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Effects of Rice Husk-Mulch on Soil Chemical Properties Under Sorghum And Millet In Maiduguri, Nigeria.

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Abstract

A split-plot experiment was carried out to assess the effects of different rates of rice husk-mulch on the chemical properties of a sandy loam soil at two sites in Maiduguri. Treatments comprised sorghum and millet as main-plot factor, and three mulch application rates (0, 10 and 15 tons/ha) as sub-plot factor, replicated three times. Composite soil samples were collected from 0 – 15 and 15 – 30 cm depths after crop harvest for physicochemical analysis. At Site 1, millet plots had higher pH in 0.01M $CaCl_2$ than sorghum plots at 0 – 15 cm depth. Also at Site 1, exchangeable calcium content of millet plots were lower than those of sorghum plots at 0 – 15 cm depth. At Sites 1 and 2, organic carbon and total nitrogen contents increased with mulch application rate. At site 2 and in the combined data, sorghum plots exhibited higher exchangeable acidity, CEC and ECEC than millet plots at 0 – 15 cm depth. At Site 2, 0 t/ha mulch rate resulted in higher pH in water than 10 t/ha application rate. The interaction relationship of crop type and mulch application rate exhibited some significant influence on soil C/N ratio, exchangeable calcium and exchangeable acidity in this study. Mulch application has the potential to increase soil organic carbon and total nitrogen content.

Keywords: *Rice husk-mulch, sorghum, millet and soil chemical properties.*

Introduction

The soils found around Maiduguri are generally sandy in nature, poorly structured and inherently low in fertility, organic matter content and water holding capacity (Yandev and Sachan, 1985; Rayar, 1988). Thus, crop growth and yields could be adversely affected, especially under conditions of scanty and highly variable rainfall that characterize the study area.

Crop residues returned to the soil have been found to be beneficial for the maintenance and/or improvement of the physical, chemical and biological properties of the soil that enhance easy tillage, crop growth and yield (Linden *et al*., 2000; Ewulo, 2005). These workers reported that non return of crop residues to the soil or removal of crop residues from the soil surface was observed to give rise to a significant decrease in organic matter content and degradation in physicochemical properties with a consequent reduction in average crop yields, especially in moisture limited environments. Lal (1995) noted that addition of crop residues to some nutrient deficient soils in savannah region of northern Nigeria enhanced soil fertility and increased crop yields. Crop residue management practices affect plant growth and development through their influence on soil properties.

Rice husk, unlike other crop residues, is relatively cheap and readily available around the study area. It faces less competition, especially, as livestock feed and material for construction, and could effectively be used as mulching material. Sorghum (*Sorghum bicolor* (L.) Moench) and millet (*Pennisetum glaucum* (L) Br.) are important grain crops in semi-arid regions of Nigeria, Ghana and Ethiopia amongst others, primarily as major staple food (Chiroma *et al.,* 2005; Ojeniyi *et al., 2009*).

Crop residue mulching materials serve as nutrient source, although their effects may vary with their nature and composition (Ojeniyi and Ighomrore, 2004; Akanbi and Ojeniyi 2007; Ogban, 2009), and soil type. Mulching with plant residues increases soil organic matter content, improves soil fertility and enhances microbial activities (Ewulo, 2005; Akanbi and Ojeniyi 2007; Ogban, 2009). Thus, the objective of this research is to determine the effect of rice husk-mulch on the chemical properties of a sandy loam soil under sorghum and millet crops.

Materials and Methods

A field experiment was carried out under rain-fed conditions for one year period at two sites within University of Maiduguri, Borno State, northeast Nigeria in 2009. Site 1 is situated near Gate 2, in the Faculty of Agriculture Teaching and Research Farm (11^0 49′ N, 13^0 13′ E and 324 m above mean sea level), while site 2 is situated in the Faculty of Agriculture orchard, opposite Centre for Arid Zone Studies complex (11^0 49′ N, 13^0 12′ E and 327 m above mean sea level). The dominant soil type in the study area is sandy loam, developed from Aeolian sand deposit as parent material. The research comprised sorghum and millet, and three mulch application rates (0, 10 and 15 tons/ha) replicated three times, laid out in a split-plot design. The experimental plots were ploughed and levelled, while their edges were raised to minimize run-on and/or run-off. Rice husk-mulch was uniformly applied on the soil surface just before planting. Harvesting was done at 12 WAP.

