Original Research Article

MOUND DISTRIBUTION AND SOIL TRANSFORMATION BY *MACROTERMES BELLICOSUS* IN BAGUDO AND AUGIE IN KEBBI STATE, NIGERIA.

ABSTRACT

The study was carried out to determine the distribution and soil transformation by *Macrotermes bellicosus* species. Two local government areas of Kebbi State namely; Bagudo and Augie were selected for the study. Field survey and proximate analysis was used for the study, data generated were analysed using descriptive (Means) and inferential (ANOVA) statistics. Mounds were manually counted; where distance, height and basal circumferences were measured using measuring tape. Results obtained showed mound size was significantly different ($P<0.05$) among the study area. Physical characteristics of mounds such as distance, basal circumference, height: were also significantly different ($P<0.05$) in all the locations. Dry land and wet land showed no significant ($P>0.05$) difference exhibited in physical characteristics. Results indicated significant ($P<0.05$) difference in Cation exchange capacity (C.E.C), sand, silt, and clay, and all mineral elements in study locations. Mound soils differed: ($P<0.05$) significantly in Cation exchange capacity (C.E.C), sand, silt, and clay and all the elements in study locations: In conclusion, termites: can be considered to be cheap agents of soil amendments which can help farmers in improving soil fertility.

Key words: Mounds, *Macrotermes bellicosus*, Physical characteristics, minerals, Abundance, distribution and soil transformation.

INTRODUCTION

Termites are social land dwelling insects, cosmopolitan and they are mainly found in tropical and sub-tropical areas [1]. Termites are usually small, measuring between 4 to 15 millimeters (0.16 to 0.59 inches) in length [2]. Through the activities of nesting and foraging, termites considerably modify the structure of the soil surface horizon; by enriching it with clay, increase its infiltration capacities and thus promote microbial metabolism and nutrient availability to woody plants. Similarly, improve in rain water infiltration, tunnels in soil allow rain water to soak in deeply and help to reduce runoff and subsequent soil erosion through bioturbation [3].

Thus, the nest building activities inevitably influence soil functions and processes and preserves soil and ecosystem diversity [4]; [5]; [6]. They promote modification and redistribution of soil materials [6]. [7], reported that due to the digging of termites and their decomposition of plant material, mound soils are generally more fertile than other soil. [8], also said that mound soils have been found to contain more water than the surrounding soils, a clear advantage for plant growth in savannahs. [5], observed mound soils to contain higher content of phosphorus and organic matter than the surrounding soils. The author also in his study collected soil samples from top, middle and bottom of termite mounds and that of adjacent areas and observed a greater content of potassium, phosphorus, calcium, magnesium, organic carbon and lower pH value in the inner part of termite mounds in relation to adjacent soils of the area. [5], reported that, organic matter decomposition and nutrient cycling are highly influenced by termites. Their mounds posed problems to farming activities in the study area, thereby reduce land mass for crop cultivation.

Termites' mounds can be beneficial to agriculture, such as boosting crop yield and enriching the soil. The presence of mounds in the field enables large amount of rain water to soak into the ground and increase the amount of nitrogen in the soil, both essential for the growth of crops [9]. [5], reported that, termites modify the structure of the soil surface; they enrich the soil and also promote microbial metabolism and nutrient availability to plants.

MATERIALS AND METHODS

A survey research was conducted in some selected local Governments areas of Kebbi State, particularly at Bagudo and Augie. The areas were purposefully selected because of the population and widespread of mounds across each landscape in the study area. Kebbi State is located in north-western Nigeria and is bordered by Sokoto State, Zamfara State, Niger State. Kebbi State lies between 10^0 8’ and 13^0 15’N latitude; 3^0 30’ and 6^0 2’E longitude [10]; [11]. The elevation of the study area is between 250 and 350 meters above sea level. The soils in the areas are categorizes as reddish brown or brown soils of the semi-arid and arid regions. The soil pH values range at 6.0 to 7.0 with a bulk density 1.4 g/cm^3 [12].

