INFLUENCE OF ORGANIC RESIDUE OF *Typha domingensis* ON SOME PHYSICOCHEMICAL PROPERTIES OF UNIVERSITY FARM, GUBI/BAUCHI, NIGERIA

* [1]U.F. HASSAN, [1]E.O. EKANEM, [1]H.M. ADAMU, [2]N. VONCIR AND [3]H.F. HASSAN

[1]DEPARTMENT OF CHEMISTRY, ABUBAKAR TAFAWA BALEWA UNIVERSITY, BAUCHI, NIGERIA.

[2]DEPARTMENT OF CROP PRODUCTION, ABUBAKAR TAFAWA BALEWA UNIVERSITY, BAUCHI, NIGERIA.

[3]GENERAL HOSPITAL, DASS, BAUCHI, NIGERIA.

*Email: ufhassan2007@gmail.com

ABSTRACT: Studies were carried out on soil samples obtained from the Abubakar Tafawa Balewa University farm, Gubi/Bauchi, Nigeria to determine the influence of the organic residue of *Typha domingensis* of the soil samples. The treatments were laid in complete randomized design with three replications and incubated at 35^0 C for 15, 30 and 45 days. Neither water nor the organic residue of the noxious *Typha domingensis* was added to the control soil samples (0 day incubation period). Each of the treatments consists of 2.00 kg of soil sample incubated with 300.00 g of the organic residue of the plant. 100.00 cm^3 of water was added to each of the replicated treatments daily. At the end of the specified incubation periods, samples were taken separately from each treatment and used for chemical analyses using standard analytical methods. Results obtained showed variations in the ranged values of bulk density (1.363 ± 0.017 to 1.424 ± 0.004 g/cm^3), pH (H_2O) (7.93 ± 0.05 to 8.05 ± 0.06), pH ($CaCl_2$) (7.73 ± 0.05 to 8.10 ± 0.00), exchangeable sodium (0.72 ± 0.01 to 1.85 ± 0.13 cmol/kg), calcium (7.34 ± 0.01 to 43.92 ± 0.27 cmol/kg) and magnesium (1.35 ± 0.02 to 7.54 ± 0.02 cmol/kg) respectively. The addition of the organic residue of *Typha domingensis* was however found to have decreased the level of the total exchangeable acidity (TEA) possibly due to the high concentration of calcium. The total exchangeable acidity (TEA) unlike the other parameters determined was not statistically affected ($p \leq 0.05$) by the varied incubation periods as indicated by Single Factor Analysis of Variance and the Least Significant Difference Test. The organic residue of *Typha domingensis* is therefore a moderate liming material and it is recommended that incubating it for 45 days is adequate for the soil sample investigated.

Key words: *Typha domingensis*, Complete Randomized Design, Physicochemical properties, Soil, Organic Residue and Total Exchangeable Acidity.

---

1 INTRODUCTION

Soil is a complex substance displaying many inter-related properties. It is also the medium for plant growth and can be described in numerous ways by its appearance, position in the landscape, touch or by its physical and chemical properties. To the farmer, the soil provides mechanical support for plants, nutrients for their growth and acts as a reservoir for the storage of water [1]. Soils also change gradually with time and the characteristics of the soil depend upon environmental conditions. The original and to some extent direct source of all the salt constituents are the primary minerals found in the soil and also in the exposed rocks of the earth's crust. During the process of chemical weathering, which involves hydrolysis, hydration, solution, oxidation and carbonation, these constituents are gradually released and made soluble. The carbon dioxide dissolved in water is an active weathering agent, surface and ground waters being inclusive.

The soils of Northern Nigerian Savannah have inherent low fertility. They are characterized by low activity kaolinic clay, coarse textural surfaces, slightly acidic to basic pH, low levels of soil organic matter and nutrient holding capacity [2]. In order to improve the soils for sustainable agriculture, farmers apply inorganic fertilizers so as to obtain high yield of crops. However, due to high cost of these fertilizers, as a result of reduction of government subsidy on fertilizers coupled with scarcity, most peasant farmers cannot afford to buy or purchase fertilizers [3]. Inorganic fertilizers have harmful effects on soil physical, chemical and biological properties after a long term and improper use [2].This has resulted in low crop yield, yet the poor farmers are not encouraged to use organic residues to increase plant productivity [4].