Composite soil samples were collected from 0 – 15 and 15 – 30 cm depths after crop harvest for chemical analysis. The soil samples were air-dried, crushed and passed through a 2 mm sieve for the laboratory analysis. The Bouyoucos hydrometer method (Gee and Bauder, 1986) was used for the determination of particle size distribution. Textural class of the soil was determined using a textural triangle. Soil pH was determined using glass-electrode pH meter. The pH was determined on a 1:2.5 soil : solution ratio in both water and 0.01M $CaC1_2$ solution (Mc Lean, 1982). Total nitrogen was determined by employing the modified macro-Kjeldahl method (Bremner and Mulvaney, 1982). The organic carbon content of the soil was determined by Walkley - Black (1934) wet - oxidation method. Available phosphorus extraction was carried out by employing the Bray No.1 method, and the amount of available phosphorus measured by colorimetry (Bray and Kurtz, 1945). Exchangeable bases (Ca^{2+}, Mg^{2+}, K^+ and Na^+) were extracted with 1N neutral ammonium acetate (NH_4OAc) solution (Grant, 1982). Calcium and magnesium were determined by titration, while potassium and sodium were determined by flame photometry. Exchangeable H^+ and Al^{3+} were extracted with 1N KCl and the extract titrated with 0.05 N Na0H. The total acidity was estimated by summing the amounts of H^+ and Al^{3+} determined (Grant, 1982). Cation exchange capacity (C.E.C.) was determined by summation of the total exchangeable bases (Ca^{2+}, Mg^{2+}, K^+ and Na^+). Effective CEC (ECEC) was also determined by summation of the total exchangeable cations (Ca^{2+}, Mg^{2+}, K^+, Na^+, Al^{3+} and H^+). Percent base saturation was computed as follows:

$$\%\text{ Base saturation} = \frac{\text{Exchangeable bases,cmolkg}^{-1}}{\text{Exchangeable cations,cmolkg}^{-1}} \text{x} 100$$

The data obtained were subjected to statistical analysis so as to determine significant differences that exist between treatments at 5% significant level.

Results and Discussion

The soils of the experimental sites are classified as Typic Ustipsamment (Rayar, 1986). They are sandy loam in texture, and exhibit a slightly acidic pH. The organic matter content is low, and decreases with depth as expected. The available phosphorus content of these soils is low, total nitrogen is moderate high and base status of these soils is low according to the ratings for soil fertility by FAO (1984; 2004) and Esu (1991).

Soil chemical Properties

Tables 1 and 2 show the chemical properties of soil samples collected from 0 – 15 and 15 – 30 cm depths, respectively, in the sorghum and millet plots at Sites 1 and 2, and the combined data. At Sites 1 and 2, and in the combined data, both crop type and mulch treatment did not significantly affect soil pH in water **(**1 : 2.5**),** percent clay, C/N ratio, available phosphorus, exchangeable bases (Mg^{2+}, K^+ and Na^+) and base saturation at 0 – 15 cm depth. At Site 1, crop type significantly affected soil pH in 0.01M $CaCl_2$ **(**1 : 2.5**)** and exchangeable calcium contents at 0 – 15 cm depth**,** while mulch treatment did not. At Site 2 and in the combined data, both crop type and mulch had no significant influence on soil pH in 0.01M $CaCl_2$ **(**1 : 2.5**),** organic carbon, total nitrogen and exchangeable calcium contents at 0 – 15 cm depth. At 15 – 30 cm soil depth at Sites 1 and 2, and in the combined data, both crop type and mulch treatment did not significantly affect soil pH in 0.01M $CaCl_2$ **(**1

: 2.5**),** C/N ratio, available phosphorus, exchangeable acidity (H^+ + Al^{3+}), exchangeable bases (Ca^{2+}, Mg^{2+}, K^+ and Na^+), cation exchange capacity (CEC), effective cation exchange capacity (ECEC) and base saturation. At Site 1 and in the combined data, both crop type and mulch treatment had no significant influence on soil pH in water **(**1 : 2.5**)** and total nitrogen content at 15 – 30 cm depth.