The vegetation consists of Northern Savannah, that experience low rainfall of usually less than 1000mm and the prolonged dry season (6-9 months) sustains fewer trees and shorter grasses of about 1.5 - 2m and few stunted trees hardly above 15m. The vegetation has undergone severe destruction in the process of clearing land for the cultivation of important economic crops such as cotton, millet, sorghum, cowpea, and maize [13]. The areas have an average temperature of 18.3^0C with a rainy season from May to October during which showers occur. From late October to February as the cold season, the climate dominated by the Harmattan wind blowing Sahara dust over the land [14].

A simple random sampling technique was used to select mounds between the months of April, 2015 to June, 2016 in the study area. The selected local governments areas were; Bagudo and Augie. In each Local Government area six (6) sample plots measuring 500/20 m/sq were selected, (three plots both from dry and wet land). Termite mounds were surveyed by transect walk by foot, in each of the sample plot and abundance was observed by counting their numbers in each plot, while distance, height and basal circumference were determined by measuring with a tape.

Soil samples were collected for chemical analyses; two plots each from both dry land and wet lands. During soil sampling; soil samples from the mounds were collected. In collecting samples, exposed parts of mounds were scraped off and 1.0 Kg of soil samples from each point was collected separately. Collected soil samples were sun-dried, ground, sieved through 2.0 mm sieve. They were then packaged into bags separately and labeled accordingly, taken to the Soil Science Laboratory of the Faculty of Agriculture Usmanu Danfodiyo University Sokoto for the analyses, a proximate analysis was used to determine the nutrients composition of soil samples using standard methods [15].

The data generated from field survey and proximate analysis was analyzed using descriptive (means) and inferential statistics (ANOVA).

RESULTS

From the results of mound distribution in the dry land Bagudo was observed to record number of mounds than Augie as follows 49 and 23 in dry land respectively (Table 1). While in wet land Bagudo recorded higher number of mounds (38) compared with Augie (21). The circumference results reveal that Bagudo dry land recorded higher circumference of 599.95. Bagudo was observed to have 355.81, as circumference in the wet land when compared with Augie that have 263.37 as the circumference. These could be attributed to the fact that Bagudo area lies closely to the guinea savannah while Augie was closely to Niger Republic and it is semi-arid area

The physical characteristics of mounds within the locations and land types in the study area are shown on table 2. The measured physical characteristics were distance, height and basal circumference. There was no significant (P>0.05) difference in terms of distance in all land type in the locations. Height and basal circumference of the mounds for all the land type in all locations followed the same pattern with distance. For distance Bagudo and Augie recorded similar results with average means as follows; 4.33 and 4.22 on dry land respectively. In wet land the highest mean average of distance was recorded in Bagudo with mean average of 4.56 and Augie with mean averages of 3.78.

Mineral elements, calcium, magnesium, potassium, sodium, phosphorus, zinc, copper and iron studied in both dry and wet land in table 3. Calcium was significantly ($P<0.05$) higher in Bagudo compared to Augie with mean average as thus, 0.850 and 0.585 in dry land respectively. Phosphorus recorded significantly ($P<0.05$) higher mean average in Augie than Bagudo at both the condition (dry and wet land).

Soil pH, organic carbon, organic matter, Nitrogen, Cation Exchange Capacity, sand, silt, and clay in the soil of the selected land type and locations are shown on table 4. Soil pH significantly ($P<0.05$) differed in all the locations of the study. In dry land Bagudo was observed to be significantly ($P<0.05$) differ in pH value than found in Augie which were as follows; 7.70 and 6.65 per cent respectively. While in wet land Bagudo was observed to have higher ($P<0.05$) pH value, followed by Augie, Similarly in dry land organic matter was found to differ ($P<0.05$) in all locations. While in wet land the highest ($P<0.05$) mean average of organic matter was observed in Bagudo and the least ($P>0.05$) was found in Augie. Nitrogen percentage in dry land was observed to be higher ($P<0.05$) in Bagudo compared to Augie, whereby in wet land the maximum ($P<0.05$) content of nitrogen was observed in Bagudo and the minimum was found in Augie.

