POTENTIAL OF ORGANIC RESIDUE OF *Typha domingensis* IN ENHANCING CATION EXCHANGE CAPACITY AND MICRONUTRIENTS OF UNIVERSITY FARM, GUBI-BAUCHI, NIGERIA

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ABSTRACT: The organic residue of *Typha domingensis* was incubated at varied incubation periods (0, 15, 30 and 45 days) into soil samples obtained from the Abubakar Tafawa Balewa University farm, Gubi-Bauchi, Nigeria in order to determine the potential of the organic residue of the invasive *Typha domingensis* in enhancing cation exchange capacity (CEC) and the extractable micronutrients of the soil samples. A Complete Randomized Design was used. The control soil sample (0 day incubation period) was neither added water nor the organic residue of the noxious plant. Each treatment was replicated three times and contains 2.00 kg of the soil sample incubated at 35^0C with 300.00 g of the organic residue of *Typha domingensis*. The mixtures in the 15, 30 and 45 days treatments were each added 100.00 cm^3 of water daily. At the end of each incubation period, soil samples were taken from the treatments and analyzed for cation exchange capacity (CEC) and the extractable micronutrients (Cu, Fe, Mn and Zn) using standard methods. Results obtained indicated that application of the organic residue of the plant enhanced the CEC value of the soil from 8.60 (control) to a maximum value of 15.43 cmol/kg (45 days incubation period). The levels of copper, iron, manganese and zinc (extractable micronutrients) were found to be in the range of 0.20 (control) to 0.43 (45 days), 4.85 (control) to 51.04 (45 days), 25.00 (control) to 56.08 (45 days) and 21.00 (control) to 43.00 mg/kg (45 days) respectively. The CEC and all the extractable micronutrients were separately found to be significantly different ($p \leq 0.05$) from the control based on Single Factor Analysis of Variance and Tukey pair-wise differences. It is therefore recommended that the organic residue of the invasive plant can be used to enhance the CEC and micronutrients of the soil samples investigated.

Key words: *Typha domingensis*, Complete Randomized Design, Soil, Organic Residue, Extractable Micronutrients, Invasive, Noxious and Cation Exchange Capacity.

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1 INTRODUCTION

In soil science, cation exchange capacity is used as a measure of fertility, nutrient retention capacity and the capacity to protect groundwater from cation contamination [1]. A naturally fertile soil is therefore one that has the correct proportions of sand and clay particles, adequate humus and mineral salts, good crumb structure, well drained and aerated and is neutral or slightly alkaline [2], [3]. Zinc, copper, manganese and iron are micronutrients that are required by plants in very small amounts. Most secondary and micro-nutrients deficiencies are easily corrected by keeping the soil at optimum pH value [1]. Mineral salts include salts of potassium, iron, magnesium, phosphates, sulphates and nitrates. They are present in solution in soil water. They usually come from the soil particles and from the breakdown of dead organic matter by decomposers in the soil. Mineral salts are absorbed by the roots of plants and used to build up cell material [2]. Mineral salts, also known as nutrients for healthy plant growth are divided into three categories namely the primary, secondary and micronutrients [1].

The Hadeja-Nguru wetland (HNW) is an important wetland that supports about one and a half million (1.5 million) farmers and fishermen. Most important crops that are grown are rice, pepper and wheat. Uncultivated areas are used as cattle pasture. The flooded area continuously declined from an area of 2000 km^2 in 1964 to less than 300 km^2 in the draught year of 1984. The decline in the flooded area was as a result of colonization of the invasive *Typha spp* [4].*Typha domingensis* has three reproductive strategies, dominance of local habitats by colonial growth, survival of long inhospitable periods with buried seeds and dispersal to new sites with wind-dispersed seeds [5].

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].

The aim of this study is to estimate the potential of the organic residue of invasive *Typha domingensis* in enhancing cation exchange capacity (CEC) and the micronutrients (Cu, Fe, Mn and Zn) of the soil samples obtained from Abubakar Tafawa Balewa University farm, Gubi-Bauchi, Nigeria after varying the incubation periods at 0, 15, 30 and 45 days.