In the current study, the pH (1:2.5) in 0.01M $CaCl_2$ of soil samples collected from sorghum plots was lower than that of soils collected from millet plots at 0 – 15 cm depth at Site 1. Also at Site 2, application of 10 t/ha mulch resulted in a lower pH (1:2.5) in water of soil samples at 15 – 30 cm, than 0 t/ha mulch application rate. The lower pH observed in the sorghum plots, and also following the application of 10 t/ha mulch may be due to the production of organic and inorganic acids from breakdown of organic residues (Brady and Weil, 1999). Consistently, soils collected from sorghum plots at 0 – 15 cm depth had higher exchangeable calcium at Site 1, exchangeable acidity in the combined data, CEC and ECEC at Site 2 and in the combined data than soils collected from millet plots at the same depth. Also, soils collected from sorghum plots at 15 – 30 cm depth had higher exchangeable potassium content than those collected from millet plots at Site 2. The superiority of sorghum plots compared with the millet plots in respect of exchangeable calcium and potassium content, CEC and ECEC may be due to mineralization of higher organic matter resulting from higher dry matter production that may have occurred in the sorghum plots. The better performance observed in the sorghum plots could be due, probably, to higher nutrient recycling arising from the deeper penetration of the roots of sorghum crop as found in this study (Eze *et al.*, 2006; Brady and Weil, 1999).

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Table 1: Effects of crop and mulch on physicochemical properties of soils at 0 – 15 cm depth under sorghum and millet after crop harvest at Maiduguri, 2009.

Treatment	pH (1:2.5) H_2O	pH (1:2.5) 0.1M $CaCl_2$	E.C µS cm^{-1}	Sand (%)	Silt (%)	Clay (%)	O.C ($g\ kg^{-1}$)	Tot. N ($g\ kg^{-1}$)	C:N ratio	Avail. P mg kg^{-1}	Exch. Ca^{2+} (cmol kg^{-1})	Exch. Mg^{2+} (cmol kg^{-1})	Exch. K^+ (cmol kg^{-1})	Exch. Na^+ (cmol kg^{-1})	Exch. Acid. (cmol kg^{-1})	C.E.C. (cmol kg^{-1})	E.C.E.C. (cmol kg^{-1})	Base Sat. %
Site 1																		
A: Crop type																		
Sorghum	6.07a	5.27b	46.61a	63.72b	25.27a	11.07a	3.71a	1.79a	2.08a	8.94a	2.71a	1.02a	1.12a	0.51a	1.64a	5.36a	7.01a	71.62a
Millet	6.22a	5.67a	30.84a	65.20a	23.90b	11.12a	2.87a	1.36a	2.13a	5.99a	2.49b	1.18a	0.53a	0.46a	1.09a	4.65a	5.74a	81.02a
SE ±	0.06	0.09	11.11	0.10	0.31	0.20	0.35	0.21	0.08	1.66	0.02	0.16	0.27	0.05	0.24	0.47	0.68	1.60
B: Mulch rate																		
