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Impacts of Varied Durations of Treatments and Masses of Sesame Plant on Some Soil Nutrients of Sabon Kaura, Bauchi Nigeria

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ABSTRACT

Returning plant residues into the soil can enhance the availability of nutrients, conservation of water and storage. This experiment was conducted to determine the impacts of incorporation of sesame residue on Soil Organic Carbon (SOC), Soil Organic Matter (SOM), Soluble Salts (SS) and Total Exchangeable Acidity (TEA) of soil from Sabon Kaura-Bauchi, after varied treatment periods (0, 2, 4 and 6 months). It was found that the impacts of plant residue vary with the amount of residue applied. A complete randomized design was used and it comprised of four treatments. Neither water nor the organic residue of Sesame plant was added to the 0 day treatment (control). Each treatment was replicated four times and contained 1.00 kg of the soil sample incubated for two, four and six months with organic residue of Sesame plant. A volume of 100.00 cm3 of distilled water was added to the three different set ups of two, four and six months treatments. Soil samples were taken from the treatments at the end of each incubation period and analysed for TEA, SOC, SOM and soil soluble salts using standards analytical methods. The observed values showed that addition of organic residue of Sesame plant increases the levels of soil parameters from the control to six months treatment in the following trend. SOC (%): 0.50-7.50, SOM (%): 0.80-4.50. A negative impact was recorded on the concentrations of TEA (5.40-3.00 cmol/kg) and SS (3000.00-1300.00 mg/kg) due to the addition of Sesame residue. All the parameters were found to be statistically different ($p \leqslant 0.05$) with the exception of SOM, using Double factor Analysis of Variance and Least Significance Difference Test (LSD). It is therefore recommended that the organic residue of Sesame plant can be used to improve the soil organic matter, organic carbon and reduce total exchangeable acidity and soluble salts of the soil investigated.

KEYWORDS: Sesame plants, randomized design, total exchangeable acidity, soluble salts, soil organic carbon, soil organic matter, analysis of variance and least significant difference.

I INTRODUCTION

Intensive use of chemical fertilizers at the expense of organic wastes can increase yields, but damages the soil through loss of mineral elements, acidification of the environment and release of heavy metals. These fertilizers are expensive to be afforded by small farmers with limited resources (He *et al*., 2009).

To cope with the physical degradation of soils, enhancement of their structure by improving the content of organic matter should be considered. In agriculture, the use of crop waste is not only due to their nutrients contents, but also to their ability to reduce erosion and improve water retention needed for the development of plants and microorganism (Erestein, 2002) The return of crop residue to the soil is the main component that led to the gathering of nutrients, increasing the level of organic matter and improving soil structure. Incorporation of plants waste into the soil has the ability to enrich the plants with adequate nutrients (Nottidge *et al*., 2005).

Unfortunately, the wastes are left in farm after harvest as a result of lack of information on the importance of organic residue as a source of nutrient for adequate crop yield. The impacts of crop residues on soil properties are bases on the quantity of residue incorporated and the chemical composition of the residue, the content of clay and organic matter are other condition affecting the changes in soil fertility. As crop residue interferes with field operations of the next crops, farmers often prefer to burn the residues. Burning led to loss of nutrients, kill soil organisms and pollute the environment (Katyal, 2002). A better understanding of the impacts of Sesame residue on soil nutrients is needed in order to manage and sustain agricultural lands.

II Materials and Methods

Description of the Study Area

The study was undertaken in a farming land of Sabon Kaura, located within Bauchi Local Government, Bauchi. Bauchi State is in North-East geo-political zone of Nigeria and was created in 1976. The State is located between latitudes 9° 30' and 12° 30' North of equator and between longitudes 8°45' and 11°0' East of the Greenwich Meridian.