2 MATERIALS AND METHODS

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 [8].

2.1 Soil Sampling and Handling

Bulk soil samples were randomly collected from the top 0-30 cm using soil auger from the Abubakar Tafawa Balewa University farm, Gubi-Bauchi, Nigeria.

The sampling of *Typha spp.* was also carried out randomly along Kano road, Bauchi, Nigeria. The plant was identified in the Department of Biological Sciences, Abubakar Tafawa Balewa University, Bauchi as *Typha domingensis*. The *Typha domingensis* was washed with water in order to get rid of extraneous substances from the sampling location. The photograph of *Typha domingensis* is shown in Figure 1:

Fig. 1: Photograph of *Typha domingensis* plant

The soil samples and plant material were separately air-dried and ground using wooden pestle and mortar. The ground soil samples and plant samples were separately passed through a 2.00 mm sieve to get rid of the "not soil" and impurities respectively. The sieved samples were appropriately labeled prior to the laboratory analyses.

2.2 Treatments and Experimental Design

The experiment was a complete randomized design with three replications and four treatments (incubation periods of 0, 15, 30 and 45 days). The zero incubation day (control soil sample) was neither added water nor the organic residue of the invasive *Typha domingensis*. The control only contains 2.00 kg of the soil sample replicated three times. 300.00 g of the organic residue of *Typha domingensis* was each added to 2.00 kg of the soil sample in the remaining nine pots and incubated at 35^0 C for 15, 30 and 45 days. During the incubation period, 100.00 cm^3 of water was added daily into the nine pots in the remaining three treatments so as to keep the soil slightly moist. At the end of each incubation period, all the replicated soil samples from a particular treatment 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 [9], [10], [11].

2.3 Laboratory Analyses

Some physicochemical properties of the soil at varied incubation periods (days) of 0 (soil sample only), 15, 30 and 45 were analyzed. Four replicate laboratory analyses were carried out in each case using various standard methods adopted by different researchers. Particle size distribution was determined before incubation by the hydrometer method [12], [13]. Cation exchange capacity was determined at a pH of 7 using ammonium ethanoate saturation method [12]. Extractable micronutrients (Cu, Fe, Mn and Zn) were extracted using 0.10 N hydrochloric acid and determined at their respective wavelengths using the BUCK Scientific Atomic Absorption Spectrophotometer Model 210/11 VGP [10], [14].

3 DATA ANALYSES

The results of the research work were subjected to Single Factor Analysis of Variance [15]. The data analyses revealed that there was significant difference ($p \leq 0.05$) in all the parameters determined and the treatment means that were significantly different were separated using the Tukey pair-wise differences as indicated in Tables 2-6.

4 RESULTS AND DISCUSSION

The mean mechanical properties of the soil samples obtained from the 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 deviation (n = 4).

The textural class of the soil obtained from the University farm is sandy clay loam. The texture of a soil influences its productivity or health. Therefore, soil health impacts directly on plant health. The mechanical properties of the soil samples obtained from the sampling frame investigated may be due to low organic matter content. A similar soil texture before incubation was also reported [10].

4.1 Cation Exchange Capacity (CEC)

The levels of cation exchange capacity (CEC) of University farm, Gubi as shown in Figure 2 ranged from 8.60 cmol/kg (control) to 15.43 cmol/kg (45 days incubation). The high cation exchange capacity value may be due to high buffering capacity, which implies that crops will benefit much from the applied nutrients and this will in turn increase crop yield. Incubating all the soil samples investigated has therefore enhanced their CEC values at varied incubation periods. A soil with a cation exchange capacity value of less than 6.00, 6.00 - 12.00 and greater than 12.00 cmol (+)/kg is considered to be low, medium and high respectively [16].