0 t/ha	6.15a	5.54a	54.08a	64.71a	24.15a	11.14a	3.18b	1.58ab	2.01a	7.29a	2.43a	1.37a	0.88a	0.48a	1.33a	5.15a	6.49a	80.29a
10 t/ha	6.12a	5.39a	32.57a	64.21a	25.06a	11.07a	2.90b	1.35b	2.17a	5.54a	2.53a	1.10a	0.71a	0.48a	1.30a	4.82a	6.12a	78.80a
15 t/ha	6.18a	5.49a	29.53a	64.46a	24.56a	11.07a	3.78a	1.78a	2.14a	9.57a	2.83a	0.83a	0.89a	0.50a	1.47a	5.05a	6.52a	77.36a
SE ±	0.04	0.17	18.71	0.57	0.63	0.25	0.19	0.12	0.12	3.02	0.28	0.21	0.27	0.03	0.20	0.38	0.34	3.11
Interaction: A x B	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Site 2																		
A: Crop type																		
Sorghum	6.23a	5.78a	93.00a	64.44a	24.08a	11.48a	5.03a	2.19a	2.48a	11.08a	5.74a	2.53a	1.27a	0.51a	0.73a	10.06a	10.79a	93.12a
Millet	6.19a	5.71a	83.10a	65.55a	23.38a	11.07a	4.41a	2.28a	2.04a	6.88a	4.64a	2.38a	1.00a	0.50a	0.64a	8.52b	9.17b	93.01a
SE ±	0.04	0.10	5.23	0.73	0.53	0.22	0.94	0.49	0.30	4.60	0.75	0.33	0.13	0.03	0.12	0.32	0.36	0.98
B: Mulch rate																		
0 t/ha	6.22a	5.71a	89.77a	65.13a	23.41a	11.45a	4.47a	2.10a	2.55a	6.77a	4.45a	2.60a	1.15a	0.53a	0.67a	8.73a	9.40a	92.79a
10 t/ha	6.21a	5.67a	89.50a	64.72a	23.98a	11.30a	4.68a	2.22a	2.12a	11.73a	5.80a	2.53a	1.11a	0.48a	0.63a	9.92a	10.55a	93.91a
15 t/ha	6.20a	5.87a	84.88a	65.13a	23.80a	11.07a	5.02a	2.38a	2.11a	8.46a	5.33a	2.23a	1.14a	0.51a	0.77a	9.22a	9.98a	92.51a
SE ±	0.05	0.16	7.50	0.34	0.31	0.40	0.92	0.64	0.43	4.52	0.92	0.50	0.11	0.03	0.15	1.01	1.10	1.23
Interaction: A x B	NS	NS	*	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Combined																		
A: Crop type																		
Sorghum	6.15a	5.53a	69.81a	64.08a	24.68a	11.27a	4.37a	1.99a	2.28a	10.01a	4.23a	1.78a	1.20a	0.51a	1.19a	7.71a	8.90a	84.87a
Millet	6.20a	5.69a	56.97a	65.38a	23.64a	11.09a	3.64a	1.82a	2.09a	6.44a	3.57a	1.78a	0.76a	0.48a	0.87b	6.59b	7.46b	87.02a
SE ±	0.05	0.09	4.28	0.41	0.28	0.21	0.43	0.20	0.12	1.75	0.38	0.22	0.19	0.04	0.07	0.25	0.32	0.72
B: Mulch rate																		
0 t/ha	6.18a	5.62a	71.93a	64.92a	23.78a	11.30a	3.83a	1.84a	2.28a	7.03a	3.44a	1.98a	1.01a	0.50a	1.00a	6.94a	7.94a	86.54a
10 t/ha	6.16a	5.53a	61.03a	64.46a	24.52a	11.19a	3.79a	1.78a	2.14a	8.63a	4.17a	1.82a	0.91a	0.48a	0.97a	7.37a	8.34a	86.36a
15 t/ha	6.19a	5.68a	57.21a	64.80a	24.18a	11.07a	4.40a	2.08a	2.13a	9.01a	4.08a	1.53a	1.02a	0.50a	1.12a	7.14a	8.25a	84.94a
SE ±	0.05	0.16	14.85	0.36	0.43	0.22	0.56	0.34	0.23	2.70	0.77	0.43	0.16	0.02	0.22	1.15	1.02	3.78
Interaction: A x B	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