Table 1: Mound distribution and sizes in selected locations of the study

Location	land type	Number of mounds	Circumference (m)

Augie:	Dry land	23	283.23
	Wet land	21	263.37
Bagudo:	Dry land	49	599.95
	Wet land	38	387.56

Table 2: Physical characteristics of mounds in dry and wet lands in the study area

		Physical characteristics of mounds		
Location	Land type	Distance (m)	Height (m)	Basal circumference (m)
Augie	Dry land	4.22 ± 0.36	2.67 ± 0.42	4.22 ± 0.36
Augie	Wet land	3.78 ±0.31	2.44 ± 0.39	3.78 ± 0.31
Bagudo	Dry land	4.33 ± 0.38	3.67 ± 0.68	6.00 ± 0.59
Bagudo	Wet land	4.56 ± 0.40	3.22 ± 0.49	4.56 ± 0.40

Table 3: Mineral elements of mound soils in dry and wet lands in the study locations

		Nutrient elements of mound soil							
Location	land type	Ca	Mg	K	Na	P	Zn	Cu	Fe
Augie	Dry land	0.585 ±0.006^{b}	1.308 ±0.014^{a}	1.118 ±0.005^{a}	0.615 ±0.01^{b}	1.038 ±0.002^{a}	0.019 ±0.009^{c}	0.053 ±0.015	22.158 ±0.45
Augie	Wet land	0.958 ±0.002^{a}	0.386 ±0.02^{b}	1.558 ±0.026^{a}	0.618 ±0.01^{b}	0.965 ±0.004^{a}	0.057 ±0.02^{ab}	0.093 ±0.017	15.334 ±0.95
Bagudo	Dry land	0.850 ±0.006^{a}	0.350 ±0.02^{b}	1.858 ±0.041^{a}	1.132 ±0.006^{a}	0.912 ±0.004^{a}	0.026 ±0.01^{c}	0.117 ±0.018	22.308 ±1.47
Bagudo	Wet land	0.833 ±0.007^{a}	0.458 ±0.02^{b}	1.780 ±0.06^{a}	1.180 ±0.005^{a}	0.911 ±0.005^{a}	0.076 ±0.02^{a}	0.125 ±0.019	17.773 ±1.13

Means along the same column with similar superscripts are not significantly ($P>0.05$) different from each other.

Table 4: Physico-chemical properties of dry and wet lands in mound soils in the study area

		Chemical properties							
Location	Land type	pH	Organic. c	Organic. m	Nitrogen	C.E.C	Sand %	Silt %	Clay %
Augie	Dry land	6.79 ±0.33^{b}	0.546 ±0.016^{b}	0.929 ±0.019^{c}	0.052 ±0.015^{b}	6.70 ±0.34^{b}	83.97 ±6.23^{a}	6.90 ±0.36c	8.80 ±0.49^{c}
Augie	Wet land	6.65 ±0.34^{a}	0.566 ±0.015^{a}	0.730 ±0.010^{a}	0.047 ±0.014^{c}	6.57 ±0.33^{b}	84.62 ±6.28^{a}	6.58 ±0.34^{c}	8.80 ±0.49^{c}

Bagudo	Dry land	7.70 ± 0.41^{a}	0.516 ± 0.017^{a}	0.460 ± 0.018^{c}	0.069 ± 0.016^{a}	6.60 ± 0.33^{bc}	73.52 ± 5.41^{b}	16.68 ± 1.05^{c}	9.80 ± 0.56^{b}
Bagudo	Wet land	6.90 ± 0.37^{a}	0.609 ± 0.014^{ab}	0.540 ± 0.016^{b}	$0.0670.016^{b}$	7.58 ± 0.40^{a}	76.95 ± 5.68^{b}	11.25 ± 0.66^{c}	11.80 ± 0.70^{b}

Means along the same column with similar superscripts are not significantly (P>0.05) different from each other.