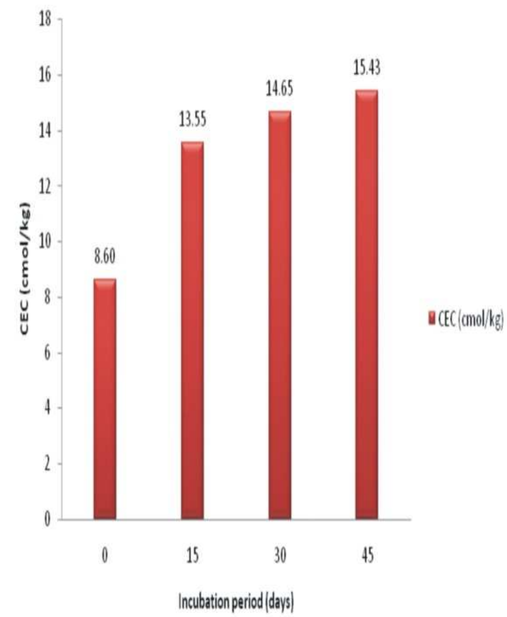

Fig. 2: Variation of cation exchange capacity content of the University farm, Gubi with incubation periods

It can be seen from Table 2 that the value at the third incubation period (45 days) has significantly affected ($p \leq 0.05$) the concentration of the cation exchange capacity when compared with the values in the second, first and control incubation periods. The values in the second and first incubation periods similarly influenced the level of the cation exchange capacity in the control.

Table 2: Tukey pair-wise differences of cation exchange capacity (CEC) content of University farm, Gubi-Bauchi (n = 4, q critical = 4.20)

	TI: 15.43	SI: 14.65	FI: 13.55	C: 8.60
TI: 15.43		10.40	25.06	91.40
SI: 14.65			14.66	80.66
FI: 13.55				65.98

C = Control (0 day), FI = First incubation period (15 days), SI = Second incubation period (30 days), TI = Third incubation period (45 days) and q critical = Tukey pair-wise critical value.

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4.2 Extractable Micronutrients

The levels (mg/kg) of copper, iron, manganese and zinc in Gubi farm as shown in Figures 3, 4, 5 and 6 ranged from 0.20 (control) to 0.43 (45 days), 4.85 (control) to 51.04 (45 days), 25.00 (control) to 56.08 (45 days) and 21.00 (control) to 43.00 (45 days) respectively. A more or less similar trend was also reported [11]. In soil chemistry, the trace elements determined are generally referred to as extractable micronutrients (Cu, Fe, Mn and Zn).

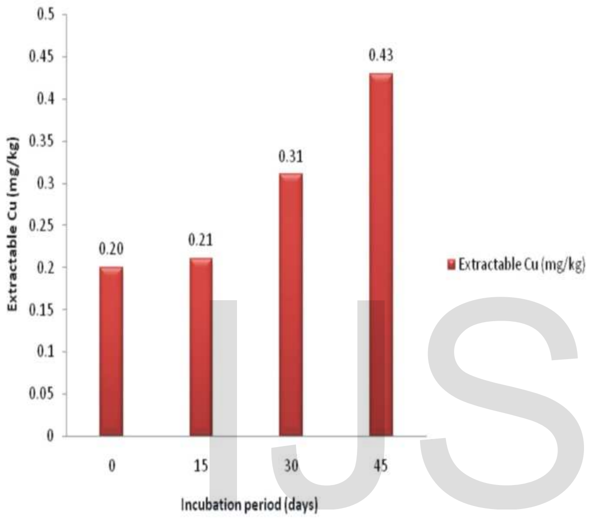

Fig. 3: Variation of extractable copper content of the University farm, Gubi with incubation periods

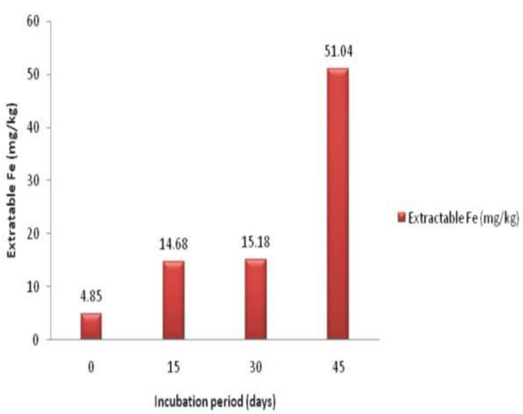

Fig. 4: Variation of extractable iron content of the University farm, Gubi with incubation periods