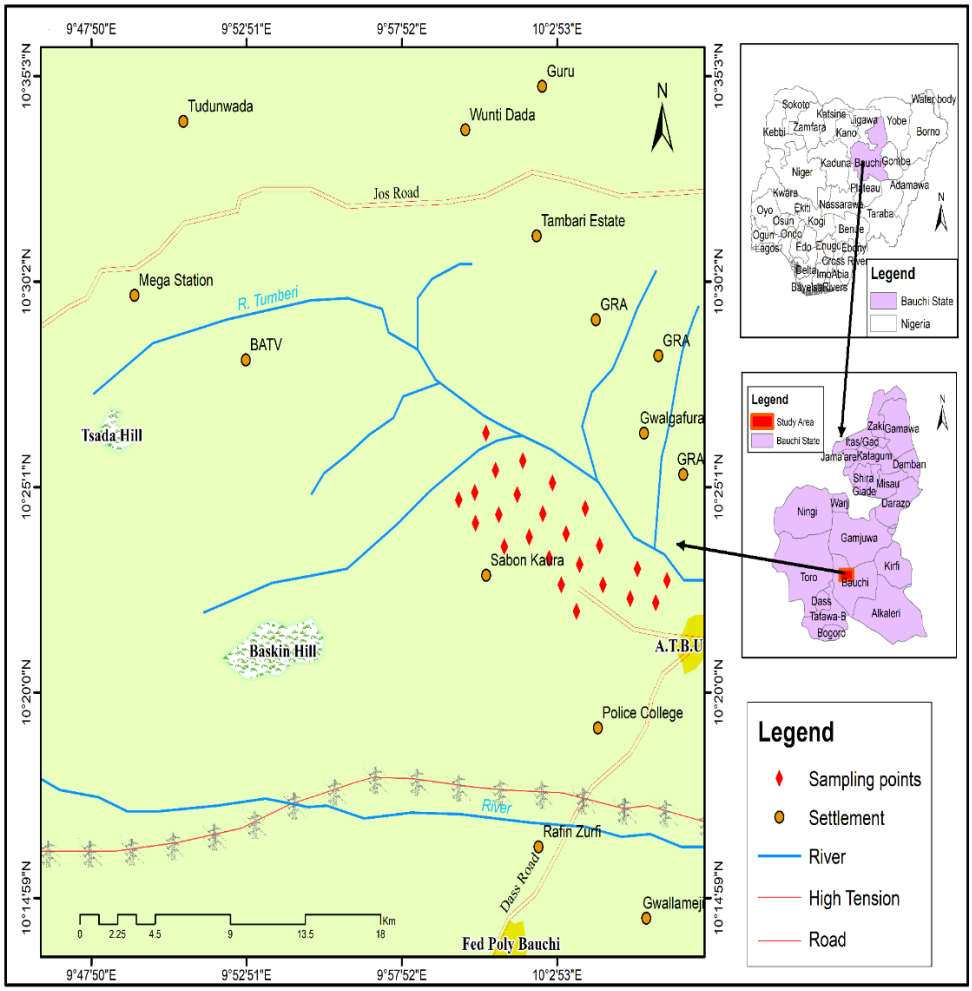


Figure 1: Map of Bauchi showing the Sampling Locations

Soil and Sesame plant sampling

Bulk soil samples were collected randomly at a depth of 0-30 cm from different sampling points in Sabon Kaura Bauchi after removing the debris. The soil samples were homogenized, air-dried, ground using a wooden pestle and mortar, sieved to pass through a 2 mm mesh with the aim of getting rid of small stones and impurities. The sieved soil samples were labelled appropriately prior to the laboratory analyses.

The sampling of Sesame plant (*Sesamum indicum*) was collected at old Airport road, Bauchi. The plant was collected from various locations within the sampling site and mixed up in order to ensure sample homogenization. The samples were air-dried for five days, weighed until constant mass was obtained, ground using a wooden pestle and mortar, sieved through a 2.00 mm mesh so as to obtain the finest possible power for analyses. The sieved samples were kept in air-tight plastic containers and labelled appropriately before analyses

Treatments and experimental design

The experiment was a complete randomized design with four treatments. Each treatment consisted of three separate pots. A mass of 1.00 kg soil was weighed into each pot and water was neither added nor the organic residue of Sesame plant to the control soil. The three separate treatments of two, four and six months contained 100.00 (M_1), 200.00 (M_2) and 300.00 g (M_3) each of Sesame residue respectively. A volume of 100.00 cm^3 of water was added

daily to each treatment in order to keep the soil slightly moist. At the end of each treatment, soil from each treatment was air-dried, pounded using a wooden mortar and pestle, sieved through a 2.00 mm mesh and analysed for its pH, organic matter, organic carbon, soluble salts and total exchangeable acidity.

