 

# Modeling of Soil Total Nitrogen Function to Soil Organic Matter on Sandy Clay Loam Soil, Khartoum- Sudan

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**Abstract**— The aim of this study is to estimate the soil total nitrogen (TN) from soil organic matter (SOM). To achieve this goal, a linear regression model (TN -SOM model) for predicting soil TN using from SOM was suggested. 15 soil samples were collected from the field of the experiment (Wadi Soba farm, Khartoum- Sudan), soil TN was estimated from SOM to compare the predicted results with measured TN by laboratory tests. The results the Standard Error of Mean (SEM) of predicted TN obtained using TN -SOM model was 0.003729, while the P-value was 0.0671. The statistical analysis indicated no significance difference between these values. Based on the analytical results the linear regression model (TN -$_{SOM}$ model), TN % = 0.04×OM + 0.05 with R2 = 0.6041 can be recommended to predict soil TN from SOM.

**Index Terms**— Linear Regression, Laboratory Tests, Nitrogen, Soil Organic Matter, Soil chemical Properties, Soil Analysis, TN -$_{SOM}$ model.

## 1 INTRODUCTION

The Soil chemical, physical and biological properties affect many processes in the soil that make it suitable for agriculture practices and other purposes. Some physical properties such as texture, structure, and porosity influence the movement and retention of water, air and solutes in the soil, which subsequently affect plant growth [1]. Soil organic matter (SOM) is known to play vital roles in the improvement of many soil properties. SOM it considered as an important source of plant nutrients, mainly Nitrogen (N), phosphorus (P) and sulfur (S) [2,3]. According to [4] Nitrogen is a primary element for plant and in many cases yield-limiting nutrient. In the event of leaching, a valuable nutrient is lost, and an environmental problem is created. Inadequate supply of available N frequently results in plants that have slow growth, depressed protein levels, and inefficient water use Nitrogen-stressed plants often have greater disease susceptibility compared with adequately nourished plants. Meanwhile, excessive N can be harmful to crop growth and quality, besides causing adverse environmental impacts. [5] Stated that the sustainable agricultural production could be achieved by increasing soil OC and soil TN, or maintaining these levels close to native quantities. Accurate and rapid predictions and relatively simple methods are ideally needed for soil analysis particularly for time-consuming soil tests [6,7,8]. Using empirical models to predict some complex soil properties from some easily available soil properties has been reported by many researchers. [9] suggested two models to predict soil Cation Exchange Capacity (CEC) using soil organic carbon (OC) and soil clay (CL) as CEC = 3.8 OC + 0.5× CL and CEC = 2.0 OC + 0.5 ×CL. [10] Stated that there is an exact relation between SOM and soil TN, they reported that soil TN is released mainly from the mineralization of the soil organic matter. Based on this relation there are many studies proposed empirical models e.g. [11] suggested a model predict soil N from soil organic carbon. The aim of this study is to predict the soil TN based on soil organic matter.

## 2 MATERIALS AND METHODS

### 2.1 Soil Sampling and Analysis:

A field of experiment was conducted at Wadi Soba farm (Sharq Elneel) about 50 kilometers from Khartoum- Sudan. Fifteen soil samples were taken randomly from the field, all the soil samples were mixed thoroughly and then air-dried. Then, the soil samples were passed through a 2-mm sieve. According to [12] Rechards, 1954 soil Electrical Conductivity (EC), soil pH, texture, soluble calcium and magnesium were measured using soil saturated extract. Total nitrogen (TN) was measured by the method that described by [13]. Soil Organic Matter (OM) was measured using Walkley and Black method according to [14]. Some chemical and physical properties of the soil under study are seen in Table 1. In this paper, a new regression model that obtained from linear regression with $R^2$ = 0.6041 defined as Eq. (1) was used.

$$T.N\ \% = 0.04\times OM + 0.05 \quad (1)$$

The results of this model were directly compared with the laboratory tests using some statistical measurements.

**Table 1:** The mean, median, minimum, maximum and standard deviation (Sd.) of some soil chemical and physical properties used to verify the T.N$_{-OM}$ model:

| Parameter | ECe (dS/m | pH | Sand % | Silt % | Clay % |
|---|---|---|---|---|---|
| Mean | 1.33 | 7.51 | 48 | 22 | 30 |

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| | | | | | |
|---|---|---|---|---|---|
| Median | 1.5 | 7.6 | 49 | 14 | 35 |
| Min. | 0.15 | 6.8 | 43 | 8 | 22 |
| Max. | 3.61 | 8.1 | 57 | 37 | 50 |
| Sd. | 1.09 | 0.46 | 6.52 | 7.01 | 8.03 |

ECe: Electrical Conductivity of soil saturated extract.

### 2. 2 Statistical Analysis:

A paired samples t-test analyses used to compare the soil TN values predicted using $TN_{-OM}$ model with the soil TN values measured with the laboratory tests. The [15] approach was also used to plot the agreement between the soil TN values measured by laboratory tests with the soil TN values predicted using the $TN_{-OM}$ model.

## 3 RESULTS AND DISCUSSION

### 3. 1 Results

The SOM values used to predict the soil TN by $TN\text{-}_{SOM}$ model and the measured TN using laboratory tests are shown in Table 2 and the average difference, standard deviation of difference, 95% confidence intervals for the difference in means, standard error of mean (SEM) and the p-value of the $TN\text{-}_{SOM}$ model are calculated to assess the efficiency of the $TN\text{-}_{SOM}$ model when comparing to the measured laboratory test values. The statistical analyses using paired samples t-test for these results are shown in Table 3.