Soil management is the basis of sustainable agricultural production. In the tropical soils, most soil nutrients required by plants especially nitrogen, potassium, phosphorus, calcium and magnesium are often found deficient at the root zones [5].This trend may not be unconnected with loses due to surface run-off and/or leaching from the upper to the lower soil horizons. Consequently, the bulk of the essential nutrients are either lost or far from the reach of plant roots. This therefore increases the cost of production through the application of amendments.

Typha plants have many common names. The plants are known in British English as bulrush or cumbungi, American English as cattail or corndog grass, in Australia as bulrush or cumbungi and in New Zealand as raupo [6]. The plant is known with different names in Hausa as geranya, gyaranya or kachalla [7].

Rutchey *et al.,* 2008 [8] reported that in Water Conservation Area 2A (WCA-2A), an impounded area within the Northern Everglades, *Typha* expanded from 442 ha to 1979 ha from the years 1991 to 2003. Throughout the United States, many ecosystem including wetlands, are threatened by invasive species [9]. *Typha domingensis* is considered to be a dominant competitor in wetlands, and often exclude other plants with its dense canopy [10]. Owing to its well developed aerenchyma, it is quite resistant to flooding. Even the dead stalks can transmit oxygen to the rooting zone and hence makes its control to be difficult. The most successful and effective strategy appears to be mowing and burning in order to remove the aerenchymous stalks, followed by prolong flooding.

This paper is aimed at determining the effect of organic residue of *Typha domingensis* on some physicochemical properties of soil samples obtained from Abubakar Tafawa Balewa University farm, Gubi/Bauchi, Nigeria after varied treatments (0, 15, 30 and 45 days). The zero (0) day incubation period was the control.

2 EXPERIMENTALS

In the preparation of all solutions, chemicals of analytical reagent grade purity and distilled water were used throughout the research work. All the glass and plastic wares utilized were thoroughly washed with detergent solution, then 20 % (v/v) nitric acid, rinsed with tap water and finally with distilled water [11].

2.1 Sampling of Typha plant:

The sampling of *Typha spp.* was carried out randomly along Kano road in Bauchi, Bauchi State, Nigeria. The samples were collected from ten (10) different points and mixed up in order to ensure sample homogeneity. The plant was identified in the Department of Biological Sciences, Abubakar Tafawa Balewa University, Bauchi, as *Typha domingensis*. The plant was washed with water to get rid of foreign substances from the sampling site. The samples were again weighed, air-dried for sixty (60) days to a constant mass, followed by cutting them into smaller pieces. The rhizomes, stems and leaves were again air-dried for thirty (30) days, ground in a wooden pestle and mortar, sieved to pass through a 2.00 mm mesh so as to obtain the finest possible powder for chemical analyses. The sieved samples were kept in air-tight plastic containers and labeled appropriately prior to analyses. The photograph of *Typha domingensis* obtained in Bauchi is shown in Fig. 1:

Fig. 1: Photograph of *Typha domingensis*
(Source: Hassan, 2016)

2.2 Sampling of Soil Samples

Bulk soil samples were collected randomly at a depth of 0-30 cm using soil auger from the University farm, Gubi/Bauchi. The samples were collected from ten (10) sampling points. These were homogenized, air-dried, ground using a wooden pestle and mortar and finally sieved with a 2.00 mm mesh with the aim of getting rid of the "not-soil and impurities". The sieved soil samples were also labeled appropriately prior to the laboratory analyses.

2.3 Treatments and Experimental Design

The experiment was a complete randomized design consisting of four treatments (0, 15, 30 and 45 days); each replicated three times [4], [12], [13]. A total of twelve plastic pots were used for the experiment. 2.00 kg of the soil sample was weighed into each of the pots. Water was neither added nor the organic residue of *Typha* to the control soil samples (0 day incubation period). 300.00 g of the organic residue of the plant material was added into the remaining nine pots. The set ups were then incubated for 15, 30 and 45 days in the laboratory at 35ºC. During the incubation periods, 100.00 cm^3 of water was added daily into each of the nine pots so as to keep the soil slightly moist. At the end of each incubation period, all the replicated soil samples were collected, thoroughly mixed together, air-dried, ground using a wooden pestle and mortar, then sieved through a 2.00 mm mesh, labeled appropriately and used for chemical analyses.

2.4 Methods

Various standard methods adopted by different researchers were used.

2.4.1 Determination of Soil Texture before Incubation

Soil texture was determined before incubating the organic residue of *Typha domingensis* using the hydrometer method [5], [14].

2.4.2 Determination of Bulk Density

The soil bulk density was determined using the kerosene saturation method adopted by Onwuka, 2005 [15].