Discussions and conclusion

Macrotermes bellicosus are found everywhere and have many mounds in the study area. Their abundance may be due to the fact that they are tropical insects and vegetation and climatic condition favours their activities. This was in agreement with [16], who reported that termite species are abundant in the tropics. [17], also reported the abundance of mounds as due to soil type and vegetation. The observation was in conformity with [18], who reported 3-10 mounds per hectare (ha^{-1}) for *Macrotermes bellicosus* species and termites' diversity is high in Africa. Dry land was observed to have more mounds than wet land. This could be attributed to the fact that dry land has less moisture content unlike wet land that contains high moisture content which tends to or may hinder their activities and moisture also destroys their food, while dry land promotes more foraging activities.

Physical characteristics of mounds, such as basal circumference, height and distance in dry and wet lands varied in size and height in locations of the study which could be attributed to the nature of the soil, land type and climatic conditions in the area. These findings were in agreement with that of [19]; [20], whose reported that mounds have elaborate and distinctive forms; termite builds tall, wedge-shaped mounds with long axis in different locations. Dry land was observed to record higher pH value compared to wet land, while termite mounds and the surrounding soils were observed to record varying pH value. Mound soils observed in different locations during the study showed higher pH value. This may be due to termite waste and saliva secretion which affect acidity and alkaline of mound soil. [21], reported that termite mounds with higher pH value which could be related to accumulation of calcium carbonate. Nitrogen percentage in study locations differed according to land type (dry land and wet land)

and also mound soils. This could be attributed to termite wastes accumulation in mound soils. [22], reported no significant difference in the percentage of nitrogen in mounds soils.

It was also observed that the percentage of organic carbon (O.C) in all the locations of the study differed (dry land, wet land) mound soils. In land type higher organic matter was observed in the wet land than in the dry land and this could be attributed to the deposit of materials by rain water unlike than in the dry land. Mound soils were observed to have more organic matter than surrounding soils. This could be due to the fact that termites mixed sand with feaces, saliva and residues of food which contributed in making mounds richer. This was similar to [21]; [17], whose reported that when comparing mound soils with the surrounding soils, the difference between them may not vary wide. Sand, clay and silt particles as well as Cation Exchange Capacity were found to differ according to the locations and land type. This was in agreement with [23]; [21], reported that termite mounds have finer particles. Calcium (Ca), Magnesium (Mg) Potassium (K) and Sodium (Na), in all the locations and land type differed significantly. Dry land contained more calcium compared to wet land, while Mg, K and Na were higher in wet land than dry land. This may be due to less moisture of the dry land compared to wet land. This was similar to [22], who reported that termite activities significantly increased cation, micro-nutrients, and organic matter content. There was no difference in Phosphorus (P), Zinc (Zn), Copper (Cu) and Iron (Fe) both in dry land and wet land in mound soils. This was in conformity with [17]; [21], who reported that the result of phosphorus and mineral elements in mound soil was higher. [22], reported that termite activities significantly increased exchangeable bases, cations, micro- nutrients, organic matter content and also pH value.

The study concludes that termites are abundantly distributed in the location of the study and their mounds have good compositions of nutrient elements, which may promote agricultural activities such as soil aeration and water filtrations. They can be considered to be cheap agents of soil amendments which can help farmers in improving soil fertility.

AUTHORS' CONTRIBUTION

The research work was carried out in colorations with all Authors. Authors S H A designed the study, managed the literature searchers and wrote the protocol and the first draft of the manuscript. Authors HMB, MMY and AA finished the design, protocol and check the draft report. All Authors read and approved the final manuscripts.

Competing interests

All Authors have declared that no competing interests exist.

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