**Table 2:** Chemical properties of soil used for predicting soil T.N by $T.N\text{-}_{SOM}$ model on saline soil:

| Sample No. | Organic Matter % | Laboratory Tested T. N % | $T.N_{-SOM}$ Model |
|---|---|---|---|
| 1 | 1.6 | 0.10 | 0.11 |
| 2 | 1.7 | 0.12 | 0.12 |
| 3 | 1.4 | 0.12 | 0.11 |
| 4 | 1.0 | 0.08 | 0.09 |
| 5 | 0.7 | 0.06 | 0.05 |
| 6 | 2.2 | 0.11 | 0.13 |
| 7 | 0.9 | 0.10 | 0.09 |
| 8 | 1.2 | 0.08 | 0.10 |
| 9 | 1.4 | 0.09 | 0.11 |
| 10 | 0.20 | 0.08 | 0.06 |
| 11 | 0.17 | 0.06 | 0.06 |
| 12 | 0.43 | 0.05 | 0.07 |
| 13 | 1.5 | 0.10 | 0.11 |
| 14 | 1.1 | 0.08 | 0.09 |
| 15 | 0.86 | 0.07 | 0.08 |

Table 3: Paired samples t-test analyses on comparing soil TN determination methods.

| Determination methods | Average difference | SD of difference | SEM | P value | 95% confidence intervals for the difference in means |
|---|---|---|---|---|---|
| $TN\text{-}_{SOM}$ Model & laboratory test | 0.0074 | 0.01444 | 0.00 3729 | 0.0671 | -0.0005972 to 0.01540 |

Discussion:

To compare the soil TN values predicted using the $T.N_{-SOM}$ Model with the soil TN values measured by laboratory tests, a paired samples t-test analyses and the mean difference confidence interval approach were used, as seen in are in Table 3. The average of soil TN difference between the $TN\text{-}_{SOM}$ Model and measured TN was 0.0074. While the 95% confidence interval was -0.0005972 to 0.01540. Moreover, a p-value for $TN\text{-}_{SOM}$ Model was 0.0671 and the standard deviation of the soil TN differences was 0.01444. Whereas, the Standard Error of Mean (SEM) of predicted TN calculated by $TN\text{-}_{SOM}$ Model related to the measured TN was 0.003729. The statistical results indicated that the TN values predicted by using $TN\text{-}_{SOM}$ Model were not significantly different with the TN measured by laboratory tests (Table 3), this concurred closely with the findings of [11,16]. Meanwhile, it clear from Fig. 1 that the $TN\text{-}_{SOM}$ Model proved a high degree of agreement with the measured laboratory tests values. Further, the differences of TN between these the $TN\text{-}_{SOM}$ Model and laboratory tested TN were usually expected to lie between $\mu+1.96\sigma$ and $\mu-1.96\sigma$, recognized as 95% limits of agreement according to [15]. The 95% limits of agreement for comparison of TN measured using laboratory tests and the $TN\text{-}_{SOM}$ Model were calculated at -0.031 and 0.019 % as evident in Fig. 2, indicating to that, soil TN predicted using the $TN\text{-}_{SOM}$ Model may be 0.031 % lower or 0.019% higher than the TN measured using laboratory tests.

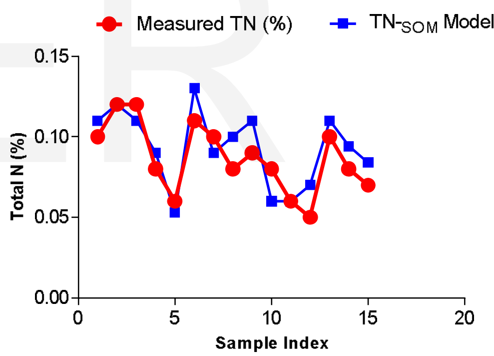


Fig. 1. Figure 1 Measured TN and predicted TN values using the TN-SOM model

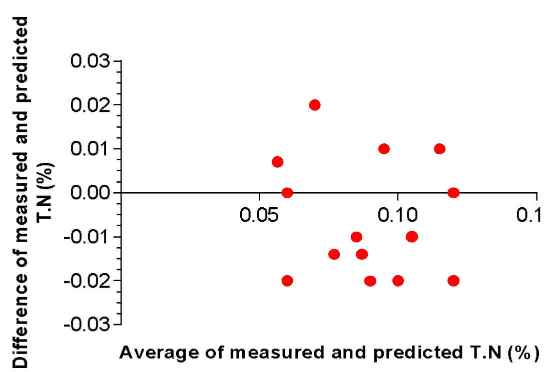


Fig. 2. Bland-Altman plot for the comparison between measured TN and predicted TN using the soil TN-SOM model.

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## 4. Conclusion

A linear regression model ($TN_{-SOM}$ Model) was used to predict soil TN from soil organic matter. The statistical results showed that there was no difference between the TN values predicted using the $TN_{-SOM}$ Model and the measured TN values by laboratory tests (P=0.0671, SEM was 0.003729). In general, the $TN_{-SOM}$ Model presented better values when comparing with laboratory tested values due to this, TN-SOM Model; total N % = 0.04×OM + 0.05 with R2 = 0.6041, can be recommended to predict the soil TN using soil organic matter.

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