2.4.3 Determination of pH

Soil pH was separately determined in aqueous suspension and 0.01 mol/dm^3 calcium chloride solution respectively using a JENWAY pH Meter Model 3510 [13], [16].

2.4.4 Determination of Exchangeable Sodium, Calcium and Magnesium

The exchangeable bases (sodium, calcium and magnesium) were extracted using ammonium ethanoate saturation method and determined at their respective wavelengths using Buck Scientific Atomic Absorption Spectrophotometer Model 210/11 VGP [4], [5], [16].

2.4.5 Determination of Total Exchangeable Acidity (TEA)

The total exchangeable acidity was determined using the method adopted by Molindo, 2008 as well as Davidescu and Davidescu, 1982 [4], [16].

3 STATISTICAL ANALYSES

The data obtained were subjected to single factor analysis of variance [17]. The least significant difference test (LSD) was further used to determine the significant differences ($p \leq 0.05$) that exist between individual mean values for all the parameters that are significantly different.

4 RESULTS AND DISCUSSION

The mean mechanical properties of the soil samples obtained from Abubakar Tafawa Balewa University farm, Gubi/Bauchi are shown in Table 1.

Table 1: Mechanical properties of soil samples before incubating *Typha domingensis*

Parameters	Percentage
Sand	65.84 ± 0.00
Silt	24.56 ± 0.00
Clay	9.60 ± 0.00
Textural Class	Sandy clay loam

Values are mean ± standard error of the mean (n = 4).

The textural class of the soil obtained from the University farm is sandy clay loam. The texture of a soil influences its health or productivity. Thus, soil health impacts directly on plant health. The mechanical properties of the soil samples obtained from the sampling location investigated could be due to low organic matter content. A similar initial soil texture before incubation was also reported [4].

4.1 Variation of Bulk Density with Incubation Periods

The bulk density of soil samples obtained from the University farm, Gubi/Bauchi compared to the varied incubation periods are shown in Table 2. The values obtained ranged from 1.376 to 1.424 g/cm^3, which shows that the values are still low when compared with the critical limit of 1.60 g/cm^3 set for optimum root growth [18], [19].

Table 2: Some nutrients status of University farm, Gubi after varied incubation periods with the organic residue of *Typha domingensis*

Parameters	Incubation Periods (days)			
	0	15	30	45
Bulk Density (g/cm^3)	$1.376^b \pm 0.001$	$1.415^a \pm 0.001$	$1.424^a \pm 0.004$	$1.363^c \pm 0.017$
pH (H_2O)	$7.93^b \pm 0.05$	$8.05^a \pm 0.06$	$8.03^a \pm 0.05$	$8.00^a \pm 0.00$
pH ($CaCl_2$)	$7.73^b \pm 0.05$	$8.05^a \pm 0.06$	$8.10^a \pm 0.00$	$8.08^a \pm 0.05$
Na (cmol/kg)	$0.72^d \pm 0.01$	$0.87^c \pm 0.01$	$1.53^b \pm 0.01$	$1.85^a \pm 0.13$
Ca (cmol/kg)	$7.34^d \pm 0.01$	$39.28^c \pm 0.05$	$41.24^b \pm 0.17$	$43.92^a \pm 0.27$
Mg (cmol/kg)	$1.35^d \pm 0.02$	$5.64^c \pm 0.02$	$6.56^b \pm 0.04$	$7.54^a \pm 0.02$
TEA (cmol/kg)	$0.80^a \pm 0.00$	$0.20^a \pm 0.00$	$0.20^a \pm 0.00$	$0.20^a \pm 0.00$

Values are mean ± standard deviation (n = 4)
TEA = Total exchangeable acidity, values on the same raw with different letters are significantly different as revealed by Single Factor ANOVA, followed by LSD test (p = 0.05).

Generally, the bulk density values at all the incubation periods are lower than the critical limit. This could be due to less compaction by the weight of overlying soil layers. A lower bulk density value was reported to be due to higher organic carbon contents [5]. The incubation of the organic residue of *Typha domingensis* on the soil significantly affected the level of the bulk density at 95.00 % confidence level. The highest increase (1.424 g/cm^3) was observed after 30 days incubation period compared to the control (1.376 g/cm^3) followed by 15 days incubation period (1.415 g/cm^3) as shown in Table 2.

4.2 Variation of pH (H_2O) and pH ($CaCl_2$) with Incubation Periods

The soil pH (H_2O) from the University farm, Gubi ranged from 7.93 (control) to 8.05 (after 15 days incubation period), with 45 and 30 days incubation periods being in between (Table 2). The first, second and third incubation periods (15, 30 and 45 days) as shown in Table 2 were seen to have significantly affected ($p \leq 0.05$) the pH (H_2O) value when compared with the control. This shows that the soil sample from Gubi is still alkaline after incubation.