Soil Chemical Analysis

Soil pH was determined using glass electrode pH meter in a suspension of soil to water at the ratio of 1:2 (Motsara and Roy, 2008), The ammonium ethanoate solution was used to extract the exchangeable bases & Total Exchangeable Acidity was extracted with potassium chloride solution as described by Molindo (2008) and determined by Atomic Absorption Spectrophotometer Model 210/11 VGP. Cation Exchange Capacity was analysed using the methods stated by Kolo *et al*. (2009). SOC was determined in potassium dichromate solution using Walkley and Black method (Kolo *et al*., 2009). SOM was determined by monitoring the change in mass of the soil after heating (Sarojini *et al*., 2013). Soil-water mixture (1:5) after mechanically agitated for four hours, filtered using Whatman filter paper number 1 and used to determine the soil soluble salts as explained by Hassan *et al*. (2019).

III. RESULTS AND DISCUSSION

Physicochemical parameters as affected by sesame plant residue

The results of physicochemical parameters in the soil samples are presented in Table 1.

Table 1: Levels of Selected Physicochemical Parameters in Control and Treated Soil

Mass of Sesame (g)	Treatments (months)	SS (mg/kg)	TEA (cmol/kg)	SOM (%)	SOC (g/kg)
0 (control)	0	3000.00±0.01	5.43±0.02	0.80±0.02	0.50±0.03
	2	2200.00±0.00	5.10±0.00	1.76±0.01	4.20±0.01
100	4	2100.00±0.01	4.50±0.01	2.45±0.00	5.50±0.02
	6	2000.00±0.03	4.00±0.02	3.20±0.03	6.30±0.01
	2	1950.00±0.03	4.70±0.03	1.95±0.00	4.50±0.01
200	4	180.000±0.01	4.10±0.03	3.00±0.01	5.70±0.00
	6	1650.00±0.02	3.60±0.00	4.20±0.02	6.50±0.03
	2	1600.00±0.02	4.20±0.01	2.60±0.01	4.90±0.03
300	4	1400.00±0.00	3.80±0.01	3.50±0.01	6.00±0.02
	6	1300.00±0.01	3.00±002	4.50±0.00	7.50±0.03

Values are mean ± standard deviation (n=4).

Critical Limits Interpreting Soil Analytical Parameters

The critical limits interpreting soil analytical parameters are shown in Table 2.

Table 2: Critical Limits Interpreting Soil Analytical Parameters

Soil Parameters	Low	Moderate	High
TEA (cmol/kg)	< 2.10	2.10-4.00	> 4.00
SOM (%)	1.00-2.00	2.00-4.00	2.00-4.00
SOC (g/kg)	0.50-1.00	1.00-2.00	> 3.00

Source: Kolo *et al*. (2009).

An increasing trend was observed in the level of SOC of the treated soil on comparison to the control (Table 1) with the highest level (7.50 %) obtained in six months treatments. This might be due to the addition of highest mass of sesame residue incorporated into the soil which resulted to increase in the

content of organic matter from the decomposition of sesame residue leading to high level of organic carbon. The SOC found in the treatments is high based on the threshold levels interpreting soil parameters (Table 2). The lowest level (0.50 g/kg) of SOC was determined in the control soil, the level is low according to the critical limits of soil parameters (Kolo *et al*., 2019) as shown in Table 2. In the current study, differences in the soil texture of the treated soil could be accounted for the changes in SOC. The significant increase in SOC with the addition of sesame residue was attributed to increased mass of sesame residue. The results of this investigation are in line with the experiments carried out by several researchers [4, 2 and 1]. Previous authors also reported higher concentration of organic carbon in soil-residue treatment as the incubation period increases, (3.37 – 3.64) [5]; 3.52-11.60 [1] and (0.52-0.72) [16].