Means with the same letter (s) in the columns are not significantly different according to Duncan's Multiple Range Test (DMRT) at 5 % level of probability.

*: Significant at 5 % probability level; NS: Not Significant;

Table 2: Effects of crop and mulch on physicochemical properties of soils at 15 - 30 cm depth under sorghum and millet after crop harvest at Maiduguri, 2009.

Treatment	pH (1:2.5) H_2O	pH (1:2.5) 0.1M $CaCl_2$	E.C ɥS cm^{-1}	Sand ←------	Silt %	Clay -----→	O.C ←-	Tot. N g kg^{-1} -→	C:N ratio	Avail. P mg kg^{-1}	Exch. Ca^{2+} ←------	Exch. Mg^{2+}	Exch. K^{+}	Exch. Na^{+} cmol kg^{-1}	Exch. Acid.	C.E.C.	E.C.E.C. ------→	Base Sat. %
Site 1																		
A: Crop type																		
Sorghum	6.09a	5.56a	45.78a	63.72b	25.27a	11.01a	2.79a	1.37a	2.05a	5.41a	2.91a	1.42a	1.25a	0.48a	1.78a	6.06a	7.84a	76.76a
Millet	6.25a	5.70a	26.56a	65.20a	23.95b	10.85a	2.48a	1.29a	1.95a	8.91a	2.58a	1.38a	1.18a	0.46a	1.11a	5.48a	6.59a	82.87a
SE ±	0.09	0.20	19.09	0.10	0.26	0.20	0.04	0.08	0.11	3.24	0.15	0.28	0.31	0.05	0.18	0.47	0.43	2.63
B: Mulch rate																		
0 t/ha	6.22a	5.56a	27.65a	64.71a	24.22a	11.07a	2.60a	1.28a	2.04a	5.37a	2.70a	1.40a	0.73a	0.43a	1.40a	5.10a	6.50a	78.34a
10 t/ha	6.12a	5.53a	56.27a	64.21a	25.06a	10.73a	2.55a	1.27a	2.03a	8.69a	2.67a	1.50a	1.52a	0.50a	1.50a	6.18a	7.68a	80.15a
15 t/ha	6.16a	5.80a	24.58a	64.46a	24.56a	10.98a	2.75a	1.43a	1.92a	7.41a	2.87a	1.30a	1.39a	0.49a	1.43a	6.05a	7.48a	80.96a
SE ±	0.05	0.15	21.57	0.57	0.60	0.24	0.19	0.11	0.05	2.26	0.17	0.24	0.66	0.03	0.20	0.64	0.54	3.35
Interaction: A x B	NS	NS	NS	NS	NS	NS	NS	NS	**	NS	**	NS	NS	NS	NS	NS	NS	NS
Site 2																		
A: Crop type																		
Sorghum	6.29a	5.72a	75.86a	64.44a	24.54a	11.02a	3.86a	1.92a	2.00a	10.11a	5.00a	2.40a	1.26a	0.45a	0.64a	9.10a	9.75a	93.20a
Millet	6.20a	5.75a	84.10a	65.55a	23.39a	11.06a	3.89a	1.86a	2.08a	7.04a	4.42a	2.02a	1.00b	0.48a	0.82a	7.93a	8.75a	90.61a
SE ±	0.02	0.15	14.09	0.73	0.75	0.21	0.19	0.06	0.06	4.56	0.27	0.24	0.02	0.03	0.06	0.34	0.29	0.73
B: Mulch rate																		
0 t/ha	6.31a	5.88a	69.63a	65.13a	23.87a	10.99a	3.05b	1.52b	2.01a	5.66a	4.20a	1.93a	1.07a	0.45a	0.73a	7.65a	8.39a	90.74a
10 t/ha	6.19b	5.59a	98.92a	64.72a	24.23a	11.06a	4.95a	2.38a	2.07a	11.32a	4.73a	2.53a	1.23a	0.46a	0.73a	8.95a	9.68a	92.45a
15 t/ha	6.23ab	5.73a	71.38a	65.13a	23.80a	11.07a	3.62b	1.77b	2.04a	8.75a	5.20a	2.17a	1.10a	0.48a	0.73a	8.95a	9.67a	92.53a
SE ±	0.03	0.15	16.81	0.34	0.43	0.25	0.54	0.02	0.04	4.02	0.52	0.35	0.21	0.07	0.12	0.65	0.70	1.34
Interaction: A x B	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	*	NS	NS	NS
Combined																		
A: Crop type																		
Sorghum	6.19a	5.64a	60.82a	64.08a	24.91a	11.04a	3.32a	1.64a	2.03a	7.76a	3.96a	1.91a	1.25a	0.47a	1.21a	7.58a	8.80a	84.98a
Millet	6.22a	5.72a	55.33a	65.38a	23.67a	11.07a	3.18a	1.57a	2.01a	7.97a	3.50a	1.70a	1.09a	0.47a	0.97a	6.71a	7.67a	86.74a
SE ±	0.05	0.12	13.31	0.41	0.47	0.10	0.10	0.07	0.03	1.73	0.19	0.18	0.14	0.04	0.11	0.40	0.36	1.60
B: Mulch rate																		
0 t/ha	6.26a	5.72a	48.64a	64.92a	24.05a	11.03a	2.83a	1.40a	2.02a	5.51a	3.45a	1.67a	0.90a	0.44a	1.07a	6.37a	7.44a	84.54a
10 t/ha	6.16a	5.56a	77.59a	64.46a	24.64a	11.06a	3.75a	1.83a	2.05a	10.00a	3.70a	2.02a	1.37a	0.48a	1.12a	7.56a	8.68a	86.30a
15 t/ha	6.20a	5.76a	47.98a	64.80a	24.18a	11.07a	3.18a	1.60a	1.99a	8.08a	4.03a	1.73a	1.25a	0.48a	1.08a	7.50a	8.58a	86.74a
SE ±	0.05	0.13	17.78	0.36	0.41	0.11	0.44	0.20	0.05	2.52	0.54	0.28	0.30	0.03	0.23	0.80	0.67	3.46
Interaction: A x B	NS	NS	NS	NS	NS	NS	NS	NS	*	NS	NS	NS	NS	NS	NS	NS	NS	NS

Means with the same letter (s) in the columns are not significantly different according to Duncan's Multiple Range Test (DMRT) at 5 % level of probability.

