOC values were observed in STW, LAH, and PRK sites when adding the highest value of N fertilization. As for LCB site , the highest value of TOC was observed by fertilizing a quantity of 90 ibs N/ ac (the max n application rate was 135 ibs/ac) .

Although the TOC value varied to the amount of N fertilizer, statistical analysis revealed that the N rate had no significant impact on the TOC value in the soils of the four locations studied. Furthermore, the N rate does not explain much of the TOC variation (the R square of the regression is low for the four sites)(Table 3) . This result was

consistent with Raun, and Al's work (1998), who demonstrated increases in soil organic C with increasing N applied in 0-30 cm depth in three of the four sites.

Other research demonstrated that N fertilization affect negatively and significantly TOC. Souza and al., (2021), showed that the nutrient application rate (especially N) significantly affects the content of TC in the soil. In addition, Luo and al., (2019) supported that N fertilization decrease SOC especially the recalcitrant in the surface layer (0–10 cm).

Table 3:Analysis of variance, mean squares and regression R squares for TOC in experiments STW,LAH,LCB and PRK for 0-15cm

Location	N treatments	Mean	Standard variance	ANOVA N rate sig	Regressions R square
STW	0	0,889	0,061	Ns 0,177	0,15
	40	0,934	0,049		
	80	0,927	0,073		
	120	1,032	0,066		
LAH	0	0,828	0,051	Ns 0,093	0,114
	20	0,934	0,081		
	40	0,917	0,115		
	60	0,840	0,031		
	80	0,928	0,092		
	100	1,004	0,253		
LCB	0	0,590	0,061	ns 0,53	0,02
	45	0,632	0,083		
	90	0,696	0,178		
	135	0,568	0,171		
PRK	0	0,713	0,082	ns 0,227	0,18
	50	0,686	0,080		
	100	0,692	0,039		
	150	0,743	0,138		

Total Nitrogen:

Figure 2 shows the TN variation according to N applied. TN values didn't necessarily increase when N applied increase. This is emphasized by the graphs of all the experimental sites. Thus, Except LBC all the others experiment sites had the highest TN concentration while adding the highest N rate.

Similar to observation for Total Organic Carbon, Soil Total Nitrogen didn't significantly change with increasing N applied. Also, all the regression equations where N rate is the explanatory variable

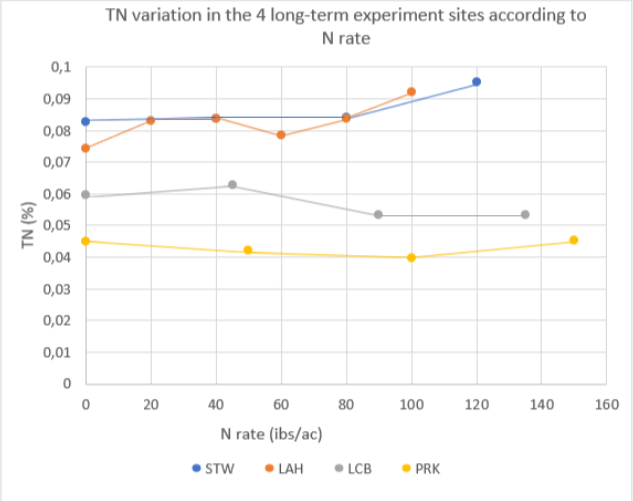

Figure 2 TN variation according to N rate in the studied sites

and TN is the dependent variable for all the sites don't explain much the variability of TN(Figure 6).

This result disagrees with two scientific researches : Jesmin and al., (2021), and Raun and al., (1998), who illustrated that total N was significantly greater after using fertilizer.

Table 4 Analysis of variance, mean squares and regression R squares for TN in experiments STW,LAH,LCB and PRK for 0-15cm

Location	N treatments	Mean	Standard variance	ANOVA N rate sig	Regressions R square
STW	0	0,083	0,004	ns 0,093	0,384
	40	0,084	0,006		
	80	0,083	0,006		
	120	0,095	0,005		
LAH	0	0,074	0,005	ns 0,126	0,113
	20	0,083	0,009		
	40	0,084	0,007		
	60	0,078	0,004		
	80	0,084	0,007		
	100	0,092	0,019		
LCB	0	0,059	0,004	ns 0,761	-0,068
	45	0,056	0,006		
	90	0,063	0,017		
	135	0,053	0,020		
PRK	0	0,045	0,008	Ns 0,724	-0,99
	50	0,042	0,009		
	100	0,040	0,009		
	150	0,045	0,010		

By calculating the OC/TN ratio for all the sites, the soils of the studied sites have an average decomposition capacity except the LCB site, whose soils are easy to medium decomposable. The C/N for all locations is not significantly changed by the N applied, same to TOC and TN. As illustred in Figure 5, the ratio values increased then decreased in the 4 sites the Ration. Raun and al., (1998) had observed a ratio the same fluctuation: the ratio value increased at the low and moderate N rates then decreased. Jesmin and al., (2021) observed also a declination of C/ ratio but with statically significant difference .

Table 5: TOC/TN ratio and SD for the 4 studied sites

	N rate (ibs/ac)	TOC/TN	SD
STW	0	10,738	0,45749669
	40	11,152	0,5039396
	80	11,052	0,4045208
	120	10,844	0,33929442
LAH	0	11,148	0,63658536
	20	11,286	0,55625162
	40	10,942	0,56377645
	60	10,737	0,56377645

	80	11,062	0,53244261
	100	10,828	0,55422904
LCB	0	9,902	0,43526926
	45	9,763	1,07692187
	90	11,167	1,1717754
	135	10,854	0,75979958
PRK	0	15,975	1,72807028
	50	16,651	2,15182177
	100	17,829	3,30607442
	150	16,550	0,9781694

CONCLUSION

The result of the present experiment can be explained by the research done by Souza and al. ,(2021) who studied the effect of Nutrient management on SOC and TN . Souza and al., (2021) have done their survey in 3 same locations that were studied in this research (LAH, STW and PRK). The time difference between the two researches is about two years. The result of their experiment showed that the impact was mostly found in the first soil layer (0-2.54 cm). From 2.54-10.16 cm and 12.7-15.4 no statistical difference was found in the OC values. Also, no difference was found in the 7.62-12.7 cm considering TN. From this research study, we can suggest the hypothesis that the sampling depth would highly influence the effect of N application on Soil organic matter. In our case, the depth selected had diluted the Carbon and Nitrogen differentiation, which impacted the significance of the Nitrogen application on SOM components. A new research must be made on the same plots in the same conditions but in a smaller depth (0-2,5 and 2,5 to 5 cm) to confirm this hypothesis. A debate should be maintained over the effect of different fertilization treatments on soil fertility because of the differences in soil types, crops, climatic conditions and soil depth.

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