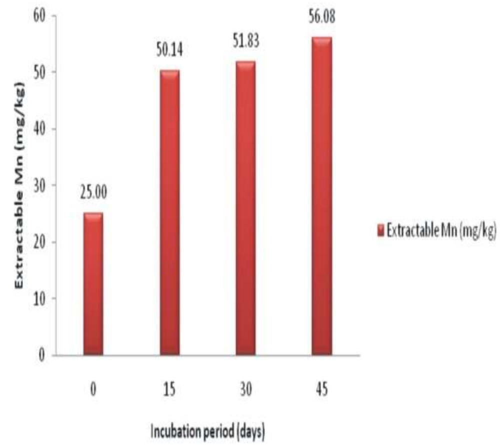

Fig. 5: Variation of extractable manganese content of the University farm, Gubi with incubation periods

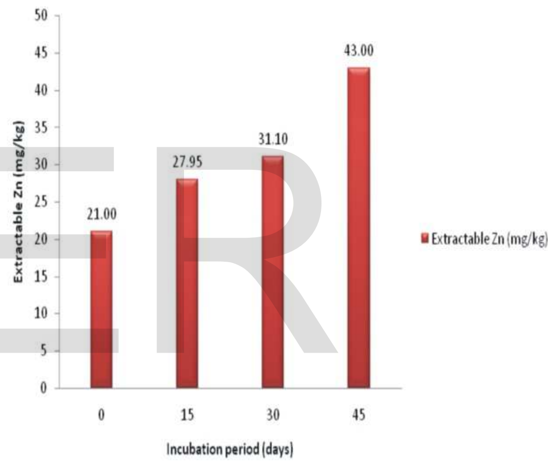

Fig. 6: Variation of extractable zinc content of the University farm, Gubi with incubation periods

The variations could be due to different buffering capacities. Buffering capacity has been defined as the rate in which some nutrients or elements are converted from a bound to a soluble state [14]. Although, the extractable micronutrients are only needed by plants and animals in very small amounts, they are nonetheless essential for the healthy growth of plants [1].

It is therefore evident from Tables 3, 4, 5 and 6 that the concentrations of copper, iron, manganese and zinc in the third incubation periods significantly and respectively affected ($p \leq 0.05$) all the micronutrient values obtained at the control. Increasing the number of incubation periods therefore produced all the extractable micronutrients that are statistically significant with the control values.

Table 3: Tukey pair-wise differences of Extractable Copper content of University farm, Gubi-Bauchi (n = 4, q critical = 4.20)

	TI: 0.43	SI: 0.31	FI: 0.21	C: 0.20
TI: 0.43		13.90	25.49	26.65
SI: 0.31			11.59	12.75

Table 4: Tukey pair-wise differences of Extractable Iron content of University farm, Gubi-Bauchi (n = 4, q critical = 4.20)

	TI: 51.04	SI: 15.18	FI: 14.68	C: 4.85
TI: 51.04		358.60	363.60	461.90
SI: 15.18			5.00	103.30
FI: 14.68				98.30

Table 5: Tukey pair-wise differences of Extractable Manganese content of University farm, Gubi-Bauchi (n = 4, q critical = 4.20)

	TI: 51.08	SI: 51.83	FI: 50.14	C: 25.00
TI: 51.08		63.37	88.57	463.40
SI: 51.83			25.20	400.04
FI: 50.14				374.84

Table 6: Tukey pair-wise differences of Extractable Zinc content of University farm, Gubi-Bauchi (n = 4, q critical = 4.20)

	TI: 43.00	SI: 31.10	FI: 27.95	C: 21.00
TI: 43.00		25.23	31.91	46.64
SI: 31.10			6.68	21.41
FI: 27.95				14.73

5 CONCLUSION

Results of this study indicated that addition of the organic residue of *Typha domingensis* at and above the first incubation period strongly enhanced the cation exchange capacity (CEC) of the soil samples. The results further suggests that the organic residue of the noxious plant is a potential source of extractable micronutrients (Cu, Fe, Mn and Zn) as it significantly enhanced the levels of the micronutrients in the soil samples at all the incubation periods tested.

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