The addition of sesame residue lowered the level (cmol/kg) of TEA from 5.43 (control) to 3.00 (six months treatments). The decrease in the concentration of TEA was possible due to the high level of calcium which was attributed to the addition of sesame residue. Our observations is in conformity with the findings of [14], [5] and [13] who reported a reduction in exchangeable acidity of the soil treated with corn straw, *Typha domingensis* and legume respectively. Soil treated with fresh cowpea residue lowered the exchangeable Aluminium from 2.20 to 0.85 cmol/kg [12].

The data regarding SOM was obtained minimum (0.80) in the control soil. Incorporation of sesame residue has a positive impact on the soil organic matter with the highest value (4.50) observed in six months treatments (Table 1). The increased level of SOM could be explained as a product of decomposition of sesame residue. The soil organic matter of the treated soil is medium as established by critical limits (Table 2). Several authors obtained an increase in soil organic matter (%) from 6.30-20.10 [1] and 5.67-6.05 [6]. Two-factor analysis of variance ($p \leq 0.05$) revealed that the percentage of organic matter determined was not statistically affected.

A decreasing trend in the level of soluble salts was noted from 2200.00-1600.00 mg/kg in two months treatment, 2100.00-1400.00 mg/kg four months treatment and 2000.00-1300.00 mg/kg in six months treatment as a result of application of sesame residue into the soil (Table 1). This might be due to decrease evaporation from the surface soil, thereby limiting the upward of salts and allowing for better leaching of salts deeper into the soil profile. Statistical significance difference ($p \leq 0.05$) of Two-way ANOVA was observed on the levels of soluble salts based on different condition of treatments, but insignificant difference seen as a result of application of different masses of sesame residue. Decrease in soluble salts due to incorporation of maize residue and straw was also reported by [19] and [18] respectively.

Interaction Effects of varied duration of treatments and masses of sesame plant on soil soluble salts.

The effects of interaction of varied duration of treatments and masses of sesame plant on the levels of soluble salts is depicted in Table 3.

Table 3: Soil Soluble Salts as Influenced by Interaction Effect of Varied Duration of

Treatments and Masses of Sesame ($LSD_{0.05}$ = 445.48).

	$M_{1:\ 100\ g}$	$M_{2:\ 200\ g}$	$M_{3:\ 300}$
SS_2	2200.00	1950.00	1600.00
SS_4	2100.00	1800.00	1400.00
SS_6	2000.00	1650.00	1300.00

The subscript numbers (2, 4, and 6) are two, four and six months treatments.

Effects of Interaction

As depicted in Table 3, the outcome of the calculation of least significance difference test (LSD_{SSM} = 445.48) depicted that the combination between the duration of treatment and masses of sesame residue shows that all the interactions are significantly difference. The best interaction is 2200.00 which is the interaction between SS_2 and M_1 followed by 1950.00 (interaction between SS_2 and M_2), all other interactions are also good enough. A positive impact was observed on the concentrations of organic carbon between the duration of treatment (two and six months treatments) and varied masses of sesame incorporated (100 and 300 g of sesame residue).

Statistical Analysis

The observed data from these findings were subjected to Two-Way ANOVA and LSD test. It was noted that most of the physicochemical properties were statistically different with the exception of soil organic matter.

Conclusion

The application of sesame residue resulted to higher level of physicochemical parameters of the soil with the exception of TEA and SS. Soil properties were statistically improved by the treatment with sesame residue. The interaction impacts of duration of treatments and masses of sesame residue were

observed in the levels of SS. Therefore, the application of sesame residue can increase the level SOC, SOM and reduce the level of TEA and SS for normal plants growth.

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