The pH ($CaCl_2$) of the University farm, Gubi determined ranged from 7.73 to 8.10 with the second incubation period (30 days) being the highest pH value. It is evident that the pH ($CaCl_2$) of Gubi soil in the first, second and third incubation periods significantly ($p \leq 0.05$) affected the pH of the control value (Table 2).

A similar increasing pH trend was also reported by Molindo, 2008 [4] when the pH values increased after 21 and 42 days incubation periods respectively with different organic residues of both plant and animal origins. Abdulhamid and Mustapha, 2009 [13] similarly reported an increasing pH trend from 5.90 to 10.07 with increasing ash concentration from 0.00 to 2.00 % after seven (7) days incubation period. Soil pH is vital as many plants and soil life forms prefer either acidic or alkaline conditions. Some diseases also tend to thrive when the soil is either acidic or alkaline. The pH also affects the availability of nutrients [20].

4.3 Variation of Exchangeable Na, Ca and Mg with Incubation Periods

The concentration of exchangeable sodium in Gubi farm ranged from 0.72 cmol/kg (control) to 1.85 cmol/kg (third incubation) as shown in Table 2. The results revealed that the value in the third incubation period (45 days) significantly influenced ($p \leq 0.05$) all the values in the other incubation periods as revealed by Single Factor ANOVA and LSD ($p \leq 0.05$).

The levels of the other exchangeable bases (Ca and Mg) in Gubi farm are shown in Table 2. The concentration of calcium as determined in Gubi farm ranged from 7.34 cmol (+) /kg (control) to 43.92 cmol (+)/kg (45 days incubation period). The result as shown in Table 2 revealed that exchangeable calcium was significantly ($p \leq 0.05$) influenced by the organic residue of *Typha domingensis* at all the incubation periods tested. A similar trend was also reported by Molindo, 2008 [4].

Magnesium concentration in Gubi farm ranged from 1.35 (control) to 7.54 cmol

(+)/kg (45 days) as indicated in Table 2. It can be seen from the Table that the concentration of magnesium in the third incubation period (45 days) significantly ($p \leq 0.05$) influenced the levels of magnesium in all the other incubation periods. A similar trend was equally reported by Abdulhamid and Mustapha, 2009 [13].

The critical limits of the exchangeable bases in soil in cmol (+) /kg were reported and rated respectively as low (less than 0.10), medium (0.10 - 0.30) and high (greater than 0.30) for sodium; low (less than 2.00), medium (2.00 - 5.00) and high (greater than 5.00) for calcium and low (less than 0.30), medium (0.30 - 1.00) and high (greater than 1.00) for magnesium [21]. Based on the present study, all the exchangeable bases determined varied widely from low to high.

4.4 Variation of Total Exchangeable Acidity with Incubation Periods

The total exchangeable acidity of Gubi farm determined ranged from 0.20 cmol/kg (values determined for the first, second and third incubation periods) to 0.80 cmol/kg (control) as depicted in Table 2. This therefore showed that incubating the organic residue of *Typha domingensis* in Gubi soil sample have a decreasing effect on the total exchangeable acidity. Bhattacharya, 2013 [20] reported that in some regions of the world, when the soil is dominated by calcium ion, total exchangeable acidity (hydrogen ion and aluminium ion) is present only in small concentrations. This could therefore be the reason why total exchangeable acidity as determined decreased with increase in incubation period.

Soils are classified based on their total exchangeable acidity (cmol/kg) of less than 2.00, 2.00 - 5.00 and greater than 5.00 as low, medium and high respectively [21]. All the soil samples investigated are therefore low in terms of total exchangeable acidity.

5 CONCLUSION

Typha domingensis significantly affected ($p \leq 0.05$) the levels of bulk density, pH (H_2O), pH ($CaCl_2$), exchangeable sodium, calcium and magnesium respectively of the soil sample obtained from the University farm, Gubi. The plant sample was however found not to have positively influenced the total exchangeable acidity. These therefore suggest that the weed is a potential source of the exchangeable bases (sodium, calcium and magnesium) determined.

REFERENCES

[1] A.K. Chakravarty, *Investigatory projects in Chemistry*, Tata McGraw-Hill Publishing Company, pp. 35-80, 1983.