*: Significant at 5 % probability level; **: Significant at 1 % probability level; NS: Not Significant;

Table 3: Interaction effects of crop x mulch on C : N ratio, exchangeable calcium (cmol kg^{-1}) and exchangeable acidity (cmol kg^{-1}) of soils under sorghum and millet at Maiduguri, 2009.

	C:N ratio (15-30 cm, Site 1)		Exch. Ca^{2+} (15-30 cm, Site 1)		C:N ratio (15-30 cm, Combined)		Exch. Acidity (15-30 cm, Site 2)	
	Crop type							
Mulch rate	Sorghum	Millet	Sorghum	Millet	Sorghum	Millet	Sorghum	Millet
0 t/ha	1.96ab	2.11a	2.53b	2.87ab	1.97ab	2.07a	0.60bc	0.87ab
10 t/ha	2.06a	1.99ab	2.80b	2.53b	2.08a	2.07a	0.87ab	0,60bc
15 t/ha	2.12a	1.74b	3.40a	2.33b	2.08a	1.89b	0.47c	1.00a
SE ±	10.12		0.25		0.07		0.15	

Means with the same letter (s) in the columns are not significantly different according to Duncan's Multiple Range Test (DMRT) at 5 % level of probability.

At Site 1, higher organic carbon content of 0 – 15 cm depth soils resulted from the application of 15 t/ha mulch compared with both 0 and 10 t/ha mulch rates. Also at Site 1, higher total nitrogen content of 0 – 15 cm depth soil samples resulted from the application of 15 t/ha mulch compared with 10 t/ha mulch application rate. These findings are attributable to the breakdown of higher amount of organic residue in respect of the 15 t/ha mulch treatment at Site 1, at the 0 – 15 cm soil depth. Eze *et al.* (2006) and Yamoah *et al.* (1986) reported that, the quality and quantity of plant materials and litter returned to the soil will, to a great extent, determine the organic matter levels and by implication, nitrogen level of the soil. Brady and Weil (1999) also noted that, soil quality is positively affected if a significant proportion of crop residues are returned to the soil. Application of residue-mulch would increase organic matter content, improve nutrient status and enhance the productive capacity of the soil (Ogban, 2009). At Site 2, the organic carbon and nitrogen contents of 15 - 30 cm depth soils that resulted from the application of 10 t/ha mulch were higher than the organic carbon and nitrogen contents of samples that resulted from the application of both 0 and 15 t/ha mulch rates.

The higher soil organic carbon content observed under 10 t/ha mulch application rate than under zero mulch may be due to the breakdown of higher amount of crop residue under 10 t/ha mulch rate compared with 0 t/ha mulch rate at Site 2. Also at Site 2, nitrogen immobilization by soil microbes under 15 t/ha mulch treatment may be responsible for the lower total nitrogen content observed following the application of 15 t/ha mulch compared with 10 t/ha mulch treatment.

The interaction relationship of crop type and mulch application rate had some significant influence on C/N ratio, exchangeable calcium and exchangeable acidity of 15 – 30 cm depth soils (Table 3). A similar trend was observed in which the three chemical properties mentioned increased with mulch application rate under sorghum, whereas under millet, the properties decreased with mulch rate. The observed differences arising from the various crop and mulch rate combinations may be due to differences between crops.

Conclusion

Soil organic carbon and total nitrogen contents increased with mulch application. The superiority of sorghum plots compared with the millet plots in respect of exchangeable calcium and potassium content, CEC and ECEC may be due to mineralization of higher organic matter and greater extent of nutrient recycling arising from the deeper root penetration that may have occurred in the sorghum plots. The interaction relationship of crop type and mulch application rate exhibited some significant influence on soil C/N ratio, exchangeable calcium and exchangeable acidity in this study.

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