[2] E.Y. Oyinlola, "Effect of Millet Thresh Waste and N-levels on Growth and Dry Matter Yield of Tomato", *ChemClass Journal*, vol. 4, pp. 147-153, 2009.

[3] J.A. Adediran, M.O. Akande, L.B. Taiwo and R.A. Sobulo, Proceedings of Soil Science Society of Nigeria, pp. 91-95, 1990.

[4] W.A. Molindo, "Determination of the Nutrient Status of Soil after Incubation with Organic Residues for Different Days in Benin City, Nigeria", *World Journal of Agricultural Science,* vol. 4, no. 6, pp. 731-736, 2008.

[5] J. Kolo, S. Mustapha and N. Voncir, "Profile Distribution of Some Physicochemical Properties of Haplustults in Gaba District, Central Nigeria", *Journal of League of Researchers in Nigeria,* vol. 10, no. 1, pp. 71-77, 2009.

[6] S.M. Selbo and A.A. Snow, "The Potential for Hybridization between *Typha angustifolia* and *Typha latifolia* in a Constructed Wetland", *Aquatic Biology*, vol. 78, pp. 361-369, 2004.

[7] E.C. Agishi and Y. Shehu, Hausa, Fulfulde and Scientific Names of Plants, *Agitab Publishers Ltd*, pp.32-142, 2004.

[8] K. Rutchey, T. Shall and F. Sklar, Development of Vegetation Maps for Assessing Everglades Restoration Progress, *Wetlands*, vol. 28, pp. 806-816, 2008.

[9] S.M. Galatowitsch, N.O. Anderson, and P.D. Ascher, Inversiveness in Wetland Plants in Temperate North America, *Wetlands*, vol. 19, pp. 733-755, 1999.

[10] R.M. Kaminski, H.M. Murkin and C.E. Smith, ''Control of Cattail and Bulrush by Cutting and Flooding in Coastal Wetland", *Lewis Publishers,* pp.58-61, 1985.

[11] U.F. Hassan, H. Baba, M.A. Shibdawa, A.A. Mahmoud and J. Ishaku, Assessment of Feed Quality Efficiency of *Moringa oleifera* seeds, *Journal of Chemical Society of Nigeria,* vol. 38, no. 2, pp. 70 – 73, 2013.

[12] J. Mendham, R.C. Denney, J.D. Barnes, and M.J. Thomas, "Vogel's Textbook of Quantitative Analysis" 6th Ed., *Pearson Education* Ltd., pp. 300-347, 2000.

[13] N.A. Abdulhamid and S. Mustapha, "Influence of Agricultural Wood Ash on Some Physicochemical Properties of Sandy Loam Soils at Maiduguri, Nigeria", *Journal of League of Researchers in Nigeria,* vol. 10, no. 1**,** pp. 84-88, 2009.

[14] A.I. Zata, I.E. Vahyala, I.S. Dzarma and H. Mohammed, "Assessment of Land Degradation in Some Ustalfs of Federal University of Technology, Yola", *Agricultural Business and Technology* Journal, vol. **7**, pp. 46-52, 2009.

[15] G.I. Onwuka, "Food Analysis and Instrumentation, Theory and Practice", *Naphthali* prints, pp.133 – 135, 2005.

[16] D. Davidescu and V. Davidescu, "Evaluation of Fertility by Plant and Soil Analysis", *Abacus Press,* pp. 387-487, 1982.

[17] D.A. Skoog, D.M. West, F.J. Holder and S.R. Crouch, "Fundamentals of Analytical Chemistry", 8th Ed., Thomson Asia Ltd., Singapore, pp. 160-167, 2004.

[18] R.L. Donahue, R.M. Miller and J.C. Shickluna, "An Introduction to Soil and Plant Growth", *Prentice-Hall of India*, pp. 57-58, 1990.

[19] National Soil Service Centre (NSSC), Soil Survey Information Manual, Soil Survey Report, No. 45, May Version, p. 305, 1995.

[20] L. Bhattacharya, "Textbook of Soil Chemistry", *Discovery Publ. House,* pp.10-119, 2013.

[21] T. Kparmwang, A.S. Abubakar, V.O. Chude, B.A. Raji and W.B. Malgwi, 1998, The Inherent Fertility and Management of the Micropographical land features of the River Galma Fadama at Zaria In: J. Kolo, S. Mustapha and N. Voncir, "Profile Distribution of Some Physicochemical Properties of Haplustults in Gaba District, Central Nigeria", *Journal of League of Researchers in Nigeria*, vol. 10, no. 1, pp. 71-77, 2009.